



**U.S. Department Of Energy**  
San Francisco Operations Office, Oakland, California 94612

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**Lawrence Livermore National Laboratory**  
University of California Livermore, California 94551



UCRL-AR-109105

**Record of Decision  
for the Lawrence Livermore  
National Laboratory  
Livermore Site**

**July 15, 1992**



**Environmental Protection Department**  
Environmental Restoration Division

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## Acronyms for ROD and Responsiveness Summary

AEC	Atomic Energy Commission
ARAR	Applicable or Relevant and Appropriate Requirement
BAT	Best Available Technology
BPHA	Baseline Public Health Assessment
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CPF	cancer potency factors
CWG	Community Work Group
DHS	California Department of Health Services
DOE	U.S. Department of Energy
DTSC	California Department of Toxic Substances Control
EDB	ethylene dibromide
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ERD	Environmental Restoration Division
ERWM	Environmental Restoration and Waste Management
FHC	fuel hydrocarbon
FS	Feasibility Study
GAC	granular activated carbon
HI	hazards index
HQ	hazard quotient
HWCA	Hazardous Waste Control Act
LDR	land-disposal restriction
LLNL	Lawrence Livermore National Laboratory
MCL	Maximum Contaminant Level
MDL	Method Detection Limits
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPL	National Priorities List
ORAD	Operations and Regulatory Affairs Division
OSHA	Occupational Safety and Health Administration
PCE	tetrachloroethylene, also perchloroethylene
PRAP	Proposed Remedial Action Plan

RCRA	Resource Conservation Recovery Act
RD	Remedial Design
RfD	reference dose
RI	Remedial Investigation
ROD	Record of Decision
RWQCB	California Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SMCL	secondary MCL
SNL	Sandia National Laboratories
STLC	Soluble Threshold Limit Concentration
SWRCB	State Water Resources Control Board
TBC	"to be considered"
TCE	trichloroethylene
THM	total trihalomethanes
TSD	Transport, Storage, or Disposal
TTLC	Total Threshold Limit Concentration
VOC	volatile organic compounds

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# 1. The Declaration

## 1.1. Site Name and Location

The Lawrence Livermore National Laboratory (LLNL) Livermore site, located at 7000 East Avenue, Livermore, California, is a research and development facility owned by the U.S. Department of Energy (DOE) and operated by the University of California. LLNL was placed on the U.S. Environmental Protection Agency's (EPA) National Priorities List (NPL) in 1987. Currently, about 10,000 people use ground water blended from several downtown Livermore municipal supply wells as their primary drinking water supply. Contaminants from LLNL are currently about 1.6 miles from these supply wells. U.S. EPA, in conjunction with the California Department of Toxic Substances Control (DTSC) and the California Regional Water Quality Control Board (RWQCB), oversees LLNL's investigations and cleanup activities in accordance with Section 120 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended.

## 1.2. Statement of Basis and Purpose

This decision document presents the selected remedial actions for the LLNL Livermore site, in Livermore, California, which were chosen in accordance with CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision document is based on the administrative record for this site.

The U.S. EPA, the RWQCB, and the DTSC of the California Environmental Protection Agency, formerly the California Department of Health Services (DHS), concur with the selected remedies.

## 1.3. Assessment of Site

The identified compounds of concern, if not addressed by the selected remedies or other considered measures, may present a potential risk to public health as discussed in the Proposed Remedial Action Plan (PRAP) for the site.

## 1.4. Description of the Selected Remedy

The Feasibility Study (FS) evaluated many potential remedies for the LLNL site. Those remedies were divided into two general groups, according to whether the chemical contaminants are in ground water or in unsaturated sediment (i.e., sediment above the water table where pore spaces are only partially filled with water). Three alternatives were evaluated for the ground water plume, and two remedies were evaluated for the unsaturated zone (i.e., the interval above the water table where pore spaces are only partially filled with water).

The selected remedy for ground water is Remedial Alternative No. 1 from the FS, which includes:

- Pumping water at 18 initial locations to contain and remediate the ground water plume. Water will be pumped from one or more wells at each of these locations using existing monitor and extraction wells, along with new extraction wells. The initial well locations will be chosen to prevent any contaminants, primarily volatile organic compounds (VOCs), from escaping from the current plume area in concentrations above their Maximum Contaminant Levels (MCLs). To enable more rapid remediation, wells will also be placed in all areas with higher concentrations [i.e., greater than about 100 parts per billion (ppb) VOCs or fuel hydrocarbons (FHCs)]. The initial 18 locations will be augmented when field data indicate that new pumping locations will speed the cleanup.

- Constructing about seven onsite facilities (A to G) to treat the extracted ground water. Each treatment system would be designed to treat the specific combination of compounds in the associated extraction wells.
- Using ultraviolet (UV)/oxidation-based remediation technology to treat VOCs at Treatment Facilities A, B, and E, and FHCs and VOCs at Treatment Facility F. Treatment Facilities C, D, and G would use air-stripping-based technology, which is more effective on the higher concentrations of specific compounds in the area of those facilities (chloroform, carbon tetrachloride, Freon 113; and 1,1,1-trichloroethane). Treatment Facility D will employ ion exchange to remove chromium, and Treatment Facility F will use granular activated carbon (GAC) to remove lead, if necessary.

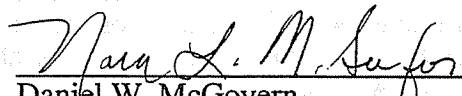
The selected remedy for treating the unsaturated zone is Remedial Alternative No. 1 from the FS. This alternative includes using a process called vacuum-induced venting to extract the contaminants in vapor form from the unsaturated sediments, and treating the vapors by catalytic oxidation and activated carbon.

The selected remedies address the principal concerns at the LLNL site by removing contaminants in ground water and soil vapor and treating them at the surface to levels protective of human health and the environment.

This Record of Decision (ROD) applies to all known contaminants in ground water and unsaturated sediment originating from activities at the LLNL site. An additional potential source of hazardous materials (i.e., the Trailer 5475/East Taxi Strip Area) was identified after completion of the PRAP on the LLNL site. If future investigations identify additional public health or environmental risks from this or other potential sources, this ROD may be augmented through CERCLA/SARA and the NCP to address any additional action.

### 1.5. Statutory Determinations

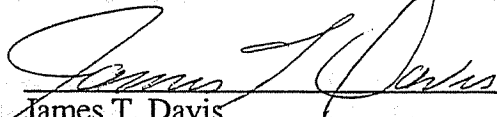
The selected remedies are protective of human health and the environment, comply with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and are cost-effective. The remedies utilize permanent solutions and alternative treatment technology, to the maximum extent practicable, and satisfy the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element. Because these remedies may result in hazardous materials remaining onsite above health-based levels until cleanup is complete, a review will be conducted within 5 years after commencement of remediation to assure that the remedies continue to provide adequate protection of human health and the environment.



Daniel W. McGovern  
Regional Administrator, EPA Region IX

8-5-92

Date



James T. Davis  
Acting Manager, DOE San Francisco Field Office

7/23/92

Date

## 2. Decision Summary

### 2.1. Site Name, Location, and Description

LLNL is a multidisciplinary research facility owned by DOE and operated and managed by the Regents of the University of California under contract with DOE. LLNL is located at 7000 East Avenue in southeastern Alameda County, approximately 3 miles east of the downtown area of Livermore, California (Fig. 1). The LLNL site, including the adjacent buffer zone, comprises approximately 800 acres (Fig. 2). The site is heavily developed with large-scale experimental research and support facilities. About 223 storage tanks exist onsite, 46 of which are underground tanks that currently store hazardous materials. A stormwater drainage retention basin roughly 800 feet by 300 feet in size is situated near the center of LLNL. This basin was recently lined to prevent infiltration of ponded surface water.

The LLNL site land surface slopes approximately 1% to the northwest. Hills of the Diablo Range flank the site to the south and east. The site is underlain by several hundred feet of complexly interbedded alluvial and lacustrine sediments.

Ground water beneath the site is partly within the Spring and Mocho I hydrologic subbasins (DWR, 1974). Depth to ground water at the site varies from about 120 feet in the southeast corner to about 25 feet in the northwest corner. Ground water about 2 miles west of LLNL is used for municipal supply in downtown Livermore. Ground water about 1,000 feet south of East Avenue and about 1,000 feet west of Vasco Road and south of East Avenue is used for domestic and agricultural irrigation. Two intermittent streams, the Arroyo Seco and the Arroyo Las Positas, traverse the area (Fig. 2) and recharge the ground water system during wet periods.

Land immediately north of the LLNL site is zoned for industrial use. To the west, the land use is zoned for high-density urban use. Sandia National Laboratories (SNL), Livermore are located south of the site (Fig. 2) in an area zoned for industrial development. The area east of LLNL is zoned for agriculture and is currently used as pasture land [LLNL Remedial Investigation (RI), Thorpe *et al.*, 1990].

As reported in the Draft Environmental Impact Statement and Environmental Impact Report for LLNL and Sandia National Laboratories, Livermore (DOE and University of California, 1992), no threatened or endangered species are present at the LLNL Livermore site. Wetlands are very limited at the Livermore site and consist of three small areas associated with culverts that channel runoff from the surrounding area into Arroyo Las Positas at the northern perimeter of the site (DOE and University of California, 1992).

### 2.2. Site History and Summary of Enforcement Activities

#### 2.2.1. Site History

The LLNL site was converted from agricultural and cattle ranch land by the U.S. Navy in 1942. The Navy used the site until 1946 as a flight training base and for aircraft assembly, repair, and overhaul. Solvents, paints, and degreasers were routinely used during this period. Between 1946 and 1950, the Navy housed the Reserve Training Command at the site. In 1950, the Navy allowed occupation of the site by the Atomic Energy Commission (AEC), which formally received transfer of the property in 1951. Under the AEC, the site became a weapons design and basic physics research laboratory. In 1952, the site was established as a separate part of the University of California Radiation Laboratory. Responsibility for the site was transferred from AEC to the Energy, Research, and Development Administration in 1975. In 1977, responsibility for LLNL was transferred to the DOE, which is currently responsible for the site. In addition to weapons research, LLNL programs have been established in biomedicine, energy, lasers, magnetic fusion energy, and environmental sciences. Details of the site history and the

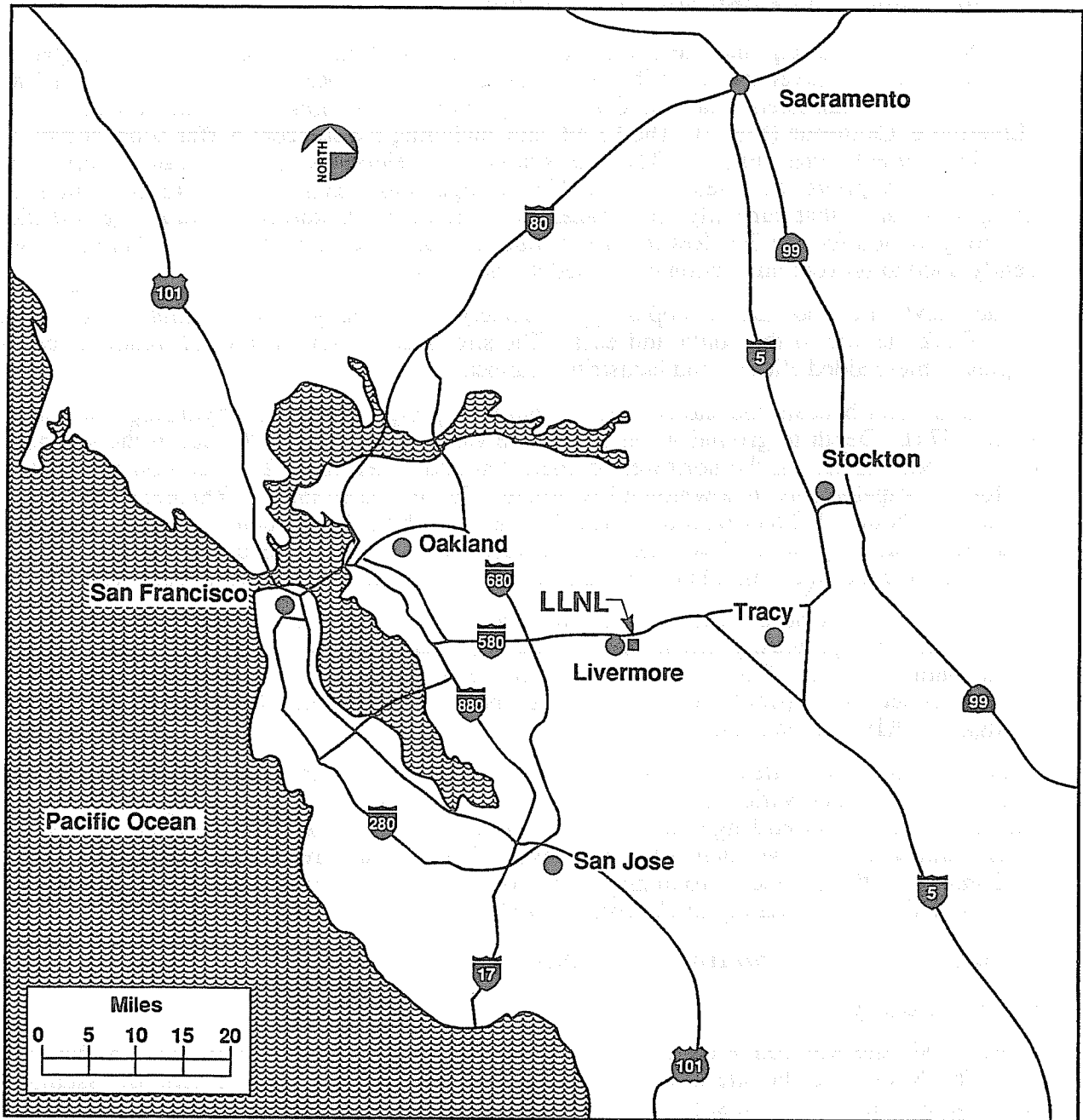


Figure 1. Location of the LLNL Livermore site.

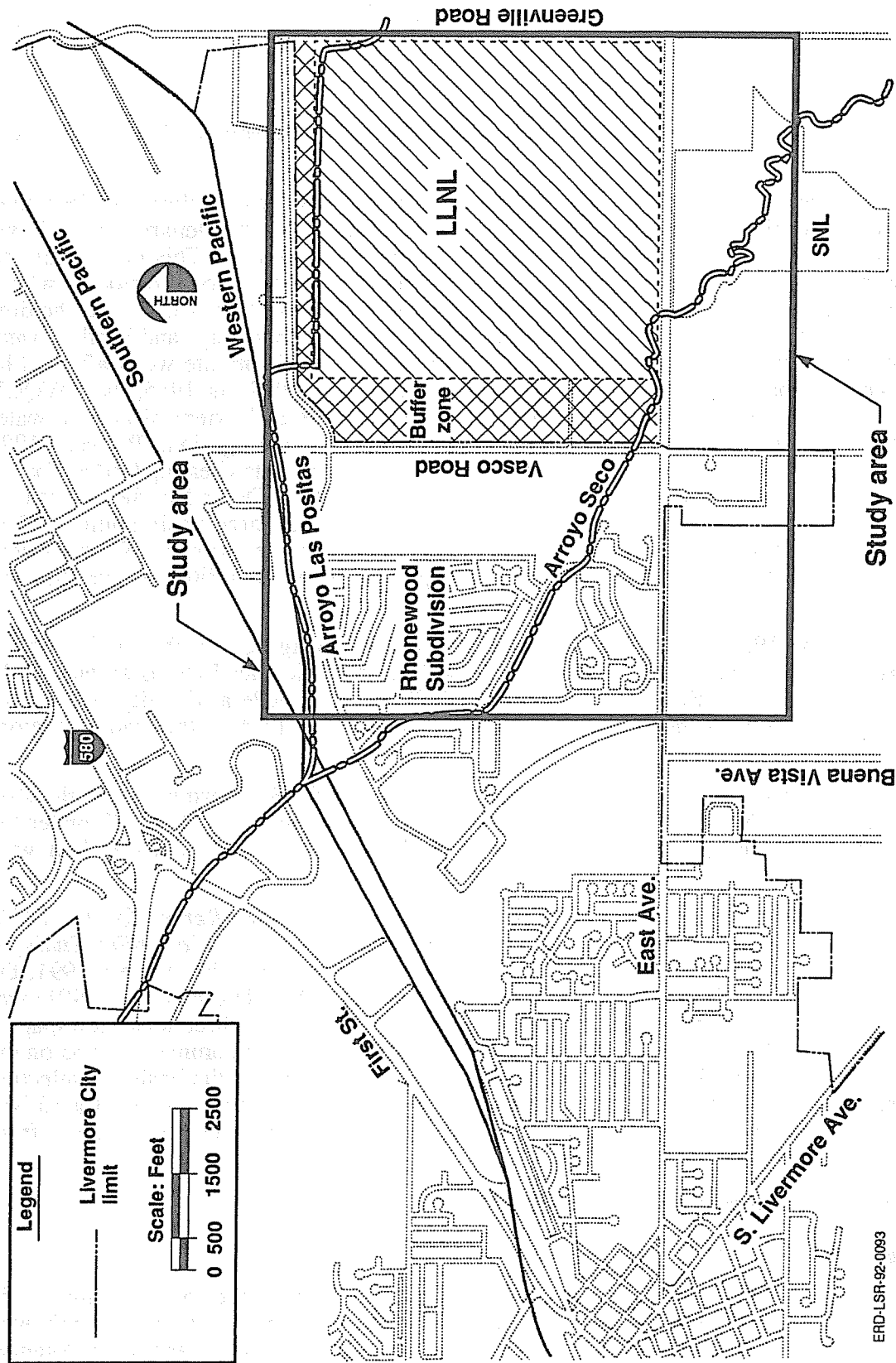


Figure 2. The LLNL site and surrounding area.

use, storage and disposal of hazardous materials are presented in the Remedial Investigation (RI) (Thorpe *et al.*, 1990).

### 2.2.2. Summary of Enforcement Activities

The LLNL site was in operation prior to the enactment of the Resource Conservation and Recovery Act of 1976.

The first regulatory order for the LLNL ground water problem was a compliance order issued in 1984 by the California Department of Health Services (DHS) (now the Department of Toxic Substances Control of the California Environmental Protection Agency). This order required LLNL to investigate ground water quality and to supply bottled water to local residents whose domestic wells had been affected by solvents migrating in ground water from LLNL. At the time this order was issued, the ground water investigation was already underway, and bottled water had been supplied to those local residents since December 1983. All private wells affected by the solvents were permanently sealed by LLNL between 1985 and 1989. In 1985, the RWQCB issued Waste Discharge Requirements to define the vertical and lateral extent of ground water contamination, and to allow discharge of ground water during the investigation. Between 1986 and 1991, the RWQCB issued four Waste Discharge Orders and two Site Cleanup Orders for the LLNL site. Currently, two RWQCB Orders are in effect at LLNL. Order No. 88-075 allows discharge of treated water from pilot Treatment Facility A to a recharge basin south of East Avenue. Order No. 91-091 allows discharge of treated ground water from LLNL treatment facilities to ditches and arroyos, and recharge of treated ground water via infiltration trenches and recharge wells.

Between 1985 and 1987, the RWQCB was the lead regulatory agency for the LLNL ground water investigation. In 1987, LLNL was added to the National Priorities List, as amended. In November 1988, DOE, U.S. EPA, DTSC, and RWQCB signed a Federal Facility Agreement (FFA), which named DOE as the overall lead agency and the U.S. EPA as the lead regulatory agency.

LLNL conducted two significant removal actions prior to 1985. Four former pits in the Taxi Strip Area in eastern LLNL were excavated and backfilled in the winter of 1982-83 under the oversight of the RWQCB. In 1984, a former landfill was excavated and backfilled with oversight by the DHS.

In May 1990, LLNL issued the *CERCLA Remedial Investigations Report for the LLNL Livermore Site* (RI) (Thorpe *et al.*, 1990). In December 1990, the *CERCLA Feasibility Study for the LLNL Livermore Site* (FS) (Isherwood *et al.*, 1990) was issued, and, in October 1991, the *Proposed Remedial Action Plan for the LLNL Livermore Site* (PRAP) (Dresen *et al.*, 1991) was submitted. The Notices of Availability for the PRAP were published in three local newspapers on October 18, 1991, and again on November 19 and 20, 1991, when the comment period on the PRAP was extended. These documents, and all other documents that are the basis for selecting the cleanup remedies for the LLNL site, are contained in the Administrative Record for LLNL, which is located at the LLNL Visitors Center. The LLNL Visitors Center can be accessed from the Greenville Road (east) entrance to LLNL.

## 2.3. Highlights of Community Participation

### 2.3.1. Background

The LLNL ground water problem was brought to the attention of the local community in December 1983, when perchloroethylene (PCE) was first discovered in the domestic supply well of a former rental property northeast of the intersection of Vasco Road and East Avenue. LLNL's immediate action was to sample private wells and deliver bottled water to nearby residents whose wells had been affected. LLNL periodically surveyed these households, located

south, southwest and west of LLNL, to ensure that residents were receiving bottled water to meet their water needs, and that the water was arriving in a timely manner. Subsequently, LLNL provided free municipal (City of Livermore) water hookups to the affected households. LLNL also began a regular private well sampling program. In all cases, testing results were (and continue to be) shared with the residents either through telephone calls, personal visits, or follow-up letters that include written sampling results.

In May 1988, LLNL and DOE held a general information meeting for the community on the ground water investigation with key Ground Water Project staff. In addition, LLNL and DOE have responded and continue to respond to requests from the public for information.

LLNL staff conducted interviews between April and July of 1988 with approximately 45 individuals, groups, and agencies to investigate their concerns and information needs regarding the Livermore site cleanup. The results of these interviews formed the basis for the Community Relations Plan that LLNL issued in May 1989. Copies of this plan were made available to the public, and placed in the information repositories located at the Livermore Public Library and at the LLNL Visitors Center.

The specific objectives of the LLNL Livermore Site Community Relations Program are to:

- Continue providing interested members of the community with timely information about technical activities and findings.
- Provide ongoing opportunities for two-way communication between the LLNL Ground Water Project and the community.
- Establish effective communication with local elected and administrative officials.
- Remain alert to the community's needs and concerns about the Ground Water Project and other LLNL activities.

### 2.3.2. Community Involvement

The LLNL Community Relations Program communicates with the public through six primary methods:

1. Meetings with a Community Work Group (CWG).
2. Distribution of a quarterly newsletter called the *Ground Water Project Update* and fact sheets.
3. Maintenance of the two information repositories.
4. Support to those responsible for offsite water samples and water level surveys.
5. Setting up tours and responding to general information requests.
6. Meeting with members of the public, including the Technical Advisors hired by a local community group as part of the EPA Technical Assistance Grant (TAG) Program.

Each of these activities is described below.

#### 2.3.2.1. Community Meetings

LLNL established the CWG in 1988 to provide an ongoing forum to advance understanding of technical issues and project decisions, community interests, and the Superfund process throughout the course of the LLNL Ground Water Project. The group is composed of private individuals, representatives of a local community group, and representatives of U.S. EPA, RWQCB, and DTSC. The CWG meets quarterly, and sometimes more often, depending on the status of the technical and regulatory aspects of the Ground Water Project. LLNL has worked to

distribute and explain technical information to the CWG and identify key issues of concern. LLNL has taken steps to respond to those concerns by providing additional information, making changes to certain aspects of the project or, when changes are not possible, by providing the reasons for not taking the proposed action. CWG meetings are open to the public.

A public meeting on the PRAP was held on November 6, 1991, as required by the CERCLA process. About 80 people attended the meeting. The Notice of Availability for the PRAP was published in three local newspapers on October 18, 1991. The public comment period on the PRAP extended from October 18 to December 18, 1991. All comments on the PRAP are addressed in Attachment A, the Responsiveness Summary, to this ROD.

#### ***2.3.2.2. Ground Water Update and PRAP Fact Sheet***

Distributed on a quarterly basis, the *Ground Water Project Update* reflects LLNL's desire to regularly inform the community about the Ground Water Project. This multipage fact sheet is distributed to more than 1,800 individuals and organizations. The first edition was published in June 1989.

A fact sheet on the PRAP was distributed in October 1991 prior to the opening of the public comment period on the PRAP. The fact sheet was written specifically to facilitate community understanding of the PRAP.

#### ***2.3.2.3. Information Repositories***

LLNL established two information repositories in 1989 to provide locations for interested members of the public to review project-related reports. One repository is located at the Livermore Public Library, 1000 South Livermore Avenue, the other is at the LLNL Visitors Center on Greenville Road. The Visitors Center also contains the Administrative Record, which is comprised of all the documents that form the basis for LLNL's final cleanup plan.

#### ***2.3.2.4. Support to Offsite Well Monitoring Program***

The Ground Water Project arranges sampling times and locations that are convenient to those residents and businesses affected by the offsite well monitoring program. Followup includes mailing a letter that explains the significance of the results.

#### ***2.3.2.5. Tours and General Information Requests***

Tours have been conducted on request for interested members of the public and for the press. In 1991, tours were conducted of the pilot study treatment units for CWG members and the press. On LLNL Family Day of 1990, special sitewide tours for a number of interested groups were conducted. Requests for general information are handled by community relations staff or appropriate LLNL staff.

#### ***2.3.2.6. Contact with Technical Assistance Grant Advisors***

A local citizens group hired two technical advisors under a grant approved by U.S. EPA and funded by the DOE as part of the TAG program. The technical advisors have attended CWG meetings and have submitted comments to LLNL regarding project reports. LLNL provided copies of project documents, conducted tours, responded to the advisors' queries, and held an all-day meeting with these advisors in July 1991. LLNL also provided one of the advisors with work space and resources for a week to review project-related documents.

#### ***2.3.2.7. Future Community Involvement***

DOE and LLNL are committed to maintaining community involvement throughout the cleanup. If desired by the local community, DOE/LLNL will continue to support a CWG. CWG meetings may be used to brief TAG advisors, if desired. Progress of the cleanup will also be



reported to the regulatory agencies and the community in *Monthly Progress Reports*. As required by CERCLA, the Community Relations Plan will be updated after the ROD is signed.

## 2.4. Scope and Role of Response Actions

The remedial alternatives described in the FS (Isherwood *et al.*, 1990) and the PRAP (Dresen *et al.*, 1991) are summarized in this ROD and address VOCs, FHCs, chromium, and lead in ground water, and FHCs and VOCs in sediment above the water table (the unsaturated zone). In addition, tritium has been detected locally in the soil and ground water, but as described in Section 4.2.1 of the PRAP, tritium at LLNL is self-remediating via natural decay and does not require cleanup. There is no significant way for people to be exposed to the contaminants in the unsaturated zone at LLNL except by migration of the contaminants to the ground water.

This ROD addresses all known ground water and unsaturated zone contamination and any resultant human health and environmental risks, and incorporates the results of LLNL pilot studies. Amendments to this ROD may be made in the future to address significant new or additional contaminants and/or source areas or other unforeseen conditions.

The cleanup objectives for all contaminants originating at LLNL are to:

1. Prevent future human exposure to contaminated ground water and soil.
2. Prevent further migration of contaminants in ground water.
3. Reduce contaminant concentrations in ground water to levels below MCLs, and reduce the contaminant concentrations in treated ground water to levels below State discharge limits (Table 1).
4. Prevent migration in the unsaturated zone of those contaminants that would result in concentrations in ground water above an MCL.
5. Meet all discharge standards of existing permits for treated water, and to treat vapor so that there are no measurable atmospheric releases from treatment systems.

The selected remedial alternatives will achieve these cleanup objectives and address all of the principal concerns at the site by removing the hazardous compounds from the ground water and subsurface soil, when warranted, and treating them at the surface at about seven onsite facilities. Ground water extraction will contain contaminant plumes, stop further migration of contaminants in ground water, and prevent any human exposure to them via water wells. The ground water treatment facilities will use different remediation technologies appropriate for the different influent contaminants and will be designed to reduce contaminant concentrations in the treated ground water to levels below established State discharge standards.

Ground water extraction and treatment will continue until the Federal and State agencies agree that the remediation standards have been met. The target objective is to reduce the concentrations in the ground water after cleanup to levels below MCLs (Table 1).

The ground water remediation standards in Table 1 are the lower of the Federal or State MCLs, and apply to the concentrations remaining in the ground water after remediation is complete. Ground water cleanup is complete when samples taken anywhere in the plume demonstrate that the remediation standards have been achieved. The discharge limits in Table 1 apply to the effluent water from treatment systems that may be discharged to ditches or arroyos. Although some discharge limits are lower than MCLs, remediation will continue until the remediation standards are met.

Volatile contaminants in the unsaturated zone will be removed by extracting them in vapor, which will be treated onsite. Atmospheric emissions from treatment systems will comply with

Table 1. Remediation standards and State discharge limits for compounds of concern in ground water at the LLNL site.

Constituent	Concentration limit for drinking water <sup>a</sup>		Pre-remediation concentration range at LLNL, March 1990–March 1991 (ppb)	Discharge limit <sup>b</sup> for treated water (ppb)
	Federal MCL (ppb)	California MCL (ppb)		
PCE	5	5	<0.1–1,050	4
TCE	5	5	<0.1–4,800	5
1,1-DCE	7	6	<0.5–370	5
cis-1,2-DCE	70	6	<0.5–24	5 (total 1,2-DCE)
trans-1,2-DCE	100	10	<0.5–1	5
1,1-DCA	—	5	<0.5–60	5
1,2-DCA	5	0.5	<0.1–190	5
Carbon tetrachloride	5	0.5	<0.1–91	5
Total THM <sup>c</sup>	100 <sup>c</sup>	100 <sup>c</sup>	<0.5–270	5
Benzene	5	1.0	<0.1–4,600	0.7
Ethyl benzene	700	680	<0.2–610	5
Toluene	1,000	—	<0.5–4,200	5
Xylenes (total)	10,000	1,750 <sup>d</sup>	<0.5–3,700	5
Ethylene dibromide	0.05	0.02	<0.1–51	0.02
Total VOCs	—	—	up to 5,808	5
Chromium <sup>+3</sup>	50 (total Cr) <sup>e</sup>	50 (total Cr)	<5–150 (total Cr)	50 (total Cr)
Chromium <sup>+6</sup>	50 (total Cr) <sup>e</sup>	50 (total Cr)	<10–140	11
Lead	15 <sup>f</sup>	50	<2–10	5.6
Tritium <sup>g</sup>	20,000 pCi/L	20,000 pCi/L	<200–33,100	(h)

<sup>a</sup> Human receptor. The more stringent concentration limits on this part of the table are shown in a larger typeface to illustrate that LLNL will comply with the most stringent requirements.

<sup>b</sup> From National Pollutant Discharge Elimination System (NPDES) Permit No. CA0029289 (revised 8/1/90) and RWQCB Order No. 91-091. Of the LLNL compounds of concern, VOC-specific State discharge limits exist in RWQCB Order No. 91-091 only for PCE (4 ppb), benzene (0.7 ppb), and ethylene dibromide (0.02 ppb). Other VOCs listed in this table are included in the 5 ppb total VOC limit. Discharge limits for metals differ slightly according to discharge location.

<sup>c</sup> Total trihalomethanes (THMs); includes chloroform, bromoform, chlorodibromomethane, and bromodichloromethane (California Drinking Water Requirement).

<sup>d</sup> MCL is for either a single isomer or the sum of the ortho, meta, and para isomers.

<sup>e</sup> National Interim Primary Drinking Water Regulation for total chromium is presently 50 ppb, but will increase to 100 ppb in July 1992. No MCLs exist for Cr<sup>+3</sup> or Cr<sup>+6</sup>.

