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Remedial Design Work Plan for Interim Remedies at Lawrence Livermore National Laboratory Site 300

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October 2001

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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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Executive Summary

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 is located in the eastern Altamont Hills, 17 miles east of Livermore, California. At Site 300, DOE conducts research, development, and testing associated with high-explosive materials. A number of contaminants were released to the environment during past Site 300 operations. These releases occurred primarily from spills, 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. The contaminants of concern at Site 300 include volatile organic compounds (VOCs), high-explosive compounds, perchlorate, tritium, depleted uranium, nitrate, polychlorinated biphenyls (PCBs), dioxins, furans, silicone-based oils, and metals.

DOE began environmental restoration activities at Site 300 in 1981, and the site was placed on the U.S. Environmental Protection Agency National Priorities List in 1990. An Interim Site-Wide Record of Decision (ROD) for Site 300 was signed in February 2001. This ROD was designated as interim to ensure remediation activities commence while additional testing and evaluation of cleanup technologies occurs and final ground water cleanup standards are negotiated. The following areas at Site 300 were not included in the Interim Site-Wide ROD and are not discussed in this work plan: (1) the General Services Area operable unit, currently being remediated under a Final ROD, (2) the Pit 3, 5, and 7 Landfills, collectively designated the Pit 7 Landfill Complex, that will be addressed in a future, area-specific Remedial Investigation/Feasibility Study, and (3) Building 865 (the Advanced Test Accelerator), Building 812, and the former Sandia Test Site release sites where additional characterization is underway or planned.

This Remedial Design Work Plan presents the overall plan and schedule for implementing the remedies selected in the Interim Site-Wide ROD. These remedies include ground water and soil vapor extraction and treatment, monitored natural attenuation, soil excavation, risk and hazard management, and monitoring.

The overall DOE/LLNL remedial design philosophy is to achieve a rapid, efficient, and cost-effective cleanup within budgetary constraints and in compliance with regulatory requirements. The selected interim remedies will be implemented in phases using a prioritized, risk-based approach to: (1) evaluate and optimize remedial systems before deploying subsequent phases, (2) take advantage of new technologies as they become available, and (3) be consistent with available funding.

Where ground water extraction and treatment are the part of the selected remedy, wellfields will be dynamically managed to optimize and expedite cleanup. Extracted ground water will be treated by aqueous-phase granular activated carbon (GAC), air sparging, zero-valent iron, ion exchange, and/or biological treatment. Where soil vapor extraction is planned, extracted VOC vapors will be treated by vapor-phase GAC. The selected remedies for some areas include monitored natural attenuation, and soil contaminated with PCBs and tritium will be excavated. Risk and hazard management will ensure that the selected interim remedies protect human health and the environment during cleanup. A monitoring program will track changes in ground water

plumes over time, evaluate the effectiveness of the interim remedies, and detect any future releases of contaminants.

Area-specific Interim Remedial Design reports will be prepared and will include detailed information on extraction wellfield configurations, capture zone analyses, treatment system specifications, and excavation procedures. Each Interim Remedial Design report will also contain a Remedial Action Work Plan that includes: (1) quality assurance/quality control and health and safety plans for construction, operation, and maintenance, (2) requirements for onsite storage and offsite shipment of hazardous waste generated by the remedy, and (3) a detailed schedule to implement the interim remedy in that area.

Treatability studies are being conducted or planned to support the interim remedies, including technologies to remove VOCs, high-explosive compounds, nitrate, and perchlorate from extracted ground water. These studies include evaluating zero-valent iron, aqueous-phase GAC, ion exchange, containerized wetlands, open-container bioreactors, and fixed-film bioreactors. The role of intrinsic *in situ* bioremediation is also being investigated.

DOE and the regulatory agencies have negotiated a schedule of environmental restoration milestones to implement the remedies selected in the Interim Site-Wide ROD. These milestones are enforceable under the terms of the Federal Facility Agreement. The schedule includes milestones for:

- Completing area-specific Interim Remedial Design reports.
- Implementing the interim remedies.
- Performing treatability studies supporting the interim remedies.

This schedule will be revised as needed during the cleanup process and as additional information becomes available. It was based on the best available budget estimates and assumes that funding is consistent with these estimates. The schedule of milestones for areas that were not addressed in the Interim Site-Wide ROD is contained in Appendix A of the Site 300 Federal Facility Agreement. The schedule in the Federal Facility Agreement also contains milestones for completing the Site-Wide Remediation Evaluation Summary, the Proposed Plan for the final remedies, and the Final Site-Wide ROD.

Community relations activities will continue throughout implementation of the remedies selected in the Interim Site-Wide ROD. Public workshops and meetings will provide opportunities for DOE/LLNL and the community to continue interactions.

1. Introduction

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 is situated in the eastern Altamont Hills, about 17 miles east of Livermore and 8.5 miles southwest of Tracy, California (Figure 1). Site 300 is located primarily in San Joaquin County, except for the westernmost portion which is in Alameda County. The site is 11 square miles in size.

Site 300 is primarily an experimental test facility where DOE conducts research, development, and testing associated with high-explosive materials. This work includes processing explosives, preparing new explosives, and pressing, machining, and assembling explosives components.

DOE is the lead agency for environmental restoration at Site 300. Regulatory oversight of restoration activities is provided by the U.S. Environmental Protection Agency (U.S. EPA), the California Department of Toxic Substances Control (DTSC), and the Central Valley Region of the California Regional Water Quality Control Board (RWQCB). A Federal Facility Agreement is in effect between DOE and the 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 1990, 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 *et al.*, 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 (ROD) for Site 300 was signed (U.S. DOE, 2001). The ROD was designated as interim to ensure remediation activities commence while additional testing and evaluation of cleanup technologies occurs and final ground water cleanup standards are negotiated. A Final Site-Wide ROD is planned that will establish ground water cleanup standards.

DOE will conduct individual five-year reviews for each area to assess the protectiveness and effectiveness of the cleanup. These reviews are required by statute (CERCLA) because ground water cleanup standards have not been set and therefore DOE cannot determine if the interim remedies will result in contaminants remaining at the site above concentrations that allow unlimited use and unrestricted exposure.

1.1. Background

During past Site 300 operations, a number of contaminants were released to the environment. These releases occurred primarily 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. Release sites and the corresponding operable unit are shown on

Figure 2. In some cases, ground water contamination has resulted from these releases as shown on Figure 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, used in explosives tests.
- Depleted uranium, also used in explosives tests.
- Nitrate, which typically results from releases of explosives formulation rinsewater, septic-system effluent, and/or leaching of naturally-occurring nitrate from bedrock. DOE is 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 explosives 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 lead, copper, zinc, vanadium, and barium) found as a byproducts of explosives tests and in rinsewater discharges.

The following sections present background information, the nature of contamination, completed remedial activities, and the major components of DOE's selected interim remedies for areas addressed in this Remedial Design Work Plan. All remedies include monitoring, and some of the remedies include risk and hazard management. The full scope of the interim remedies is shown on Table 1. The locations of the remedies selected in the Interim Site-Wide ROD are shown on Figure 4.

Building 834 - Spills and piping leaks at the Building 834 Complex from the early 1960s to the mid-1980s resulted in contamination of the subsurface with VOCs and TBOS/TKEBS. Nitrate contamination in ground water results from septic-system effluent but may also have natural sources. Remedial activities performed at Building 834 include excavating VOC-contaminated soil in 1983 and installing a surface water drainage diversion system in 1998 to prevent rainwater infiltration in the contaminant source area. 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 area-specific Interim ROD was signed in 1995 that was superceded by the Interim Site-Wide ROD. Significant *in situ* bioremediation is occurring, and treatability studies focusing on understanding and enhancing this process are underway (Section 4.5). The selected interim remedy for Building 834 includes continued ground water and soil vapor extraction and treatment using an expanded wellfield.

Pit 6 Landfill - From 1964 to 1973, approximately 1,900 cubic yards of waste 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. During the period covered by the Interim Site-Wide ROD, DOE will continue evaluating the source, extent, and natural degradation of perchlorate and nitrate at the Pit 6 Landfill. The interim remedy for these substances in ground water is continued monitoring.

High Explosives Process Area - 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 Burn Pits were capped under RCRA in 1998. In 1999, DOE/LLNL implemented a CERCLA removal action to perform ground water extraction at the site boundary to prevent the TCE plume from migrating offsite. Treatability studies are underway near Building 815 to assess high explosives, nitrate, and perchlorate treatment technologies (Sections 4.1, 4.2, and 4.3). The selected interim remedy for the High Explosives Process Area includes continued ground water extraction and treatment.

Building 850 Firing Table - High-explosives experiments have been conducted at the Building 850 Firing Table since 1958. Tritium was used in these experiments, primarily between 1963 and 1978. As a result of the dispersal of test assembly debris during explosions, 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 contamination 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 remedy for the Building 850 area includes excavation of the 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.

Pit 2 Landfill - The Pit 2 Landfill was used from 1956 to 1960 to dispose of firing table debris and gravel from Buildings 801 and 802. Waste material was buried to depths of 6 to 8 ft and covered with locally-obtained 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.

Building 854 - 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 (Sections 4.1, 4.2, and 4.3). The selected interim remedy for Building 854 includes ground water and soil vapor extraction and treatment.