<sup>f</sup> National Primary Drinking Water Regulation Enforceable Action Level (Federal Register, volume 56, number 110, June 7, 1991, p. 26460).

<sup>g</sup> The RI shows that ground water in the one well that currently exceeds the tritium MCL will be naturally remediated long before it migrates offsite.

<sup>h</sup> There is currently no NPDES discharge limit for tritium. LLNL will use the MCL for tritium as the discharge limit.

Bay Area Quality Management District (BAAQMD) standards. Contaminants in the unsaturated zone will be remediated only if it is predicted that they would result in concentrations above an MCL if allowed to migrate into the ground water. Unsaturated zone remediation will be complete when modeling shows that contaminants will no longer migrate to ground water and create concentrations in the ground water above an MCL.

As part of the additional source investigations that are in progress, evaluations of the transport of VOCs and non-VOCs from the unsaturated zone to the ground water will be conducted. These investigations may identify areas where additional soil and ground water remediation is necessary. Results of these investigations will be summarized in *Monthly Progress Reports* for review by the regulatory agencies and the public.

Treated ground water will be recharged via wells, the LLNL recharge basin, and local arroyos, and/or used for LLNL landscape irrigation or in LLNL cooling towers, to conserve water resources.

## 2.5. Site Characteristics

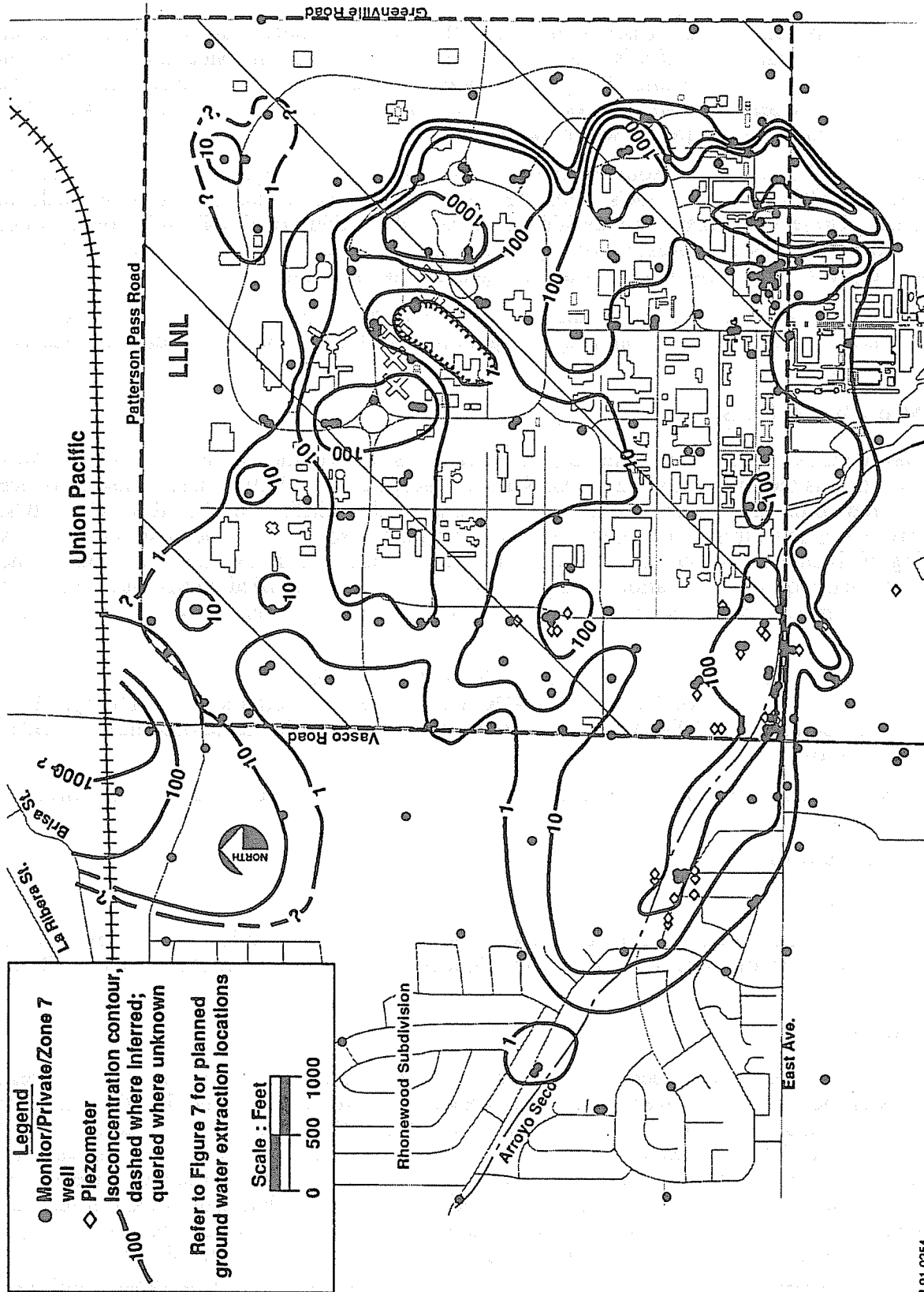
Initial releases of hazardous materials occurred at the LLNL site in the mid- to late 1940s when the site was the Livermore Naval Air Station (Thorpe *et al.*, 1990). There is also evidence that localized spills, leaking tanks and impoundments, and landfills contributed VOCs, FHCs, lead, chromium, and tritium to ground water and unsaturated sediment in the post-Navy era. A screening of all environmental media showed that ground water and unsaturated sediment are the only media that require remediation (Thorpe *et al.*, 1990). The identified compounds that exist in ground water at various locations beneath the site at concentrations above drinking water standards are:

1. The VOCs trichloroethylene (TCE), perchloroethylene (PCE), 1,1-dichloroethylene (1,1-DCE), 1,2-dichloroethylene (1,2-DCE), 1,1-dichloroethane (1,1-DCA), 1,2-dichloroethane (1,2-DCA), carbon tetrachloride, and the trihalomethane (THM) chloroform.
2. FHCs (leaded gasoline), including benzene, ethylbenzene, toluene and ethylene dibromide.
3. Chromium and lead.
4. Tritium.

The quality of data for these compounds was considered in the selection of the remedies for the LLNL site in accordance with the *LLNL Quality Assurance Project Plan* (QAPP, Rice, 1988).

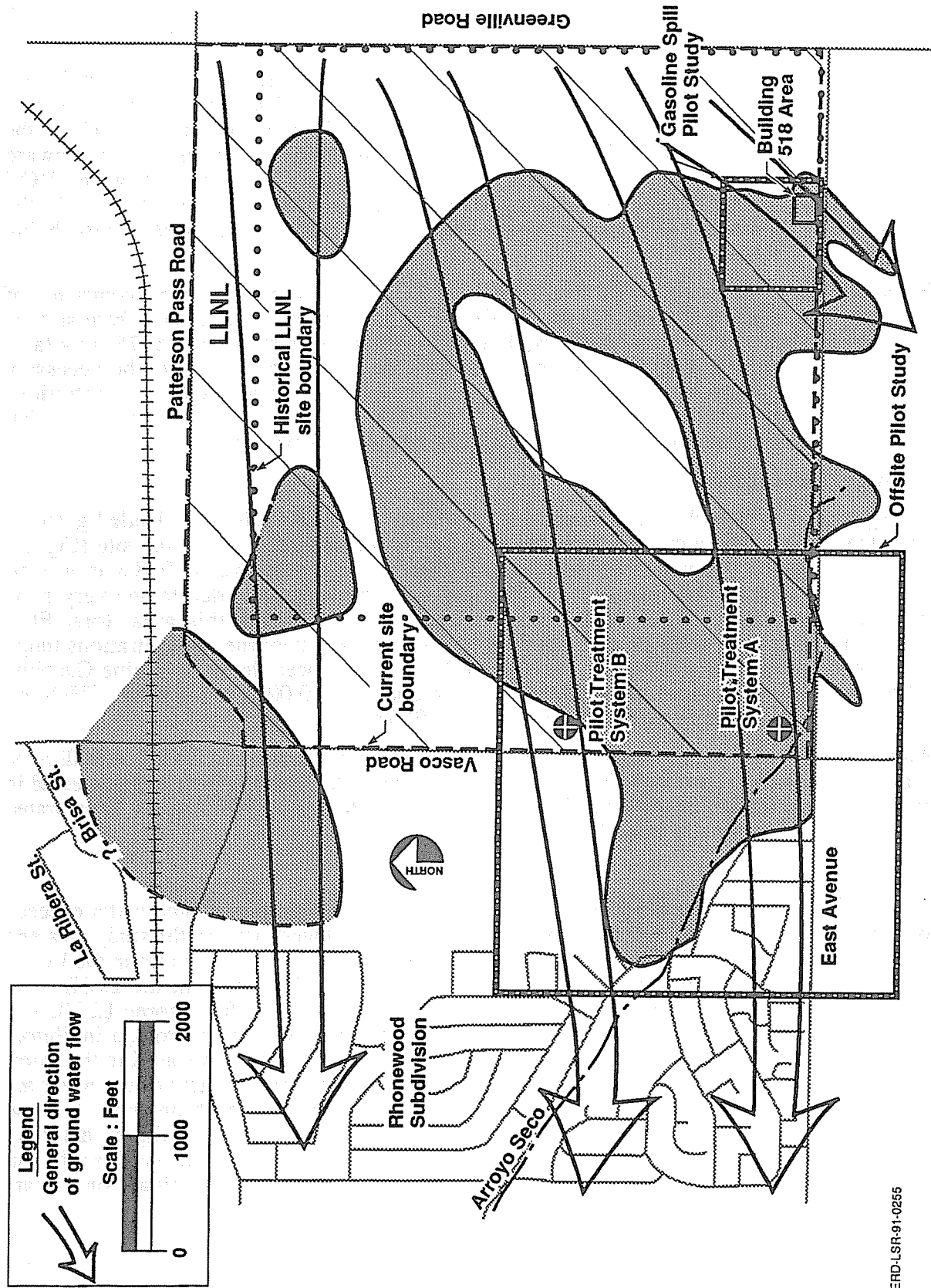
### 2.5.1. VOCs

The VOCs in ground water beneath LLNL occur in relatively low concentrations that underlie about 85% of the LLNL site, over a total area of about 1.4 square miles (Fig. 3). The calculated total volume of undiluted VOCs in ground water is less than 200 gallons. The vertical thickness of the ground water VOC plumes varies from about 30 to 100 feet, and VOCs are seldom found below a depth of about 200 feet. VOCs are relatively mobile in ground water and migrate at a rate of about half the velocity of ground water. TCE and PCE are the predominant VOCs in the study area, and are currently present locally in concentrations up to 4.8 and 1.1 parts per million (ppm) respectively (1992 data). However, the higher concentrations are localized, and total VOC concentrations exceed 1 ppm in ground water from only 10 out of a total of more than 300 wells. The distribution of VOCs in ground water exceeding MCLs is shown in Figure 4. The VOCs and chromium in ground water in the vicinity of the Patterson Pass-Vasco Road intersection appear to originate on private property northwest of the LLNL site as discussed in Iovenitti *et al.* (1991) and



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Figure 3. Isoconcentration contour map of total VOCs in ground water.



ERD-LSR-91-0255

Figure 4. Area where one or more VOCs in ground water equals or exceeds Federal or California maximum contaminant levels (MCLs).

Hoffman (1991a). This offsite area will be investigated by the potentially responsible parties under RWQCB order. If LLNL is found to be the source of chromium in this area, LLNL will incorporate this area into the remedial design.

Chemical data from boreholes drilled at the locations of suspected VOC releases at LLNL indicate that generally low residual VOC concentrations (less than 100 parts per billion [ppb]) are present in unsaturated sediments. The calculated total volume of undiluted VOCs in the unsaturated zone is less than 100 gallons. Computer modeling indicates that downward movement of VOCs above the water table is not likely to result in ground water VOC concentrations exceeding MCLs for drinking water, except at the Building 518 Area in the southeast corner of the site (Isherwood *et al.*, 1990). The Trailer 5475 Area is also being evaluated for possible cleanup.

In the Building 518 Area, VOCs (predominantly TCE) reach a maximum concentration of about 6 ppm at a depth of 20 feet. These VOCs are believed to have originated from surface spills or leaking drums in the post-Navy era. Recent investigation in the Trailer 5475 Area (also called the East Taxi Strip Area) in eastern LLNL indicate that remediation may be necessary pending additional subsurface investigations and modeling. Total VOC concentrations (predominantly TCE) reach a maximum concentration in unsaturated soil of about 5 ppm in that area. These VOCs originate from former landfills and surface impoundments.

### 2.5.2. Fuel Hydrocarbons

FHCs occur almost exclusively where a leak of roughly 17,000 gallons of leaded gasoline occurred from a U.S. Navy-era underground fuel tank in the southern part of the site (Fig. 5). Although some gasoline constituents are relatively mobile in ground water, FHCs in ground water have not migrated more than about 500 feet from the leak point due to the very slow ground water movement in the area (Thorpe *et al.*, 1990). Within this area, total FHC concentrations in ground water range from 0.001 to 16 ppm, and benzene concentrations range from less than 0.0001 to about 4 ppm. Ethylene dibromide has been detected in nine Gasoline Spill Area monitor wells above the MCL in concentrations from 0.0001 to 1.3 ppm. FHCs are not present in ground water beneath a depth of about 150 feet.

Prior to withdrawal of fuel vapor by vacuum-induced venting as part of a Gasoline Spill Area pilot study, up to 11,000 ppm total FHCs and 4,800 ppm aromatic hydrocarbons were detected in the unsaturated sediments beneath the former fuel tank. Virtually all FHCs in the unsaturated zone are about 50 feet radially from the leak point.

### 2.5.3. Metals

Metals above MCLs are present in only a few locations. Chromium in ground water exceeds the MCL in 16 wells scattered in the northwest, central, and southwest parts of the study area and near Arroyo Seco (Fig. 6). The maximum chromium concentration in ground water in the LLNL study area is 160 ppb, in the northwestern corner of the site. Chromium in the LLNL area sediments and ground water appears to have originated naturally and from some LLNL site activities. At LLNL, chromate solutions were used in cooling towers as corrosion inhibitors from approximately 1958 to 1970. Blowdown from the cooling towers was released to the storm drain system, but neither the exact quantity of releases nor the chromium content of the water are known. According to anecdotal information, storm runoff caused the blowdown to flow northerly before infiltrating into the ground near the West Traffic Circle. In addition, naturally occurring chromium deposits have been mined in the hills southeast of LLNL. As described in Section 2.5.1, chromium in ground water northwest of LLNL appears to originate on private property and will be investigated by others (i.e., the potentially responsible parties).

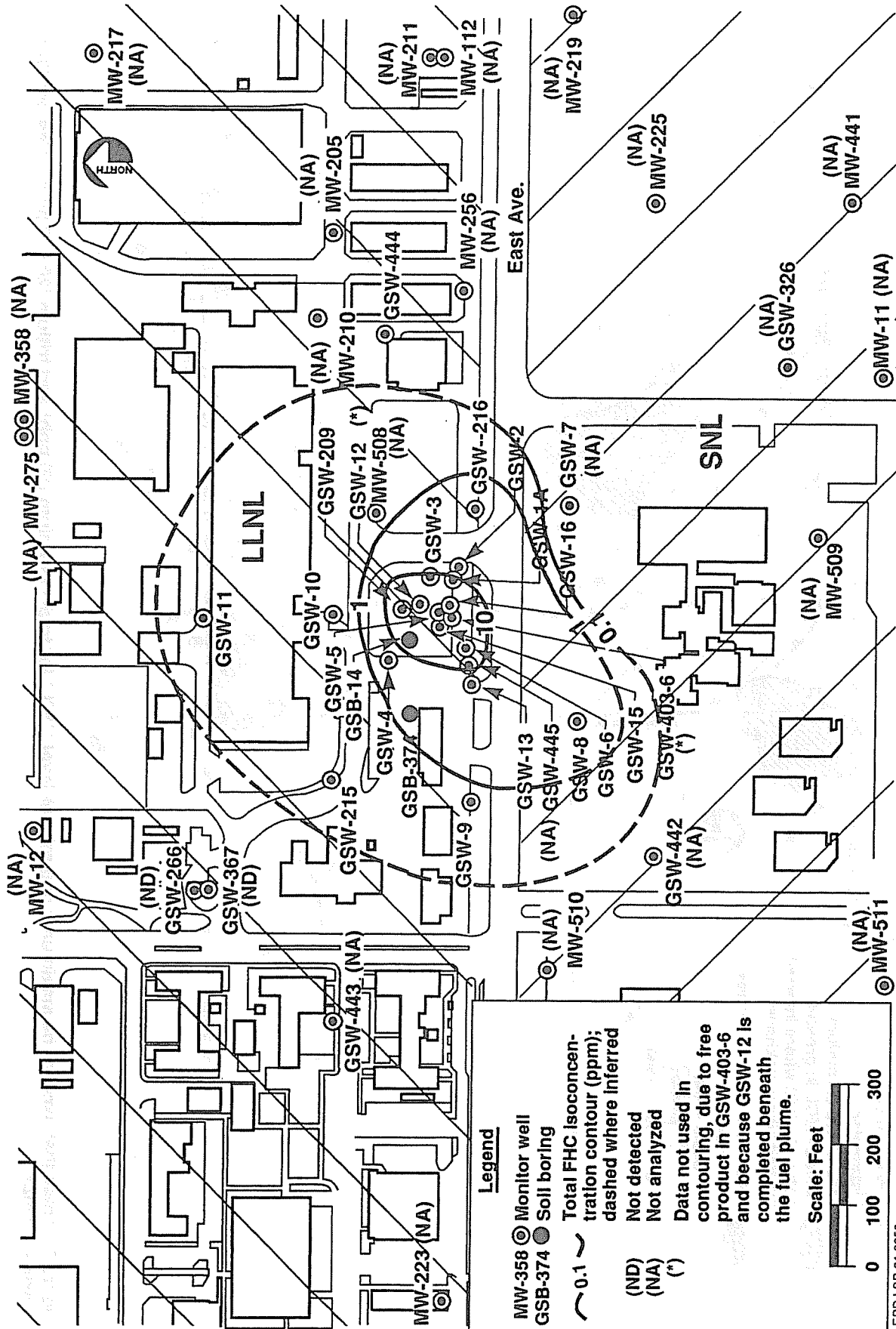
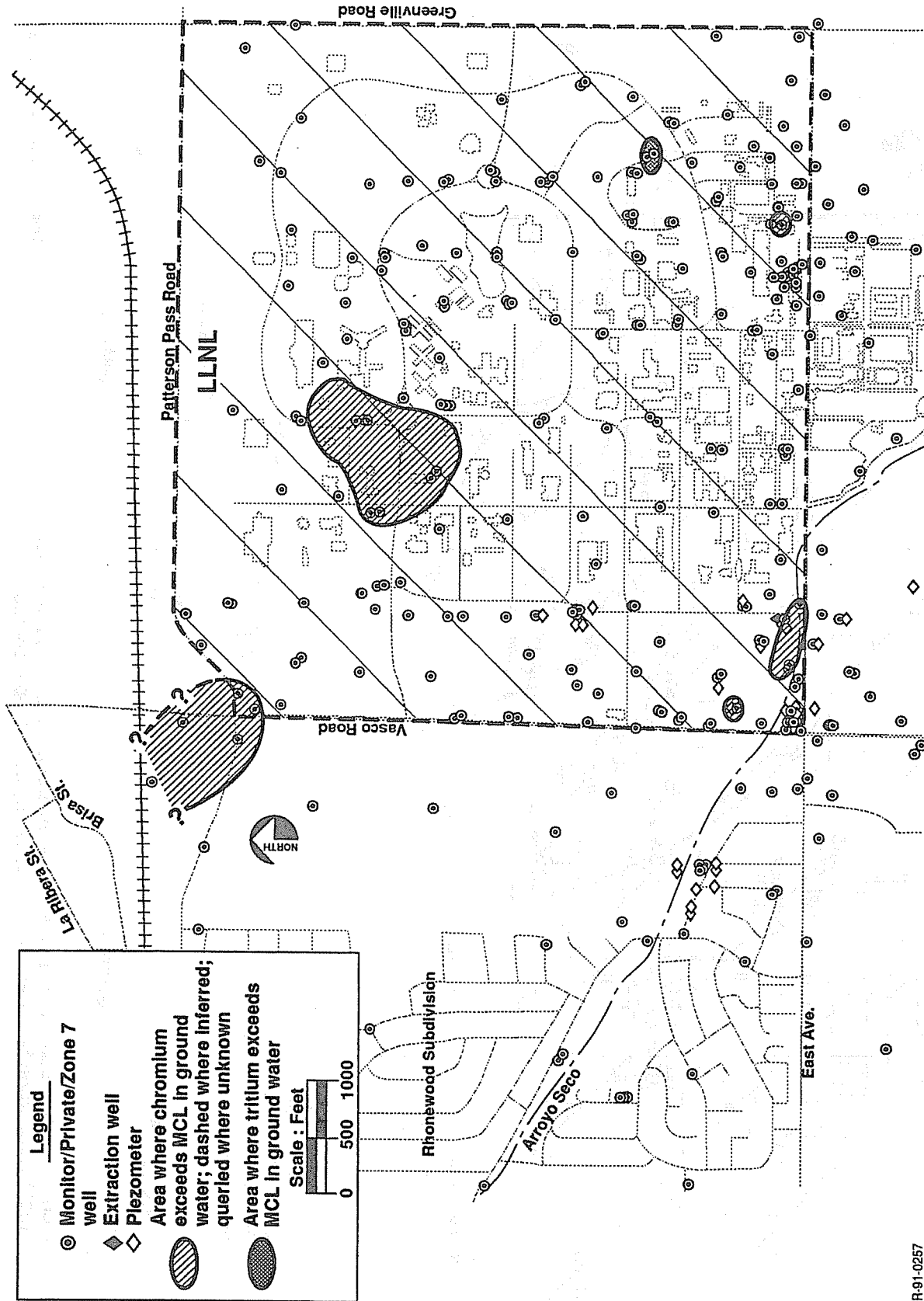


Figure 5. Isoconcentration contour map of total fuel hydrocarbons (FHCs) in ground water, Gasoline Spill Area, March 1989. All areas that exceed fuel hydrocarbon MCLs are encompassed by the 0.1-ppm contour.



ERD-LSR-91-0257

Figure 6. Areas that exceed the maximum contaminant level (MCL) for total chromium (50 ppb) and tritium (20,000 picocuries per liter) in ground water.



Recent analyses indicate lead is above the 15 ppb remediation standard in only two wells, both in the Gasoline Spill Area, at a maximum concentration of 38 ppb. Lead has a low potential for migration in both the saturated and unsaturated zones because it binds strongly to sediment. This low migration rate and limited extent, indicate that lead at LLNL does not pose a health threat. If, however, lead is found in ground water above the remediation standard, it will be remediated.

#### 2.5.4. Tritium

Tritium in ground water has historically exceeded its MCL (20,000 picocuries per liter [pCi/L]) in only two wells, MW-206 and MW-363, both in the southeast part of the LLNL site. Currently, water from only MW-206 exceeds the tritium MCL (Fig. 6). This tritium was released to the subsurface in former, nearby evaporation ponds, is localized and well defined, and the affected ground water is not used for drinking water. Although tritium migrates at the same rate as ground water, ground water modeling indicates that by the time the affected ground water moves offsite in the absence of active remediation, tritium concentrations would be reduced to concentrations below drinking water standards by natural decay (tritium has a 12.3-year half-life). Therefore, no pathway to humans exists for the observed tritium in ground water. The tritium is effectively self-remediating via natural decay. Ground water will continue to be monitored for tritium to track its distribution and concentrations over the duration of the cleanup.

Recent investigations have identified additional areas where tritium concentrations in unsaturated sediments at LLNL are significantly elevated. These include the Building 514, Eastern Landing Mat Storage, West Traffic Circle, Building 292, and Old Salvage Yard Areas. However, the tritium activity in ground water in these areas is well below the 20,000 pCi/L MCL. The only potentially significant transport pathways to human populations for this tritium are inhalation and skin absorption of tritiated water from direct soil evaporation or from water taken up by plants and released to the air by transpiration from plant leaves. Most of the areas where tritium has been detected are paved with asphalt, thereby limiting potential evaporation from soil and further downward migration by infiltration of rainwater. Elevated tritium levels in transpired water have been measured in isolated areas at LLNL. Screening-level calculations have been performed by LLNL using the standard EPA model AIRDOS-EPA and very conservative assumptions that maximize the calculated dose. These calculations indicate that any potential dose from the measured tritium in soil would not exceed 0.01% of the 10-millirem/year Federal dose standard (Macdonald *et al.*, 1990). Additional information regarding the distribution, concentration, toxicity, mobility, potential routes of migration, and potential exposed populations of all LLNL compounds of concern can be found in the RI, the Baseline Public Health Assessment (BPHA) (Layton *et al.*, 1990), and Sections 2.1 and 2.6 of this ROD.

## 2.6. Summary of Unremediated Site Risks

As part of the RI report (Thorpe *et al.*, 1990), the BPHA (Layton *et al.*, 1990) was conducted to estimate the potential future health risks if contaminants in ground water and sediments originating from LLNL were not remediated. Evaluation of a no-action scenario is a requirement of the NCP, 40 CFR section 300.430(e)(6), to represent a baseline condition. In addition, a risk assessment was conducted as part of the FS (Isherwood *et al.*, 1990) to estimate the potential public health risks if the concentrations of VOCs in ground water were reduced to their respective MCLs. These and other assessments of potential risks are summarized in the PRAP (Dresen *et al.*, 1991) and below. Details of the risk assessments are contained in the RI and FS.

### 2.6.1. Human Health Risks

The LLNL risk assessment consisted of several steps:

- Identifying the contaminants of concern (see Section 2.5 of this ROD).

- Identifying the media through which exposure may occur.
- Assessing the exposure.
- Assessing the toxicity of each contaminant.
- Quantifying the risk.

Each of these is discussed below.

### **2.6.1.1. Contaminant Identification**

#### **2.6.1.1.1. Media of Concern**

The primary medium through which public exposure to LLNL contaminants may occur is ground water. Air is also a medium of concern for contaminants that may volatilize from contaminated soil or ground water. The public is not directly exposed to contaminated soils because no offsite surficial soils contain significant concentrations of contaminants originating from LLNL. Contaminated onsite surficial soils were evaluated as a potential medium of concern. However, a screening analysis of the risks resulting from potential onsite exposure to contaminated soils has shown these risks are insignificant (Layton *et al.*, 1990; Hoffman, 1991b; Macdonald *et al.*, 1991). Therefore, surficial soils are not a medium of concern for the LLNL site.

#### **2.6.1.1.2. Contaminants of Concern**

A screening analysis was conducted to determine which substances and exposure pathways are potentially important from the perspective of potential adverse health effects. A statistical analysis of thousands of water and soil samples estimated the relative abundance of particular contaminants in the study area (Layton *et al.*, 1990). TCE, PCE, and chloroform account for an estimated 91% of the total amount of VOCs dissolved in the LLNL-area ground water. Of the remaining VOCs, the most hazardous are carbon tetrachloride and 1,1-DCE, which were used to represent the potential adverse effects of the remaining 9% of the VOCs. Nearly 60% of the mass of the remaining 9% of VOCs is 1,1-DCE. These compounds were used to estimate the public health risks resulting from the offsite migration and domestic use of contaminated ground water. According to the U.S. EPA, PCE, TCE, chloroform, and carbon tetrachloride are classified as B2 carcinogens, which are described as "probable human carcinogens indicated by sufficient evidence in animals and inadequate or no evidence in humans" (U.S. EPA, 1989a). 1,1-DCE is classified as a Class C carcinogen by the U.S. EPA (possible human carcinogen).

Other contaminants in soil and ground water include benzene at the Gasoline Spill Area, tritium, and inorganic substances, such as chromium, lead, nitrate, sulfate, and manganese. A screening analysis of the transport and fate of benzene indicates that benzene or other gasoline-related contaminants (toluene, xylene isomers, and ethylbenzene) are not likely to reach detectable concentrations west of LLNL. Similarly, tritium continues to undergo radioactive decay with a 12.3-year half-life such that by the time ground water containing elevated levels of tritium would migrate to the western LLNL boundary in the absence of remediation, concentrations would be within background levels. As stated in Section 2.5.4, LLNL plans to monitor tritium in ground water over the life of the cleanup.

As discussed in a letter to the regulatory agencies (Hoffman, 1992), there is strong evidence that the lead in LLNL ground water is naturally occurring. Furthermore, as described in Section 2.5.3, it appears that the migration potential for lead is very low, and its occurrence above the remediation standard is very limited. Several inorganic substances, including chromium, nitrate, sulfate, and manganese, occur in ground water in concentrations exceeding regulatory limits in various monitor wells, sporadically located onsite and offsite. Except perhaps for chromium, which has been used in LLNL cooling towers, the observed concentrations appear to reflect background levels of these constituents in ground waters in the Livermore Valley.

### **2.6.1.1.3. Concentrations of Chemicals of Concern Used in the Risk Assessment**

To assess the ground water exposure pathway, migration of the five VOCs of concern (PCE, TCE, chloroform, carbon tetrachloride, and 1,1-DCE) was simulated using the January-September 1988 concentrations as initial conditions. These concentrations range from the various detection limits up to a maximum of 6 ppm for TCE in the Building 518 Area.

### **2.6.1.2. Exposure Assessment**

#### **2.6.1.2.1. Exposure Pathways**

The only potential exposure pathway for present and future offsite populations is use of contaminated well waters. For domestic water uses, the potential exposure pathways are ingestion of drinking water, inhalation of volatile substances, and entry through the skin. For irrigation uses, the potential exposure pathways are inhalation of volatilized chemicals from sprinklers, and ingestion of foods from crops or home gardens irrigated with water containing the chemicals of concern. Exposure from contact with surface water runoff or sediment in local arroyos that receive drainage waters from the LLNL site is not a pathway of concern, because no chemicals of concern have been detected in downstream drainage channels near LLNL, and ground water does not discharge to streams near LLNL. The most important offsite exposure pathways with regard to health risk are those that result from domestic well water use from offsite wells (Thorpe *et al.*, 1990).

#### **2.6.1.2.2. Potentially Exposed Population**

As described in the BPHA and in Section 2.6.1.1.1 above, there are no significant onsite exposure pathways for LLNL site contaminants. Prior to any soil excavation at LLNL, the existing soil cleanup data are reviewed and maps of known or suspected contamination are consulted to determine whether additional sampling needs to be conducted prior to excavation. If no samples have been previously collected in a given area, preconstruction sampling is performed before excavation begins. If contamination is found, appropriate safety and disposal practices are overseen by the LLNL Hazards Control Department.

The only potentially exposed offsite population consists of residents who use ground water that has migrated from LLNL. In the assessments of risk for the LLNL site, a future residential-use scenario was not considered because it is unlikely that transfer of ownership of the site from DOE would occur in the foreseeable future. No change in ownership of the LLNL Main Site or any portion thereof, or notice pursuant to Section 120 of CERCLA, will relieve DOE of its obligation to clean up contamination resulting from DOE activities, or any future contamination resulting from DOE activities at LLNL. In addition, no change of ownership of the site or any portion thereof will be consummated by DOE without provision for continued maintenance of any containment system, treatment system, monitoring system, or other response action(s) installed or implemented under terms of the LLNL FFA.

#### **2.6.1.2.3. Exposure Point Concentration Estimates**

To assess the potential future health risks of the known contaminants in ground water, the movement of VOCs from their current distribution was simulated with a model. A semianalytical model of contaminant transport and fate in ground water was used that considers advection, dispersion, retardation, and degradation. The BPHA contains details on the assumptions and the parameters used in the model.