Building 832 Canyon - 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/LLNL began a treatability study to evaluate ground water and soil vapor extraction (Section 4.4). Another treatability study is underway in the downgradient portion of the VOC plume to test the effectiveness of iron filings (zero-valent iron) in removing VOCs from ground water (Section 4.1). The selected interim remedy for Buildings 830 and 832 includes continued soil vapor and ground water extraction and treatment.

Building 801 Dry Well and the Pit 8 Landfill - Waste fluid was discharged to a dry well 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 Pit 8 Landfill was used to dispose of debris from the Building 801 Firing Table until an earthen cover was installed in 1974. There is no evidence of a contaminant release from the landfill. The selected interim remedy for Building 801 and the Pit 8 Landfill is enhanced vadose zone and ground water monitoring to detect any future releases from the landfill.

Building 833 - 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.

Building 845 Firing Table and Pit 9 Landfill - 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. In 1988, firing table gravel and adjacent soil from the Building 845 Firing Table were removed and disposed of in the Pit 1 Landfill. The Pit 9 Landfill was used to dispose of firing table debris generated at the Building 845 Firing Table. The debris buried in the pit may contain tritium, uranium, and/or high-explosive compounds. However, there is no evidence of a contaminant release from the Pit 9 Landfill. The selected interim remedy for Building 845 and the Pit 9 Landfill is enhanced vadose zone and ground water monitoring to detect any future releases from the landfill.

Building 851 Firing Table - 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.

1.2. Purpose and Scope

This Remedial Design Work Plan was prepared to comply with the requirements of the Site 300 Federal Facility Agreement and is the first step in the Remedial Design/Remedial Action process. It presents the overall work plan to implement the selected remedies established in the Interim Site-Wide ROD. The following areas at Site 300 were not included in the Interim Site-Wide ROD and are not discussed further in this work plan:

- Release sites in the central and eastern General Services Area operable unit that are currently being remediated under a Final ROD for that area.

- The Pit 3, 5, and 7 Landfills, collectively designated the Pit 7 Landfill Complex, that will be addressed in a future, area-specific Remedial Investigation/Feasibility Study.
- Building 865 (the Advanced Test Accelerator), Building 812, and the former Sandia Test Site release sites where additional characterization is underway or planned.

The remainder of this Remedial Design Work Plan:

Section 2: Outlines the overall approach to preparing the interim remedial designs and implementing the interim remedies.

Section 3: Summarizes the main conceptual elements of the interim remedies relating to the interim remedial designs.

Section 4: Describes ongoing and planned treatability studies.

Section 5: Establishes the schedule of milestones to implement the remedies selected in the Interim Site-Wide ROD.

Section 6: Describes current and planned community relations activities.

2. Overall Approach to Remedial Design and Implementation

The overall DOE/LLNL remedial design philosophy is to achieve a rapid, efficient, and cost-effective cleanup within budgetary constraints and in compliance with regulatory requirements. The Remedial Action Objectives for the areas addressed in the Interim Site-Wide ROD are:

For Human Health Protection:

- 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 and tritium 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 and tritium 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 will apply 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 HIs exceed 1.
- Ensure existing contaminant conditions do not change so as to threaten wildlife populations and vegetation communities.

The remedies in the Interim Site-Wide ROD will be implemented using a phased, prioritized, risk-based approach. In accordance with the Federal Facility Agreement for Site 300, DOE will request sufficient funding to fulfill site cleanup obligations. The U.S. Congress reviews DOE’s request and allocates environmental restoration funds annually.

There are technical advantages to implementing the interim remedies in phases, including opportunities to:

- Test and optimize remediation system designs prior to deployment at other areas of Site 300.
- Evaluate extraction system performance and assess the vertical and horizontal extent of capture zones, enabling DOE/LLNL to optimize mass removal and contaminant migration control.
- Refine and improve the interim remedies as new cleanup technologies and methodologies become available.

The Site-Wide Remedial Evaluation Summary report will present the progress of the interim remedies toward achieving cleanup and analyze final cleanup strategies.

3. General Remedial Design Criteria

The selected interim remedies to address environmental contamination at Site 300 include:

1. Ground water extraction, treatment, and discharge.
2. Soil vapor extraction, treatment, and discharge.
3. Monitored natural attenuation.
4. Soil excavation.
5. Risk and hazard management.
6. Monitoring.

The general criteria and guidelines to be used in the interim remedial designs are described in Sections 3.1 through 3.6. The Interim Remedial Design documents will include detailed information on extraction wellfield configurations, capture zone analyses, treatment system specifications, and excavation procedures. Each Interim Remedial Design report will also contain a Remedial Action Work Plan that includes: (1) quality assurance/quality control and health and safety plans for construction, operation, and maintenance, (2) requirements for onsite storage and offsite shipment of hazardous waste generated by the remedy, and (3) a detailed schedule to implement the interim remedy in that area.

3.1. Ground Water Extraction, Treatment, and Discharge

3.1.1. Ground Water Extraction

Ground water remediation is part of the selected interim remedies for Building 834, the High Explosives Process Area, Building 854, and the Building 832 Canyon areas. It involves extraction, conveying the water to a treatment system, treatment, and discharge of the treated water.

The Interim Remedial Design documents will include analyses of anticipated contaminant capture during the interim cleanup. If the designs will not result in complete capture of contaminants exceeding Maximum Contaminant Levels, DOE will provide: (1) a technical justification describing why incomplete capture will not cause a significant increase in the extent of contamination (i.e., migration of contaminants into pristine waters) or other unacceptable impacts (e.g., offsite migration of contamination), and (2) a discussion of the reasons DOE may not be able to achieve complete capture.

The configuration of extraction wellfields will depend on the hydrogeology of the area, contaminant concentrations, and logistical factors. Where appropriate, DOE/LLNL will use existing monitor wells to extract ground water, monitor water levels, track changes in contaminant concentrations during the cleanup, and calibrate ground water flow and contaminant transport models.

As described in Section 2, DOE/LLNL will implement the interim remedies in phases because fiscal constraints preclude installing all ground water extraction wellfields simultaneously. Extraction wells will be installed in the following order of priority:

1. To prevent offsite plume migration.
2. To extract the maximum mass of contaminants and prevent high concentrations of contaminants from migrating away from source areas.
3. To remove additional mass and control plume migration by extracting ground water at strategic downgradient wells.

Integral to this approach is dynamic management of wellfields. After the initial wells are installed and extraction is underway, nearby wells and piezometers will be monitored to estimate capture areas and determine the specific extraction rate of each well needed to maximize contaminant capture. Specific extraction well locations and designs will depend on the concentration and distribution of contaminants, soil or bedrock permeability, contaminant retardation and degradation, and the estimated contaminant extraction rates. As cleanup progresses, the wellfield design will be optimized to improve overall performance. A major objective of wellfield management is to prevent stagnant zones from forming by adjusting extraction well pumping rates and locations. DOE/LLNL may also consider recharging the treated ground water at strategic locations to eliminate stagnation zones and flush contaminants from high concentration areas more rapidly.

The progress of remediation will be evaluated using the contaminant concentration data collected from monitoring and extraction wells. In many areas, DOE/LLNL will use ground water flow and contaminant transport models to supplement the interpretation of these data and aid the wellfield management process.

The Interim Site-Wide ROD established that the ground water cleanup standards that will be set in the Final ROD for Site 300 will be at least as protective as achieving Maximum Contaminant Levels. In the period following the Interim Site-Wide ROD, DOE/LLNL will evaluate the technical and economic practicability of achieving various potential ground water cleanup standards to comply with the provisions of California State Water Resources Control Board Resolution 92-49 and the Basin Plan. The results of these evaluations will be presented in the Site-Wide Remediation Evaluation Summary report and considered when cleanup standards for ground water are established in the Final Site-Wide ROD. These evaluations will be conducted for a number of areas of ground water contamination at Site 300 and include at least five scenarios. The scenarios will be constructed from combinations of extraction well configuration, plume capture criteria, and target cleanup concentrations. The results of the evaluations will include the estimated length of time to reach target contaminant concentrations, treatment system design parameters, extraction wellfield configurations, and the estimated cost for implementing each scenario. The evaluations will also address technical challenges that may be encountered in implementing each scenario.

3.1.2. Ground Water Treatment

Seventeen ground water treatment facilities are included in the selected interim remedies for Site 300 (Figure 4). Of these, eight have already been installed, either through a removal action or as a treatability study. The number and location of these facilities is based on the conceptual remedial designs presented in the Site-Wide Feasibility Study and Interim Site-Wide ROD documents and will be refined through the formal remedial design process. The location of future facilities will be selected to minimize the capital, operation, and maintenance costs and to provide an efficient discharge route for treated water. DOE/LLNL will: (1) employ established technologies, (2) include appropriate controls and safeguards, and (3) use data from existing monitor and extraction wells to estimate the quantity and chemical composition of the ground water influent to each treatment facility. Table 2 summarizes the primary treatment technologies by contaminant for areas where ground water will be remediated by extraction and treatment.