To address uncertainty inherent in all contaminant migration calculations, two scenarios were investigated, one called "best-estimate" and the other "health-conservative." The health-conservative scenario uses parameter values and assumptions that yield exposures that are very unlikely to be exceeded. U.S. EPA prefers using the most conservative of the health-conservative scenarios (footnote "b," Table 4, Section 2.6.1.4.3) as their estimate of the potential

health risk from the LLNL site. The best-estimate simulations use parameter values that are considered to be the most likely or the most representative, based on existing knowledge of the LLNL ground water system and contaminant properties. Best-estimate simulation assumes no human exposure to the ground water until it reaches the currently used municipal supply wells in downtown Livermore because no private wells are currently contaminated and administrative control limits the potential for domestic well installation into a contaminated zone. The administrative control consists of notification by Zone 7, the local water agency, that a proposed new well is in or near the contaminant plume.

#### 2.6.1.2.4. Exposure Frequency and Duration

The exposure period for the offsite public for any exposure pathway of concern was assumed to be a 70-year lifetime. For offsite exposures to contaminated ground water, the fate and transport model was used to calculate maximum 70-year average concentrations in ground water at existing and potential offsite wells. It was assumed that the exposed population uses ground water as its sole source of domestic water for this continuous 70-year period. These and other assumptions were used to estimate the total daily uptake of each chemical of concern in milligrams of chemical per kilogram body mass per day (mg/kg-day).

#### 2.6.1.3. Toxicity Assessment

##### 2.6.1.3.1. Cancer Potency Factors

Cancer potency factors (CPFs) have been developed by U.S. EPA to estimate excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. CPFs, expressed in units of (mg/kg-day)<sup>-1</sup>, are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the CPF. Use of this approach makes underestimation of the actual cancer risks highly unlikely. CPFs are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied (e.g., to account for the use of animal data to predict the effects on humans).

CPFs for the LLNL chemicals of concern are listed in Table 2. In conformance with EPA methodology, cancer potencies are based on applied, rather than metabolized, doses.

Table 2. Cancer potency factors for carcinogenic chemicals of concern (Layton *et al.*, 1990).

Chemical	Oral cancer potency (mg/kg-d) <sup>-1</sup>	Inhalation cancer potency (mg/kg-d) <sup>-1</sup>
Carbon tetrachloride	0.13	0.13
Chloroform	0.0061	0.0081
1,1-DCE	0.6	1.2
PCE	0.051	0.0033
TCE	0.011	0.017

##### 2.6.1.3.2. Reference Doses for Noncarcinogens

Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects. RfDs, which are expressed in units of mg/kg-day, are estimates of lifetime daily exposure levels for humans, including sensitive individuals. Estimated intakes of chemicals from environmental media (e.g., the amount of a chemical ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which

uncertainty factors have been applied (e.g., to account for the use of animal data to predict the effects on humans). These uncertainty factors help ensure that the RfDs will not underestimate the potential for adverse noncarcinogenic effects to occur.

Reference doses for the LLNL chemicals of concern are listed in Table 3.

**Table 3. Reference doses for noncarcinogenic chemicals of concern (Layton *et al.*, 1990).**

Chemical	Reference dose (mg/kg-d)
Carbon tetrachloride	0.0007
Chloroform	0.01
1,1-DCE	0.009
PCE	0.01
TCE	NA

NA= not available.

#### **2.6.1.4. Risk Characterization**

##### **2.6.1.4.1. Carcinogenic Risks**

The information from the preceding steps was combined to determine if an excess health risk would exist if the site were not remediated. Excess lifetime cancer risks are determined by multiplying the intake level with the CPF. These risks are probabilities that are generally expressed in scientific notation (e.g.,  $1 \times 10^{-6}$  or  $1E-6$ ). An excess lifetime cancer risk of  $1 \times 10^{-6}$  indicates that, as a plausible upper bound, an individual has a one in one million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the specific exposure conditions at a site.

Tables A-1 and A-2 in Appendix A summarize the estimated cancer risks for offsite exposure to ground water for both the best-estimate and health-conservative exposure scenarios for PCE, TCE, 1,1-DCE, chloroform, and carbon tetrachloride. Under the best-estimate exposure scenario (Table A-1), the greatest incremental cancer risk is seven in ten million ( $7 \times 10^{-7}$ ), which is associated with a well 2 miles west of the LLNL site that is in the path of the plume containing the highest concentrations of 1,1-DCE. Under the health-conservative exposure scenario (Table A-2), the incremental cancer risks are on the order of one in one thousand ( $10^{-3}$ ) to one in one million ( $10^{-6}$ ) for all wells. The highest predicted risk, two in one thousand ( $2 \times 10^{-3}$ ), is for a hypothetical well about 250 feet west of the LLNL site. However, no such wells have been constructed to date or are planned for installation prior to cleanup. The most conservative of the health-conservative scenarios (i.e., the one with the  $2 \times 10^{-3}$  incremental risk) is the scenario prescribed by EPA for the LLNL site.

##### **2.6.1.4.2. Potential for Noncarcinogenic Effects**

Potential noncarcinogenic effects of a single contaminant in a single medium is expressed as the hazard quotient (HQ) (or the ratio of the estimated intake derived from the contaminant concentration in a given medium to the contaminant's reference dose). By adding the HQs for all contaminants within a medium or across all media to which a given population may be reasonably exposed, the hazard index (HI) can be estimated. If only one compound is involved, then the HQ is equivalent to the HI. If the HI value is greater than 1.0, exposure could result in adverse health effects. The HI provides a useful reference for gauging the potential significance of multiple contaminant exposures within a single medium or across media.

Tables A-3 and A-4 in Appendix A summarize the estimated HQ's for offsite exposure to ground water for both the best-estimate and health-conservative exposure scenarios for the

chemicals of concern at LLNL. Under the best-estimate exposure scenario (Table A-3), the greatest HQ is  $1.4 \times 10^{-3}$ , which is for a hypothetical well 2 miles west of the LLNL site in the path of the plume containing the highest concentrations of carbon tetrachloride. Under the health-conservative exposure scenario (Table A-4), the HQ's are on the order of  $10^{-2}$  to  $10^{-1}$  for all wells. The highest predicted HQ (0.8) is for a hypothetical well that is 250 feet west of the LLNL site.

#### 2.6.1.4.3. Combined Carcinogenic Risks and Hazard Indices

The maximum theoretical excess cancer risks for a hypothetical, no-remediation scenario, based on the assumption that an individual will use well water for a 70-year (lifetime) period, are presented in Table 4. The maximum additional cancer risk associated with the best-estimate scenario in Table 4 means that the cancer risk from a lifetime exposure to VOCs (PCE, TCE, chloroform, and carbon tetrachloride) in well water derived from a downtown Livermore municipal supply well could be as high as 7 in 10 million ( $7 \times 10^{-7}$ ), using EPA assessment methods. This means that each individual that consumes 2 liters (about 2 quarts) of this water each day for 70 years would increase his or her risk of developing cancer by 7 in 10 million above the normal 1 in 4 cancer risk for Americans (U.S. EPA, 1989a). The HI associated with the best-estimate scenario is far below 1.0, indicating exposure at the predicted concentrations would not produce any adverse health effects from noncarcinogens (see the RI, Thorpe *et al.*, 1990, for details).

Table 4. No-remediation-scenario cancer risk and hazard index (HI) values using the EPA methodology<sup>a</sup> (U.S. EPA, 1989a).

No-remediation scenario	Risk of cancer	HI
Best-estimate	$7 \times 10^{-7}$	$1.6 \times 10^{-3}$
Health-conservative <sup>b</sup>	$2 \times 10^{-3}$	1
Health-conservative <sup>c</sup>	$1 \times 10^{-3}$	1

<sup>a</sup> See Isherwood *et al.* (1990) for an alternative method of computing the risk of cancer and HI.

<sup>b</sup> Based on potential monitor well drilled 250 feet west of LLNL.

<sup>c</sup> Based on receptor wells drilled in downtown Livermore.

Under the health-conservative no-remediation scenario, the maximum additional cancer risk is two in one thousand ( $2 \times 10^{-3}$ ) for a lifetime exposure to contaminants in water from a potential monitor well drilled 250 feet west of LLNL. The HI calculated for this scenario is 1. Because no drinking water wells are likely to be drilled in the area 250 feet west of LLNL, we also calculated the risk based on a lifetime exposure to well water derived from downtown Livermore using the health conservative assumptions. This unlikely scenario results in a maximum additional cancer risk of one in one thousand ( $1 \times 10^{-3}$ ) and an HI of 1. The HI of 1 for the health-conservative scenario indicates that there is some potential for noncarcinogenic health effects if the very conservative assumptions of the health conservative scenario were ever realized, and if there was an additive effect of all the individual compounds. Both health-conservative risks in Table 4 exceed EPA's one in ten thousand to one in ten million ( $1 \times 10^{-4}$  to  $1 \times 10^{-7}$ ) acceptable risk range for Superfund sites.

#### 2.6.1.4.4. Sources of Uncertainty

Uncertainties are associated with all estimates of cancer and noncancer health hazards. These uncertainties result from incomplete knowledge of many physical and biological processes, such as carcinogenesis. Where specific information is not available, it is necessary to make assumptions and/or use predictive models to compensate for lack of information. The

assumptions, models, and calculations are chosen such that the resulting risk and hazard estimates are health-conservative. The specific sources of uncertainty in the risk and hazard estimates presented here are further discussed in the BPHA.

#### **2.6.1.5. Environmental Risks**

Currently, there is no potential risk of ecological impacts related to environmental exposure to ground water because no ground water containing contaminants is present at the surface, either onsite or offsite. No perennial streams exist at or near the site and no streams receive flow from ground water. No critical habitats are affected by the ground water and soil contamination. No endangered species or habitats of endangered species are affected by the site contaminants, as described in the FS (Isherwood *et al.*, 1990).

#### **2.6.1.6. Risk Assessment Conclusions**

In summary, the identified compounds of concern, if not addressed by implementing the response actions selected in this ROD, may present a potential risk to public health.

### **2.7. Description of Remedial Alternatives**

In the FS, three remedial alternatives were assembled for ground water for the LLNL site:

1. *Ground water extraction throughout the contaminated area, including source areas, thereby preventing further contaminant migration and enabling the most rapid cleanup.* Ground water would be treated at the surface using UV/oxidation or air stripping-based technology with GAC to prevent any measureable air emissions. The treated water would be recharged or used at the LLNL site.
2. *Ground water extraction at the downgradient edges of contamination to prevent further contaminant migration.* Ground water would be treated at the surface, as for Alternative No. 1, and recharged or used at the LLNL site.
3. *Ground water monitoring and treatment at the point of use, if drinking water supply wells should ever contain contaminants from LLNL in concentrations above drinking water standards.* Ground water would be treated at the surface as described in No. 1 above.

The remedial alternatives for contaminants in the unsaturated sediment were:

1. *Vacuum-induced venting with surface treatment of vapors using GAC, thermal oxidation, or catalytic oxidation.*
2. *Deferring action to see if contaminants migrate to the ground water, and, if they do, extracting and treating the ground water as described for the ground water remedial alternatives.*

A third alternative, excavation and treatment and/or disposal, was also considered for unsaturated sediment. However, this alternative would be applicable only if (1) contaminant concentrations are found in the unsaturated zone that are high enough to cause concentrations above MCLs in the ground water, and (2) they occur at relatively shallow, accessible depths. Currently, no known locations meet these criteria, and this alternative was not considered further. However, excavation, treatment, and/or disposal could be employed in the future if high concentrations of contaminants, treatable perhaps by bioremediation or aeration, are discovered at excavatable depths.

The volume of ground water that contains contaminants above MCLs is much greater than the volume of unsaturated sediment containing contaminants that may impact the ground water in concentrations above MCLs.

The ground water and unsaturated sediment alternatives were developed by considering the nine evaluation criteria prescribed by EPA, as discussed in the FS. The FS discusses the various technologies for treating extracted ground water and vapor and assembles them into treatment options. The preferred treatment options vary from place to place because different parts of the site contain somewhat different combinations of contaminants in ground water and unsaturated sediment.

All the remedial alternatives considered for the LLNL site would include long-term ground water monitoring and reporting, in compliance with CERCLA requirements, until demonstrated achievement of the remedial action objectives. The costs of these activities, which are common to all alternatives for their respective estimated times of operation, were not explicitly addressed in the FS, but were presented in the PRAP to reflect the additional costs of maintaining a remediation program into the distant future. Monitoring activities will be conducted and reviewed periodically to gauge the effectiveness of the remedies. For all alternatives, the costs and implementation times were estimated using the assumptions discussed in the FS. The program operations costs, which were not described in the FS, are summarized in Appendix A of the PRAP (Dresen *et al.*, 1991).

All the treatment options for ground water will reduce the effluent concentration of VOCs, FHCs, chromium, and lead below Applicable or Relevant and Appropriate Requirements (ARARs) (Isherwood *et al.*, 1990). Tables 3-1 and 3-2 in the FS, and Table 1 and Appendix B of this ROD summarize the ARARs for the LLNL site.

As discussed in Section 2.8, Ground Water Alternative No. 1 and Unsaturated Zone Alternative No. 1 meet all ARARs. Ground Water Alternatives 2 and 3 and Unsaturated Zone Alternative 2 do not fully comply with the California non-degradation ARAR.

For treatment options that include disposal of treated ground water or air emissions, the effluent concentrations will be in compliance with RWQCB Waste Discharge Requirements, National Pollutant Discharge Elimination System (NPDES), and BAAQMD standards. Treated ground water will be recharged at the LLNL recharge basin south of East Avenue, in local drainage ditches and arroyos, or in infiltration trenches or recharge wells. Treated water will also be used for onsite landscape irrigation and in LLNL's cooling towers.

The approach for tritium is to keep it in the subsurface as much as possible where it will decay naturally (i.e., self-remediate) and to minimize its migration. Extraction systems will be designed and operated to prevent tritium from entering a treatment system in concentrations above its MCL. This will be accomplished by monitoring the influent water to the treatment system, both in pipelines and in the well(s). If water containing tritium above the MCL enters a treatment system, the facility will be shut down, and the water containing tritium will be treated by evaporation under existing National Environmental Standards for Hazardous Air Pollutants requirements, or released within allowable limits under the existing permit to the sanitary sewer system. No treated ground water will be recharged back to the subsurface if the tritium level exceeds the MCL.

Treatment options utilizing air stripping will be designed with GAC on the effluent air stream, so there are no measurable VOC air emissions. For those options employing GAC to treat water or air streams, the GAC will be shipped offsite where it will be commercially regenerated to destroy or recycle, if possible, the adsorbed contaminants. Options employing ion exchange for treatment of metals will require offsite recycling or disposal of the ion-exchange resin as a hazardous waste. The expected risk reduction after cleanup is complete is described in Section 2.9.1 of this ROD.

#### 2.7.1. No-Action Alternative

A No-Action Alternative was considered in the FS for the LLNL site to establish a baseline for comparison. Under this alternative, LLNL would cease all characterization and remedial



activities. Limited ground water monitoring would continue to track changes in ground water chemistry. The No-Action Alternative is not the same as the Deferred-Action Alternatives discussed in the FS and the PRAP, in that remedial actions may be taken in the future under the Deferred-Action Alternatives. The No-Action Alternatives for ground water and unsaturated sediment do not meet Federal and State standards to protect human health and were not considered viable in the FS and the PRAP.

### **2.7.2. Ground Water Remedial Alternatives**

Two ground water extraction plans that use different arrays of extraction wells form the basis for immediate-action alternatives to remediate ground water. Each extraction plan is discussed subsequently with its remedial alternative.

Costs for the ground water remedial alternatives are summarized in Table 5. In the FS, costs were analyzed using a present worth calculation procedure, as prescribed by EPA. This is the standard procedure for comparing alternatives with costs and revenues beginning, ending, or extending over different periods of time.

#### **2.7.2.1. Ground Water Remedial Alternative No. 1 (The Selected Alternative)**

##### ***2.7.2.1.1. Ground Water Extraction Plan for Remedial Alternative No. 1—Complete Capture and Source Area Extraction***

Under this plan, extraction wells would be strategically placed near contaminant margins to intercept and hydraulically control all ground water originating from LLNL with VOC concentrations exceeding MCLs. In addition, ground water would be extracted from source areas (defined here as those areas with concentrations above about 100 ppb in ground water) to expedite cleanup. This plan would utilize 18 initial extraction locations and about 7 treatment facilities shown conceptually on Figure 7. A plot of the predicted ground water flow patterns using these locations is shown in Figure 8. The flow lines (with arrows on Fig. 8) converge on extraction locations and show the areas hydraulically captured by the extraction wells. The total rate of ground water removal for this extraction plan is estimated to be about 350 gallons per minute (gpm). Where VOCs and tritium occur together in ground water, the extraction systems will be designed and monitored to minimize tritium migration and to prevent the water influent to any treatment systems from containing tritium in concentrations above the MCL. Therefore, no tritium will be released from treatment systems in concentrations above the MCL.

The 350-gpm sitewide extraction rate is a preliminary estimate used to estimate capture areas, cleanup times and costs relative to other alternatives presented in the PRAP and ROD. This extraction rate and the estimated treatment facility capacities will be analyzed and further refined in the Remedial Design and as part of ongoing work to decrease cleanup times and optimize extraction and recharge rates.

It is estimated that it would take about 50 years to reduce contaminant concentrations to MCLs if only the 18 initial extraction locations are employed. LLNL plans to implement the selected cleanup plan in phases, and evaluate each phase with field data. Additional extraction locations may be used to ensure full hydraulic capture of the plume, and/or to expedite cleanup. If technologically feasible, and if funding permits, LLNL will attempt to achieve cleanup in less than the predicted 50 years. It is estimated that all extraction and treatment facilities under Alternative 1 would be operational in the 1993-94 timeframe, depending on congressional funding. LLNL will make every effort to obtain sufficient funding to fully support the selected cleanup plan. This alternative will comply with all ARARs.

Table 5. Summary of costs for ground water remedial alternatives for the LLNL Livermore site.

Remedial alternative	Present worth costs (millions of 1990 dollars) <sup>a</sup>			Total present worth of alternative <sup>e</sup>
	Capital costs <sup>b</sup>	Treatment system O&M costs <sup>c</sup>	Program operations <sup>d</sup>	
Remedial Alternative No. 1 50-year operation—UV/oxidation primary treatment at Treatment Facilities A, B, E, and F; air stripping primary treatment at Treatment Facilities C, D, and G	9	21	73	103
Remedial Alternative No. 2 90-year operation—UV/oxidation primary treatment at Treatment Facilities A, B, and F; air stripping primary treatment at Treatment Facility C	6	14	79	99
Remedial Alternative No. 3a <sup>f</sup> 30-year operation beginning in 200 years; air stripping treatment at the point of distribution in Livermore	0.01	0.03	87	87
Remedial Alternative No. 3b <sup>g</sup> Monitoring 10 wells for 100 years	0.00	0.00	12	12

<sup>a</sup> Present worth calculated using a 5% discount rate for Remedial Alternative No. 1 over 50 years and Remedial Alternative No. 2 over 90 years; and, for Remedial Alternative No. 3, a 5% rate for a 30-year operation and then at a 2% rate for 200 years from possible commencement of treatment to 1990 for operation and maintenance, and 230 years for program operations.

<sup>b</sup> Total capital costs of treatment systems, extraction wells, pipelines, water recharge and reuse facilities, monitor wells, and piezometers.

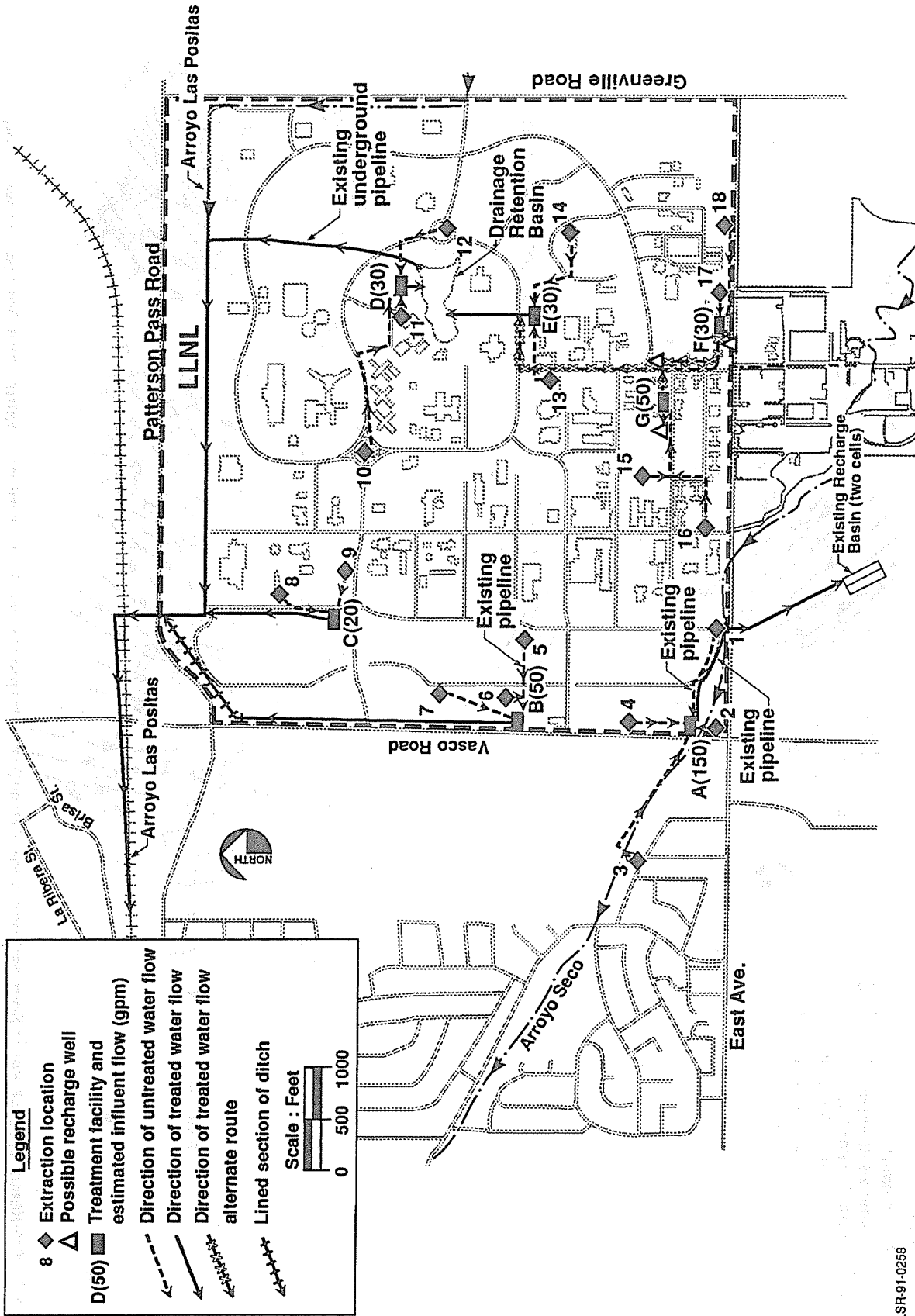
<sup>c</sup> Present worth of annual operating and maintenance costs of treatment systems, extraction wells, pipelines, water recharge and reuse facilities, monitor wells, and piezometers.

<sup>d</sup> Present worth of annual program operations; see Appendix A of PRAP (Dresen *et al.*, 1991) for details.

<sup>e</sup> Sum of present worths of capital costs, treatment systems, operating and maintenance, and program operations.

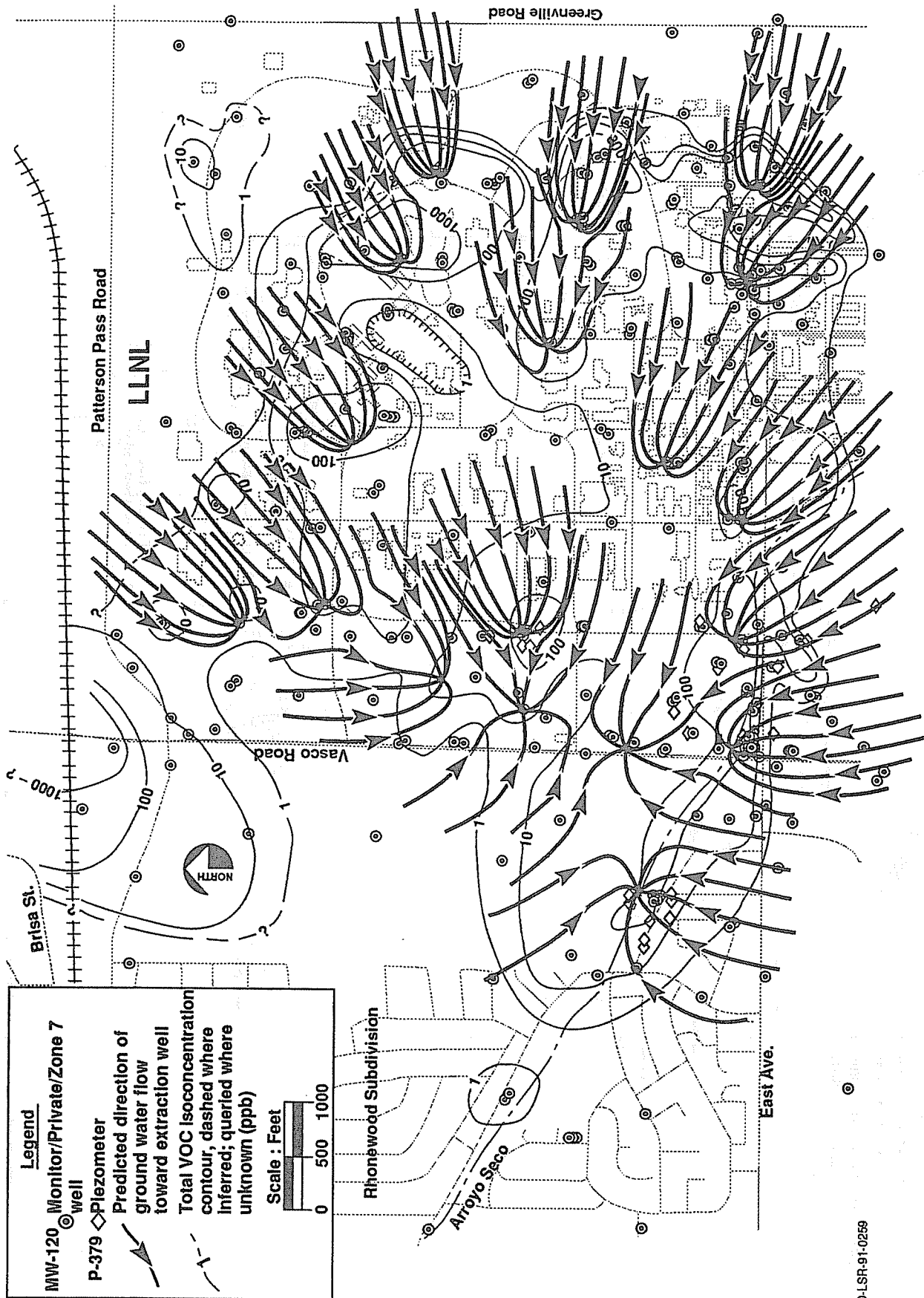
<sup>f</sup> Cost estimate for this alternative assumes that VOCs might migrate to Livermore municipal-supply wells in 200 years, if ever. Program operations costs are assumed to be \$1.75 million per year.

<sup>g</sup> Assumes lower program operations costs, \$0.6 million per year, monitoring of 10 wells for 100 years, and no treatment because computer modeling predicts that VOCs in ground water may never exceed MCLs in Livermore municipal-supply wells.



ERD-LSR-91-0258

Figure 7. Preliminary ground water extraction and treatment facility locations.



ERD-LSR-91-0259

Figure 8. Predicted ground water flow pathways for Extraction Alternative No. 1—Complete Capture and Source Remediation.

### 2.7.2.1.2. Treatment Options for Ground Water Remedial Alternative No. 1

**Ground Water Containing VOCs (Proposed Treatment Facilities A, B, C, E, and G) (Fig.7).** Treatment Facility E could potentially receive ground water containing tritium as well as VOCs.

**Treatment Option 1. Granular-Activated Carbon. (GAC)** Ground water pumped by extraction wells would pass through beds of activated carbon where VOCs would be removed by GAC. The operating costs of this treatment option are high.

**Treatment Option 2. Air Stripping with GAC Treatment of the Vapor.** Ground water pumped by extraction wells would pass through an air stripper where VOCs would be removed by transferring them from the water to the air. The vapors from the stripper would pass through GAC to completely remove contaminants. This treatment option is the most economical for ground water containing VOCs.

**Treatment Option 3. UV/Oxidation Plus Air Stripping with GAC Filtering of the Vapor.** Extracted ground water would be blended with small amounts of hydrogen peroxide and exposed to strong ultraviolet (UV) light, destroying most of the contaminants. LLNL pilot studies have shown that some compounds require secondary treatment by air stripping, which would be added to treat water after it passed through the UV/oxidation unit. The vapors from air stripping would pass through GAC to remove contaminants. This option reduces the amount of waste requiring further treatment or disposal, especially where the majority of the contaminants are readily oxidized by the UV/oxidation process. Costs for this option are moderately high.

Treatment Option 2 or 3 is preferred for Treatment Facilities A, B, C, E, and G, depending on the concentrations and types of the compounds, and the flow rate influent to each treatment facility.

### **Ground Water Containing VOCs and Chromium (Proposed Treatment Facility D) (Fig. 7)**

**Treatment Option 1. GAC Plus Ion Exchange.** Ground water pumped by extraction wells would pass through GAC beds, which would remove the VOCs. The VOC-free water would then be fed through an ion-exchange resin to extract chromium. The operating costs of this treatment option are high.

**Treatment Option 2. Air Stripping with GAC Filtering of the Vapor Phase Plus Ion Exchange.** Extracted ground water would pass through an air stripper to remove VOCs. The vapors from the stripper would pass through GAC to remove VOCs from the air. The VOC-free water would flow through an ion-exchange resin to extract chromium. This treatment option is preferred because the higher concentrations of TCE, carbon tetrachloride, chloroform, and Freon 113 make this treatment option more economical.

**Treatment Option 3. UV/Oxidation Plus Air Stripping and Ion Exchange with GAC Treatment of the Vapor.** Extracted ground water would be treated by UV/oxidation, destroying most of the VOCs. Remaining VOCs would be removed from the water by air stripping. The vapors from the air stripper would pass through GAC to completely remove VOCs. The VOC-free water would then flow through an ion-exchange resin to extract chromium. The operating costs of this treatment option are high.

### **Ground Water Containing FHCs, VOCs, and Lead (Proposed Treatment Facility F) (Fig. 7)**

**Treatment Option 1. GAC Treatment.** Ground water pumped by extraction wells would pass through GAC beds, which remove the FHCs, VOCs, and lead. The operating costs of this treatment option are high.

**Treatment Option 2. Air Stripping with GAC Treatment of Both the Vapor and Liquid Phases.** Extracted ground water would pass through an air stripper to remove FHCs and VOCs. The vapors from the stripper would pass through GAC to completely remove FHCs and VOCs.

The water would then pass through GAC to extract lead and any remaining FHCs or VOCs. This treatment option is not preferred because the high concentration of FHCs would require frequent carbon regeneration that increases the operating costs of this treatment option substantially.

**Treatment Option 3. UV/Oxidation Plus GAC.** Extracted ground water would be treated by UV/oxidation, destroying most contaminants. The water would then pass through GAC beds to remove lead and any remaining FHCs or VOCs. This treatment technology is preferred because it can handle the high concentrations of FHCs. It is also the most economical of the treatment options.

**Treatment Option 4. Subsurface Bioremediation.** Biological treatment would utilize the metabolic destruction of organic compounds by microbes that convert the organic compounds in the ground water to less toxic compounds. Bioremediation of the FHCs in the Gasoline Spill Area is potentially viable. However, the relatively great depth of FHCs at LLNL, which makes providing the correct physical and chemical conditions for the microbes difficult, and the sensitivity of microorganisms to subsurface conditions that are difficult to control, make applicability of subsurface bioremediation at LLNL uncertain. In addition, bioremediation has not yet been proven successful for chlorinated VOCs. Therefore, this treatment option was not considered as an initial remedial action.

#### **2.7.2.2. Ground Water Remedial Alternative No. 2**

##### **2.7.2.2.1. Ground Water Extraction Plan for Remedial Alternative No. 2—Downgradient Control**

Under this plan, extraction wells would be placed along the western boundary of LLNL to intercept and hydraulically control the offsite migration of those VOCs in concentrations exceeding MCLs. In addition, extraction would also occur in the Gasoline Spill Area, where a pilot remediation study is ongoing, and in the adjacent Building 518 Area to prevent migration of FHCs and VOCs to the south of LLNL. This plan would use a total of 10 extraction locations, 1 through 7 and location 9 in and near the western boundary of LLNL and locations 17 and 18 in the southeastern part of LLNL (Fig. 7). Extracted water would be treated at Treatment Facilities A, B, C, and F (Fig. 7). A plot of the predicted ground water flow patterns using the extraction locations for this plan is shown in Figure 9. The rate of ground water extraction for this plan is estimated to be about 200 gpm. This alternative would contain and remediate all known contaminants. It is estimated that it would take more than 90 years to achieve MCLs under this plan and that all extraction and treatment facilities would be operational in 1993.

##### **2.7.2.2.2. Treatment Options for Ground Water Remedial Alternative No. 2**

This alternative differs from Alternative No. 1 in that fewer initial extraction locations (10 compared to 18 for Alternative No. 1) and treatment facilities (4 compared to 7 for Alternative No. 1) would be employed. The treatment options discussed in Section 2.7.2.1.2 for Treatment Facilities A, B, C, and F would be identical for this alternative.

##### **2.7.2.3. Ground Water Remedial Alternative No. 3—Deferred Action**

For the Deferred-Action Remedial Alternative, ground water would not be treated until *and unless* contaminants in concentrations greater than MCLs migrate to a drinking water supply well, such as those operated by the California Water Service Company, located about 2 miles west of LLNL. Under this alternative, treatment would take place at the point of distribution for the affected water-supply system. If contaminants did reach supply wells, probably no sooner than about 200 years, their concentrations would be substantially lower than those currently at LLNL (Thorpe *et al.*, 1990). The ground water would be treated, at a minimum, to conform to the MCLs for each contaminant before it is distributed for human consumption. Selection of an appropriate treatment option would be made at the time that treatment may be necessary because

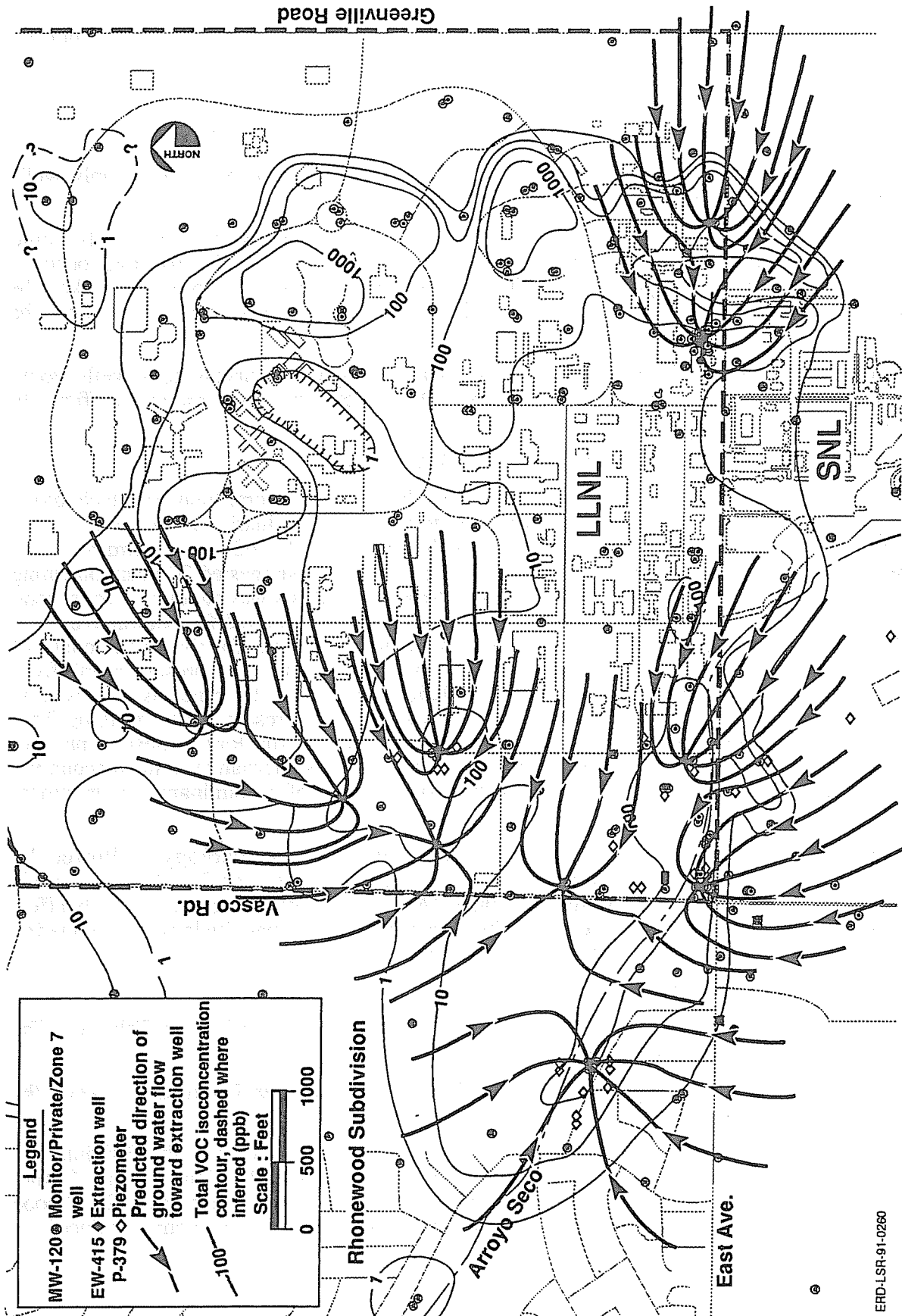


Figure 9. Predicted ground water flow pathways for Extraction Alternative No. 2—Downgradient Control.

technology and economics may have changed considerably by then. Currently available options are presented below for comparison.

#### **2.7.2.3.1. Treatment Options for Ground Water Remedial Alternative No. 3**

**Treatment Option 1. GAC Treatment.** Ground water pumped by water-supply wells would pass through GAC beds to remove contaminants.

**Treatment Option 2. Air Stripping.** Ground water pumped by water-supply wells would pass through an air stripper. Because only very low concentrations of VOCs may ever occur in water from supply wells (Thorpe *et al.*, 1990), treatment of air emissions would most likely be unnecessary. This treatment option is preferred because concentrations of compounds will be very low and it is the most economical of the treatment options.

**Treatment Option 3. UV/Oxidation.** Ground water pumped by water-supply wells would be treated by UV/oxidation. The concentrations of VOCs are expected to be reduced sufficiently so that secondary treatment would be unnecessary.

#### **2.7.2.4. Comparison of Ground Water Treatment Option Costs**

For each extraction and treatment alternative described above, several treatment technology options passed initial screening and were subjected to a detailed evaluation in Section 4 of the FS. For purposes of comparing the treatment technologies in the FS, cost estimates were prepared (see Appendices D, E, and F of the FS) using U.S. EPA's suggested 30 years operating and maintenance period (U.S. EPA, 1989b). A supplemental analysis was conducted for several of the treatment facilities assuming 90 years of operation would be required for Alternative No. 2 to achieve ARARs. This detailed analysis indicates that, in general, for the same length of operation (e.g., 30 years), (1) GAC is about 1.8 times more expensive in present worth for a treatment facility than air stripping and (2) UV/oxidation treatment is 1.3 times as expensive in present worth as air stripping. Alternative No. 3 has a very low present worth, ranging from \$30,000 for air stripping to \$280,000 for GAC, largely because the long timespan prior to possible commencement of treatment reduces the total costs of this alternative in the discounting procedure. This also takes into account the different combinations of contaminants and treatment options at each treatment facility.

In summary, GAC is generally the most costly treatment technology, followed by UV/oxidation, and then by air stripping. However, the costs in the FS do not include the program operations costs in Appendix A of the PRAP. These costs do not significantly affect the relative costs of the treatment options, but they are significant in magnitude when comparing remedial alternatives with different periods of operation.

### **2.7.3. Unsaturated Zone Alternatives**

Costs of remedial alternatives for the unsaturated zone are summarized in Table 6. The remedial alternatives and treatment options are described below.

#### **2.7.3.1. Unsaturated Zone Remedial Alternative No. 1—Vacuum-Induced Venting (the Selected Alternative)**

Current data indicate that only FHCs in the Gasoline Spill Area, VOCs in the Building 518 Area in the southeastern part of the LLNL site, and possibly VOCs in the vicinity of the Trailer 5475/East Taxi Strip Area in eastern LLNL will need unsaturated zone remediation (Isherwood *et al.*, 1990). FHCs and/or VOCs would be removed from the subsurface by vacuum-induced



Table 6. Summary of costs for unsaturated zone remedial alternatives for the LLNL Livermore site.

Remedial alternative	Present worth costs (thousands of 1990 dollars) <sup>a</sup>			Total present worth of alternative
	Capital costs <sup>b</sup>	Treatment system O&M costs <sup>c</sup>	Program operations <sup>d</sup>	
Remedial Alternative No. 1 Immediate action—10-year operation; vapor withdrawal and catalytic oxidation treatment; vapor from Building 518 piped to Treatment Facility F <sup>e</sup>	529	585	0	1,114
Remedial Alternative No. 2 Deferred action <sup>f</sup> —monitor and extract and treat ground water, if necessary	0	252 <sup>g</sup>	600 <sup>h</sup>	852

<sup>a</sup> Present worth calculated using a 5% discount rate for Remedial Alternative No. 1 over 10 years; and, for Remedial Alternative No. 2, a 5% rate for 50 years from possible commencement of treatment in 1990, and a 5% rate for 40 years of operation.

<sup>b</sup> Total capital costs of treatment systems, extraction wells, and monitor wells.

<sup>c</sup> Present worth of annual operating and maintenance costs of treatment systems, extraction wells, and monitor wells.

<sup>d</sup> Included with ground water remediation only because the major remediation is associated with ground water.

<sup>e</sup> The present worth of extracting and piping vapor from the Building 518 Area to Treatment Facility F is \$175,000 for 5 years of operation (including O&M) necessary to achieve ARARs. The present worth of installing a separate catalytic oxidation unit at the Building 518 Area and operating it for 5 years is \$1,100,000 (including O&M).

<sup>f</sup> Assumes a 50-to 60-year period before VOCs and/or FHCs migrate to ground water from the unsaturated zone in concentrations above MCLs. Treatment by UV/oxidation at Treatment Facility F for 40 years beginning in 50 years (equivalent to the difference between Remedial Alternatives No. 1 and 2 at Treatment Facility F).

<sup>g</sup> Does not include costs of additional monitoring, extraction, or recharge wells or piezometers that may be necessary.

<sup>h</sup> Ten percent of program operations costs charged to this alternative from years 51 through 90 because they would not otherwise be necessary ( $4,000,000 \times 0.1 \times 1.5$  discount factor present worth of annual expenses from years 51 to 90).

venting using extraction wells. Treatment options for the extracted vapor are described in the following section. If vapor extraction were ever considered for any of the localized areas at LLNL where elevated levels of tritium occur in the unsaturated zone, the water portion of the vapor could be (1) released to the atmosphere or (2) separated from the vapor by condensation. For possible tritium air releases from treatment systems, the AIRDOS-EPA computer model would be used to evaluate the potential annual dose to a hypothetical maximally exposed individual. LLNL will shut down any treatment system that emits tritium to the atmosphere at a rate predicted to contribute to an exposure of greater than 10 millirem/year (the Federal standard for clean air).

We estimate that it would take about 10 years to remediate the unsaturated zone under this alternative and that remediation would be underway by late 1992.

### *Treatment Options for Unsaturated Zone Remedial Alternative No. 1*

**Treatment Option 1. GAC Treatment.** Vapors from vent wells would pass through a chamber containing GAC to remove VOCs or FHCs. The treated vapor would be discharged to the atmosphere.

**Treatment Option 2. Thermal Oxidation.** Vapors from vent wells would pass through a thermal oxidation chamber where the FHC and VOC vapors would be oxidized with the assistance of a heat source such as propane. The VOCs and FHCs would be destroyed and treated air would be discharged to the atmosphere.

**Treatment Option 3. Catalytic Oxidation.** Vapors from vent wells would be heated and passed through a catalyst, where organic compounds would be converted to harmless oxidation products, such as carbon dioxide and water. The treated air would be discharged to the atmosphere. A catalyst suitable for both VOCs and FHCs has recently been found. The rationale for preferring catalytic oxidation over thermal oxidation for treatment of vapors is presented in Appendix B of the PRAP. If use of catalytic oxidation results in emission of vapors with compounds above regulatory standards, secondary treatment or alternative technologies, such as GAC, will be evaluated and implemented to comply with regulatory standards.

### *2.7.3.2. Unsaturated Zone Remedial Alternative No. 2—Deferred Action*

Under this alternative, all contaminants in the unsaturated zone would be left in place and allowed to degrade, volatilize, or migrate to ground water under natural conditions. Ground water would continue to be monitored according to the requirements of CERCLA. If any contamination of ground water above MCLs occurs, it would either be remediated by ongoing ground water extraction and treatment, or by additional ground water extraction and treatment systems, if necessary.

### *2.7.3.3. Comparison of Unsaturated Zone Treatment Option Costs*

The relative present worth costs for the three vadose zone treatment options are discussed in Section 4 of the FS. In summary, the present value of GAC is about 50% greater than for thermal oxidation, and catalytic oxidation is about 20% less than thermal oxidation.

## **2.8. Summary of the Comparative Analysis of Alternatives**

The remedial alternatives and associated treatment options were evaluated against nine EPA criteria in the FS and PRAP. The preferred remedial alternatives for ground water and unsaturated sediment were analyzed in terms of these nine criteria and are summarized in Tables 7 and 8.

Table 7. Comparison of ground water remedial alternatives for the LLNL Livermore site.<sup>a</sup>

Remedial alternative/ treatment technologies	Protective of human health and the environment	Compliance with ARARs	Long-term effectiveness
Remedial Alternative No. 1 <sup>b</sup> UV/oxidation-based systems for Treatment Facilities A, B, E, and F. Air stripping-based systems for Treatment Facilities C, D (plus ion exchange), and G.	Risk is reduced by design criteria that are lower than ARARs. Reduces ground water contaminant concentrations to MCLs; design criteria for treated ground water are lower than discharge limits.	Meets all ARARs.	Effective.
Remedial Alternative No. 2 UV/oxidation-based systems for Treatment Facilities A, B, and F. Air stripping-based system for Treatment Facility C.	Risk is reduced by design criteria that are lower than ARARs. Reduces ground water contaminant concentrations to MCLs; design criteria for treated ground water are lower than discharge limits.	Does not fully satisfy the State of California ARAR concerning non-degradation of water resources.	Effective.
Remedial Alternative No. 3 Deferred treatment— Air stripping at point of distribution, if necessary.	Risk reduced by treatment at point-of-distribution (if necessary). Ground water quality would be degraded until treatment begins or concentrations naturally fall below MCLs.	Does not fully satisfy the State of California ARAR concerning non-degradation of water resources.	Effective.

<sup>a</sup> Using the nine EPA criteria for detailed evaluation of alternatives (U.S. EPA, 1988a, pp. 6-1 to 6-31).

<sup>b</sup> The selected alternative.

<sup>c</sup> Present worth is calculated to reflect the time value of money in excess of inflation, as described in Section 5.2 of the PRAP (Dresen *et al.*, 1991).

<sup>d</sup> If monitoring of ground water only were to be conducted for 100 years, the present worth cost would be \$12 million.

UV = Ultraviolet light.

Reduce toxicity, mobility, and volume or mass	Short-term effectiveness	Implementability (technical and administrative)	Present worth cost <sup>c</sup>	State acceptance	Community acceptance
Reduces mobility by downgradient hydraulic containment and source area extraction. Toxicity/mass reduced by extraction and surface treatment.	Negligible impacts during installation and operation. About 50 years required to achieve MCLs in ground water.	Implementable.	\$103 million	Acceptable	The community accepts the concept of the selected alternative, but desires funding commitments, a detailed implementation schedule, continued opportunity for involvement, and a faster cleanup.
Reduces mobility through downgradient hydraulic containment; allows migration of contaminants across LLNL site. Toxicity/mass reduced by extraction and surface treatment.	Negligible impacts during installation and operation. Ninety or more years required to achieve MCLs in ground water.	Implementable.	\$99 million	Not acceptable	The community accepts the concept of a pump and treat alternative, but prefers Alternative No. 1 because it is more expedient and employs active source remediation.
Reduces volume by natural degradation rather than by treatment. Allows migration of contaminants beyond present extent, and increase in the volume of contaminated water.	Remediation deferred until or unless VOCs impact in-use water supplies. Negligible impacts during installation and operation. Estimated 360 years for natural degradation to reduce contaminant concentrations below MCLs, and 30 years to achieve MCLs after treatment commences in 200 years, if necessary.	Implementable. Alternative may not be acceptable to regulatory agencies because it delays remediation an estimated 200 years.	\$87 million <sup>d</sup>	Not acceptable	Not acceptable

Table 8. Comparison of unsaturated zone remedial alternatives for the LLNL Livermore site.<sup>a</sup>

Remedial alternative	Protective of human health and the environment	Comply with ARARs	Long-term effectiveness
<b>Remedial Alternative No. 1<sup>c</sup></b>			
<b>Immediate Action</b>			
Vacuum extraction and catalytic oxidation.	Risk reduced by actively removing contaminants from the unsaturated zone.	Meets all ARARs.	Effective.
<b>Remedial Alternative No. 2</b>			
<b>Deferred Action</b>			
Remove contaminants that have migrated to ground water by extraction and treatment at the nearest treatment facility.	Risk to humans not actively reduced until VOCs or FHCs migrate to ground water. Ground water quality would be degraded until treatment begins or natural processes reduce concentrations below MCLs.	Does not fully satisfy a State of California ARAR concerning non-degradation of water resources where migration to ground water will result in concentrations greater than MCLs.	Effective.

<sup>a</sup> Using the nine EPA criteria for detailed evaluation of alternatives (U.S. EPA, 1988a, pp. 6-1 to 6-31).

<sup>b</sup> Present worth is calculated to reflect the time value of money in excess of inflation, as described in Section 5.2 of the PRAP (Dresen *et al.*, 1991).

<sup>c</sup> The selected alternative.

Reduce toxicity, mobility, and volume or mass	Short-term effectiveness	Implementability (technical and administrative)	Present worth cost <sup>b</sup>	State acceptance	Community acceptance
Reduces mobility by actively removing VOCs from the subsurface. Reduces toxicity/mass by extraction and treatment at the surface.	Negligible impacts during installation and operation. About 10 years required to achieve remedial action objectives.	Implementable.	\$1.1 million	Acceptable	The community accepts the concept of the selected alternative, but desires funding commitments, a detailed implementation schedule, continued opportunity for involvement, and a faster cleanup.
Does not reduce contaminant mobility in the unsaturated zone. Volume reduced by natural degradation rather than by treatment in an estimated 90 years.	Effective for both VOCs and FHCs; as much as 90 years required to achieve remedial action objectives.	Implementable.	\$0.9 million	Not acceptable	The community appears to accept the concept of this alternative, but prefers Alternative No. 1.

### 2.8.1. Ground Water

**Overall Protection of Human Health and the Environment.** All the ground water remedial alternatives are equally protective of human health (if institutional controls are in effect for Alternative 3 to prevent new or existing wells from being used) because each is designed to meet the same cleanup criteria. Consequently, the resulting health risks are identical among the alternatives (Isherwood *et al.*, 1990). Since Alternatives 2 and 3 would allow some continued migration of VOCs in ground water, they also allow some degradation of the subsurface environment.

**Compliance with ARARs.** Ground water Remedial Alternatives No. 1 and No. 2 are designed to achieve all ARARs (Isherwood *et al.*, 1990). However, Alternative No. 2 would allow higher-concentration VOCs in eastern LLNL to migrate across the site, and thus does not fully satisfy the State of California ARAR regarding non-degradation of water resources. Remedial Alternative No. 3, treat at point-of-use, though estimated to be protective of human health (Isherwood *et al.*, 1990), does not fully satisfy the California non-degradation ARAR.

**Long-Term Effectiveness and Permanence.** All three remedial alternatives are equally effective in terms of permanence and stability of remediation and reduction in health risks by removing and treating the contaminants.

**Reduction in Toxicity, Mobility, and Volume.** Remedial Alternatives No. 1 and No. 2 reduce toxicity, mobility, and volume of the compounds. Alternative No. 1 does not allow additional contaminant migration beyond the current extent downgradient. Alternative No. 2 allows VOCs in eastern LLNL to migrate across the site. Remedial Alternative No. 3, deferred action, allows more contaminant mobility than Alternative No. 2 and does not reduce contaminant mobility until and unless contaminants reach domestic or municipal wells in concentrations above an MCL.

An advantage of the UV/oxidation remediation technology (preferred at Treatment Facilities A, B, E, and F) is that TCE, PCE, 1,1-DCE, and FHCs are destroyed in one process, thereby minimizing waste requiring further treatment or disposal. Use of GAC requires regeneration of spent carbon to convert the captured compounds to harmless substances. Ion-exchange resins for metals removal may require disposal as hazardous waste.

**Short-Term Effectiveness.** All the remedial alternatives would expose workers, the public, and the environment to negligible impacts during installation and operation.

The selected remedial alternative is estimated to achieve the remediation goals in about 50 years compared to 90 years or more for Remedial Alternative No. 2, which employs only four treatment facilities and ten extraction locations. Alternative No. 3 may take about 230 years to achieve remediation goals, and remediation may not begin for 200 years. Each treatment option, combined with the same remedial alternative, would require about the same length of time to achieve the remediation goals. For Alternative No. 1, it is estimated that plume containment and overall hydraulic control will be achieved in 1995. This estimate will be further refined in the Remedial Design.

**Implementability.** Each of the remedial alternatives and technology options is technically and administratively feasible and supported by available services, materials, and skilled labor. An advantage of the UV/oxidation technology over the GAC technology is that regeneration of the spent carbon is unnecessary. The air-stripping-based and UV/oxidation-based technologies generate substantially less spent carbon than the GAC system for water treatment. UV/oxidation and GAC technologies also have minimal visual impact compared to air-stripping towers.

**Cost.** The present worth of Ground Water Remedial Alternative No. 1 (the selected alternative) is estimated to be \$103 million, assuming 50 years of operation. The present worth for 90 years of operation for Remedial Alternative No. 2 is \$99 million. The present worth for Remedial Alternative No. 3 is \$87 million, assuming air stripping is the treatment option used. If Remedial Alternative No. 3 consisted only of monitoring ground water for 100 years, the present worth would be \$12 million.

**State Acceptance.** The California RWQCB and DTSC accept the selected ground water remedial alternative, Remedial Alternative No. 1. The RWQCB does not accept Ground Water Alternatives No. 2 and No. 3 since they do not fully satisfy the California non-degradation ARAR.

**Community Acceptance.** The community accepts the general concept of the selected alternative, but desires funding commitments, a detailed implementation schedule, continued opportunity for involvement, and a faster cleanup. Implementation schedules will be included in post-ROD documents called the Remedial Action Implementation Plan and the Remedial Design/Remedial Action reports. LLNL is continually exploring and implementing new methods and techniques that will accomplish the fastest cleanup.

### 2.8.2. Unsaturated Zone

The remedial alternatives for the unsaturated zone are described below and compared in Table 8 in terms of the EPA evaluation criteria.

**Overall Protection of Human Health and the Environment.** Unsaturated Zone Remedial Alternative No. 1 is protective of human health and the environment and creates minimal health risks. Remedial Alternative No. 2 has some impact on the subsurface above the water table as contaminants would be allowed to migrate naturally. Estimates indicate natural processes would reduce the concentrations to below MCLs in 90 to 140 years (Isherwood *et al.*, 1990, Appendix G).

**Compliance with ARARs.** Remedial Alternative No. 1 is designed to achieve ARARs. Alternative No. 2 may allow contaminants to reach the ground water in concentrations exceeding MCLs in a few isolated places (i.e., the Gasoline Spill and Building 518 Areas, and perhaps the East Taxi Strip Area), and therefore does not meet the California non-degradation ARAR.

**Long-Term Effectiveness and Permanence.** Both of the alternatives are effective in the long run and reduce health risks permanently by removing and treating contaminants.

**Reduction in Toxicity, Mobility, and Volume.** Remedial Alternative No. 1 results in the immediate removal and complete breakdown of compounds to harmless substances, thereby permanently reducing toxicity, mobility, and volume. Remedial Alternative No. 2 (deferred action) allows VOCs and FHCs to continue to migrate through the unsaturated zone to the ground water. VOCs and FHCs would then be extracted and treated in the ground water at the nearest treatment facility.

**Short-Term Effectiveness.** Both alternatives would expose workers, the public, and the environment to negligible impacts during installation and operation. Achieving the remediation objectives is estimated to require 10 years for the selected alternative, Alternative No. 1, and 90 years for Alternative No. 2.

**Implementability.** Both alternatives are technically and administratively feasible and supported by available services, materials, and skilled labor.

**Cost.** Present worth cost for 10 years of operation for the preferred alternative is \$1.1 million. The preferred alternative utilizes the most cost effective treatment option available for both VOCs and FHCs. The present worth of Alternative No. 2 is \$850,000.

**State Acceptance.** The California RWQCB and DTSC accept the selected unsaturated zone alternative, Remedial Alternative No. 1. The RWQCB does not accept Unsaturated Zone Alternative No. 2 since it may allow ground water degradation.

**Community Acceptance.** The community accepts the general concept of the selected unsaturated zone alternative, but desires funding commitments, a detailed implementation schedule, continued opportunity for involvement, and a faster cleanup. Implementation schedules will be included in post-ROD documents called the Remedial Action Implementation Plan and the Remedial Design/Remedial Action reports. LLNL is continually exploring and implementing new methods and techniques that will accomplish the fastest cleanup.

## 2.9. The Selected Remedies

Based on the requirements of CERCLA, the detailed analysis of the alternatives, and public comments, DOE, LLNL, EPA, the DTSC of the California Environmental Protection Agency, and the California RWQCB have determined that Alternative No. 1 for ground water (pumping and surface treatment by UV/oxidation and air stripping), and Alternative No. 1 for the



unsaturated zone (vacuum-induced venting and surface treatment of vapors by catalytic oxidation), are the most appropriate remedies for LLNL.

The selected remedies for this site protect human health and the environment, comply with Federal, State, and local requirements (ARARs), are implementable, and permanently and significantly reduce the toxicity, mobility, and volume of the contaminants.

The goal of this remedial action is to remediate ground water to the ARARs specified in the PRAP and this ROD. Based on information obtained during the RI and on a careful analysis of all remedial alternatives, DOE, LLNL, EPA, DTSC, and the RWQCB believe that the selected remedy will achieve this goal. The approach to be taken to the remediation will involve close monitoring of ground water quality in monitor wells, extracted water quality in extraction wells, and water level elevations near the extraction centers. The extraction well field will be operated dynamically to optimize the cleanup. That is, based on the results from the monitoring plan, individual wells may operate continuously, may be turned off, or may be pumped intermittently. During the course of the remediation, new wells will be installed at appropriate locations and will be operated in the same manner.

To ensure that cleanup levels continue to be maintained, the ground water will be monitored until DOE and the regulatory agencies agree that cleanup is complete.

### 2.9.1. Ground Water

The primary purpose of the selected ground water remedy is to contain VOCs and prevent further downgradient and offsite migration in ground water, and to reduce the concentrations of contaminants in ground water after cleanup to levels below MCLs, the designated cleanup levels. Existing conditions at the site may pose an excess lifetime cancer risk of  $2 \times 10^{-3}$  from ingestion of ground water contaminated with VOCs (primarily TCE) under health-conservative no remediation assumptions. The selected alternative will address all ground water contaminated with VOCs in excess of 5 ppb and will assure that ARARs for individual VOCs, FHCs, lead, chromium, and tritium will be achieved.

The selected ground water remedy involves immediately pumping water at approximately 18 initial locations within the ground water plume (Fig. 7). The total rate of ground water removal for this extraction plan is estimated to be about 350 gpm. Water will be pumped from one or more wells at each of these locations using existing monitor and extraction wells, along with new extraction wells. The well locations will be chosen to prevent any VOCs from escaping from the area in concentrations above their MCLs. To enable more rapid remediation, wells will also be placed in all areas where VOC or FHC concentrations in ground water exceed 100 ppb. Additional extraction locations may be added to ensure complete hydraulic capture of the plume, and/or to expedite cleanup, if field data indicate additional wells are necessary.

Seven onsite facilities (A to G) will be constructed initially to treat the extracted ground water (Fig. 7). Each treatment facility will be designed to treat a somewhat different combination of compounds. Treatment Facilities A, B, E, and F will use UV/oxidation as the primary treatment technology. Treatment Facilities C, D, and G will use air-stripping as the primary treatment technology. All facilities will use GAC to remove VOCs and FHCs from air streams, and Treatment Facility F will use GAC to remove lead from ground water. Treatment Facility D will use ion exchange to remove chromium from ground water.

The maximum additional cancer risk after remediation is complete is calculated at seven in one hundred million ( $7 \times 10^{-8}$ ) using the best estimate assumptions. This is over 100 times lower than the one in ten thousand to one in ten million ( $1 \times 10^{-4}$  to  $1 \times 10^{-7}$ ) acceptable level of risk specified in the NCP (U.S. EPA, 1990). The HI for this scenario is far less than 1.0, indicating that no adverse health effects from noncarcinogens would occur following the planned remediation. Using health-conservative assumptions that EPA prescribes for assessing site risks,

the risk of cancer after remediation, based on a potential monitor well drilled 250 feet west of LLNL, is  $4 \times 10^{-5}$ , and  $3 \times 10^{-5}$  for potential receptor wells in downtown Livermore. Both of these values are within the EPA acceptable risk range. The hazard indices for both health-conservative scenarios are far less than 1 ( $2.7 \times 10^{-2}$  and  $3.1 \times 10^{-2}$ , respectively), indicating no adverse health affects from noncarcinogens after the planned remediation.

### 2.9.2. Unsaturated Zone

The selected remedy for the unsaturated zone involves using vacuum-induced venting to extract contaminant vapors from the unsaturated sediments and treating the vapors by catalytic oxidation. Use of a catalytic oxidizer provides the flexibility to treat both FHCs and VOCs together and substantially reduces the potential for producing dioxin. The purpose of this response action is to prevent migration of VOCs and FHCs to ground water in concentrations that would impact the ground water in concentrations above MCLs.