3.1.2.1. Treatment System Design

Most ground water treatment systems for VOCs will employ aqueous-phase granular activated carbon (GAC). In some treatment systems, aqueous-phase GAC is used as a secondary step after initial treatment by air sparging or zero-valent iron. Vapor-phase GAC will be used to treat any vapor effluent from ground water treatment systems. All GAC will be shipped offsite for regeneration.

Other technologies, such as ion exchange and biological treatment, will be used for secondary treatment and/or to remove additional contaminants from the water. Contaminants (primarily nitrate and perchlorate) sorbed to ion-exchange resin will be recycled, if possible, or disposed of as hazardous waste. Regeneration of resin may be conducted offsite by an approved vendor. There are no anticipated waste management issues associated with biological treatment because contaminants are completely degraded. Water entering treatment facilities will be filtered to remove particulates. Because filters from operating treatment systems at Site 300 have been analyzed and determined to be non-hazardous, they will be disposed of at a commercial Class III landfill.

Each treatment facility will be visually inspected at least once per week. At some systems continuous remote monitoring will be performed. Electrically-powered treatment facilities will be equipped with an interlock control system. If a portion of the system malfunctions, the entire system, including the associated extraction wells, will automatically shut down until the problem is corrected. Thermal shut-off devices will be installed on all centrifugal extraction pumps to prevent overheating due to insufficient water in the wells. Treatment systems will also be shut down if the pH exceeds discharge limits.

3.1.2.2. Treatment Facility Monitoring and Reporting

The type, frequency, and number of samples and analyses for each treatment facility will comply with California RWQCB requirements. Typically, these requirements specify that water samples be collected at points prior to and after treatment. If used for onsite irrigation, the treated water may be temporarily stored in tanks near the treatment facility. The requirements also specify performance and reporting criteria for the treatment systems.

Where vapor effluent is discharged from a ground water treatment system, permits issued by the San Joaquin Valley Unified Air Pollution Control District are required. A hand-held monitoring device, such as a photo-ionization detector or flame ionization detector, will be used to verify compliance with treated vapor discharge limits.

3.1.3. Discharge of Treated Ground Water

Several methods may be used to manage treated water effluent, including discharge to the ground surface, infiltration trenches, recharge wells, air misting, or onsite re-use. Discharges of treated water from facilities with the potential to impact ground water or surface water quality are regulated by the RWQCB through Substantive Requirements or National Pollutant Discharge Elimination System (NPDES) permits. Onsite discharges typically require compliance with Substantive Requirements and discharges with any actual or potential impact to offsite surface water bodies require an NPDES permit. If the discharge is to a surface water body, a sample of the receiving water body will be collected at a point between 50 and 100 ft downstream from the discharge point. The effluent limitations and other provisions from the Substantive Requirements were included in the Interim Site-Wide ROD as Appendix B.

3.1.3.1. Discharge to the Ground Surface, Infiltration Trenches, or Recharge Wells

Where treated water is discharged directly to the ground surface, the discharge point will be selected to prevent or minimize unacceptable erosion and prevent infiltration from causing undesired mobilization of contaminants in the subsurface. Although not currently included in the interim selected remedies, treated ground water may be returned to the subsurface via recharge wells or infiltration trenches to limit dewatering, to flush contaminants from the subsurface, and/or prevent wetlands from developing. Limiting the extent of dewatering should result in extraction wells maintaining higher sustained yields and shorten cleanup time. Strategically-placed surface discharge points, recharge wells, or infiltration trenches may also decrease cleanup time by flushing treated water through soil or bedrock containing adsorbed contaminants and help hydraulically contain some plumes. Flow and transport models will be used to estimate the effectiveness of various recharge scenarios.

3.1.3.2. Air Misting

Air misting is a method of discharging treated ground water by forcing it through spray heads to create fine droplets as it is expelled into the air. It is most applicable for low flow rates and eliminates soil erosion and/or the creation of wetlands that may occur with direct surface discharge. Air misting of treated ground water is currently being conducted at the Building 834, Building 815, and Building 854 treatment systems, and at Building 833 for disposing of treated well development and sampling purge water.

3.1.3.3. Onsite Re-use

Although not currently planned due to the relatively low expected yields from wells, treated ground water may be used for onsite landscape irrigation. The regulatory agencies will be notified in advance of any onsite landscape irrigation using treated ground water.

3.2. Soil Vapor Extraction, Treatment, and Discharge

Four soil vapor extraction and treatment facilities are included in the selected interim remedies for Site 300 (Figure 4). Of these, two have already been installed as treatability studies. The number and location of these facilities is based on the conceptual remedial designs presented in the Site-Wide Feasibility Study and Interim Site-Wide ROD and will be refined through the formal remedial design process. Many of the criteria for ground water extraction and treatment discussed in Section 3.1 are also applicable to soil vapor extraction. In areas where soil vapor extraction is part of the selected interim remedy it will be conducted in conjunction with ground water extraction.

DOE/LLNL will typically target areas of high mass and concentration of VOCs in the vadose zone with the objectives of remediating the zones where contaminants might present unacceptable human health or ecological risks or would impact the underlying ground water. The specific soil vapor extraction well designs will depend on the concentration and distribution of VOCs, soil or bedrock permeability, and the estimated contaminant extraction rates.

The progress of remediation will be evaluated using soil vapor VOC concentration data collected from the vadose zone monitoring wells. In many areas, DOE/LLNL will use vapor flow and contaminant transport models to supplement the interpretation of these data and aid the wellfield management process.

Surface seals (such as asphalt paving), passive air-inlet wells (wells completed in the vadose zone open to the atmosphere), and air injection wells (which may also be used for soil moisture management) may be required to manipulate vapor flow pathways during extraction.

Extracted VOC vapors will be treated by vapor-phase GAC at the ground surface. Where treated soil vapor effluent is discharged from a treatment system to the atmosphere, permits will be obtained from the San Joaquin Valley Unified Air Pollution Control District. A hand-held monitoring device, such as a photo-ionization detector or flame ionization detector, will be used to verify compliance with treated vapor discharge limits.

Because soil vapor extraction typically achieves the desired level of cleanup much more rapidly than ground water extraction, DOE may wish to discontinue soil vapor extraction in some areas prior to the Final Site-Wide ROD. However, DOE will not discontinue operation of any soil vapor extraction and treatment facility without approval by the regulatory agencies. The evaluation process for shutdown of soil vapor extraction systems will be presented in the first scheduled Interim Remedial Design report (Building 834), with the expectation that similar shutdown evaluations will be conducted for other areas of Site 300.

3.3. Monitored Natural Attenuation

Monitored natural attenuation is the selected interim remedy for VOCs and tritium in ground water at the Pit 6 Landfill and for tritium in ground water near the Building 850 Firing Table. Monitored natural attenuation allows contaminants to degrade naturally in the environment while remaining under close observation and with protocols to assess the progress of remediation. Performance criteria for monitored natural attenuation will be specified in the Site-Wide Contingency Plan, which will also include alternative remedial actions to be considered if the performance criteria are not met.

3.4. Soil Excavation

Surface soil adjacent to the Building 850 Firing Table is contaminated with PCBs, dioxins, and furans above the health-based cleanup standards established in the Interim Site-Wide ROD. A nearby sand pile is contaminated with tritium, and while the sand pile itself does not exceed health-based standards, DOE/LLNL will eliminate potential leaching of tritium to underlying soil. The selected remedy includes excavating both the contaminated surface soil and the sand pile.

For the contaminated surface soil, DOE/LLNL will excavate native soil surrounding the firing table to a depth of up to 1 ft over an area of approximately 44,000 ft^2. Confirmation soil samples will be collected and analyzed, and the depth and area of soil excavation will be expanded, if necessary to meet cleanup standards.

After removing the sand pile, native soil samples will be collected beneath its former location. Native soil exceeding the tritium soil cleanup standard established in the Interim Site-Wide ROD will be excavated.

Specific tasks will include preparing work and safety plans, constructing temporary work staging and equipment decontamination areas, excavating or removing contaminated soil, performing post-excavation sampling to verify cleanup standards are achieved, waste characterization sampling, transporting the waste to an approved offsite disposal facility, and restoring disturbed areas.

3.5. Risk and Hazard Management

The overall objective of risk and hazard management is to ensure that the selected interim remedies protect human health and the environment during the remediation process. However, risk management is not intended to serve as a final remedy. Risk and hazard management consists of institutional and administrative measures that will be used to mitigate exposure to contaminated media primarily where the maximum additional cancer risk to humans exceeds 10^{-6} or the non-cancer hazard index exceeds one (exclusive of ingesting contaminated ground water). Measures to prevent Site 300 workers or offsite property owners from ingesting contaminated ground water are part of risk management wherever ground water contamination exists above concentrations protective of human health. In some areas, risk and hazard management will supplement other actions, such as ground water extraction. Table 3 shows the institutional risk management measures for each area at Site 300 during the interim cleanup.

During remediation, DOE/LLNL will implement a formal risk and hazard management program that will consist of:

- Implementing institutional controls to manage risks by establishing building occupancy and/or land-use restrictions.
- Establishing building ventilation controls to be operated whenever buildings with an indoor air inhalation risk exceeding 10^{-6} are occupied, if necessary.
- Posting warning signs to comply with area-access, site-specific building occupancy, and land-use restrictions.
- Collecting additional environmental samples at locations where potentially unacceptable human health risks or hazards have been identified in the baseline risk assessment.
- Refining risk and hazard estimates using current data to verify that the risks estimated in the baseline risk assessment are not exceeded due to changing conditions at the site.
- Conducting wildlife surveys by biologists to evaluate the presence of species of concern and, if found, consulting with the appropriate wildlife agencies to develop response actions.