Current data indicate that only FHCs in the Gasoline Spill Area, VOCs in the Building 518 Area in the southeastern part of the LLNL site, and possibly VOCs in the vicinity of the East Taxi Strip in eastern LLNL will need unsaturated zone remediation (Isherwood *et al.*, 1990). FHCs and/or VOCs will be removed from the subsurface by vacuum-induced venting using extraction wells.

The selected treatment option for the extracted vapors is catalytic oxidation. In this process, vapors from vent wells will be heated and passed through a catalyst, where organic compounds are converted to harmless oxidation products, including carbon dioxide and water. If use of catalytic oxidation should result in emission of vapors with compounds above regulatory standards, secondary treatment or alternative technologies, such as GAC, will be evaluated and implemented to comply with regulatory standards.

The decision regarding whether an area requires vadose zone cleanup will be based on unsaturated zone modeling and ground water monitoring. If modeling indicates that hazardous materials will impact ground water in concentrations above an MCL, remediation will be implemented. Remediation will continue until *in situ* concentrations, as verified by soil sampling, are below those predicted to impact ground water above MCLs. In addition, the ground water near the potential source will be monitored for impacts on ground water quality. Details of the modeling and monitoring will be presented in the Remedial Design.

## 2.10. Statutory Determinations

Section 121 of CERCLA specifies that the selected remedial actions must comply with all Federal and State ARARs, be cost-effective, be protective of human health and the environment, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, the selected remedies should employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as their principal element. The selected remedies for ground water and the unsaturated zone are the same as those described in the PRAP and meet these statutory requirements as discussed below.

### 2.10.1. Protection of Human Health and the Environment

The selected remedy for ground water will provide adequate protection of human health and the environment through extraction of contaminated ground water and treatment at the surface to reduce *in situ* concentrations below MCLs. Discharges to the air will be designed for no measurable contaminant emissions. In addition, further offsite migration of the contaminant plume will be prevented. The selected remedy will reduce exposure to levels within or below EPA's acceptable carcinogenic risk range of  $10^{-4}$  to  $10^{-7}$ , and hazard indices will be far below 1.0 after cleanup.

Vacuum-induced venting of the unsaturated zone will remove subsurface VOCs and FHCs and prevent contaminant migration to ground water. Implementation of the selected remedies will not pose unacceptable short-term risks or impact the adjacent subsurface media, other than some lowering of water levels due to ground water extraction. Lowering of the water table will be mitigated by locally recharging the ground water with treated ground water.

#### **2.10.2. Compliance with ARARs**

The selected remedies will comply with all Federal and State ARARs, including the to be considered (TBC) criteria in Appendix B. Table 1 and Table B-1 in Appendix B list and describe the ARARs and TBCs that will be attained by each selected remedy.

#### **2.10.3. Cost-Effectiveness**

The selected remedies provide overall effectiveness proportionate to their costs. Present worth cost estimates for each alternative are presented in Tables 5 and 6. Although the selected remedies cost somewhat more in terms of present worth compared to the other alternatives, they enable more rapid cleanup.

#### **2.10.4. Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable**

The selected remedies utilize permanent solutions and alternative treatment technologies to the maximum extent practicable. The selected alternatives permanently remove contaminants from ground water and the unsaturated zone by extraction and treatment at the surface using UV/oxidation, air stripping, GAC, and ion exchange for ground water and catalytic oxidation for vapor. Both selected alternatives provide the best balance of tradeoffs among the alternatives, and use treatment technologies that destroy most contaminants, converting them to harmless compounds.

The selected alternatives will reduce contaminant mobility more than the other alternatives. Although the selected alternatives have a higher present worth cost than the other alternatives, the selected alternatives will accomplish the cleanup objectives in a shorter time period. Therefore, reducing contaminant mobility and expediting cleanup time (short-term effectiveness) were the most important primary balancing criteria in selecting the remedies.

For both selected alternatives, overall protection of human health and the environment and the compliance with ARARs were also decisive factors in remedy selection. Community concerns were included in the decision-making process by addressing community input received at CWG meetings and during the public comment period on the PRAP. The Responsiveness Summary, attached to this ROD, addresses community comments on the remedial alternatives.

#### **2.10.5. Preference for Treatment as a Principal Element**

The selected remedial actions satisfy the statutory preference for selecting remedies in which treatment that permanently and significantly reduces the volume, toxicity or mobility of the contaminants is a principal element. The selected remedial action for ground water uses treatment to address the contaminated ground water, which is the principal medium of concern. UV/oxidation-based technology destroys contaminants leaving residual harmless compounds such as carbon dioxide and water. Both UV/oxidation and air stripping-based technologies will achieve a permanent and significant reduction of the toxicity, mobility, or volume of the contaminants. Similarly, for the unsaturated zone, vacuum-induced venting followed by catalytic oxidation of the extracted vapor will destroy VOCs and FHCs after removal from contaminated soil, thereby also meeting this statutory preference.

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## Appendix A

### Tables Summarizing Predicted Cancer Risks and Hazard Quotients for Offsite Exposure

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Table A-1. Predicted cancer risks for the best-estimate exposure scenario based on EPA methodology.

Receptor location <sup>a</sup>	Chemical	Predicted concentration <sup>b</sup> (mg/L)	Oral intake (mg/kg-d)	Oral cancer risk	Inhalation cancer risk	EPA total cancer risk
<i>Maximum chloroform concentration</i>	Chloroform	$1.5 \times 10^{-4}$	$4.3 \times 10^{-6}$	$3 \times 10^{-8}$	$3 \times 10^{-7}$	$4 \times 10^{-7}$
<i>Maximum TCE concentration</i>	TCE	$1.0 \times 10^{-4}$	$2.9 \times 10^{-6}$	$3 \times 10^{-8}$	$4 \times 10^{-8}$	$7 \times 10^{-8}$
	1,1-DCE	$5.6 \times 10^{-6}$	$1.6 \times 10^{-7}$	$1 \times 10^{-7}$	$2 \times 10^{-7}$	$3 \times 10^{-7}$
	Carbon tetrachloride	$4.4 \times 10^{-6}$	$1.3 \times 10^{-7}$	$2 \times 10^{-8}$	$2 \times 10^{-8}$	$4 \times 10^{-8}$
					Sum =	$4 \times 10^{-7}$
<i>Maximum 1,1-DCE and carbon tetrachloride concentrations</i>	TCE	$8.0 \times 10^{-5}$	$2.3 \times 10^{-6}$	$2 \times 10^{-8}$	$3 \times 10^{-8}$	$5 \times 10^{-8}$
	Chloroform	$1.0 \times 10^{-5}$	$2.9 \times 10^{-7}$	$2 \times 10^{-9}$	$2 \times 10^{-8}$	$2 \times 10^{-8}$
	1,1-DCE	$1.1 \times 10^{-5}$	$3.1 \times 10^{-7}$	$2 \times 10^{-7}$	$4 \times 10^{-7}$	$6 \times 10^{-7}$
	Carbon tetrachloride	$9.0 \times 10^{-6}$	$2.6 \times 10^{-7}$	$3 \times 10^{-8}$	$3 \times 10^{-8}$	$6 \times 10^{-8}$
					Sum =	$7 \times 10^{-7}$
<i>Maximum PCE concentration</i>	PCE	$1.0 \times 10^{-5}$	$2.9 \times 10^{-7}$	$1 \times 10^{-8}$	$9 \times 10^{-10}$	$2 \times 10^{-8}$

<sup>a</sup> All receptor wells are 2 miles west of LLNL.

<sup>b</sup> Predicted maximum ground water concentrations have been reduced by a factor of ten to account for in-well dilution that would occur because the municipal well would draw water from both contaminated and uncontaminated zones.

Table A-2. Predicted cancer risks for the health-conservative exposure scenario based on EPA methodology.

Receptor location	Chemical	Predicted concentration (mg/L)	Oral intake (mg/kg-d)	Oral cancer risk	Inhalation cancer risk	EPA total cancer risk
<b><i>250 feet west of LLNL</i></b>						
<b><i>Maximum chloroform concentration</i></b>						
	PCE	$6.2 \times 10^{-3}$	$1.8 \times 10^{-4}$	$9 \times 10^{-6}$	$6 \times 10^{-7}$	$1 \times 10^{-5}$
	TCE	$2.6 \times 10^{-1}$	$7.4 \times 10^{-3}$	$8 \times 10^{-5}$	$1 \times 10^{-4}$	$2 \times 10^{-4}$
	Chloroform	$5.5 \times 10^{-2}$	$1.6 \times 10^{-3}$	$1 \times 10^{-5}$	$1 \times 10^{-4}$	$1 \times 10^{-4}$
	1,1-DCE	$1.0 \times 10^{-2}$	$2.9 \times 10^{-4}$	$2 \times 10^{-4}$	$3 \times 10^{-4}$	$5 \times 10^{-4}$
	Carbon tetrachloride	$7.9 \times 10^{-3}$	$2.3 \times 10^{-4}$	$3 \times 10^{-5}$	$3 \times 10^{-5}$	$6 \times 10^{-5}$
					Sum =	$9 \times 10^{-4}$
<b><i>Maximum TCE, 1,1-DCE, and carbon tetrachloride concentrations</i></b>						
	PCE	$5.2 \times 10^{-2}$	$1.5 \times 10^{-3}$	$8 \times 10^{-5}$	$5 \times 10^{-6}$	$8 \times 10^{-5}$
	TCE	$4.7 \times 10^{-1}$	$1.3 \times 10^{-2}$	$1 \times 10^{-4}$	$2 \times 10^{-4}$	$3 \times 10^{-4}$
	Chloroform	$2.0 \times 10^{-2}$	$5.7 \times 10^{-4}$	$3 \times 10^{-6}$	$5 \times 10^{-5}$	$5 \times 10^{-5}$
	1,1-DCE	$2.4 \times 10^{-2}$	$6.7 \times 10^{-4}$	$4 \times 10^{-4}$	$8 \times 10^{-4}$	$1 \times 10^{-3}$
	Carbon tetrachloride	$1.8 \times 10^{-2}$	$5.3 \times 10^{-4}$	$7 \times 10^{-5}$	$7 \times 10^{-5}$	$1 \times 10^{-4}$
					Sum =	$2 \times 10^{-3}$
<b><i>Maximum PCE concentration</i></b>						
	PCE	$2.7 \times 10^{-1}$	$7.7 \times 10^{-3}$	$4 \times 10^{-4}$	$3 \times 10^{-5}$	$4 \times 10^{-4}$
	TCE	$6.2 \times 10^{-2}$	$1.8 \times 10^{-3}$	$2 \times 10^{-5}$	$2 \times 10^{-5}$	$4 \times 10^{-5}$
	Chloroform	$8.2 \times 10^{-3}$	$2.3 \times 10^{-4}$	$1 \times 10^{-6}$	$2 \times 10^{-5}$	$2 \times 10^{-5}$
	1,1-DCE	$1.4 \times 10^{-2}$	$4.0 \times 10^{-4}$	$2 \times 10^{-4}$	$5 \times 10^{-4}$	$7 \times 10^{-4}$
	Carbon tetrachloride	$1.1 \times 10^{-2}$	$3.1 \times 10^{-4}$	$4 \times 10^{-5}$	$4 \times 10^{-5}$	$8 \times 10^{-5}$
					Sum =	$1 \times 10^{-3}$



Table A-2. (Continued)

Receptor location	Chemical	Predicted concentration (mg/L)	Oral intake (mg/kg-d)	Oral cancer risk	Inhalation cancer risk	EPA total cancer risk
<b><i>1 mile west of LLNL</i></b>						
<b><i>Maximum chloroform concentration</i></b>						
	PCE	$5.9 \times 10^{-3}$	$1.7 \times 10^{-4}$	$9 \times 10^{-6}$	$6 \times 10^{-7}$	$9 \times 10^{-6}$
	TCE	$2.4 \times 10^{-1}$	$6.9 \times 10^{-3}$	$8 \times 10^{-5}$	$9 \times 10^{-5}$	$2 \times 10^{-4}$
	Chloroform	$4.9 \times 10^{-2}$	$1.4 \times 10^{-3}$	$9 \times 10^{-6}$	$1 \times 10^{-4}$	$1 \times 10^{-4}$
	1,1-DCE	$1.0 \times 10^{-2}$	$2.9 \times 10^{-4}$	$2 \times 10^{-4}$	$3 \times 10^{-4}$	$5 \times 10^{-4}$
	Carbon tetrachloride	$7.9 \times 10^{-3}$	$2.3 \times 10^{-4}$	$3 \times 10^{-5}$	$3 \times 10^{-5}$	$6 \times 10^{-5}$
					Sum =	$9 \times 10^{-4}$
<b><i>Maximum TCE, 1,1-DCE, and carbon tetrachloride concentrations</i></b>						
	PCE	$5.2 \times 10^{-2}$	$1.5 \times 10^{-3}$	$8 \times 10^{-5}$	$5 \times 10^{-6}$	$8 \times 10^{-5}$
	TCE	$3.8 \times 10^{-1}$	$1.1 \times 10^{-2}$	$1 \times 10^{-4}$	$1 \times 10^{-4}$	$3 \times 10^{-4}$
	Chloroform	$1.7 \times 10^{-2}$	$4.9 \times 10^{-4}$	$3 \times 10^{-6}$	$4 \times 10^{-5}$	$4 \times 10^{-5}$
	1,1-DCE	$2.2 \times 10^{-2}$	$6.4 \times 10^{-4}$	$4 \times 10^{-4}$	$8 \times 10^{-4}$	$1 \times 10^{-3}$
	Carbon tetrachloride	$1.8 \times 10^{-2}$	$5.0 \times 10^{-4}$	$7 \times 10^{-5}$	$7 \times 10^{-5}$	$1 \times 10^{-4}$
					Sum =	$2 \times 10^{-3}$
<b><i>Maximum PCE concentration</i></b>						
	PCE	$2.1 \times 10^{-1}$	$6.0 \times 10^{-3}$	$3 \times 10^{-4}$	$2 \times 10^{-5}$	$3 \times 10^{-4}$
	TCE	$5.8 \times 10^{-2}$	$1.7 \times 10^{-3}$	$2 \times 10^{-5}$	$2 \times 10^{-5}$	$4 \times 10^{-5}$
	Chloroform	$7.3 \times 10^{-3}$	$2.1 \times 10^{-4}$	$1 \times 10^{-6}$	$2 \times 10^{-5}$	$2 \times 10^{-5}$
	1,1-DCE	$1.5 \times 10^{-2}$	$4.2 \times 10^{-4}$	$2 \times 10^{-4}$	$5 \times 10^{-4}$	$7 \times 10^{-4}$
	Carbon tetrachloride	$1.1 \times 10^{-3}$	$3.3 \times 10^{-4}$	$4 \times 10^{-5}$	$4 \times 10^{-5}$	$9 \times 10^{-5}$
					Sum =	$1 \times 10^{-3}$

Table A-2. (Continued)

Receptor location	Chemical	Predicted concentration (mg/L)	Oral intake (mg/kg-d)	Oral cancer risk	Inhalation cancer risk	EPA total cancer risk
<i><u>2 miles west of LLNL</u></i>						
<i>Maximum chloroform concentration</i>						
	PCE	$6.1 \times 10^{-3}$	$1.7 \times 10^{-4}$	$9 \times 10^{-6}$	$6 \times 10^{-7}$	$9 \times 10^{-6}$
	TCE	$2.3 \times 10^{-1}$	$6.6 \times 10^{-3}$	$7 \times 10^{-5}$	$9 \times 10^{-5}$	$2 \times 10^{-4}$
	Chloroform	$4.5 \times 10^{-2}$	$1.3 \times 10^{-3}$	$8 \times 10^{-6}$	$1 \times 10^{-4}$	$1 \times 10^{-4}$
	1,1-DCE	$1.0 \times 10^{-2}$	$2.9 \times 10^{-4}$	$2 \times 10^{-4}$	$3 \times 10^{-4}$	$5 \times 10^{-4}$
	Carbon tetrachloride	$7.9 \times 10^{-3}$	$2.3 \times 10^{-4}$	$3 \times 10^{-5}$	$3 \times 10^{-5}$	$6 \times 10^{-5}$
					Sum =	$9 \times 10^{-4}$
<i>Maximum TCE, 1,1-DCE, and carbon tetrachloride concentrations</i>						
	PCE	$4.9 \times 10^{-2}$	$1.4 \times 10^{-3}$	$7 \times 10^{-5}$	$5 \times 10^{-6}$	$8 \times 10^{-5}$
	TCE	$3.4 \times 10^{-1}$	$9.7 \times 10^{-3}$	$1 \times 10^{-4}$	$1 \times 10^{-4}$	$2 \times 10^{-4}$
	Chloroform	$1.6 \times 10^{-2}$	$4.6 \times 10^{-4}$	$3 \times 10^{-6}$	$4 \times 10^{-5}$	$4 \times 10^{-5}$
	1,1-DCE	$2.0 \times 10^{-2}$	$5.6 \times 10^{-4}$	$3 \times 10^{-4}$	$7 \times 10^{-4}$	$1 \times 10^{-3}$
	Carbon tetrachloride	$1.5 \times 10^{-2}$	$4.4 \times 10^{-4}$	$6 \times 10^{-5}$	$6 \times 10^{-5}$	$1 \times 10^{-4}$
					Sum =	$1 \times 10^{-3}$
<i>Maximum PCE concentration</i>						
	PCE	$1.7 \times 10^{-1}$	$4.9 \times 10^{-3}$	$2 \times 10^{-4}$	$2 \times 10^{-5}$	$3 \times 10^{-4}$
	TCE	$5.6 \times 10^{-2}$	$1.6 \times 10^{-3}$	$2 \times 10^{-5}$	$2 \times 10^{-5}$	$4 \times 10^{-5}$
	Chloroform	$6.9 \times 10^{-3}$	$2.0 \times 10^{-4}$	$1 \times 10^{-6}$	$2 \times 10^{-5}$	$2 \times 10^{-5}$
	1,1-DCE	$1.3 \times 10^{-2}$	$3.8 \times 10^{-4}$	$2 \times 10^{-4}$	$5 \times 10^{-4}$	$7 \times 10^{-4}$
	Carbon tetrachloride	$1.1 \times 10^{-3}$	$3.0 \times 10^{-4}$	$4 \times 10^{-5}$	$4 \times 10^{-5}$	$8 \times 10^{-5}$
					Sum =	$1 \times 10^{-3}$

Table A-3. Calculation of the noncarcinogenic hazard index for the best-estimate exposure scenario.

Observation point <sup>a</sup>	Chemical	Predicted concentration <sup>b</sup> (mg/L)	Water ingestion (mg/kg-d)	EPA hazard index (exposure/Rfd)
<i>Maximum chloroform concentration</i>	Chloroform	$1.5 \times 10^{-4}$	$4.3 \times 10^{-6}$	$4.3 \times 10^{-4}$
<i>Maximum TCE concentration</i>	TCE	$1.0 \times 10^{-4}$	$2.9 \times 10^{-6}$	NA
	1,1-DCE	$5.6 \times 10^{-6}$	$1.6 \times 10^{-7}$	$1.8 \times 10^{-5}$
	Carbon tetrachloride	$4.4 \times 10^{-6}$	$1.3 \times 10^{-7}$	$1.8 \times 10^{-4}$
			Sum =	$2.0 \times 10^{-4}$
<i>Maximum carbon tetrachloride and 1,1-DCE concentrations</i>	Chloroform	$2.0 \times 10^{-5}$	$5.7 \times 10^{-7}$	$5.7 \times 10^{-5}$
	1,1-DCE	$4.5 \times 10^{-5}$	$1.3 \times 10^{-6}$	$1.4 \times 10^{-4}$
	Carbon tetrachloride	$3.5 \times 10^{-5}$	$1.0 \times 10^{-7}$	$1.4 \times 10^{-3}$
			Sum =	$1.6 \times 10^{-3}$
<i>Maximum PCE concentration</i>	PCE	$1.0 \times 10^{-5}$	$2.9 \times 10^{-7}$	$2.9 \times 10^{-5}$

NA = Not available.

<sup>a</sup> All receptor wells are 2 miles west of LLNL.<sup>b</sup> Predicted maximum ground water concentrations have been reduced by a factor of ten to account for in-well dilution that would occur because the municipal well would draw water from both contaminated and uncontaminated zones.

Table A-4. Calculation of the noncarcinogenic hazard index for the health-conservative exposure scenario.

Observation point	Chemical	Predicted concentration (mg/L)	Water ingestion (mg/kg-d)	EPA hazard index (exposure/RFD)
<b><u>Well 250 feet west of LLNL</u></b>				
<b><i>Maximum chloroform concentration</i></b>				
	PCE	$6.2 \times 10^{-3}$	$1.8 \times 10^{-4}$	$2 \times 10^{-2}$
	TCE	$2.6 \times 10^{-1}$	$7.4 \times 10^{-3}$	NA
	Chloroform	$5.5 \times 10^{-2}$	$1.6 \times 10^{-3}$	$2 \times 10^{-1}$
	1,1-DCE	$1.0 \times 10^{-2}$	$2.9 \times 10^{-4}$	$3 \times 10^{-2}$
	Carbon tetrachloride	$7.9 \times 10^{-3}$	$2.3 \times 10^{-4}$	$3 \times 10^{-1}$
			Sum =	$5 \times 10^{-1}$
<b><i>Maximum TCE, 1,1-DCE, and carbon tetrachloride concentrations</i></b>				
	PCE	$5.2 \times 10^{-2}$	$1.5 \times 10^{-3}$	$1 \times 10^{-1}$
	TCE	$4.7 \times 10^{-1}$	$1.3 \times 10^{-2}$	NA
	Chloroform	$2.0 \times 10^{-2}$	$5.7 \times 10^{-4}$	$6 \times 10^{-2}$
	1,1-DCE	$2.4 \times 10^{-2}$	$6.7 \times 10^{-4}$	$7 \times 10^{-2}$
	Carbon tetrachloride	$1.8 \times 10^{-2}$	$5.3 \times 10^{-4}$	$8 \times 10^{-1}$
			Sum =	$1 \times 10^0$
<b><i>Maximum PCE concentration</i></b>				
	PCE	$2.7 \times 10^{-1}$	$7.7 \times 10^{-3}$	$8 \times 10^{-1}$
	TCE	$6.2 \times 10^{-2}$	$1.8 \times 10^{-3}$	NA
	Chloroform	$8.2 \times 10^{-3}$	$2.3 \times 10^{-4}$	$2 \times 10^{-2}$
	1,1-DCE	$1.4 \times 10^{-2}$	$4.0 \times 10^{-4}$	$4 \times 10^{-2}$
	Carbon tetrachloride	$1.1 \times 10^{-2}$	$3.1 \times 10^{-4}$	$4 \times 10^{-1}$
			Sum =	$1 \times 10^0$
<b><u>Well 1 mile west of LLNL</u></b>				
<b><i>Maximum chloroform concentration</i></b>				
	PCE	$5.9 \times 10^{-3}$	$1.7 \times 10^{-4}$	$2 \times 10^{-2}$
	TCE	$2.4 \times 10^{-1}$	$6.9 \times 10^{-3}$	NA
	Chloroform	$4.9 \times 10^{-2}$	$1.4 \times 10^{-3}$	$1 \times 10^{-1}$
	1,1-DCE	$1.0 \times 10^{-2}$	$2.9 \times 10^{-4}$	$3 \times 10^{-2}$
	Carbon tetrachloride	$7.9 \times 10^{-3}$	$2.3 \times 10^{-4}$	$3 \times 10^{-1}$
			Sum =	$5 \times 10^{-1}$

Table A-4. (Continued)

Observation point	Chemical	Predicted concentration (mg/L)	Water ingestion (mg/kg-d)	EPA hazard index (exposure/RFD)
<i>Maximum TCE, 1,1-DCE, and carbon tetrachloride concentrations</i>				
	PCE	$5.2 \times 10^{-2}$	$1.5 \times 10^{-3}$	$1 \times 10^{-1}$
	TCE	$3.8 \times 10^{-1}$	$1.1 \times 10^{-2}$	NA
	Chloroform	$1.7 \times 10^{-2}$	$4.9 \times 10^{-4}$	$5 \times 10^{-2}$
	1,1-DCE	$2.2 \times 10^{-2}$	$6.4 \times 10^{-4}$	$7 \times 10^{-2}$
	Carbon tetrachloride	$1.8 \times 10^{-2}$	$5.0 \times 10^{-4}$	$7 \times 10^{-1}$
			Sum =	$1 \times 10^0$
<i>Maximum PCE concentration</i>				
	PCE	$2.1 \times 10^{-1}$	$6.0 \times 10^{-3}$	$6 \times 10^{-1}$
	TCE	$5.8 \times 10^{-2}$	$1.7 \times 10^{-3}$	NA
	Chloroform	$7.3 \times 10^{-3}$	$2.1 \times 10^{-4}$	$2 \times 10^{-2}$
	1,1-DCE	$1.5 \times 10^{-2}$	$4.2 \times 10^{-4}$	$5 \times 10^{-2}$
	Carbon tetrachloride	$1.1 \times 10^{-2}$	$3.3 \times 10^{-4}$	$5 \times 10^{-1}$
			Sum =	$1 \times 10^0$
<i>Well 2 miles west of LLNL</i>				
<i>Maximum chloroform concentrations</i>				
	PCE	$6.1 \times 10^{-3}$	$1.7 \times 10^{-4}$	$2 \times 10^{-2}$
	TCE	$2.3 \times 10^{-1}$	$6.6 \times 10^{-3}$	NA
	Chloroform	$4.5 \times 10^{-2}$	$1.3 \times 10^{-3}$	$1 \times 10^{-1}$
	1,1-DCE	$1.0 \times 10^{-2}$	$3.2 \times 10^{-4}$	$3 \times 10^{-2}$
	Carbon tetrachloride	$7.9 \times 10^{-3}$	$1.9 \times 10^{-4}$	$3 \times 10^{-1}$
			Sum =	$5 \times 10^{-1}$
<i>Maximum TCE, 1,1-DCE, and carbon tetrachloride concentrations</i>				
	PCE	$4.9 \times 10^{-2}$	$1.4 \times 10^{-3}$	$1 \times 10^{-1}$
	TCE	$3.4 \times 10^{-1}$	$9.7 \times 10^{-3}$	NA
	Chloroform	$1.6 \times 10^{-2}$	$4.6 \times 10^{-4}$	$5 \times 10^{-2}$
	1,1-DCE	$2.0 \times 10^{-2}$	$5.6 \times 10^{-4}$	$6 \times 10^{-2}$
	Carbon tetrachloride	$1.5 \times 10^{-2}$	$4.4 \times 10^{-4}$	$6 \times 10^{-1}$
			Sum =	$9 \times 10^{-1}$
<i>Maximum TCE, 1,1-DCE, and carbon tetrachloride concentrations</i>				
	PCE	$1.7 \times 10^{-1}$	$4.9 \times 10^{-3}$	$5 \times 10^{-1}$
	TCE	$5.6 \times 10^{-2}$	$1.6 \times 10^{-3}$	NA
	Chloroform	$6.9 \times 10^{-3}$	$2.0 \times 10^{-4}$	$2 \times 10^{-2}$
	1,1-DCE	$1.3 \times 10^{-2}$	$3.8 \times 10^{-4}$	$4 \times 10^{-2}$
	Carbon tetrachloride	$1.1 \times 10^{-2}$	$3.0 \times 10^{-4}$	$4 \times 10^{-1}$
			Sum =	$1 \times 10^0$

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**Appendix B**

**LLNL ARARs**

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## Appendix B

### LLNL ARARs

This Appendix discusses those standards, requirements, criteria, or limitations under Federal environmental law, and any promulgated standards, requirements, criteria, or limitations under State environmental or facility siting law that are more stringent than those provided under Federal law, that the signatories to LLNL's Federal Facility Agreement consider legally applicable or relevant and appropriate to the LLNL site. In addition, nonpromulgated criteria advisories or guidance that do not meet the definition of Applicable or Relevant and Appropriate Requirements (ARARs), but that may assist in determining what is necessary to be protective, are listed as to be considered (TBC). Some of these apply to remediation activities, such as discharges from treatment facilities, whereas others form the basis for determining when cleanup is complete. Table B-1 is a summary of corresponding ARARs for ground water and the vadose zone. A complete discussion of LLNL ARARs is presented in Section 3 of the Feasibility Study (FS) (Isherwood *et al.*, 1990).

There are three general kinds of ARARs: chemical-specific, location-specific, and action-specific. Chemical-specific ARARs usually result in health- or risk-based concentration limits. The Comprehensive Environmental Response, Compensation, and Liability Act (*CERCLA Compliance with Other Laws Manual* (U.S. EPA, 1988b)) contains a nonexhaustive list of potential chemical-specific ARARs from which LLNL has drawn to ensure that no ARAR is overlooked.

The chemical-specific concentrations proposed as remedial action objectives for ground water remediation are given for the compounds of concern at LLNL in Table 1 of this document. The standards in the columns of Federal and State drinking water Maximum Contaminant Levels (MCLs) and Federal non-zero Maximum Containment Levels Goals become remedial action objectives for ambient ground water (i.e., ground water left in place after remediation), whereas the discharge limits given in the last column apply to discharges of treated water under LLNL's National Pollution Discharge Elimination System permit. The most stringent concentration limit is the governing ARAR for each chemical of concern.

San Francisco Bay Area Regional Water Quality Control Board's Basin Plan ("Basin Plan") taste and odor objectives are not considered an ARAR because acceptable numerical expressions of these objectives are not available at the present time. There is no methodology for enforcement of these objectives and consequently they have not been enforced by the State. We, therefore, cannot use the Basin Plan's taste and odor objectives to establish a cleanup level for compliance purposes. If in the future a method is established for measurement and achievement of the Basin Plan's taste and odor objectives and achievement of those objectives is determined to be applicable or relevant and appropriate and necessary to ensure that the remedy is protective of human health and the environment, then LLNL will consider the objectives applicable to the cleanup.

If any additional hazardous substances are found in the ground water environment at levels of concern in the future, standards for those will be requested and agreed upon with the U.S. Environmental Protection Agency and the California Department of Toxic Substances Control.

Resource Conservation Recovery Act (RCRA) Section 3020 bans hazardous disposal by underground injection into or above a source of drinking water unless the reinjection involves treated ground water from a CERCLA response action. This section does not apply if certain conditions are met. At LLNL, proposed injection is a CERCLA response

action intended to clean up contamination; the contaminated ground water will be treated to substantially reduce hazardous constituents prior to such injection; and the response action will be sufficient to protect human health and the environment upon completion. LLNL thus meets the conditions for exemption and is not subject to the ban.

Whereas specific ARARs do not appear to exist as cleanup standards for vadose zone sediments, LLNL considers health protection (at a  $10^{-6}$  risk) to be a remedial action objective. Based on results of the Baseline Public Health Assessment (BPHA), ground water constitutes the only significant pathway of exposure from vadose zone contaminants. The BPHA demonstrates that, if ground water concentrations are at MCLs or below, the health risk is well below  $10^{-6}$ .

Unsaturated sediment cleanup concentrations will be based on the mobility of specific contaminants in the sediment at the LLNL site. We have examined the potential for hazardous substances in the sediments of the unsaturated zone to migrate to ground water (Appendix G of the FS). The preliminary results of our investigation indicate that the potential for affecting the ground water depends on the mass, concentration, and distribution of contaminants in the vadose zone.

For the areas of greatest potential concern at LLNL, we conclude that the dominant transport mechanism for migration to the ground water is vapor diffusion. The model illustrated in Appendix G of the FS provides a basis for deciding which, if any, areas at LLNL may warrant vadose zone remediation.