The following administrative controls are already in place at Site 300 and are expected to be maintained:

- Access is restricted and controlled by fencing and a full-time security force.
- Building occupancy and land use are controlled by Site 300 management.

- Safety briefings that discuss access requirements and areas of contamination are required of personnel working at Site 300.
- New water-supply wells are subject to environmental review.
- Operational Safety Plans are required for all construction activities.
- A wildlife biologist reviews proposals for land-disturbing activities and recommends ecological protection measures, if appropriate.
- Land-disturbing activities are not allowed on top of Site 300 landfills.

Remedies will be reevaluated if a transfer of ownership from DOE or a change in land use is anticipated. DOE will meet its commitments in the Site 300 Federal Facility Agreement regarding cleanup obligations if property ownership changes in the future, specifically Sections 28 (Transfer of Real Property) and 37 (Facility Closure). DOE is also bound by CERCLA Section 120(h) pertaining to transfer of contaminated property.

3.6. Monitoring

Monitoring is an integral part of all the selected interim remedies. Enhanced vadose zone and ground water monitoring systems will be installed at the Pit 2, 8, and 9 Landfills to detect any future contaminant releases.

Periodic monitoring for contaminants will be conducted by collecting samples of ground water, surface water, soil vapor, and soil as remedial activities progress. This monitoring will:

- Track changes in plume concentration, composition, and size that result from remediation or natural processes.
- Evaluate the effectiveness of the remedial action.
- Detect future releases of contaminants.
- Determine when cleanup standards (to be set in the Final Site-Wide ROD) are achieved.

Ground water levels and soil vapor pressures will be monitored to assess ground water and vapor flow conditions and capture areas, and compared to the results of flow and transport models. Landfill surfaces will be inspected regularly for damage that could compromise their integrity and repaired, if necessary.

Sampling and analysis plans for each area will be included in the Interim Remedial Design reports. The Site-Wide Compliance Monitoring Plan will also contain details of monitoring activities to be conducted during the remedial activities.

4. Treatability Studies

A number of treatability studies are being conducted or planned at Site 300, primarily to evaluate the effectiveness of ground water extraction and treatment techniques. The results of the treatability studies will be reported in the Site-Wide Remedial Evaluation Summary report. Prior to the Final Site-Wide ROD, DOE may choose to modify the selected interim remedies to include technologies evaluated in treatability studies by preparing an Explanation of Significant

Differences document, an amendment to the Interim Site-Wide ROD, or other appropriate documentation placed in the Administrative Record.

4.1. VOC and RDX Treatability Studies

A treatability study to evaluate the effectiveness of iron filings (zero-valent iron) in removing VOCs from ground water is underway in the downgradient portion of the Building 832 Canyon. This study consists of extracting ground water using the natural pressure of a confined aquifer and piping the water to aboveground containers filled with iron filings. The iron converts the VOCs to ethane, ethene, methane, and chloride ions by reductive dehalogenation. Preliminary results indicate a 90% destruction efficiency for VOCs.

Aqueous-phase GAC units are in use at Building 815, Building 832, Building 830, and Building 854. While it is well documented that aqueous-phase GAC removes VOCs from extracted ground water, the treatability studies indicate that RDX (and perchlorate to a limited extent) also sorb to carbon. However, breakthrough of perchlorate in the aqueous-phase GAC units tends to occur relatively rapidly. No significant reduction in nitrate concentration has been observed following GAC treatment.

4.2. Perchlorate Treatability Studies

In some areas at Site 300, perchlorate contamination resulted from wastewater discharges to unlined rinsewater lagoons. In other areas, the sources of perchlorate have not been identified. Because tests have shown that aqueous-phase GAC does not efficiently treat perchlorate, ion-exchange units are included as part of the treatment process where perchlorate is present in extracted ground water (Building 815, Building 832, and Building 854).

Ion exchange is a process through which target ions, such as perchlorate, are removed from water by exchanging this ion with chloride ions. Contaminated water is pumped into large columns filled with ion-specific resin beads. The beads are composed of a polymer substrate coated with resin designed to attract the target ion. The ion-exchange units at Site 300 have been effective in removing perchlorate to concentrations below detection limits. Biological nitrate treatment systems may also be able to degrade perchlorate.

4.3. Nitrate Treatability Studies

Removal of nitrate from extracted ground water presents a significant challenge to remediation efforts at Site 300, primarily due to the large mass of nitrate present. The objective of the nitrate treatability studies underway at Site 300 is to determine the effectiveness and operational efficiency of three experimental biological systems. These treatment systems are differentiated primarily by the choice of substrate material. Biological processes are particularly attractive because they destroy nitrate rather than transfer it to other media.

At Site 300, three primary sources contribute to nitrate in ground water: (1) weathering and decomposition of bedrock and soil, (2) septic-system effluent, and (3) decomposition and dissolution of mock explosives (barium nitrate) and nitrate-bearing high-explosive compounds. Both microorganisms and plants can remove nitrate from water to produce proteins and biomass. In addition, certain anaerobic microorganisms can use nitrate as an alternative electron acceptor when their environment becomes depleted in dissolved oxygen. In anoxic conditions, these “facultative” anaerobic bacteria reduce nitrate to nitrogen gas when presented with a suitable food source. Denitrifying microorganisms are ubiquitous in ground water and soil. Therefore, a denitrification reactor can be engineered by reducing the influx of oxygen to an environment, providing a suitable substrate for the microorganisms, and by adding a food source for the microorganisms already present. As an added benefit, some denitrifying bacteria also have the ability to degrade perchlorate. In the treatability studies at Site 300, acetic acid (table vinegar) serves as a nontoxic, inexpensive, and readily available microbial food source. The three nitrate treatability studies being conducted at Site 300 are described in the Sections 4.3.1 through 4.3.3.

4.3.1. Containerized Wetland System

At Building 854, a containerized wetland system is being tested for its ability to reduce nitrate concentration in extracted ground water. The system consists of large containers planted with cattails and sedges to simulate water-logged soil. A solar-powered submersible pump extracts ground water from a well at about 1 gallon per minute. VOCs are removed by aqueous-phase GAC. The water then flows into the wetland containers and infiltrates downward with a total residence time of about 15 hours. Acetic acid is injected into the wetland to encourage biological removal of nitrate and perchlorate. Prior to discharge, the extracted ground water passes through an ion-exchange resin to remove any residual perchlorate.

The Building 854 containerized wetland system began operation in 2000. Testing has shown that nitrate concentration is reduced from about 46 mg/L in the influent to 0.5–6.0 mg/L in the effluent.

4.3.2. Open-Container Bioreactor

In the Building 832 Canyon, two open-container bioreactors are being tested to remove nitrate from extracted ground water. Each open-container bioreactor consists of a large, open-topped box filled with layers (from top to bottom) of fine sand, coarse sand, aquarium gravel, lava rock, and drainage gravel. Peat moss is mixed with the lava rock to act as a long-term carbon source. The layers are separated by permeable screens. Acetic acid is added as a carbon source. After pre-treatment by zero-valent iron to remove VOCs, extracted ground water is evenly distributed over the top surface of each open-container bioreactor and allowed to gravity-drain through the sand, gravel, and rock layers. The large surface area of the materials supports microbial colonization, and the increasing porosity in the direction of flow promotes flushing of silt and biomass. The residence time in each reactor is about 1.5 hours.

The system began operation in 2000 and typically reduces nitrate concentration from 60 mg/L in the influent to less than 10 mg/L in the effluent.

4.3.3. Fixed-Film Bioreactor

A fixed-film bioreactor is being tested at Building 815, consisting of three 190-gallon tanks operated in series. Each tank is filled with a packing material that maximizes the surface area available for microbial growth. Acetic acid is injected at the bioreactor inlet to provide a food source for the microorganisms. Prior to discharge, the extracted ground water passes through ion-exchange resin to remove any residual perchlorate.

The bioreactor began operating in 2000 and the system typically reduces nitrate concentrations from 75 mg/L in the influent to 20–30 mg/L in the effluent.

4.4. Soil Vapor Extraction Treatability Study

A treatability study to evaluate the effectiveness of soil vapor and ground water extraction began at Building 832 in 1999. Nine wells are connected to the soil vapor extraction system and vapor-phase GAC is used to remove VOCs (primarily TCE). As of September 2000, approximately 0.5 kg of TCE had been extracted. If the treatability study is successful, the system will be optimized and long-term remediation conducted.

4.5. Treatability Studies Evaluating *In Situ* Bioremediation of VOCs

At Building 834, intrinsic and enhanced *in situ* bioremediation are being evaluated for remediating VOCs in several shallow perched water-bearing zones, as discussed below.