Based on the findings of the BPHA section of the Remedial Investigation (RI) (Thorpe *et al.*, 1990) that no surficial soils at LLNL constitute a potential health threat, we have no cleanup standards for surficial soils.

Location-specific ARARs are restrictions placed on the concentration of chemicals or conduct of operations based on the location of a site. Potential location-specific ARARs include the protection of:

- Wetlands.
- Floodplains.
- Historic landmarks.
- Coastal zones.
- Coastal barriers.
- Rare and endangered species.
- Cultural resources.

The LLNL site contains no floodplains, historic landmarks, coastal zones, or coastal barriers. As stated in the Livermore Site Environmental Impact Report (EIR) (DOE and University of California, 1992), three small wetlands exist at the culverts that channel runoff into Arroyo Las Positas at the northern perimeter of the site. A review of the LLNL site for rare and endangered species was performed as part of the site EIR, and none have been found. No contemplated action will have an impact beyond those discussed in Section 5 of the FS. LLNL does not believe that significant cultural resources will be impacted, because (1) there is no source of water on the site to sustain early cultures, and (2) virtually the entire site has been subject to intense development over the last 50 years. No excavation is contemplated that would disturb sites to depths greater than they may have already been disturbed.

California's Alquist-Priolo Special Studies Zones Act of 1972 (California Public Resource Code, Section 2621, *et seq.*) provides constraints on the building of residences



within 50 feet of an active fault. RCRA 40 CFR Section 264.18(a) prohibits new treatment, storage, or disposal facilities within 200 feet of a Holocene fault. There are no active faults within 200 feet of LLNL, and construction of residences is not permitted onsite; therefore, these two requirements are not ARARs. All treatment facilities will comply with local construction codes as applied by LLNL's Plant Engineering Department.

Action-specific ARARs are usually technology- or activity-based limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. Since there are usually several alternative actions for any remedial site, different requirements can be triggered. Action-specific ARARs may indicate or influence how a selective alternative is implemented.

The ARARs for the LLNL Livermore site are summarized in Table B-1.

Table B-1. Federal and State and local ARARs for LLNL (modified from Chapter 3 of the LLNL FS).

	Comments	Media to be remediated <sup>a</sup>	Applicable (A)	Relevant and Appropriate (RAR)	To be considered (TBC)
<i>Federal Chemical-Specific Requirements</i>					
Safe Drinking Water Act (SDWA) [42 USCA 300] [40 CFR 141.11-141.16; 141.50-141.51]	This law establishes treatment standards for current potential drinking water sources by setting Maximum Contaminant Levels (MCLs) and non-zero Maximum Contaminant Level Goals (MCLGs), which are used as cleanup standards. Those standards for the LLNL site are listed in Table 1 of the ROD.	GW, VZ	X <sup>b</sup>	X <sup>b</sup>	
Clean Air Act (CAA) [42 USCA 7401-7642] [40 CFR 50-69]	National primary and secondary ambient air quality standards (NAAQS) are defined under Section 109 of the CAA and are listed in 40 CFR 50.	GW, VZ	X <sup>c</sup> X <sup>c</sup>		
Clean Air Act [42 USCA 7412] [40 CFR 61.92]	National Emission Standards for Hazardous Air Pollutants (NESHAPs) are specific to industrial emissions. 40 CFR 61.92 limits emissions of radionuclides to those amounts that would cause any member of the public to receive, in any one year, a maximum effective dose equivalent of 10 millirem per year.	GW, VZ	X <sup>c</sup> X <sup>c</sup>		
<i>Federal Action-Specific Requirements</i>					
<i>Action: Closure</i>					
Resource Conservation Recovery Act (RCRA) 42 USCA 6901 [40 CFR 264.111]	Requires that a facility be closed in a manner which minimizes the need for further maintenance and is protective of human health and the environment. Applicable to hazardous waste management facilities.	GW, VZ	X <sup>b</sup> X <sup>b</sup>		
RCRA [40 CFR 264.178]	Requires removal of all hazardous waste and waste residues from containment systems. Although the treatment facilities and thermal system are not considered containment systems, this closure requirement will be considered RAR.	GW, VZ		X <sup>b</sup> X <sup>b</sup>	

Table B-1. (Continued)

	Comments	Media to be remediated <sup>a</sup>	Applicable (A)	Relevant and Appropriate (RAR)	To be considered (TBC)
<i>Action: Pump and Treat</i>					
RCRA [40 CFR 264.190-192]	Design and operating standards for tank systems. Tank systems may be used for pump and treat alternatives.	GW, VZ	X <sup>b</sup> X <sup>b</sup>		
RCRA [40 CFR 264.601-602]	Design, monitoring, and performance standards for miscellaneous treatment units.	GW, VZ	X <sup>b</sup> X <sup>b</sup>		
Land Disposal Restrictions (LDRs) RCRA [40 CFR 268]	Any waste placed in land-disposal units must comply with LDRs by either attaining specific performance or technology-based standards. This is applicable to untreated soil or debris from the CERCLA cleanup.	GW, VZ	X <sup>b</sup> X <sup>b</sup>		
<i>Action: Thermal Treatment</i>					
RCRA [40 CFR 265.373-381]	These regulations apply to owners or operators of facilities that thermally treat hazardous waste in devices other than enclosed devices that use controlled flame combustion.	VZ	X <sup>b</sup>		
<i>Action: Transportation</i>					
Transportation of Hazardous Waste RCRA [40 CFR 263]	Transporters must be licensed hazardous waste haulers. In the event of a discharge during transportation, the transporter must take immediate action to protect human health and the environment (263.30) and clean up the discharge such that it no longer presents a hazard (263.31). Generated waste being transported to an offsite disposal facility would be subject to this requirement.	GW, VZ	X <sup>b</sup> X <sup>b</sup>		
<i>Action: Reinjection of Treated Ground Water</i>					
Safe Drinking Water Act Underground Injection Control Program [40 CFR 144.26-27] [40 CFR 146.51-52]]	These regulations consist of inventory and monitoring requirements for reinjection of treated ground water.	GW, VZ	X <sup>b</sup> X <sup>b</sup>		

Table B-1. (Continued)

Comments	Media to be remediated <sup>a</sup>	Applicable (A)	Relevant and Appropriate (RAR)	To be considered (TBC)
<i>Action: Discharge of Treatment System Effluent</i>				
Clean Water Act (CWA) [33 USCA 1251-1376]	GW, VZ	X <sup>d</sup>		
National Pollutant Discharge Elimination System (NPDES) [40 CFR 122-125]		X <sup>d</sup>		
<i>Action: Air Stripping</i>				
OSWER Directive 9355.0-28	GW, VZ			X <sup>e</sup> X <sup>e</sup>
<i>General Action-Specific TBCs.</i>				
DOE Order 5400.4	GW, VZ			X <sup>d</sup> X <sup>d</sup>
<i>State and Local Chemical-Specific Requirements</i>				
Hazardous Waste Control Act (HCWA) (Health and Safety Code, Section 25100-25395), CCR, Title 22, ch. 30: Minimum Standards for Management of Hazardous and Extremely Hazardous Wastes	GW, VZ	X <sup>b</sup> X <sup>b</sup>		

Table B-1. (Continued)

	Comments	Media to be remediated <sup>a</sup>	Applicable (A)	Relevant and Appropriate (RAR)	To be considered (TBC)
Criteria for Identifying Hazardous Wastes [Title 22, 66693-66776]	Tests for identifying hazardous characteristics are set forth in these regulations. If a chemical is either listed or tested and found hazardous, then remedial actions must comply with Title 22 requirements.	GW, VZ	Xb Xb		
California Safe Drinking Water Act, Health and Safety Code, Section 2549.5	Regulations and standards for public water systems; MCLs and secondary MCLs (SMCLs), which are enforceable in California; requirements for water quality analyses and laboratories.	GW, VZ		Xb Xb	
Persistent and Bioaccumulative Toxic Substances [Title 22, 66699]	Total Threshold Limit Concentrations (TTLCs) and Soluble Threshold Limit Concentrations (STLCs) have been established for selected toxics to be used in establishing whether waste is hazardous. If a chemical is either listed or tested and found hazardous, then remedial actions must comply with the hazardous waste requirements under Title 22.	GW, VZ	Xb Xb		
Porter-Cologne Water Quality Control Act [WC13000-13806], as administered by the State Water Resources Control Board (SWRCB) and the Regional Water Quality Control Board (RWQCB) under CCR Title 23, subch. 15, 1050-2836.	Establishes authority for State and Regional Water Boards to determine site-specific discharge requirements and to regulate disposal of waste to land.	GW, VZ	Xb Xb		
State Water Resources Control Board's Resolution 68-16	The State Board's policy on maintaining the high quality of California's waters implies that ground water cleanup should continue below MCLs if it can be shown that it is technically feasible and cost effective to do so.	GW, VZ	Xb Xb		

Table B-1. (Continued)

	Comments	Media to be remediated <sup>a</sup>	Applicable (A)	Relevant and Appropriate (RAR)	To be considered (TBC)
29 USC 651 <i>et seq.</i> Occupational Safety and Health Act (OSHA)	OSHA requirements under 29 CFR 1910.120 are applicable to worker exposures during response actions at CERCLA sites; 29 CFR 1926 construction standards apply during construction phase of treatment facilities.	GW, VZ	X <sup>b</sup> X <sup>b</sup>		
29 CFR 1910 <i>et seq.</i> Noise Control Act of 1972, as amended by the Quiet Communities Act of 1978 [40 CFR 204, 205, 211]	Construction and transportation equipment noise levels (e.g., portable air compressors, and medium and heavy trucks), process equipment noise levels, and noise levels at the property boundaries of the project are regulated under this Act. State or local agencies typically enforce these levels.	GW, VZ	X <sup>b</sup> X <sup>b</sup>		
<i>State and Local Action-Specific Requirements</i>					
<i>Action: General Treatment of Hazardous Waste</i>					
Hazardous Waste Control Act, Health and Safety Code (HCWA), Sections 25100-25395 [22 CCR 67100-67195]	Requirements for general operations of interim status and permitted facilities [67100-67108], including preparedness and prevention [67120-67126], contingency plans and emergency procedures [67140-67145], and manifesting and monitoring requirements [67180-67195].	GW, VZ	X <sup>b</sup> X <sup>b</sup>		
Hazardous Waste Control Act Land-Disposal Restrictions [22 CCR 66900]	This law requires that certain hazardous wastes meet minimum treatment standards prior to disposal at a landfill.	GW, VZ	X <sup>b</sup> X <sup>b</sup>		
Hazardous Materials Release Response Plans and Inventory [H&SC, Div. 20, ch. 6.95] [19 CCR, ch. 3, subch. 3]	This law requires businesses handling hazardous materials to plan for emergency response actions.	GW, VZ	X <sup>b</sup> X <sup>b</sup>		

Table B-1. (Continued)

	Comments	Media to be remediated <sup>a</sup>	Applicable (A)	Relevant and Appropriate (RAR)	To be considered (TBC)
<i>Action: Closure</i>					
Hazardous Waste Control Act Closure Requirements, Sections 25100-25395 [22 CCR 67210-67220]	A facility shall be closed in a manner that minimizes the need for future maintenance. If hazardous wastes are left in place, postclosure care must continue for 30 years.	GW, VZ	Xb Xb		
<i>Action: Transportation</i>					
Hazardous Waste Control Act Hauler Registration Requirements [22 CCR 66420-66465] and Requirements for Transporters of Hazardous Waste [22 CCR 66530-66564]	Hazardous wastes must be transported by a hauler registered with the State of California.	GW, VZ	Xb Xb		
Requirements for Generators of Hazardous Waste [Title 22 66470-66515]	Owners or operators who ship hazardous waste from a Transport, Storage, or Disposal (TSD) facility shall comply with the generator standards in these regulations. These standards include keeping of manifests [66481], submission of manifest to CDHS within 30 days of shipment [66484(f)], preparation of a biennial report [66493(a)], and a maximum 90-day accumulation time [66508(a)]. These regulations are applicable to transportation and offsite disposal of hazardous waste.	GW, VZ	Xb Xb		
<i>Action: Discharge of Treatment System Effluent</i>					

Table B-1. (Continued)

	Comments	Media to be remediated <sup>a</sup>	Applicable (A)	Relevant and Appropriate (RAR)	To be considered (TBC)
Porter-Cologne Water Quality Control Act [WC 13000-13806], as administered by the State Water Resources Control Board (SWRCB) and the Regional Water Quality Control Board (RWQCB) under CCR Title 23, subch. 15, 1050-2836	Establishes authority for State and Regional Water Boards to determine site-specific discharge requirements and to regulate disposal of waste to land.	GW, VZ	X <sup>b</sup> X <sup>b</sup>		
Fish and Game Regulations on Pollution	Prohibits water pollution with any substance or material deleterious to fish, plant, or bird life.	GW, VZ	X <sup>f</sup> X <sup>f</sup>		
<i>Action: Air Stripping</i>					
Air Resources Act (Health and Safety Code, section 3900 <i>et. seq.</i> )	Establishes allowable discharge standards for point sources within each air pollution control district, and establishes ambient air quality standards.	GW, VZ	X <sup>b</sup> X <sup>b</sup>		
Bay Area Air Quality Management District [Regulation 8, Rule 47]	Requires permitting of VOC air discharges (e.g., from an air-stripping unit).	GW, VZ	X <sup>b</sup> X <sup>b</sup>		
<i>Location-Specific Requirements</i>	There are no Federal or State location-specific requirements for the LLNL site.				

a GW — Pump and treat; complete hydraulic capture with source remediation.

VZ — Vacuum-induced venting with catalytic oxidations.

b All RARs are the same for all treatment options contemplated under this treatment alternative.

c CAA requirements only apply to treatment options with atmospheric discharges.

d Only offsite CERCLA discharges to surface waters must be NPDES-permitted.

e Factors TBC are the same for all treatment options contemplated under this treatment alternative.

f Applies only to treatment options with surface discharges.



**Attachment A**  
**Responsiveness Summary**  
**for**  
**LLNL Livermore Site Record of Decision**

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## Introduction

This Responsiveness Summary responds to comments and questions directed to Lawrence Livermore National Laboratory (LLNL), the U.S. Department of Energy (DOE), and the regulatory agencies [the U.S. Environmental Protection Agency (EPA), the California Regional Water Quality Control Board (RWQCB), and the California Department of Toxic Substances Control (DTSC)] regarding the LLNL Livermore Site Proposed Remedial Action Plan (PRAP) and other supporting documents. This document responds to comments and questions received during the PRAP public comment period –both in writing and at the public meeting. We have incorporated responses to comments and community concerns on the PRAP into the Record of Decision (ROD) for the LLNL Livermore Site.

The 30-day public comment on the PRAP began on October 18, 1991. It was extended by an additional 30 days, to December 18, 1991, in response to a request from Western States Legal Foundation. On the evening of November 6, 1991, LLNL held a public meeting at Livermore High School, Livermore, California. During the meeting, LLNL and DOE summarized the findings of the Remedial Investigation (RI) and Feasibility Study (FS), and presented their preferred approach for addressing the ground water and soil contamination at the Livermore site. Formal presentations were followed by a question and answer session, directed to a panel of LLNL, DOE, and regulatory agency representatives. Following the question-and-answer session, 15 members of the public read their comments into the formal public record for that meeting. In keeping with standard protocol for public meetings of this type, no one from the panel responded to these formal comments. The transcript from the public meeting can be found in the Livermore Public Library and at the LLNL Visitors Center. LLNL also received 16 letters from community groups and private citizens during the PRAP public comment period.

## Organization of the Responsiveness Summary

Members of the public commented on a wide range of topics, which have been grouped into one of six categories, shown below with their subcategories.

- A. Comments Specific to the PRAP
  - A1. Overall Impressions
  - A2. CERCLA Standards
  - A3. Current/Future Containment Problems and Accidents
  - A4. PRAP and ROD Milestone/Schedules/Commitments
  - A5. Radioactive Contaminants/Investigations
  - A6. Source Investigations
  - A7. Technical Basis for PRAP
  - A8. Cleanup Alternatives/Technologies/Costs
  - A9. Other PRAP Issues
- B. RI/FS Documents
  - B1. Deficiencies in RI/FS
  - B2. Timing
- C. Community Relations
  - C1. Community Work Group
  - C2. Technical Advisors
  - C3. Future Public Comment Periods and Meetings
  - C4. General Community Relations
- D. Federal Facility Agreement (FFA)/CERCLA
  - D1. Federal Facility Agreement
  - D2. Relationship Between the FFA and CERCLA
- E. Nuclear Weapons Research/LLNL Mission
  - E1. LLNL Nuclear Weapons Design, Power Policies, and Activities
  - E2. Weapons Funding vs Environmental Restoration Funding
- F. Other Issues
  - F1. General Criticism of LLNL/DOE
  - F2. Support for Senate Bill 1402
  - F3. Procedural Questions/Suggestions

In keeping with EPA Superfund guidance and common practice, LLNL and DOE summarized individual comments and grouped them by subject area. Where two or more comments are identical or very similar, only one response is provided. The benefits of organizing the Responsiveness Summary in this manner are: (1) the reader is able to get a better overall understanding of the breadth of public comments, and (2) unnecessary repetition is avoided. Whenever possible, comments are summarized verbatim from either the meeting transcript or the letters.

Individual commenters often tried to make a number of points, either in their written comments or during the November 6 public meeting. Each comment was assigned a number. The letters yielded 111 comments; the public meeting yielded 108 comments and 19 questions. Each letter was numbered, as well (e.g., Letter #1, #2, etc.).

Following each summarized comment are notations that identify the origin of the summarized comment. If the comment was made at the public meeting, the code would be: Transcript p. x, MC-y or MQ-z, where MC stands for Meeting Comment and MQ stands for Meeting Question. If the comment was received in a letter, the code would be: Letter #1; WC-x, where WC stands for Written Comment.

The Information Repositories contain a copy of each of the comment letters, as well as the meeting transcript. The number of each comment letter is marked at the top of the letter (e.g., Letter #1, #2, etc.). Next to each comment is the number assigned to that comment. The section of the Responsiveness Summary containing LLNL's response is indicated in brackets beside the comment number (e.g., [C4]). A copy of the meeting transcript, coded in a similar way, is also available in the Information Respositories. These repositories are located at the LLNL Visitors Center and at the Livermore Public Library.

## Comment Summaries and Responses

### A. Specific To The PRAP

#### A1. Overall Impressions

##### **Comment A1a:**

*LLNL has, in general, done a lot of very good work on the PRAP. The Ground Water Project staff have done a good job of describing most of the Superfund cleanup issues, providing a series of health risk assessments, and putting together a cleanup proposal. LLNL has put a significant level of scientific expertise into the PRAP and has taken this effort seriously.*

*Transcript p.91; MC-4  
Transcript p.104; MC-25  
Transcript p.109; MC-37*

##### **Response A1a:**

Comment noted.

##### **Comment A1b:**

*However, the PRAP is unacceptable for a number of reasons, including that it does not meet Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) requirements and does not present clear alternatives for effective remedial action. We request that LLNL respond to our (Tri-Valley CAREs) comments in writing and, at a minimum, incorporate these comments into a final remedy selection and Record of Decision (ROD) that overcomes the deficiencies we have identified in the PRAP.*

*Delays in acceptance of the PRAP and the ROD in order to address Tri-Valley CAREs' concerns need not delay containment and cleanup. In fact, LLNL has been conducting cleanup and containment operations for some time now. Containment of the moving plume is the highest priority at the site, and one that can and should be implemented while design and discussion of the other aspects of the remedial actions continue. Instead of turning the PRAP into a public outreach document, it would have been, and still would be, better to make a separate, accurate summary of a much more substantive PRAP, acting decisively in the meantime to arrest further plume migration.*

*Transcript p.93; MC-7  
Transcript p.110; MC-40  
Transcript p.118; MC-64  
Letter #1; WC-3  
Letter #1; WC-9  
Letter #1; WC-12*

**Response A1b:**

The U.S. EPA believes that the PRAP meets CERCLA requirements, as discussed in the responses to Comments A2a through A2k.

The PRAP meets CERCLA requirements because it has been prepared according to CERCLA guidance and has been reviewed and approved by the regulatory agencies, including the U.S. EPA. We believe that the PRAP does present viable alternatives for effective Remedial Action.

LLNL is responding to Tri-Valley CAREs' comments on the PRAP via this Responsiveness Summary. In addition, LLNL has responded to Tri-Valley CAREs comments and concerns at CWG meetings; initiated an all-day meeting on July 25, 1991, to discuss Tri-Valley CAREs technical concerns; and responded in writing to the April 8, 1991, written comments on the PRAP from Peter Strauss. Our records indicate that the written responses to Mr. Strauss' comments were mailed to Mr. Strauss on June 24, 1991, and were sent again on January 29, 1992, to Mr. Strauss and to Marylia Kelley of Tri-Valley CAREs. Other specific comments on the PRAP are addressed throughout this Responsiveness Summary.

We agree that plume containment is a high priority, and it will be the first objective of the remedial action. However, delays in acceptance of the ROD will delay implementation of the complete cleanup because continuous, full cleanup can begin only after the ROD is signed. The plume cannot be contained fully by ground water extraction using the currently approved pilot studies because the currently approved pilot study extraction wells are not located near all plume margins. A more "substantive" PRAP is not consistent with CERCLA and would delay the ROD and, therefore, the ability to begin full plume containment as soon as possible.

**A2. CERCLA Standards**

*The PRAP does not meet CERCLA standards for the following reasons:*

*Transcript p.116; MC-62  
Letter #8; WC-70*

***Comment A2a:***

*The construction schedule does not meet requirements for CERCLA cleanups at Federal facilities. Specifically, CERCLA Section 120(e)(2) requires that "Substantial continuous physical onsite remedial action shall be commenced at each facility not later than 15 months after completion of the [remedial] investigation and [feasibility] study." For the Ground Water Project, this date would be March 31, 1991. LLNL's proposed "1993-94" time frame for construction and 1996 date for containment of the plume appears to be in violation of this section, unless the pilot studies now underway can be considered "substantial," which we do not consider to be the case. Furthermore, there is no technical reason why LLNL can't contain the moving plume by the statutory deadline.*

**Response A2a:**

The Remedial Investigation (RI) and Feasibility Study (FS) are complete on the date that all Federal Facility Agreement (FFA) signators that wish to sign the ROD do so. This date marks the beginning of the 15-month period in which "Substantial continuous physical onsite remedial action shall be commenced" [CERCLA 120(e)(2)]. The pilot studies do not satisfy this requirement because they represent a noncontinuous implementation of the overall remedial action plan. LLNL is in the process of negotiating a Remedial Design/Remedial Action schedule with U.S. EPA, the RWQCB, DTSC that is consistent with this requirement.

**Comment A2b:**

*Only one remediation alternative was presented. In effect, the choice presented to the public was one of being in favor of the plan presented –or against. For example, the projected 53-year time frame for cleanup of the ground water was not compared to other, more aggressive and faster cleanup approaches.*

**Response A2b:**

A total of three ground water remediation alternatives are presented in the PRAP: two immediate action alternatives (numbers 1 and 2), which are both pump and treat approaches, and a deferred action, treat at point of use, if necessary, approach. The recommended alternative is the *starting point* for cleanup, and will be expanded to include more extraction wells to reduce cleanup time as funding and technical developments allow. Cleanup may be expedited by changing the number and location of extraction wells, testing new treatment technologies, and recharging most of the treated ground water. *Monthly Progress Reports* will contain evaluations of the cleanup and present new technologies and/or design modifications. In addition, the progress of the cleanup will be reviewed every 5 years as required by CERCLA. The Remedial Design documents will present the details of remedial systems and schedules for their implementation. The Remedial Design documents will present the remedial design criteria for the vadose zone and ground water, details of treatment system design, plans for discharging treated ground water, a preliminary construction schedule, and plans for post-ROD community relations activities.

**Comment A2c:**

*PRAP actions aren't effective in the short-term because it will take 5 years to contain the contaminant plume. Short-term effectiveness is one of EPA's nine criteria for comparing and evaluating the cleanup alternatives.*

**Response A2c:**

The recommended alternative is effective in the short term, because pumping at key locations to contain the plumes begins as soon as extraction wells and treatment systems can be installed.

**Comment A2d:**

*The discharge quality commitments shown in Table 1 of the PRAP do not necessarily protect public health. For example, the discharge concentration limits for ethylene dibromide (EDB), carbon tetrachloride, and 1,2-dichloroethane are significantly greater than the California Maximum Contaminant Level (MCL), and some are higher than the Federal MCL. Further analysis of the specific quantity and locations of discharge should be done. Also, the selection of Applicable or Relevant and Appropriate Requirements (ARARs) for off-site discharge, which are far above the applicable drinking water standards, is highly questionable. We suggest using the more stringent MCL for drinking water as a discharge standard, except in the case of tritium, which should be set at the detection limit for off-site discharges.*

**Response A2d:**

The cleanup levels for LLNL are the lowest existing MCLs, and the discharge limits for treated water are set by the RWQCB Basin Plan, which is an ARAR for these discharges. The Basin Plan is available at the RWQCB Office at 2101 Webster Street, Suite 500, Oakland, California. Note that the RWQCB discharge limit for EDB (ethylene dibromide) is now 0.02 ppb, which is its MCL (See Table 1 of the ROD).

Carbon tetrachloride and 1,2-DCA are grouped together with other VOCs in the LLNL National Pollution Discharge Elimination System (NPDES) permit, and the effluent limit for total VOC contaminants is 5 ppb. While this value is higher than individual California MCLs for 1,2-DCA and carbon tetrachloride, it has been demonstrated that the 5 ppb effluent limitation for total organic contaminants in treated ground water is considered to be consistent with best available technology (BAT). More stringent limitations for certain organic pollutants may be imposed on a case-by-case basis if necessary to protect beneficial uses of water bodies and maintain water quality objectives in the Basin Plan; thus the 0.02-ppb limit for EDB. In the absence of categorical limitations, BAT permits must be issued on a case-by-case basis using best professional judgment.

Specific radiological effluent and receiving water limits are not included in the LLNL NPDES permit because the Nuclear Regulatory Commission and the Department of Toxic Substances Control (DTSC) have primary responsibility for regulation of such constituents in waste water discharges pursuant to the Code of Federal Regulations—Energy, Title 10, Chapter 1, Part 20 et seq., and the California Code of Regulation Titles 17 and 22 (Regulations for Radiation Control and for Domestic Water Quality and Monitoring, respectively).

The Basin Plan provides that ground water and surface waters designated for domestic or municipal drinking water supply, such as the areas in the Alameda Creek Watershed (Arroyo Los Positas), shall not contain concentrations of radionuclides in excess of the following objectives: 5pCi/L (picocuries per liter) of combined radium-226 and radium-228, 15 pCi/L of gross alpha particle activity, 20,000 pCi/L of tritium, 8 pCi/L of strontium-90, and 50 pCi/L of gross beta particle activity. These objectives conform with the MCLs contained in Title 22 of the California Administrative Code administered by DTSC and with the Primary Drinking Water Limits specified by the EPA.

The State believes the discharge limits in Table 1 of the ROD are health protective of human health.



**Comment A2e:**

*CERCLA requires Federal facilities to submit "alternative agency funding" for cleanups with their budget requests, so that Federal facility cleanups will not be held hostage to other intra-agency priorities. The PRAP contains no such commitment to alternative funding, and in fact makes all cleanup activities contingent upon DOE funding. Also, on its face it appears that CERCLA Section 120(e)(3) requires funding for the cleanup of DOE Superfund sites, like this one, to be of higher priority than other DOE budget line items. We would be interested in EPA's interpretation of this section.*

**Response A2e:**

The response to Comment A4j addresses this comment. Also, DOE filed a claim upon the Department of Defense Restoration Account in 1987 for environmental damage caused by the U.S. Navy during its occupation of the LLNL site from 1942 to 1946. This claim may also be a source of funding for LLNL ground water remediation.

**Comment A2f:**

*The PRAP cleanup actions proposed are neither aggressive, nor expeditious, as required in the preamble to the National Contingency Plan (NCP) and in CERCLA Section 120(e)(3). This is especially the case given the target date of 1996 for containment, which was announced during the November 6, 1991, public meeting. This 1996 target date represents a slackening of the schedule proposed in the June 1991 PRAP by some 3 years.*

**Response A2f:**

The PRAP cleanup actions are expeditious and aggressive considering that the preferred alternative stipulates immediate action to begin plume containment and cleanup. This is especially true in view of the fact that no one is currently using or is exposed to ground water containing LLNL site contaminants, and no use of this ground water is expected before plume containment is achieved. Current estimates are that plume containment may be achieved in 1995.

**Comment A2g:**

*The PRAP does not include an "operable units" approach, as discussed in the NCP at 300.430(a)(1)(ii).*

**Response A2g:**

The entire LLNL site is considered one operable unit as established in the 1988 Federal Facility Agreement (FFA), approved by U.S. EPA, the State of California, and DOE.

**Comment A2h:**

*The PRAP does not include any contingency plans, as encouraged (though not required) by EPA as part of pump and treat systems.*

**Response A2h:**

As noted in the comment, contingency plans are not a required element of the PRAP and DOE is not considering a contingency plan for inclusion in the ROD in lieu of pump and treat remediation. DOE and LLNL are committed to remediating contaminants from the LLNL site as funding and the CERCLA process allow. Contingency plans are required in the Remedial Design/Remedial Action documents, which follow the ROD.

**Comment A2i:**

*The technical basis for the PRAP is inadequate, particularly with respect to cleanup duration estimates (See Letter #1 for more on this issue).*

**Response A2i:**

This comment is addressed in the responses to Comments A7d, A7e, A7g, and A7h.

**Comment A2j:**

*Although called for in the FFA, Resource Conservation Recovery Act (RCRA) requirements have not been included as ARARs. For example, the RI did not encompass all RCRA solid waste management units, nor does the PRAP refer to the requirements of RCRA Section 3016.*

**Response A2j:**

RCRA requirements are included as ARARs in the FS. RCRA ARARs for the LLNL cleanup include design and operation standards for tank systems and miscellaneous treatment units, 40 CFR 264.190-192, 264.601-602; RCRA land disposal restrictions; 40 CFR 268; RCRA thermal treatment requirements, 40 CFR 265.373-381; RCRA hazardous waste transportation requirements, 40 CFR 263; and RCRA clean closure requirements; 40 CFR 264.111, 264.178. LLNL also submits a RCRA Section 3016 inventory to DOE on a biennial basis.

CERCLA does not require that all RCRA requirements are ARARs. RCRA has nine subtitles that deal with specific waste management activities. In order to be designated as an ARAR, the requirement must be applicable or relevant and appropriate to the response action. RCRA requirements that are applicable and/or relevant and appropriate are included as ARARs in the FS and summarized in Table 1 and Appendix B of the ROD.

The RCRA requirements that are ARARs pertaining to solid waste management units in the cleanup include design and operation standards for tank systems and miscellaneous treatment units, 40 CFR 264.190-192, 264.601-610 and RCRA thermal treatment requirements, 40 CFR 265.373-381. Other RCRA requirements designated as ARARs are RCRA land disposal

restrictions, 40 CFR 268; RCRA hazardous waste transportation requirements, 40 CFR 263; and RCRA clean closure requirements, 40 CFR 264.111, 264.178.

RCRA Section 3016 is an inventory requirement. Administrative RCRA requirements, such as reporting and recordkeeping requirements, are not ARARs for onsite activities. RCRA Section 3016 is therefore not included in the definition of an ARAR. However, LLNL submits a RCRA Section 3016 inventory to DOE on a biennial basis.

***Comment A2k(i):***

*The PRAP isn't acceptable to the community, based on the fact that: no one spoke in favor of the plan at the November 6, 1991, public meeting; it is not acceptable to Tri-Valley CAREs; and the CWG has found serious omissions in the plan.*

**Response A2k(i):**

We believe we have addressed the community issues via this responsiveness summary. Comment A1a indicates that at least one speaker at the public meeting believes that LLNL has done "a lot of very good work on the PRAP and has taken the effort seriously."