4.5.1. Intrinsic *In Situ* Bioremediation

In 1997, a monitoring program began in the central (core) area of the Building 834 Complex to monitor the rate and extent of naturally-occurring VOC biodegradation. Site-specific data indicate that reductive dechlorination of VOCs is occurring in locations where silicon-based lubricants (TBOS/TKEBS) occur as co-contaminants. Laboratory studies also suggest that TBOS/TKEBS may promote intrinsic aerobic cometabolism of both TCE and DCE. Monitoring data from 1999 suggest that intrinsic bioremediation destroyed approximately 6 kg of VOCs at Building 834 within a two-month period. This destruction rate indicates that intrinsic bioremediation processes may be removing roughly the same mass of VOCs from the subsurface as the ongoing ground water and soil vapor extraction systems. However, since soil vapor extraction introduces oxygen into the subsurface, soil vapor extraction inhibits reductive biological dechlorination, and optimization strategies may be required. DOE/LLNL will continue studies to delineate the biologically-active treatment zone, more precisely determine biotransformation rates, and develop models to predict the magnitude of intrinsic bioremediation.

4.5.2. Enhanced *In Situ* Bioremediation

DOE/LLNL are conducting studies to determine if adding nutrients and non-native microorganisms can expand the biologically-active TCE degradation zone at Building 834, currently limited to locations containing both TCE and TBOS/TKEBS. Various nutrient formulations will be tested in laboratory experiments to determine their ability to biotransform VOCs. Later, suitable nutrients will be injected into the subsurface in controlled field experiments. If biotransformation is incomplete following the injection of nutrients, DOE/LLNL will investigate adding anaerobic microorganisms to the subsurface with the goal of completely dechlorinating VOCs to ethene and ethane.

5. Schedule

DOE and the regulatory agencies have negotiated a schedule of environmental restoration milestones to implement the remedies selected in the Interim Site-Wide ROD (Table 4). These milestones are enforceable under the terms of the Federal Facility Agreement. The schedule includes milestones for:

- Completing area-specific Interim Remedial Design reports. Remedial Action Work Plans will be contained in these documents.
- Implementing the interim remedies.
- Performing treatability studies to support the interim remedies. In some areas, DOE intends to continue operating or install new extraction and treatment facilities as treatability studies. Interim remedial actions formally begin after the interim remedial designs are completed.

The following factors were considered in developing the schedule to implement the interim remedies:

- Existing or potential threat to human health or the environment, including the potential for offsite migration of contaminants.
- Existing or potential contamination of water-supply aquifers.
- Rate of contaminant migration.
- The existence of extraction and treatment facilities.
- The need for additional information from treatability studies and/or characterization.
- Level of stakeholder concern.

The general priorities for accomplishing the milestones shown on Table 4 are:

1. Building 832 Canyon OU – Expanding the ground water cleanup in this area is considered to be a high priority, due to: (1) the threat of offsite contaminant migration, (2) potential impacts to onsite water-supply aquifers, and (3) the potentially high rate of contaminant migration. Three extraction and treatment systems are currently in operation as treatability studies (B832-SRC, B830-PRXN, and B830-DISS) as shown on Figure 4. Implementing source control at Building 830 by constructing the B830-SRC soil vapor and ground water extraction facility is considered time-sensitive and essential to the overall cleanup strategy. Constructing three other facilities to extract ground water within the downgradient areas of contamination (B832-PRX, B830-DIS, and B832-DIS) is important but less time-critical. Additional site characterization is needed to define the extent of ground water contamination. Treatability studies are in progress that will help develop an effective remedial design document.

2. High Explosives Process Area OU – Similar to the Building 832 Canyon OU, DOE considers increasing the scope of ground water cleanup in this area to be a high priority to prevent offsite migration and protect the regional water-supply aquifer. The rate of contaminant migration is relatively low. Two facilities are in operation: B815-SRC near the Building 815 contaminant release area and B815-DSB at the site boundary. DOE considers the expeditious construction of facility B815-PRX, upgradient from the site

boundary, to be essential in preventing offsite migration of contaminants. Constructing four other facilities (B817-SRC, B829-SRC, B817-PRX, and B815-DIS) is important but less time-sensitive. Existing information is sufficient to produce the interim remedial design document immediately.

3. Building 834 OU – Extraction and treatment facility B834-SRC is in operation, and expanding the extraction wellfield to include the downgradient portion of the ground water contaminant plume and changing the ground water treatment technology from air sparging to aqueous phase GAC can be implemented relatively quickly and easily. There is no threat of offsite migration or impact to water-supply aquifers and the rate of contaminant migration is relatively low. Existing information is sufficient to produce the interim remedial design document immediately.

4. Building 854 OU – Extraction and treatment facilities B854-SRC and B854-PRX are in operation as treatability studies, and no additional facilities are planned. The rate of contaminant migration is fairly low, and there is little threat of offsite migration of contaminants. Data from these treatability studies will be used to produce an effective interim remedial design document.

5. Building 850 – Because of the health risks associated with PCBs in surface soil and the possible threat to ground water from tritium in the sand pile, excavating these two areas is planned but is not considered to be time-critical. The threat of offsite migration of contaminants is low. More characterization data are required to accurately define the extent of soil excavation and produce the interim remedial design document.

6. Pits 2, 8, and 9 Landfills – DOE considers implementing the enhanced vadose zone and ground water monitoring system to detect any future contaminant releases to be important but not time-sensitive. No threat to human health or the environment has been identified and no releases have been identified from the landfills, and the landfills are located in the central part of Site 300. The potential for offsite migration of contaminants is low.

DOE will conduct individual five-year reviews for each area to assess the protectiveness and effectiveness of the cleanup. These reviews are required by statute (CERCLA) because ground water cleanup standards have not been set and therefore DOE cannot determine if the interim remedies will result in contaminants remaining at the site above concentrations that allow unlimited use and unrestricted exposure. The triggers and schedules for performing the five-year reviews will contained in the Remedial Action Work Plans for each area. These Work Plans will be included in the Interim Remedial Design documents.

This schedule will be revised as needed during the cleanup process and as additional information becomes available. These revisions will require concurrence from the regulatory agencies. The schedule was based on the best available budget estimates and assumes that funding is consistent with these estimates.

The schedule of milestones for areas that were not addressed in the Interim Site-Wide ROD is contained in Appendix A of the Federal Facility Agreement for LLNL Site 300. These areas include:

- The Pit 7 Landfill Complex.
- Building 865.

- Building 812.
- The Sandia Test Site.

The schedule in the Federal Facility Agreement also contains milestones for completing site-wide documents, including the Compliance Monitoring Plan, Contingency Plan, Remediation Evaluation Summary, Proposed Plan, and Final ROD. The Site-Wide Compliance Monitoring Plan will contain details of monitoring activities to be conducted during the interim remedial actions. The Site-Wide Contingency Plan will include alternative remedial actions to be considered if the interim cleanup does not perform as anticipated. The Site-Wide Remediation Evaluation Summary report will present the progress and status of interim cleanup measures, the results of treatability studies and site investigations, and will evaluate compliance with State Water Resources Control Board Resolution 92-49. The Proposed Plan will summarize DOE's preferred final remedies, and the Final Site-Wide ROD will establish ground water cleanup standards and select the final remedial actions to be performed at Site 300.

6. Community Relations

Community concerns and information needs have been a factor in DOE/LLNL technical decisions since environmental investigations began at Site 300 in 1981. During the remedial design and remedial action stages of the project, DOE/LLNL will continue to balance community concerns with significant technical, legal, budget, and policy issues. DOE/LLNL are committed to maintaining a community relations program throughout the life of the cleanup.

Community relations activities after the Interim Site-Wide ROD will continue to be informational in nature. In addition, public workshops and meetings will provide opportunities for DOE/LLNL and the community to continue communications. The nature of these activities will be evaluated through a community relations reassessment process that will solicit input by:

- Meeting with civic and community groups.
- Corresponding with interested neighbors.
- Publishing notices informing the public of the reassessment process.

The purpose of this reassessment process is to identify community interest in and information needs of the ongoing environmental restoration project, and the best ways to continue working with the community as the cleanup is designed and implemented. DOE/LLNL expect that the reassessment process will yield useful suggestions concerning community involvement. Based on the information from the community relations reassessment and its own experience with the current program, DOE/LLNL may formally revise the current community relations program by publishing an addendum to the existing Site 300 Community Relations Plan (LLNL, 1992). The addendum will be made public and placed in the Site 300 environmental information repositories.

In the past, the community relations program has consisted of the activities listed below. Future community relations activities are likely to include many of these activities, pending completion of the reassessment process.

Fact Sheets - DOE and LLNL have been writing and distributing fact sheets regarding CERCLA decision documents since 1995.

Executive Summaries - When appropriate, an executive summary is included in technical reports to facilitate the public's understanding of these documents.

Environmental Community Newsletter - Mailings to neighbors and other stakeholders convey information on Site 300 and Livermore Site environmental remediation and provide periodic reports on environmental impacts.

Neighbor Mailings - Notices sent to nearby residents and landowners inform them of Site 300 public meetings, proposed actions, and environmental issues.

Web Site - A web site (http://www-envirinfo.llnl.gov/) provides the public access to many Site 300 environmental documents.

News Media - Local news media are periodically updated on Site 300 environmental issues and are encouraged to cover public workshops and meetings.

One-on-One and Small Group Meetings - DOE and LLNL environmental restoration staff will continue to be available to meet with interested individuals or groups on a scheduled basis. The current LLNL community relations contact is Bert Heffner at (925) 424-4026.

Information Line - LLNL staff are available to respond to telephone inquiries regarding environmental restoration. Inquiries may be directed to Bert Heffner.

Public Workshops - DOE/LLNL have voluntarily held public workshops in addition to the public meetings required by CERCLA. These workshops allow the public to gain a greater understanding of environmental restoration issues and to be involved in the decisions made by DOE and the regulatory agencies. DOE expects to continue this process of enhanced public involvement for each of the Interim Remedial Design documents and the Final ROD.

Information Repositories/Administrative Record - Since 1988, DOE/LLNL have maintained two information repositories where the public can review key Site 300 documents. These repositories are located at the LLNL Livermore Site Visitors Center and the City of Tracy Public Library.

Public Notices - Notices are placed in local newspapers to inform the public of all public workshops and meetings. The notices are also placed in the Site 300 information repositories.

Meetings with Technical Assistance Group Advisors - Since 1989, DOE and LLNL staff have been interacting with the technical advisors retained by Tri-Valley Communities Against a Radioactive Environment (CAREs) under the U.S. EPA's Technical Assistance Grant program. DOE interacts with Tri-Valley CAREs on environmental remediation issues at both Site 300 and the Livermore Site. Those interactions have taken the form of oral and written responses to questions, in-depth conversations, site tours, and meetings at LLNL. Because DOE/LLNL recognize the value of interaction with the technical advisors as the project moves into the post-Interim Site-Wide ROD phase, DOE and LLNL staff meet with the technical advisors regularly. The advisors are invited to submit written agenda items prior to each meeting. Tri-Valley CAREs is invited to have representatives at these meetings. The goal is to hold these meetings within 30 days following the release of draft project documents to provide sufficient time to incorporate Tri-Valley CAREs concerns into subsequent drafts.

Tours - DOE and LLNL staff have provided a number of scheduled tours of Site 300 to Tri-Valley CAREs members, the media, and other interested members of the public. These tours will continue to be available during the remedial design and remedial action stages of the project.

Public Meetings and Public Comment Periods - In addition to public workshops on important draft documents, DOE/LLNL will conduct a public comment period and offer the opportunity for a public meeting if any new contamination is found at Site 300 that requires a cleanup approach that is significantly different from that outlined in the Interim Site-Wide ROD.

In summary, the nature and timing of future community relations activities will be established during the community relations reassessment process. The program will be documented in an addendum to the Site 300 Community Relations Plan. DOE and LLNL staff are committed to working with the public throughout the life of the cleanup at Site 300 and will continually seek to refine the community relations program to meet the needs of the public.

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Glossary

Baseline Risk Assessment: An assessment of the pre-cleanup potential for adverse health effects of human and non-human species to environmental hazards.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): A law passed in 1980 that authorized the federal government to respond directly to releases of hazardous substances that may endanger human health or the environment.

Contaminant: A chemical that degrades the natural quality of a substance or environmental media such as ground water, surface water, soil or air.

Downgradient direction: The direction of ground water flow.

Dry well: A shallow dry borehole, usually filled with gravel, once used to dispose of waste fluids.

Federal Facility Agreement: A document that specifies the required actions at a federal facility like Site 300 as agreed upon by various federal and state agencies.

Firing table: An area next to building or bunker where high explosives are detonated for experimental purposes.

Granular activated carbon: A treatment medium that is generally effective for removing volatile organic compounds and some inorganic compounds from fluids such as water or air.

Ground water extraction: The process of removing ground water from the ground, usually accomplished by pumping from wells. It can be used to remove dissolved contaminants, lower the water table, and/or control ground water movement.

HMX: A high-explosive compound called High-Melting Explosive, also known as octogen or homocyclonite.

Ion Exchange: A technology for removing certain charged substances, such as metals, from water.

Maximum additional cancer risk: The maximum risk of developing cancer in addition to the one in three risk for Californians from other causes.

Perched water-bearing zone: Soil or rock containing ground water that is above the regional water table. Water moving downward through the ground collects (is “perched”) above a layer (such as clay) that does not allow water to pass through, creating the perched zone.

Plume: A well-defined area of contamination in ground water.

Record of Decision (ROD): A document prepared under CERCLA that documents the selection of a remedial alternative and the strategy for its implementation.

RDX: A high-explosive compound called Research Department Explosive, also known as cyclonite or hexogen.

Soil vapor: Air (or other vapor) in the pore spaces of soil or rock in the unsaturated zone.

Soil vapor extraction: Removing soil vapor from the ground, usually by applying a vacuum to one or more wells. This technology is used to clean up chemicals that readily evaporate that are present in soil or rock above the water table.

Unsaturated zone: The region in the ground above the water table where the pore spaces in soil and rock are only partially filled with water. Also called the vadose zone.

Depleted uranium: Natural uranium is composed of approximately 99.3% uranium-238, 0.7% uranium-235, and 0.006% uranium-234. Uranium-235 is the fissile component (that which can sustain a chain reaction) and is removed during processing for use in either reactor fuel or weapons. The residue after uranium-235 separation is known as depleted uranium. The uranium used at Site 300 contains less than 0.2% uranium-235 and over 99.8% uranium-238.

Vadose zone: See unsaturated zone.

Volatile organic compounds (VOCs): Organic compounds that evaporate easily at room temperature. Examples are solvents, gasoline, paint thinner and nail polish remover. Trichloroethylene (TCE) is a VOC.

Acronyms and Abbreviations

1×10^{-6}	One in one million
1,1-DCE	1,1-Dichloroethylene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	Department of Energy
DTSC	Department of Toxic Substances Control
EPA	U. S. Environmental Protection Agency
GAC	Granular activated carbon
gpm	gallons per minute
HMX	High-melting explosive
LLNL	Lawrence Livermore National Laboratory
mg/L	milligrams per liter
NPDES	National Pollutant Discharge Elimination System
OU	Operable unit
PCE	Perchloroethylene, also known as tetrachloroethylene
PCB	Polychlorinated biphenyl
RCRA	Resource Conservation and Recovery Act
RDX	Research department explosive
ROD	Record of Decision
RWQCB	Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act
TBOS/TKEBS	Tetra-butyl-orthosilicate/tetra-kis-2-ethylbutylorthosilicate
TCE	Trichloroethylene
VOCs	Volatile organic compounds

Figures

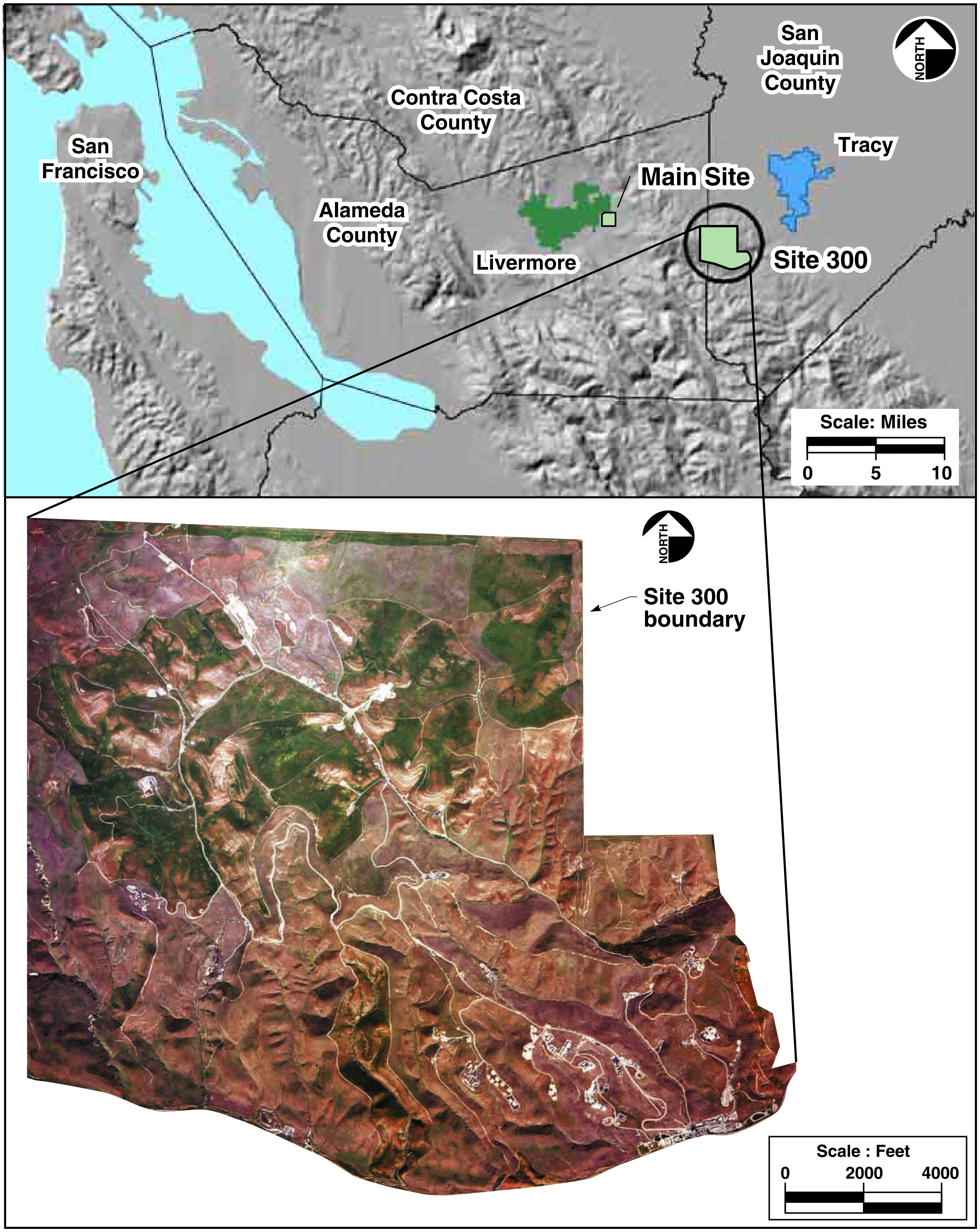

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Figure 1. Location of LLNL Site 300.