The degree of community acceptance was one of nine factors prescribed by EPA to select the remedy. In summary, the community accepts the concept of the selected alternative and desires funding commitments, a detailed implementation schedule, continued opportunity for involvement, and a faster cleanup. These issues will be addressed in the Remedial Design documents.

***Comment A2k(ii):***

*LLNL has not been responsive to community concerns. Past comments submitted by Tri-Valley CAREs and the CWG have been either ignored or not addressed in the preparation of the final PRAP. One of the Technical Advisors is concerned that he has received no telephone calls or written communication from any Ground Water Project personnel since the July 25, 1991, meeting.*

**Response A2k(ii):**

This comment is addressed in the response to Comment C4c.

**A3. Current/Future Containment Problems and Accidents**

***Comment A3a:***

*Have there been any recent accidents that would cause concern for the potential cleanup? How are these accidents and potential future accidents considered under this Superfund cleanup plan? Are they included or will they not be addressed?*

*Transcript p.57; MQ-5*

*Transcript p.57; MQ-6*

**Response A3a:**

The Ground Water Project has examined all identifiable past accidents that have resulted in spills to the ground. None of these recent accidents have allowed any contaminants to reach the ground water. Ongoing operations which result in future spills are not included under the CERCLA cleanup, but are handled by other LLNL Environmental Programs. Any spills that result, or have significant potential to result, in contaminants reaching ground water in concentrations above MCLs will be cleaned up according to the existing plans, or plans will be modified to ensure that the affected ground water is remediated. LLNL does have its own spill response plans (Radian, 1985).

Common activities that use hazardous materials at LLNL are now conducted under stringent environmental control, from both within and outside of LLNL. During the past 10 years, accidents that have resulted in discharges of contaminants to the environment have been minor, and none have resulted in contaminants reaching ground water. We expect that the current LLNL policies and practices will prevent major releases in the future. Any releases that do occur in the future will be immediately addressed.

The LLNL Operations and Regulatory Affairs Division (ORAD) of the Environmental Protection Department is responsible for the evaluation and assessment of ongoing operations. If a spill occurs, their analysts assess the size, type, and quantity of spilled material(s). LLNL Hazards Control is called to evaluate the level of personnel protection necessary for the cleanup. If a significantly hazardous material is spilled, the LLNL Fire Department is called for immediate containment. The Hazardous Waste Management Division of the LLNL Environmental Protection Department removes, manifests, and disposes spilled hazardous materials.

The response to Comment A3b also addresses this comment.

**Comment A3b:**

*The PRAP should contain provisions for carefully controlling current sources of potential contamination concurrent with the cleanup of old problems. The relationship between cleanup and ongoing operations (e.g., handling and storage of hazardous waste) and future contamination needs to be addressed in the PRAP (and, one commenter suggests, in the ROD, as well). The lack of an integrated management plan to address all of LLNL's pollution and environmental problems at one time is a problem. The potential impact of continuing LLNL operations on the cleanup needs to be discussed. Abnormal occurrences such as spills or leaks from ongoing operations should be expected, as well as small releases from normal operations. The PRAP needs to contain provisions for potential future accidents, especially given such incidents as the October 26, 1991, accident in which 2.6 microcuries of americium were released to the environment.*

*Information regarding ongoing operations needs to be included in the PRAP for several reasons, including the possibility that future discharges may come under different, less stringent regulations without the same level of public scrutiny. Because the focus in the CERCLA-related documents is narrowed by LLNL to only problems resulting from past contamination by volatile organic compounds (VOCs), the Superfund cleanup solutions inadequately address soil contamination generally, underground tanks, sewer lines, and ongoing programs. Other concerns of possible sources of contamination include Buildings 281, 292, 331, the plutonium facility, LLNL sewer lines, and leaking tanks, and should be referenced in the CERCLA documents.*

Transcript p.61; MC-1  
Transcript p.95; MC-10  
Transcript p.104; MC-23  
Transcript p.107; MC-31  
Transcript p.107; MC-32  
Transcript p.113; MC-50  
Transcript p.124; MC-76  
Letter #1; WC-24  
Letter #3; WC-51  
Letter #7; WC-69  
Letter #9; WC-76  
Letter #10; WC-82  
Letter #13; WC-92  
Letter #15; WC-101

### **Response A3b:**

The LLNL Environmental Restoration Division (ERD) identifies where past releases have occurred and develops remediation technologies for cleanup. Ongoing operations at LLNL are chemically and radiologically monitored by LLNL's Environmental Measurements and Analysis Division on a regular basis. LLNL's hazardous waste is handled by the Hazardous Waste Management Division, which operates under State and Federal regulations and oversight. All areas that handle hazardous materials have spill containment and control equipment so that spills will not significantly affect the environment. If spills do occur in any of the hazardous waste management units, they are quickly contained, cleaned up to regulatory standards, and evaluated by LLNL's Operations and Regulatory Affairs Division. In addition, every program operates under Standard Operating Procedures to ensure that spills and leaks are promptly detected and cleaned up. With current use and disposal procedures, it is unlikely that spills with significant environmental impact would occur.

The partially decommissioned Building 281 reactor is only contaminated in its core and affiliated plumbing, which has been sealed from the public and the environment since its regulated cooling-down phase. The superstructure, which has been decontaminated, is monitored on a regular basis, and is now used for storage. Access to the superstructure is not restricted.

Tritiated water leaked from an underground tank near Building 292. The soil and ground water in this area are being extensively monitored as discussed in the response to Comment A3c. The highest detected tritium activity in the Building 292 area was  $2.21 \times 10^8$  picocuries of tritium per liter of soil moisture directly beneath the leak. Tritium in ground water in this area is well below the MCL. Building 292 has been largely decontaminated. There are no current plans to decommission Building 292.

The Building 331 (tritium facility) subsurface is being monitored by LLNL due to the nature of operations at this facility. Water from downgradient monitor wells contains no tritium above the drinking water standard. Unsaturated sediment samples collected in the past near the facility contained tritium activities up to  $9.12 \times 10^4$  picocuries per liter of soil moisture. Additional boreholes are planned in 1993 for this area.

Sewer lines, both sanitary and storm, are checked regularly for leaks, and if leaks are found they are repaired. CERCLA does not require reporting of sewer line leaks. However, we have sampled the soil and ground water near the sewer lines, and no VOC or radionuclide contamination

has been found. DOE, EPA, DTSC, and the RWQCB have discussed the separation of issues related to leaking sewers and the CERCLA process. These meetings took place early in the Ground Water Project and included: Joe Cullen, a technical representative from DOE; Jan Tulk, a legal representative from LLNL, Susan Brechbill, a legal representative from DOE; Don Cox, a representative from DTSC; Don Dalke from the RWQCB; and Bill Isherwood, former Ground Water Project Leader at LLNL.

LLNL has a separate underground tank program that is responsible for tank closure and removal activities. These activities are regularly reported to the RWQCB, which oversees the tank program.

Environmental restoration activities will not cease after the ROD. The Remedial Design Report(s) will be prepared, the full cleanup will be implemented, and the cleanup will be monitored and optimized as it progresses.

Areas of contamination that are not presently described in the ROD will be assessed and remediated, if necessary, with oversight from the regulatory agencies. Any amendments to the ROD will be prepared as necessary and as determined with DOE and the regulatory agencies.

The response to Comment A3e also addresses this comment.

**Comment A3c:**

*Other accidents at LLNL of concern include the tritium accident at Building 292 where concentrations of tritium and soil moisture are currently peaking at about 220 million picocuries per liter; some leaching to the ground water has occurred. Some uptake by the vegetation to transpire that tritium into the air has occurred. The risk assessment that was done is a problem because it treats the tree as if it were a stack atop a building and the hypothetical maximally exposed individual is too far away from the tree. These things need to be remediated and not trivialized by the Lab.*

*Transcript p.124; MC-77*

**Response A3c:**

ERD has been and will continue to monitor the migration of tritium in the vicinity of the tritiated water release at Building 292. On a quarterly basis, ground water is sampled from seven wells, multiple soil moisture data are collected from two 40-ft boreholes, transpired water is sampled from plants and trees in the vicinity of Building 292, and air samples are collected near the ground surface during drilling. In addition, LLNL monitors soil moisture movement at three locations in the area and soil moisture flux from the ground surface just south of the underground tank.

Remediation of tritiated water is complicated by many factors. Tritium is an isotope or form of hydrogen and becomes part of a water molecule. There is no effective method to extract the tritiated water from the soil without releasing tritium to the atmosphere. All available information indicates that there will be less human exposure if the tritiated water is left in place to naturally decay along with some natural discharge to the atmosphere via evapotranspiration. Tritium decays with a half-life of 12.3 years. In about 40 years, there will be only one-eighth of the present

tritium remaining. Decay products consist of an electron, which will readily adsorb onto a soil particle, and helium-3, (an inert gaseous isotope of helium used in balloons).

The highest observed tritium activity (concentration) from a pine tree near Building 292, along with site meteorological data, were input to the AIRDOS EPA computer model to determine the annual doses to a maximally exposed individual. We assumed the tritium release height was 20 ft, according to the average tree canopy (not a "stack atop a building"). The resultant tritium dose was estimated to be  $1 \times 10^{-3}$  millirem/year, which is substantially lower than the applicable dose limit in the Clean Air Act (40 Code of Federal Regulations, Part 61, Subpart H) of 10 millirem/year. Although the release height is considered too high by a commenter, the resultant dose is so much lower than the dose limit that lowering the height of release will have only a small effect on the resultant dose. In addition, recent monitoring of water transpired from the pine tree indicates that tritium activities have decreased by 3 orders of magnitude since the initial dose screening.

***Comment A3d:***

*What is the point of cleaning anything up at LLNL if you are going to continue to pollute? How can you clean up the old mess if you continue to make newer and better messes?*

*Transcript p.63; MQ-8*

***Response A3d:***

This comment is addressed under the responses to Comments A3b and A3e.

***Comment A3e:***

*Is there any provision in the PRAP for dealing cost-effectively with current Lab activities that produce waste and contamination? It seems foolish to not include plans to minimize waste and in particular minimize the production of hazardous, radioactive, or mixed waste that can contaminate ground water.*

*Letter #12; WC-88*

***Response A3e:***

There are active programs in place at LLNL for the management of all hazardous materials and hazardous waste. There are also programs for waste minimization that are directed at reducing the amount of hazardous materials that are used onsite and the amount of hazardous waste that is produced. Neither of these programs are addressed in the PRAP as they are not part of the CERCLA cleanup. The CERCLA cleanup activities have been designed to minimize production of hazardous waste by using technologies that destroy contaminants, and/or by employing recycling whenever possible.

**A4. PRAP and ROD Timetables/Milestones/Schedules/Commitments****Comment A4a:**

*The PRAP should include an overall timetable and schedule for the ground water cleanup, including installation schedules. One way to set this up might be to say, "given x-funding level, using xyz model, this particular ground water site will have contaminant concentration decreased to x-parts per billion in 1 year, or 2 years, etc..." It should contain a means for verification of plume capture and cleanup.*

*Performance milestones for the ground water and vadose zone cleanup could be codified in the PRAP and keyed into the regular 5-year cleanup reviews that are part of the Superfund process. These could include either mass removal or plume-area control or concentration reduction targets. The former should be based on mass removal curves developed by a multi-dimensional model of the pump and treat system. The exponential mass-reduction curve for the plume, expressed as a mass removal half-life of 13.3 years, and contained in Appendix C of the FS, could provide the basis for a performance schedule. However, it should be noted that Tri-Valley CAREs believes that the Appendix C analysis is overly optimistic and that a 50 year cleanup goal is unattainable without removing more contaminant mass in early time than the Appendix C analysis suggests. By codifying the milestones in the PRAP, it will help guarantee DOE funding for the cleanup.*

*Transcript p.66; MC-2*

*Transcript p.92; MC-5*

*Transcript p.94; MC-8*

*Transcript p.98; MC-17*

*Transcript p.105; MC-26*

*Transcript p.111; MC-42*

*Transcript p.119; MC-68*

*Transcript p.126; MC-81*

*Transcript p.135; MC-90*

*Transcript p.140; MC-97*

*Letter #1; WC-14*

*Letter #2; WC-48*

*Letter #3; WC-50*

*Letter #4; WC-56*

*Letter #7; WC-64*

*Letter #9; WC-72*

*Letter #10; WC-77*

*Letter #12; WC-87*

*Letter #13; WC-94*

*Letter #15; WC-103*

**Response A4a:**

The regulatory agencies, DOE, and LLNL agree that such information is not warranted in a PRAP, nor desired by the regulatory agencies to be in the PRAP. Consistent with other U.S. EPA Superfund sites, schedules and performance milestones will be presented in the Remedial Action Implementation Plan and the Remedial Design/Remedial Action documents, as already communicated by LLNL in writing and verbally at CWG meetings. These post-ROD documents will become part of the Administrative Record and will be available to the public at the LLNL Visitors Center and the City of Livermore Public Library.



The 50-year cleanup goal, and recent modeling efforts to reduce that cleanup time, are discussed in the responses to A7a and A8n.

**Comment A4b:**

*The time frame for completing the cleanup of the Gasoline Spill area is not presented in the PRAP. Does LLNL plan to remediate this area prior to the overall remediation of the LLNL site? What will be the lifetime of the refractory EDB component of the plume, and what plans does LLNL have to remediate this compound? The answers to these questions do not appear in the PRAP.*

*Letter #1; WC-40*

**Response A4b:**

The Gasoline Spill Area is part of the general ground water cleanup. Work schedules for the entire cleanup, including the Gasoline Spill Area, will be included in the Remedial Action Implementation Plan and Remedial Design documents.

The schedule, design, and operation details for the treatment facilities will be included in the Remedial Design documents that will be issued during the post-ROD period and will be available to the public at the LLNL Visitors Center and the City of Livermore Public Library. These reports will include the technologies necessary to clean up all contaminants that are in the extracted ground water, including EDB.

**Comment A4c:**

*The need for milestones and deadlines is especially important, due to frequent deadline slippage by LLNL on other CERCLA documents. For example, the formal deadlines in the FFA have been extended two times (in October 1989, and again in January 1991). The last deadline shown there for the PRAP is February 1, 1992, to be followed by a remedial design (RD) on January 1, 1992. Is this the formal schedule that we are now supposed to be following? On November 6, 1991, it was said that the RD is to be prepared by "early 1993."*

*In the June PRAP, installation of 18 wells was to have been complete in 1993. By October, the PRAP said that installation would be complete in "the 1993 to 1994 time frame." On November 6, 1991, we heard that containment was to be achieved by 1996, but this is only a "planned goal."*

*Letter #8; WC-71*

**Response A4c:**

Milestones and schedules will be specified in post-ROD documents, as specified by the CERCLA process. The submission date for the Draft Remedial Action Implementation Plan is July 10, 1992, and for the Draft Remedial Design Report is October 9, 1992. Also, the PRAP specifies 18 initial extraction locations, not wells. From one to five wells may be installed at each extraction location, depending on the site-specific hydrogeology.

**Comment A4d:**

*The PRAP should contain a clear and formal commitment to actually cleaning up the site. The Administrative Record does not yet do this. If the present PRAP, which lacks commitment to any performance standards or milestones, is allowed to stand, only the ROD remains as a context for such commitments. The commitments currently contained in the PRAP are vitiated by their conditional nature. Should the preferred alternative not be adopted in full, even portions of the plume with concentrations above 100 ppb may not be remediated. There is no design standard for remediating the areas with total VOC concentrations that do not exceed 100 ppb. The "1993 to 1994 time frame" is likewise very uncertain. In case the conditional nature of the commitments of the PRAP were not clear enough, on p. 23 the PRAP explicitly links a deadline for installation of equipment to DOE and congressional funding. That explicit caveat on p. 23, despite Secretary Watkins' statement that environmental, safety, and health concerns are to rank first in DOE priorities, is worrisome.*

*Transcript p.111; MC-42*

*Transcript p.134; MC-89*

*Letter #1; WC-10*

*Letter #12; WC-90*

**Response A4d:**

DOE/LLNL are committed via the FFA to cleaning up the site in compliance with all ARARs. According to EPA guidance, performance schedules and milestones are included in post-ROD documents, not in the PRAP. The purpose of the PRAP is to recommend a conceptual approach for LLNL's preferred cleanup plan. The post-ROD documents include the Remedial Action Implementation Plan and the Remedial Design/Remedial Action documents, which contain the details of remedial action performance.

In addition, the LLNL FFA and the ROD require that the cleanup will be reviewed and modified, if necessary, every 5 years at a minimum.

**Comment A4e:**

*It appears that the PRAP contains no guaranteed funding commitments for the cleanup. If this is the case, how can we really take this seriously? And how are we going to clean up future accidents that are going to happen?*

*Transcript p.62; MQ-7*

**Response A4e:**

Congress and the President, based on the DOE budget request, have appropriated approximately 23% of the DOE's total fiscal year 1992 budget for Environmental Restoration and Waste Management (ERWM) activities. This amount is \$5.3 billion, \$1 billion more than 1991. Based on funding levels and the amount of work performed to date, DOE has taken its commitment to environmental cleanup very seriously, both at LLNL and at DOE facilities across the country. Part of DOE's environmental commitment has been to improve operations at all DOE facilities to reduce

the possibility of releases of hazardous and radioactive materials. The Department is also committed to cleanup of releases that might occur in the future as a result of DOE operations.

**Comment A4f:**

*How is it that DOE seems to be able to guarantee funding for ongoing LLNL operations, but cannot guarantee funding to clean up the problems associated with these operations? Similarly, how can you say you can afford a bomber and not afford to devote adequate funds for cleanup?*

*Transcript p.64; MQ-9  
Transcript p.101; MC-21*

**Response A4f:**

DOE cannot guarantee funding for ongoing LLNL operations outside the annual Congressional budget appropriations for DOE programmatic work. DOE takes the budget allocation for various Congressionally defined programs and distributes it to each facility according to program needs (research vs production, etc.) and facility capabilities. LLNL continues to demonstrate the ability to perform specific Congressionally mandated program work. Thus, in each year DOE looks to LLNL to perform such work. Each year, DOE is required to request funding from Congress for all work required by State and Federal regulations, including those implemented by the EPA and the State of California.

Requests to fund military aircraft are not included in DOE's mission. The Secretary of Energy is committed to comply with environmental regulations. In pursuit of that goal, the Department is responsible for developing budget requests and plans for submission to Congress that support such compliance, including compliance with cleanup requirements for LLNL.

**Comment A4g:**

*I understand that DOE recently transferred \$50 million of cleanup funds into more nuclear research and design for testing. Who then, will fund this cleanup and will adequate funding be provided for total cleanup services?*

*Letter #13; WC-96  
Letter #13; WC-97*

**Response A4g:**

Congress is the only government body that can approve reprogramming and appropriation transfers between weapons design, production, and testing work (as well as other program work) and environmental restoration work. If such a transfer should occur, it is DOE's responsibility to ensure that compliance with environmental regulations is maintained, or that funding be reallocated within available funds, or to request supplemental funding from Congress, if necessary.

**Comment A4h:**

*The PRAP and the Administrative Record should contain a written commitment by DOE to provide complete, stable, long-term funding for this project. This should be a legally binding commitment. There is concern that the regulatory agencies cannot sue DOE for failure to remediate due to the*

*"force majeure" clause of the FFA. Given recent occurrences such as the Congressionally approved shift of \$50 million from the Environmental Restoration and Waste Management budget to its nuclear weapons design, development, and testing budget, such a commitment is critical. Similarly, LLNL's Main Site cleanup lost \$1 million in one fell swoop recently. We are concerned that LLNL cleanup may be vulnerable to delays and reduced standards due to inadequate DOE funding over the life of the cleanup. Also, LLNL should commit to unconditional, 100% funding to capture the entire ground water plume -- particularly the western portion of the VOC plume that is offsite. One commenter proposed establishing a reserve fund such as insurance companies use. Another asked that the dollars come from DOE and not the Superfund account.*

*Transcript p.93; MC-6*

*Transcript p.94; MC-8*

*Transcript p.99; MC-18*

*Transcript p.121; MC-71*

*Transcript p.121; MC-72*

*Transcript p.122; MC-74*

*Transcript p.126; MC-82*

*Transcript p.126; MC-83*

*Letter #3; WC-52*

*Letter #4; WC-53*

*Letter #6; WC-61*

*Letter #7; WC-66*

*Letter #7; WC-67*

*Letter #9; WC-74*

*Letter #10; WC-79*

*Letter #10; WC-80*

*Letter #11; WC-84*

*Letter #11; WC-85*

*Letter #12; WC-89*

*Letter #15; WC-104*

#### **Response A4h:**

DOE cannot legally commit to funding cleanup (or any other activities) beyond the current budget year appropriation. However, DOE places a high priority on risk reduction, compliance, and associated contamination cleanup in its annual budget submittals. DOE understands that cleanup delays will likely increase the overall cost of the cleanup at LLNL as well as other facilities, so it is in DOE's best interest to support an adequately funded and progressive cleanup effort through its annual Congressional budget requests each year. DOE does commit to request from Congress through the Office of Management and Budget (OMB) funding necessary to establish hydraulic control of contaminant plumes, both offsite and onsite, as fast as technically feasible. In addition, DOE is also committed to removing as much contaminant mass as possible in the shortest time with currently available technology.

Cleanup standards are developed with the regulatory agencies and can only be changed with the permission of the regulatory agencies.

DOE is not currently authorized to establish special funds for specific projects such as environmental restoration. Congressional authorization is required for such a fund to be established. Cleanup funds for the LLNL site are from DOE, not the Superfund account.

**Comment A4i:**

*How confident can we, the people in the community, and people in communities across the country, feel that Congress, DOE, and LLNL are committed to taking full responsibility for cleanup up the hazardous and radioactive waste they have made? How much of a priority is it?*

*Transcript p.132; MC-88*

**Response A4i:**

The budget for environmental restoration activities at DOE facilities is based on data from the past 10 years. The Secretary of Energy has publicly stated that DOE operations will be consistent with Environmental, Safety, and Health regulations and initiated significant changes within DOE and with its contractors to ensure that operations are performed in accordance with all appropriate standards. A significant percentage (23%) of DOE's total fiscal year 1992 Congressional appropriation is for ERWM activities.

**Comment A4j:**

*The commitments contained in the present PRAP are weaker than in previous PRAP drafts; as per CERCLA, which requires Federal facilities to present alternative funding plans to assure the continuity of funding for projects, the PRAP should include provisions for alternative funding.*

*Transcript p.111; MC-43*

*Letter #1; WC-10*

**Response A4j:**

Current DOE funding requirements for environmental restoration remedial activities are outlined in the DOE ERWM Five-Year Plan, which describes the requirements for remedial activities and risks associated with not performing remedial actions. To meet the CERCLA Section 120 requirement for the identification of "alternative funding," if DOE's environmental restoration budget appropriation is not adequate to meet CERCLA remedial action deadlines, DOE, through the OMB, must ask Congress to request supplemental funding to fund CERCLA remedial actions.

**Comment A4k:**

*LLNL should commit to not releasing radionuclides, particularly tritium, offsite in any concentration above natural background.*

*Transcript p.107; MC-33*

*Letter #15; WC-102*

**Response A4k:**

Tritium is the only radionuclide that occurs in ground water in concentrations above a drinking water standard. The commitments that LLNL has made for the discharges of treated ground water to the environment are summarized in Table 1 of the ROD, which has been approved by all overseeing regulatory agencies. The RWQCB sets the discharge limit for tritium and believes that the EPA and State 20,000 pCi/L MCL in Table 1 of the ROD is health-protective.

**Comment A4l:**

*LLNL should commit to total containment of present or future toxic or radioactive contamination.*

*Transcript p.136; MC-92*

**Response A4l:**

LLNL is committed to comply with all Federal, State, and local requirements regarding the handling and containment of radioactive and toxic materials.

**Comment A4m:**

*The PRAP should commit to specific plans for cleaning up all of the contaminated soil areas.*

*Transcript p.126; MC-84*

*Letter #7; WC-68*

*Letter #9; WC-75*

*Letter #10; WC-81*

*Letter #13; WC-98*

**Response A4m:**

DOE and LLNL are committed to cleaning up all soil contamination that could impact the ground water with concentrations above the lowest existing MCLs. The potential for contaminated soil to impact ground water in concentrations above an MCL is determined using analytical and numerical models. An example of this type of analysis is described in Appendix G of the Feasibility Study (FS).

As discussed on page 3 of the PRAP, the Gasoline Spill Area, the Building 518 Area, and possibly the Trailer 5475 (East Taxi Strip) Area are the only locations that are currently known to contain contaminants in the unsaturated soil that could impact ground water with concentrations above an MCL. Section 6.5 (page 41) of the PRAP commits LLNL to continue source investigations and clean up any sources discovered in the future under regulatory oversight.

As mentioned on pages 13 and 14 of the PRAP and in the Remedial Investigation (RI) report, there are no significant health risks from contaminated subsurface or surficial soils at LLNL.

**A5. Radioactive Contaminants/Investigations****Comment A5a:**

*The PRAP minimizes radioactive problems at the LLNL Main site, including and especially with regard to tritium. For example, the map that LLNL displayed at the November 6th public meeting showed that there are nine different areas where tritium has been found in the ground water and there are numerous areas where tritium has been found in soil.*

*Transcript p.118; MC-67*

*Transcript p.126; MC-79*

**Response A5a:**

The PRAP and RI describe the known occurrences of radioactive materials in the subsurface. In considering the risk associated with these occurrences, LLNL has been very conservative with respect to human health in its risk calculations, which are described on page 11 of the PRAP. The calculated risks are very low, as discussed in the response to Comment A3c.

**Comment A5b:**

*The PRAP should provide more details on plans to investigate and possibly remediate areas of high tritium concentration. Tritium has the potential to move offsite by several different pathways. Furthermore, LLNL is now investigating additional sites of tritium. This investigation and possible remediation are not covered in the PRAP.*

*Transcript p.107; MC-34*

*Transcript p.108; MC-35*

**Response A5b:**

At the request of the CWG, LLNL devoted most of a CWG meeting to the subject of tritium at LLNL, and added information on tritium to the PRAP. LLNL believes that the PRAP contains sufficient documentation and references regarding tritium. In addition, an attachment discussing tritium issues in greater detail was distributed with the June 24, 1991, draft of the PRAP.

Additional investigations of tritium and other contaminants are currently in progress in the Trailer 5475 and Building 292 Areas. LLNL is committed to fully addressing these areas, and other areas that may be discovered in the future, via the ROD and amendments thereto. Progress and results of these investigations will be provided in *Monthly Progress Reports*, at CWG meetings, and via the public information repositories. LLNL is open to further dialogue on this issue, if desired.

**Comment A5c:**

*Regarding cleanup of the "recent tritium contamination as a result of last year's underground tank rupture," LLNL should prepare a more timely and concerted cleanup plan; government funding of this plan; a reassurance to the public that such events will not take place in the future; and a reassurance that the present problem is being taken care of on an urgent basis.*

*Letter #6; WC-60-63*

*Letter #12; WC-91*

**Response A5c:**

Studies of the Building 292 tritiated water release in 1990 indicate that the release did not reach the ground water in concentrations exceeding the drinking water standard. Therefore, there is no urgency for a cleanup plan nor is any cleanup plan required. We will continue to monitor the unsaturated zone and the ground water in the immediate vicinity of Building 292 to ensure that no standards are exceeded.

At the time of the pipe rupture, there was an urgent response made in which the discharge was discontinued and the tank pumped out. Investigations of the release began immediately.

Investigations of radioactivity in the subsurface and surface soils of LLNL have been conducted over a period of years and have been documented in the RI and the FS.

**Comment A5d:**

*A comprehensive radiological characterization should be done for the entire LLNL site and subsurface. Such a study is necessary to complete the RI and, it appears, in the RCRA Section 3016 requirements as well. It should answer the question of the potential for tritium to be released and migrate to ground water, and include a detailed discussion of the hazards and potential hazards posed by ongoing operations at LLNL.*

Letter #1; WC-46

**Response A5d:**

In the course of the recent subsurface investigations, hundreds of soil borings have been drilled and thousands of analyses have been conducted for radioactivity. No radionuclides in concentrations that would cause any health problems whatsoever, or that would require any remediation, have been found. Tritium exceeds the drinking water standard in the ground water only in the East Taxi Strip Area. There is also an existing radiological monitoring program that surveys LLNL on a regular basis. Results of this program are reported in the LLNL Annual Environmental Monitoring Report, which covers all environmental media.

**Comment A5e:**

*The PRAP does not discuss contamination by radionuclides at the East Taxi Strip Area. The CERCLA documents mention but do not examine this occurrence in detail. What steps have been taken by LLNL to review data from this area and monitor the area for residual contamination that was not removed in the initial cleanup (i.e., soil excavation), which occurred prior to LLNL being designated for the NPL in 1987?*

Letter #1; WC-39

**Response A5e:**

As noted, the PRAP does not discuss the details of the distribution of radionuclides in the East Taxi Strip Area. As stated in the response to Comment A5d, there is an existing radiological monitoring program that surveys LLNL on a regular basis. Results of this program are reported in the LLNL Annual Environmental Reports. These reports cover all environmental media. LLNL is in the process of additional characterization of VOCs and other potential contaminants. However, in the East Taxi Strip cleanup performed in 1982-83 under RWQCB oversight, all soil with any radioactivity (except for tritium) over twice the natural background was excavated and removed. Over the past 3 years, we have drilled 28 additional boreholes in the East Taxi Strip Area, all but one to the water table. Twelve of the boreholes were completed as piezometers for monitoring. Most of the boreholes were extensively sampled from the surface to the water table for VOCs,



metals, PCBs, and a full suite of radiological parameters. We have also collected air samples beneath the buildings in the area and analyzed them for VOCs. In addition, sampling and analysis of near-surface (< 6 inches) soil for plutonium was completed in the general area, the results of which will be published in LLNL's Environmental Report for 1991. Additional boreholes are scheduled to be drilled in 1992 to fully characterize the East Taxi Strip Area.

**Comment A5f:**

*The extent of tritium contamination, its mobility, and its possible effect on ground water remediation have not been described. The suite of documents supporting the PRAP should include a site-wide survey and map of tritium occurrences in soil and ground water, along with an analysis of tritium transport within air, soil, and ground water; a detailed discussion of handling, assessment, and cleanup techniques, including a risk assessment and plans to involve the public.*

Transcript p.116; MC-61  
Letter #1; WC-37

**Response A5f:**

A screening-level risk assessment for tritium was performed in 1990 and is summarized on page 11 of the PRAP and in the October 1990 *Monthly Progress Report*. Additional information regarding tritium was also attached to the June 24, 1991, draft of the PRAP. A forthcoming report characterizing the fate and transport of tritium in the vadose zone at LLNL will include a sitewide survey and map of tritium occurrence in soil and ground water. The report is being prepared with a planned completion date of October 1992 and will address tritium transport, the history of tritium use, and known releases, and will discuss sampling and monitoring techniques.

A closure plan is being prepared for the underground tank near Building 292, which has released tritium to the subsurface. This closure plan is subject to regulatory review by the RWQCB. This closure plan will also report on the measurements of evapotranspiration of tritium from soil at the ground surface and from plants in the vicinity of Building 292 and other areas within LLNL. Concerns such as current remedial actions will also be addressed in the closure plan.