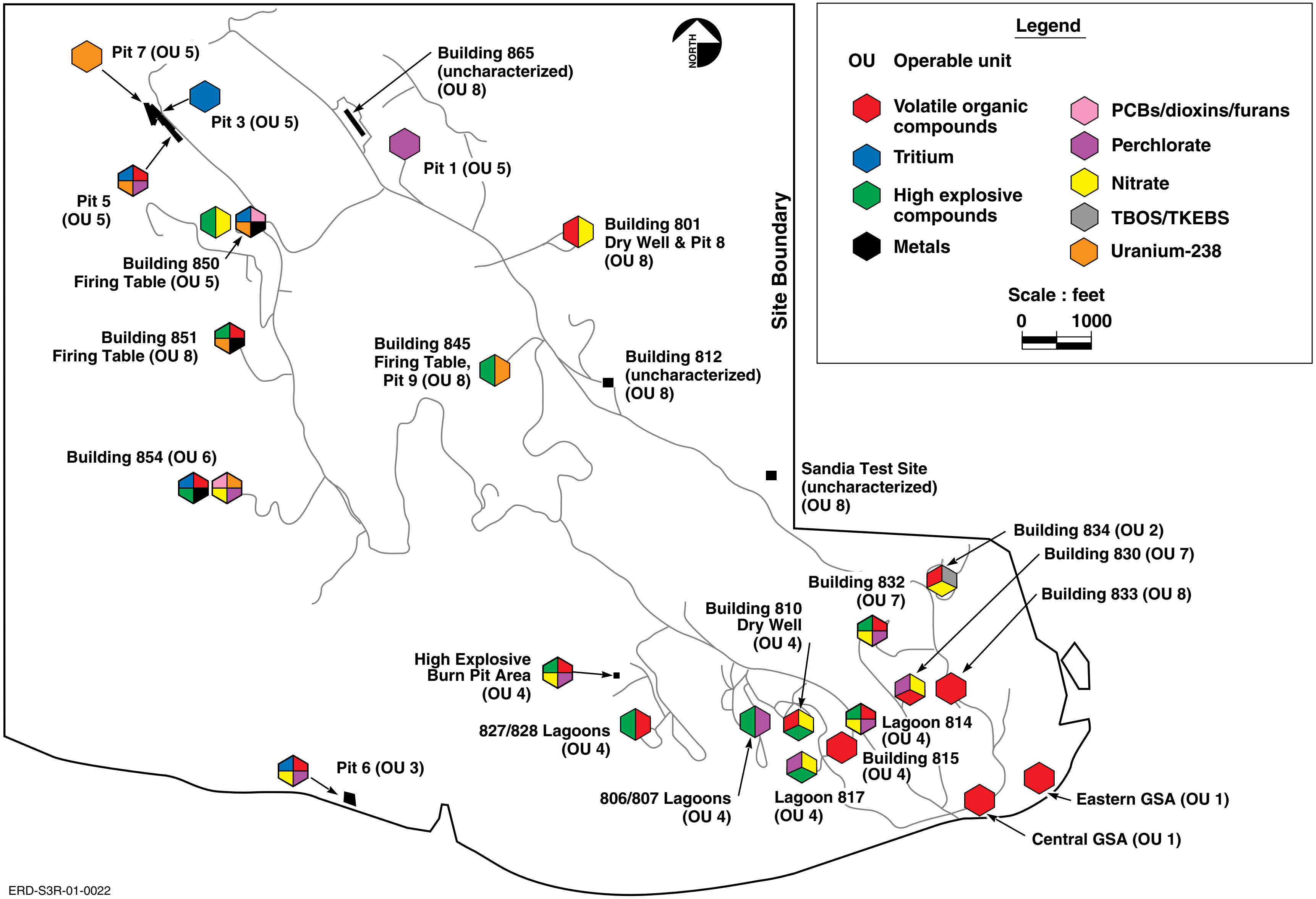

Figure 2. Site 300 contaminant release sites.

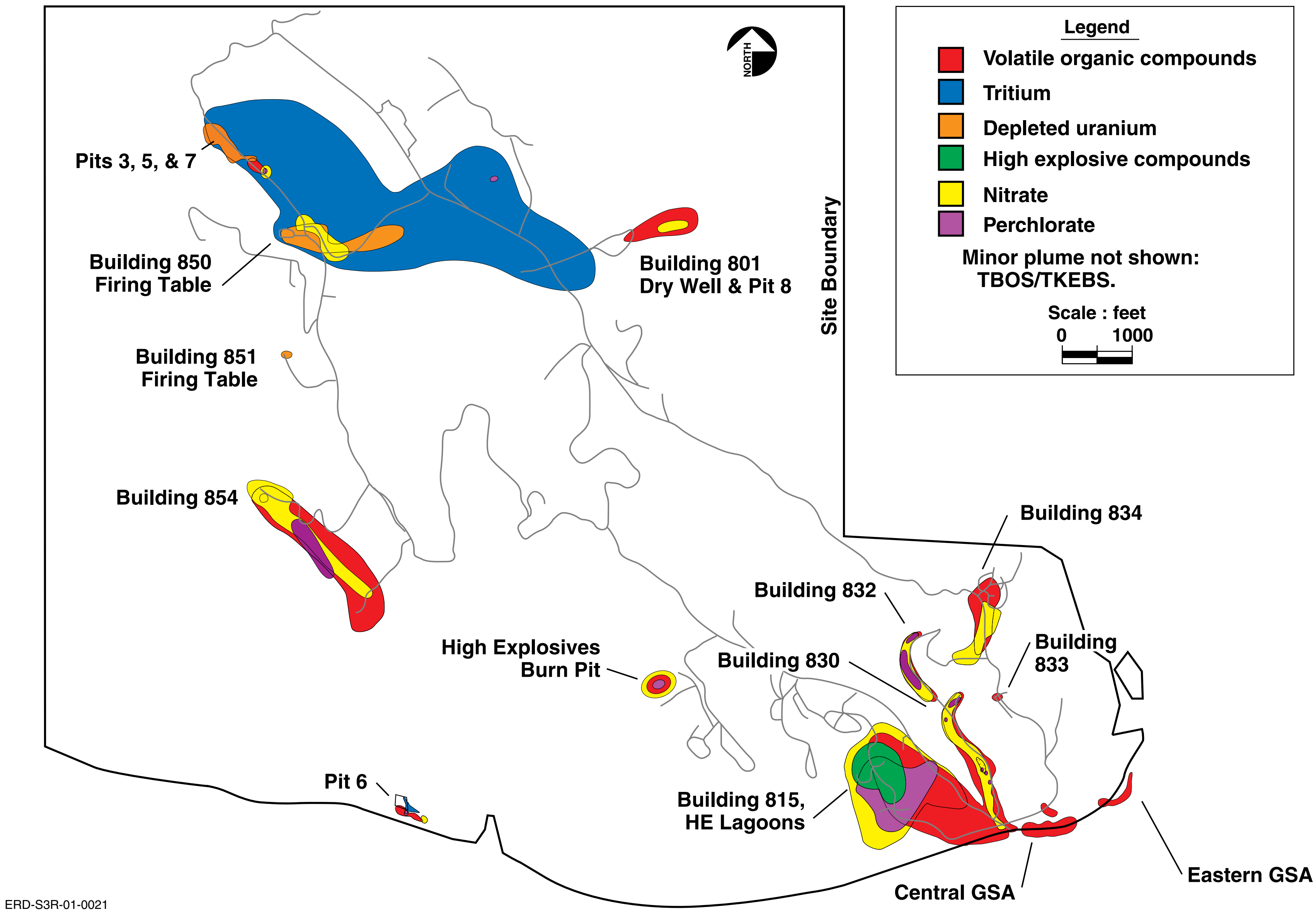

Figure 3. Site 300 ground water contaminant plumes.

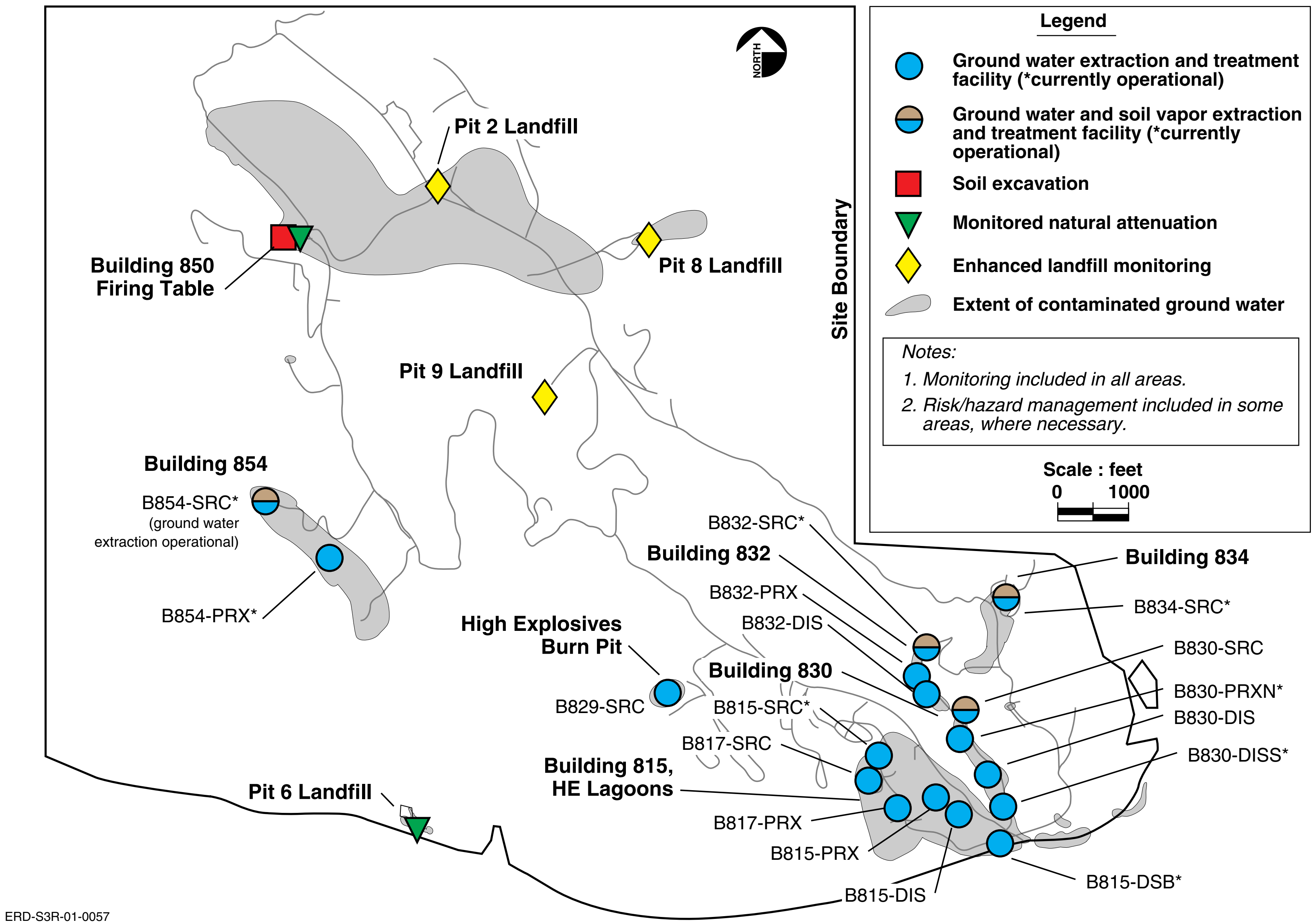

Figure 4. Locations of the remedies selected in the Interim Site-Wide ROD for Site 300.

Tables

Table 1. Technologies comprising the remedies selected in the Interim Site-Wide ROD for LLNL Site 300.

Technology	Building 834	Pit 6 Landfill	HE Process Area	Building 850 Firing Table	Pit 2 Landfill	Building 854	Building 832 Canyon	Building 801, Pit 8 Landfill	Building 833	B845 Firing Table, Pit 9 Landfill	Building 851 Firing Table
Monitoring	√	√	√	√	√	√	√	√	√	√	√
Risk and hazard management	√	√	√	√		√	√		√		
Monitored natural attenuation		√		√							
Ground water extraction	√		√			√	√				
Soil vapor extraction	√					√	√				
Excavation of surface soil and sand pile				√							

Table 2. Ground water and soil vapor treatment technologies for the remedies selected in the Interim Site-Wide ROD for LLNL Site 300.

Medium/ Treatment Technology	Building 834	HE Process Area	Building 854	Building 832 Canyon
Ground Water				
GAC	VOCs	VOCs, HE, Perchlorate	VOCs	VOCs
Air Sparging	VOCs	–	–	–
Bioreactor[a]	Nitrate	Nitrate, Perchlorate	Nitrate, Perchlorate	Nitrate, Perchlorate
Ex-Situ Zero-Valent Iron[b]	–	–	–	VOCs, Nitrate
Oil/Water Separator	TBOS/ TKEBS	–	–	–
Ion Exchange[a]	–	Perchlorate	Perchlorate	Perchlorate
Soil Vapor				
GAC	VOCs	–	VOCs	VOCs

Notes:

HE = High-explosive compounds.

GAC = Granular activated carbon.

VOCs = Volatile organic compounds.

[a] **These technologies may be used for perchlorate, if needed.**

[b] **The effectiveness of iron filings to treat nitrate is being evaluated.**

Table 3. Summary of risk and hazard management actions for the remedies selected in the Interim Site-Wide ROD for LLNL Site 300.

	Building 834	Pit 6 Landfill	HE Process Area	Building 850 Firing Table	Pit 2 Landfill	Building 854	Building 832 Canyon	Building 801, Pit 8 Landfill	Building 833	B845 Firing Table, Pit 9 Landfill	Building 851 Firing Table
Risk and hazard monitoring and assessment	√	√	√	√		√	√		√		
Outdoor air sampling	√	√	√				√				
Indoor air sampling	√					√	√		√		
Surface soil sampling				√		√					
Building occupancy restrictions	√					√	√		√		
Land use restrictions	√	√	√	√		√	√		√		
Building ventilation[a]	√					√	√		√		
Warning signs	√	√	√	√		√	√		√		
Wildlife surveys	√	√		√		√					

[a] **To be implemented if building is regularly occupied.**

Table 4. Schedule of milestones for the remedies selected in the Interim Site-Wide ROD for LLNL Site 300.

Milestone	Deliverable date
Building 834: Draft Final Interim Remedial Design report[a]	December 28, 2001
Building 834: Final Interim Remedial Design report	January 28, 2002
High Explosives Process Area: Draft Interim Remedial Design report	February 18, 2002
High Explosives Process Area: Draft Final Interim Remedial Design report	July 1, 2002
High Explosives Process Area: Final Interim Remedial Design report	August 1, 2002
Building 832 Canyon: Construct B830-SRC ground water and soil vapor extraction and treatment facility as a treatability study	September 30, 2002
High Explosives Process Area: Construct B815-PRX ground water extraction and treatment facility	September 30, 2002
Building 834: Initiate wellfield expansion, and upgrade the B834-SRC ground water and soil vapor extraction and treatment facility	December 2, 2002
Building 854: Draft Interim Remedial Design report	April 1, 2003
Building 854: Draft Final Interim Remedial Design report	August 11, 2003
Building 854: Final Interim Remedial Design report	September 12, 2003
High Explosives Process Area: Construct B817-SRC ground water extraction and treatment facility	September 29, 2003
Building 850: Draft Interim Remedial Design report	January 15, 2004
Building 850: Draft Final Interim Remedial Design report	May 28, 2004
Building 850: Final Interim Remedial Design report	June 30, 2004
Building 832 Canyon: Construct B832-PRX ground water extraction and treatment facility as a treatability study	September 30, 2004
Building 832 Canyon: Draft Interim Remedial Design report	April 11, 2005
Building 832 Canyon: Draft Final Interim Remedial Design report	August 19, 2005
Building 850: Remove contaminated surface soil	September 16, 2005
Building 850: Remove contaminated sand pile	September 16, 2005

Table 4. Schedule of milestones for the selected remedies in the Interim Site-Wide ROD for LLNL Site 300 (Cont. Page 2 of 2).

Milestone	Deliverable date
Building 832 Canyon: Final Interim Remedial Design report	September 19, 2005
High Explosives Process Area: Construct B829-SRC ground water extraction and treatment facility	September 30, 2005
High Explosives Process Area: Construct B817-PRX ground water extraction and treatment facility	September 30, 2005
Building 832 Canyon: Construct B830-DIS ground water extraction and treatment facility	September 29, 2006
High Explosives Process Area: Construct B815-DIS ground water extraction and treatment facility	September 28, 2007
Building 832 Canyon: Construct B832-DIS ground water extraction and treatment facility	September 28, 2007
Pit 2, 8, and 9 Landfills: Install enhanced monitoring systems	September 30, 2008

Location of extraction and treatment systems relative to contaminant plume:

SRC - Source area extraction and treatment (source control and mass removal).

PRX - Proximal extraction and treatment (immediately downgradient from source area for mass removal).

DIS - Distal extraction and treatment (downgradient for migration control).

[a] The milestone for the Draft Interim Remedial Design document for Building 834 is contained in Appendix A of the Federal Facility Agreement.