The Remedial Design documents will specify the processes LLNL will implement to control the potential release of tritiated water vapor during vadose and ground water treatment processes as part of the Trailer 5475 Area cleanup. Monitoring for detecting tritium entry into the treatment process and effluent will be detailed. All treated effluent will meet discharge limits established by the RWQCB. This report will also address concerns such as the proposed methods for controlling the migration of tritium in soil and ground water.

The activities at LLNL that release tritium from ongoing research programs are regulated by DOE and subject to National Environmental Standards for Hazardous Air Pollutants (NESHAPs). The LLNL Environmental Protection Department's Environmental Monitoring and Analysis Division (EMAD) has monitored tritium at LLNL facilities and has found that calculated exposures from any individual facility do not exceed one one-hundredth of the Federal clean air standard of 10 millirem/year. In addition, the calculated exposure for all LLNL tritium discharges is less than 10 millirem/year. Results of radionuclide monitoring are reported in the LLNL Annual Environmental

Monitoring Report and the Annual NESHAP report to DOE (DOE provides the Annual NESHAP reports to EPA).

**Comment A5g:**

*The preferred alternative has the potential to spread low-level tritium contamination offsite. There is a dispute between LLNL and Tri-Valley CARES about the health significance of this, but nevertheless it stands that additional areas of low-level tritium contamination could be created. Although LLNL has voluntarily committed to VOC concentrations in its discharge water that are, in some cases, more stringent than the applicable MCLs, LLNL has refused to agree to any limit on tritium concentration in off-site discharge water that is less than the MCL. It is possible and inexpensive to prevent tritium that is inadvertently extracted by the ground water remediation system from being spread off-site, and LLNL should commit to this. More generally, removing VOCs, fuel hydrocarbons, and metals from the ground water should not result in additional areas that are contaminated by radiochemicals above natural background levels.*

*Transcript p.116; MC-60  
Letter #1; WC-36*

**Response A5g:**

LLNL acknowledges Tri-Valley CAREs' concerns regarding the discharge of any water containing tritium. DOE and LLNL renew their commitments to prevent discharge of any water containing tritium above the RWQCB discharge limit. The 20,000 pCi/L discharge limit is set as the drinking water MCL for tritium. EPA and the State believe the drinking water standard is health-protective and restores the water to its highest potential beneficial use. DOE and LLNL are committed to limiting tritium migration as a key element in the cleanup approach.

**A6. Source Investigations**

**Comment A6a:**

*The PRAP is based on an incomplete source investigation, which throws the conclusions of the PRAP into serious question. The radiochemical characterization is almost dismissive.*

*Transcript p.113; MC-49  
Letter #1; WC-22*

**Response A6a:**

LLNL acknowledges Tri-Valley CAREs' comments about the source investigation work performed to date and conclusions presented in the PRAP. Extensive source characterization work has been performed and has found that VOCs are by far the most widespread contaminants of concern in ground water and soil at LLNL. The LLNL Annual Environmental Report documents the results of periodic soil sample analysis for a wide range of radionuclides onsite and offsite. In addition, samples for inorganic and radiochemical analyses were collected in all areas investigated for the RI as part of our source investigations. If historical information suggested that these

contaminants were used previously at a particular location under investigation, then the sampling density and frequency for those contaminants were increased to aid in the evaluation.

Subsequent to the RI, investigations of radiochemical and inorganic compounds in the vadose zone and ground water have been conducted in much greater detail. Results of these investigations are reported in the LLNL Ground Water Project *Monthly Progress Reports*. Since mid-1990, the frequency of sampling for inorganic and radiochemical contamination has increased, and onsite analyses for tritium, plutonium, and gamma spectrometry have been conducted. Tritium analysis is now conducted on sediment samples collected at every sampling interval, and in ground water bailed from open boreholes drilled for source investigations. In areas in which past releases of radiochemicals are known or possible, additional gamma spectrometry and/or plutonium analyses are performed.

Additional detailed source investigations have been initiated in areas where ongoing operations may result in releases to the environment. The LLNL Operations and Regulatory Affairs Division (ORAD) is responsible for monitoring ongoing operations, the LLNL Environmental Measurements and Monitoring Division (EMAD) conducts the annual monitoring program that samples all media for radiochemical and chemical analyses, and the LLNL ERD conducts evaluations of soil and ground water contamination from past releases from those operations.

After investigations and risk analyses are completed, LLNL may propose additional remedial actions to augment those in the ROD. Public participation would be provided via *Monthly Progress Reports*, CWG meetings, the requirements of CERCLA, and the NCP.

Facilities are decontaminated under the guidance of LLNL Operational Safety Procedures developed for each facility, and are monitored on a regular basis to prevent contamination from reaching the environment. In the unusual event that contamination is released from these facilities, it is quickly cleaned up and monitored by ORAD and ERD personnel.

#### **Comment A6b:**

*To overcome the deficiencies identified above (Comment A6a), LLNL should publish, every 2 years (as required by RCRA Section 3016), an ever more complete source database, cross-referenced with the Dreicer report, with RCRA investigations, with DOE audits, and with all other investigations of contamination at LLNL, and including both an annotated bibliography of investigations to data and a database on diskette for ready use by outside agencies and interested citizens. The work should be completed by the first 5-year EPA audit of the CERCLA cleanup. These activities should be guaranteed by the ROD.*

*Letter #1; WC-23*

#### **Response A6b:**

ERD reports source investigation activities every month in the LLNL Ground Water Project *Monthly Progress Reports*, and summarizes them each year in the Annual Report. When investigations in a potential source area are complete, the data for that area are presented and conclusions are drawn regarding whether past releases have occurred and whether they have impacted ground water. The history of the area and pertinent maps and cross sections are also

presented. Progress of field activities in each area are reported every month. LLNL believes this reporting of source investigations is sufficient and that the level of reporting requested in the comment would detract significantly from cleanup efforts.

**Comment A6c:**

*I understand that a leak or leaks were found in the chemistry building's holding tank or tanks. In view of the practices of the past, there is some concern about what these tanks might have received and possibly released into the ground. Mercury is a common lab tool, and I would expect to find it in the tanks. I do not recall seeing mercury on the checked list of materials analyzed.*

*Letter #16; WC-107*

**Response A6c:**

Sediment samples collected in the vicinity of the tank were analyzed for metals including mercury. No mercury was detected above the soluble threshold limit concentration, as reported in the January 1992 Quarterly Report for LLNL's Underground Tank Program.

**A7. Technical Basis for PRAP (Research/Modeling/Additional Detail Needed)**

**Comment A7a:**

*All of the findings and research upon which the PRAP was based need to be published, incorporated in the public record and ROD, and actually used in the Remedial Design and in the field.*

*Letter #1; WC-6*

**Response A7a:**

All of the findings and engineering analysis that form the basis for the PRAP are published in the Administrative Record, as required by CERCLA. The ongoing analysis conducted by the LLNL Ground Water Project has been, and will continue to be, incorporated into remedial designs when new developments occur. For example, development of a new catalyst prompted recommendation of catalytic oxidation over thermal oxidation for treatment of vapor, as described in Appendix B of the PRAP. Also, recent numerical flow and transport modeling and optimization indicate that using 35 extraction locations and 15 recharge locations, with a different subset of wells being used at various times, could reduce the cleanup time to about 30 years. However, the results of this optimization were not complete until after the PRAP had been released for public comment. These and subsequent modeling results will be incorporated into the initial Remedial Design as funding allows.

The scientific validity of the ongoing technical work is established by internal LLNL review and external peer review, in addition to regulatory review. The findings and conclusions of ongoing engineering analyses are reported in LLNL *Monthly Progress Reports*, as stand-alone LLNL publications, at technical conferences, and in refereed technical journals. To achieve the cleanup objectives listed on pages 11 and 12 of the PRAP, LLNL will incorporate the results of ongoing

optimization into the remediation with oversight from the regulatory agencies and with public review via the CWG, if there is sufficient interest to continue such a group.

**Comment A7b:**

*It is not clear from the PRAP whether LLNL will discharge water other than ground water extracted in the course of its remediation program to the recharge basin located on DOE property administered by Sandia National Laboratories (SNL). If other waters are discharged, their source and quality, particularly with respect to radionuclides, along with their expected flow rates, should be estimated and reported.*

Letter #1; WC-43

**Response A7b:**

LLNL does not plan to discharge water other than treated ground water to the LLNL recharge basin, located south of East Avenue on DOE property administered by SNL.

As mentioned in the response to Comment A7a, recent optimization modeling results indicate that recharge of treated ground water could help accelerate ground water cleanup. All but one of the potential recharge locations evaluated in the optimization are on the LLNL site. The other location is just south of southeastern LLNL on DOE property administered by SNL. At present, the preferred method of ground water recharge is via recharge wells, or perhaps via infiltration trenches.

**Comment A7c:**

*PRAP needs more specificity on the subject of discharge of treated water, especially water that may be near the maximum contamination limit for one or more of the pollutants. As a result, there seems to be a potential for spreading low levels of contamination offsite, particularly south of East Avenue if the recharge basin on Sandia's property will continue to be used.*

Transcript p.94; MC-9

**Response A7c:**

Figure 7 of the PRAP shows that treated water from Treatment Facility A would be discharged to the recharge basin south of East Avenue. Figure 7 also shows possible locations of recharge wells in the vicinities of Treatment Facilities F and G. All treated water discharged from LLNL treatment facilities will comply with discharge limits established by the RWQCB.

Refer to the responses to Comments A7a and A7b for further information regarding recharge of treated ground water.

**Comment A7d:**

*Regarding the 50-year prediction of cleanup, what kind of model is that based on? You mentioned that there was new work on that.*

*Transcript p.80; MQ-17*

**Response A7d:**

The 50-year cleanup prediction presented in the FS and PRAP was obtained using a simple, zero-dimensional mixed-tank model. This model is discussed further in the response to Comment A7h. More refined predictions were subsequently obtained using a more detailed two-dimensional numerical flow and transport model based on the computer code CFEST (Gupta *et al.*, 1987). Refer to the response to Comment A7g for more information regarding the CFEST model. Remedial alternative simulations using CFEST are discussed further in the response to Comment A7e.

**Comment A7e:**

*Did you consider more aggressive cleanup alternatives with shorter cleanup times in the process? If you did, were these alternatives weeded out in the preliminary screening? What happened to them?*

*Transcript p.81; MQ-18*

**Response A7e:**

More aggressive pumping strategies will result in excessive dewatering unless recharge is also increased. At the time that pump-and-treat alternatives were being screened for the FS, we assumed that subsurface recharge of treated ground water would not be feasible due to technical and regulatory impediments. This limited the total extraction rate and, therefore, the total number of extraction locations. Subsequently, the benefits of recharge have become widely recognized and additional extraction/injection patterns have been evaluated, as discussed in the response to Comment A7a.

Numerous remedial alternatives were simulated using the two-dimensional flow and transport model based on the computer code CFEST (Gupta *et al.*, 1987). The results of these simulations will be presented in a future LLNL report. This report is scheduled for completion in late 1992 and will evaluate several strategies for more aggressive pump and treat remediation. *Monthly Progress Reports* will be used to address new information, and evaluate new technologies, and to present ongoing evaluations of the cleanup systems after the Remedial Design. See also the responses to Comments A7g and A7j.

**Comment A7f:**

*The technical basis for the PRAP reflects overly optimistic thinking and modeling (e.g., no leaching of contaminants from vadose zone to ground water; cleanup time calculated from*

*assumption of site being a "well mixed tank," which is erroneous; plume capture analysis; analysis of pumping tests and the choice of parameters that underlie the PRAP are optimistic and probably faulty). These assumptions could have a negative impact on achieving a complete cleanup in a timely manner.*

*Transcript p.95; MC-11*

*Transcript p.114; MC-52*

*Transcript p.115; MC-58*

#### **Response A7f:**

LLNL believes that the technical basis for the PRAP and the ongoing work is sound. The potential for contaminants leaching from the vadose zone to the saturated zone is discussed in the response to Comment A7t. Assumptions of the mixed tank model are presented in the response to Comment A7h. Plume capture analysis is discussed in the response to Comment A7j. Pumping test analyses are discussed in the response to A7i. The parameters and associated model assumptions are health-protective.

#### **Comment A7g:**

*LLNL has not to date presented a model of the cleanup process that incorporates distance, let alone acknowledges that the contamination occurs in a porous medium, and still less that the site lithology is heterogeneous. Nor does the LLNL model account for any additions of contaminants to the aquifer from the vadose zone.*

*Letter #1; WC-15*

#### **Response A7g:**

We discussed many of these issues with the commenter in a meeting in July 1991. A two-dimensional numerical flow and transport model is being developed using the computer program CFEST (Gupta *et al.*, 1987). Development of the flow portion of this model is summarized in a recent LLNL report (Tompson *et al.*, 1991). A similar document describing the development of the transport portion of the model and summarizing flow and transport simulations is in progress. A discussion regarding considerations for simulating flow and transport within the saturated zone beneath LLNL is presented in Tompson (1990). Additional evaluations are in progress regarding transport of contaminants in the vadose zone and the potential for future impacts to the saturated zone (see response to Comment A7t). Areas containing high concentrations of VOCs in the vadose zone are under investigation, and potential sources that would impact ground water with concentrations above MCLs will be removed.

#### **Comment A7h:**

*To the extent that diffusive processes dominate VOC movement to wells, and to the extent that VOCs have entered low-permeability facies and lenses at the site, simple advective models, let alone the "bathtub" model of Appendix C, cannot accurately predict cleanup time. Yet LLNL has found (see p. 4-236 ff of the RI) that VOCs are primarily confined to the coarser-grained sediments*

*in downgradient areas, consistent with a transport mechanism dominated by advection. If true, this has two important implications for pump-and-treat alternatives at LLNL. First, it means that advective capture by pumping can remove the bulk of the contaminant mass in the downgradient areas, with more aggressive capture schedules being rewarded by proportionally more aggressive mass removal curves for those areas. As noted above, this is the conclusion of LLNL optimization modeling to date, and it supports the qualitative conclusions of the table on p. 13 of the subject letter (Letter #1).*

*Second, it means that the area or volume of contaminated ground water exceeding MCLs can be aggressively diminished using aggressive capture scenarios. While it may take a longer time to remediate the aquifer in the source areas, the bulk of the plume may be cleaned up much sooner than this, with corresponding lower risk, with lower costs for operating and maintenance and especially for monitoring, and with correspondingly high payoffs for novel remediation technologies that can then be applied on a relatively localized scale.*

*A better model would be an advective model with a linked diffusive component (although there might not be sufficient data to truly calibrate such a model). With such an effort and review of experience at other sites, LLNL could present a histogram of possible durations with estimated likelihoods for each time bracket; this analysis could be repeated for each cleanup alternative.*

Letter #1; WC-17

Letter #1; WC-33

#### **Response A7h:**

The tank model gives a very approximate, zero-order estimate of cleanup time and was conducted to provide a rough idea of cleanup times to compare the remedial alternatives. If enough extraction wells are installed within the plume, the time necessary to transport contaminants to individual wells is shorter, and the most important factor becomes the total quantity of pumped water moving through the plume. In this case, the tank model may be a reasonable simplification of reality. Subsequent work has shown the tank model predictions to be similar in character to predictions using more complex models that relax many of the simplifying assumptions of the tank model.

The cleanup plan, as shown in the PRAP, does call for extraction in the regions of highest contamination, which will result in the highest rates of mass removal.

Small-scale, diffusive transport processes between materials of low and high permeability are not considered in any known conventional, available ground water transport model. We agree that these processes are likely to have a negative effect on cleanup times, and we are in the process of developing state-of-the-science techniques to simulate these phenomena.

We are experimenting with ways of incorporating this diffusive process into numerical simulations of sitewide VOC transport and cleanup. We expect that the results will indicate longer cleanup times. In anticipation of this, we are evaluating means of enhancing the diffusive release of VOCs from fine-grained materials, such as by the addition of heat or by more vigorous recirculation of treated ground water. These strategies will be evaluated through the use of computer simulations and/or by field experiments. If a method proves successful, the *Monthly Progress Reports* and the 5-year CERCLA reviews will be used to present new technological findings and/or design modifications.



**Comment A7i:**

*The analysis of pumping tests and choice of aquifer parameters that underlies the PRAP appears optimistic and at variance with previous work. I question the choice of porosity and hydraulic conductivity values, and the interpretation of the degree of continuity of high-permeability channels.*

Letter #1; WC-99 (p.23)

**Response A7i:**

The following quote is from a paper, entitled "Assessment of Uncertainty in Time-Related Capture Zones Using Conditional Simulation of Hydraulic Conductivity" (Varljen and Shafer, 1991), recently published in the journal *Ground Water*, and is presented in response to concerns regarding the uncertainty of aquifer parameters.

"For the purpose of this investigation, hydraulic conductivity is considered to be the only uncertain parameter. Ground-water travel times also are influenced by effective porosity; however, the effect of uncertainty in this parameter is not as significant as uncertainty in hydraulic conductivity. Effective porosity values are typically more homogeneous in any one particular aquifer than are hydraulic conductivity values, and the maximum range of variation of effective porosity (15%-35%) is significantly less than that of hydraulic conductivity, which can vary over several orders of magnitude. Therefore, it is assumed that uncertainty in hydraulic conductivity is the principal source of natural uncertainty in the delineation of time-related capture zones."

The geologic interpretation presented in the RI is one interpretation of the distribution of subsurface sediments. Although the commenter may feel the RI report stresses the discontinuity of the geologic structure, the interpretations presented in the RI are consistent with the available data. Similarly, although pump test data may indicate individual wells communicate hydraulically, this is not conclusive evidence that continuous paleochannels exist between the wells.

A published report on parameter estimation for LLNL modeling (Tompson, 1990) is available to all interested parties.

**Comment A7j:**

*The analysis of plume capture given in the PRAP is inadequate and in fact might be seriously in error. Despite the assurances given in the PRAP, it is possible that LLNL does not actually intend to capture the offsite plume, given the optimistic capture modeling in the FS/PRAP, the order and locations in which LLNL has chosen to make its investments in the site so far and the capture wells in particular, and the difficulty in obtaining well and piping easements on private property. LLNL has yet to try to contain the plume, despite the approximately 8 years of its known existence. On p. 63, Dresen et al. (1987) suggest that complete contaminant capture may not actually be necessary. The combined influence of the extraction wells may result in excessive dewatering.*

GWP staff should prepare, as part of a revised PRAP, a detailed containment plan, including a detailed analysis of lithology, aquifer parameters, recent trends in water quality in the off-site area,

*the effect of non-LLNL pumping, hydraulic capture design, and the verification of hydraulic capture.*

*Transcript p.114; MC-53*

*Letter #1; WC-28*

*Letter #15; WC-105*

#### **Response A7j:**

The commenter misses a key point in noting that the ground water velocity estimates may not be (and probably are not) accurate: extraction well locations will be installed in a phased manner, and the well spacing will be based on observed, not predicted extent of capture. Piezometric data from monitor wells will be used to determine the horizontal and vertical extent of capture after each extraction well is installed and begins pumping. Although the capture estimates shown in the PRAP and FS are our best estimate of expected well performance, they are used only to give a rough estimate of the number and approximate locations of wells for planning and budgeting purposes. LLNL recognizes the uncertainty inherent in velocity (and capture) estimates and presented high, medium, and low velocity scenarios in the original Remedial Alternatives report (Dresen *et al.*, 1987). As shown in that report, the number of wells required to capture the plume varies with the estimated ground water velocity.

In response to the concern about significant lowering of the water table, LLNL is concerned about excessive drawdown for two reasons. First, we aim to avoid significant dewatering of the sediments containing VOCs, because pump-and-treat will cease to be effective in those sediments that are dewatered. Second, we also seek to avoid excessive drawdowns in offsite private wells. These concerns are mutually compatible. Although onsite recharge was not specifically addressed in the PRAP, we do plan to recharge treated ground water at selected locations to avoid excessive dewatering and to flush regions of slow-moving ground water (see response to Comment A7e). The currently operating recharge basin is an example of reapplication of treated ground water that will enhance flushing and mitigate excessive drawdowns. Simulations of onsite recharge indicate that it is very effective in limiting dewatering and enhancing cleanup, and will be implemented if technical and regulatory requirements can be met.

If excessive dewatering does occur, either within the VOC plume or at private wells, we will adjust the flow rates and/or locations of extraction or injection wells to correct the problem.

#### **Comment A7k:**

*The PRAP is not sufficiently comprehensive. It needs more details. The PRAP fails to address inherent uncertainties in cleaning up this highly complex site. It is a conceptual approach at best. Many unanswered contamination questions remain. For example, after 8 or 9 years of investigation, the LLNL Ground Water Project is still not sure where all of the contaminated soils at LLNL are, where to best pump water to contain the ground water plume, where to best recharge the water, and which areas in the vadose zone need remediation. There are very basic questions. It is disturbing that LLNL has not yet answered them better -- and that LLNL has not acted more substantively and decisively on its answers.*

*Transcript. p.105; MC-28*

Transcript p.125; MC-78  
Letter #1; WC-7

**Response A7k:**

LLNL/DOE and the regulatory agencies believe that the PRAP is sufficiently comprehensive for its intended purpose as a conceptual cleanup plan. This comment implies that the CERCLA process requires complete site characterization before a conceptual cleanup plan can be developed. Complete site characterization is not necessary or advisable for development of a conceptual cleanup plan. The commenters also do not recognize that additional site characterization and refinements of the conceptual cleanup approach can (and have) occur (red) contemporaneously with the CERCLA documents. LLNL and DOE are committed to cleaning up the LLNL site, and to implementing the most effective cleanup technologies. To enable this, the cleanup plan must be flexible to allow incorporation of new scientific and engineering developments as they occur. All ongoing investigations and developments will be reported in the LLNL *Monthly Progress Reports*.

As some of the commenters indicate, cleanup of the LLNL site is a complex technical problem. Numerous potential contaminant sources were reported in the RI, and others have been identified since the RI was completed. The PRAP, in section 6.5, acknowledges that additional source investigations will be conducted. Responses to Comments A7a and A7b discuss the work in progress to address "uncertainties" in the PRAP regarding extraction and recharge locations.

**Comment A7l:**

*The PRAP doesn't fully utilize existing LLNL research, experience, and currently known cleanup techniques, even within the realm of pump-and-treat design, as was made clear to us by GWP staff on July 25th. This undercuts LLNL's argument that it needs flexibility to design remediation activities that incorporate the latest site data and the latest cleanup techniques. General installation or performance deadlines can be written without unduly constraining LLNL to existing techniques.*

Letter #1; WC-13

**Response A7l:**

The PRAP is a conceptual description of the remedies to be selected for cleanup of the ground water and unsaturated soil at LLNL. DOE and LLNL fully intend to use state-of-the-art science and technologies, and hope to advance the state-of-the-art and science in its cleanup of the site. DOE and LLNL also intend to achieve site restoration as rapidly as possible. The "general installation and performance deadlines" will be specified in the Remedial Design documents.

**Comment A7m:**

*The analysis of vadose zone transport in the RI/FS series of documents is optimistic and inadequate. The boundary conditions in the analysis of transport in the Building 518 Area, discussed in Appendix G of the FS, were poorly posed. There are a number of other problems, as well. The potential for recharge and leaching of contaminants was dismissed too quickly in the RI/FS/PRAP.*

Transcript p.114; MC-54

Letter #1; WC-27

Letter #1; WC-29

### Response A7m:

As stated in Appendix G of the FS, the vadose zone engineering analysis presented there is preliminary, and is based on the assumption that infiltration is low in the Building 511 and Building 518 Areas, and that the ground surface is uncovered. In the Building 518 Area, the ground surface at the site of the VOC spill at the southeast corner of the building is almost totally uncovered. Consequently, the assumption that VOCs escape from the vadose zone through the ground surface to the atmosphere in this area is valid.

The Building 511 Area, also modeled in Appendix G, is covered by asphalt. However, it was incorrectly modeled as if it were bare ground. We are re-running the Building 511 vadose analysis with a no-flux boundary condition at the ground surface, which will simulate a completely sealed asphalt surface. These results will be made available to all regulatory agencies, information repositories, and all interested parties. Additionally, we are planning to measure the ground-surface flux of pollutants at specific sites, including Buildings 518 and 292, and Trailer 5475 under covered and uncovered ground surface conditions.

LLNL site-specific data (e.g., Stone *et al.*, 1982) suggest that infiltration is occurring in and along the courses of Arroyo Seco and Arroyo Los Positas, and where water is ponded (e.g., storm channels and the Drainage Retention Basin, which is now lined to prevent infiltration). We agree with the stated reasons for suggesting that infiltration may be occurring at LLNL. Appendix G clearly states that aqueous advection may be a significant transport mechanism at LLNL in areas of high recharge from surface water. However, site-specific quantitative data indicating that water infiltrates through the vadose zone to ground water in the areas evaluated in Appendix G were not available at the time the RI and FS were prepared.

As a result of the preliminary vadose zone investigation work presented in Appendix G of the FS, LLNL has initiated a program to investigate the potential role of vadose zone leaching at the site. The program is an integrated field, laboratory and computational investigation of potentially operative vadose zone processes at LLNL. All ongoing investigations and new information will be included in the LLNL *Monthly Progress Reports*.

Additional issues raised in Comment A7m primarily from Stone *et al.* (1982) are addressed below in Comments A7m(i) through A7m(xvii).

### Comment A7m(i):

*The authors (Stone et al., 1982) note on p. 25 that "Groundwater recharge apparently occurs at the LLNL and local vicinity because hydraulic gradients are...downward."*

### Response A7m(i):

Stone *et al.* (1982, p. 25) narrowly defined the term ground water recharge as being restricted to flow processes in the saturated zone, as defined by Freeze (1969). As such, their reference to a downward component of the hydraulic gradient can arise from several hydrologic conditions, one

of which could be percolation through the vadose zone. Refer also to the response to Comment A7m(vi) for additional information.

**Comment A7m(ii):**

*MWs 4, 5, 8, and TB20 all show Class III water ... (i.e., show some evidence of recharge from the surface). At least three of these are located remotely from the recharge basin; although MWs 5 and 8 are near unlined surface drainage channels, MW 4 is not.*

**Response A7m(ii):**

Stone *et al.* (1982, p. 31) report that MW-4, MW-5, MW-8, and TB20 are located in or near arroyos or drainage channels. They report that infiltration is occurring in and along the courses of Arroyo Seco and Arroyo Las Positas, and where water ponds (e.g., storm channels).

**Comment A7m (iii):**

*The authors (Stone et al., 1982) note (p. 76) that "...[drum] racks at LLNL drain to fields, ...[creating] the potential for infiltration of contaminated water at LLNL."*

**Response A7m (iii):**

We recognize that direct infiltration from such features as leaking drums or leaking underground storage tanks, for example, can be a potential mechanism for contaminants to migrate from the surface through the vadose zone to the ground water. All of the suspect drum racks were the subject of study early in the project and were removed. For example, infiltration is the mechanism by which we believe that solvents entered the subsurface at the south side of Building 518 (see FS Appendix G, p. G-20). We agree that in areas of high infiltration, recharge to the ground water is more likely to occur.

**Comment A7m(iv):**

*The apparent deep infiltration to the water table at Building 331 (without an obvious mechanism of infiltration enhancement) is not fully understood. Note that the RI does not even discuss infiltration enhancement as a possibility.*

**Response A7m(iv):**

The specific reasons for deeper tritium penetration at Building 331 as referenced in Stone *et al.* (1982) are unknown. Infiltration through the vadose zone at LLNL will be investigated as part of planned vadose zone investigations. All ongoing investigations and developments will be reported in *LLNL Monthly Progress Reports*.

**Comment A7m(v):**

*If this interpretation [non-piston flow] is correct, it infers that Laboratory effects on ground water may continue long after atmospheric releases [or soil contamination] have ceased (p. 92). The RI does not even discuss the possibility of non-piston flow.*

**Response A7m(v):**

Aqueous advection through the vadose zone at LLNL is currently being investigated. Results of this investigation will be made available to all interested parties.

**Comment A7m(vi):**

*The conclusions of Stone et al. (1982) on pp. 94-95 in regard to the low potential for contamination of groundwater have not been borne out by later data, e.g., by what has been found at the East Taxi Strip area.*

**Response A7m(vi):**

The data presented in Stone *et al.* (1982) indicate that infiltration through the vadose zone to the saturated zone occurs only "...along the course of Arroyo Seco, Arroyo Los Positas, the smaller tributary drainage ways ... [the Drainage Retention Basin area]... Elsewhere at LLNL, rainfall infiltration apparently does not progress further than approximately 12 meters (40 feet) below the surface...Contaminants could move to the saturated zone from other locations such as a leaky underground tank."

We are currently investigating the role of short duration, high intensity rainfall events on the migration of contaminants through the vadose zone to ground water. In the case of the East Taxi Strip Area, contaminant migration through the vadose zone to ground water appears to have been enhanced due to the presence of one or more disposal pits and lined evaporation ponds which leaked. Therefore, the migration of compounds through the vadose zone to the ground water at the East Taxi Strip Area is consistent with the results of Stone *et al.* (1982) and the aqueous advection analysis in Appendix G of the LLNL FS.

**Comment A7m(vii):**

*Data [elevated tritium activities] in Stone and Ruggieri (1983) show recent infiltration to ground water at TB11.*

**Response A7m(vii):**

The evidence for recent infiltration in TB11 is equivocal. The elevated tritium activities in soil and water from TB11, located in the Building 212 Area, may have resulted from higher-than-average recharge and/or an historical tritium spill (see Thorpe *et al.*, 1990, p. 4-72). The general issue of infiltration through the vadose zone at LLNL is currently being investigated.

**Comment A7m(viii):**

*The mixed fission products and transuranic wastes mentioned by Stone et al. (1982) as possible ground-water contaminants are of concern in the long run, where present in sufficient levels. Also of concern are metallic contaminants.*

**Response A7m(viii):**

Ground water analyses for radionuclides have been conducted for 290 wells and were discussed in the RI. Tritium is the only radionuclide found in the LLNL ground water and exceeds its drinking water standard in only one well. We plan to perform radionuclide analyses on ground water on a regular schedule that will be specified in the Remedial Design.

**Comment A7m(ix):**

*Tritium has been able to enter the saturated ground water system in what appear to be several places without an apparent unusual driving head. One example is in the East Taxi Strip Area.*

**Response A7m(ix):**

The responses to Comments A7m, A7m(ii), A7m(iii), A7m(iv), A7m(vi), as well as the response to Item A7m(x), address this comment.

**Comment A7m(x).**

*The analysis of aqueous advection in Appendix G has been superseded by new data regarding the transport of tritium to groundwater in the East Taxi Strip (and possibly in other areas not yet published, that have been discovered in the LLNL ...[tritium]... monitoring program), and relies upon the very questionable assumption that a spatially and temporally constant flux exists down to the water table.*

**Response A7m(x):**

The first part of this comment is addressed in the response to item A7m(vi).

We assume a spatially and temporally constant rainfall flux to the water table in Appendix G in order to compare the relative effect of liquid advection to gaseous diffusion. Two calculations were made to evaluate these effects. One calculation was for a single-day rainfall event with variable rainfall recharge. The other calculation was for a longer time period with a spatially and temporally constant rainfall flux. The assumption of constant rainfall flux is appropriate as long as the flux at any point in the model is less than the flux values in the variable case. If this condition is satisfied, as available data indicate for the Buildings 511 and 518 modeling, the use of a constant flux is a worst-case analysis.

**Comment A7m(xi):**

*A shallow perched zone does indeed develop in ...[the Building 518 Area]...in response to rainfall...The area of highest VOC concentration is located at the bottom of a landscaping slope and just off the edge of a paved parking lot--both sufficient causes for enhanced percolation. All this is clearly in contradiction to the idealizations in Appendix G.*

**Response A7m(xi):**

A shallow perched water bearing zone has been identified north of Building 518 and on the eastern flank of the subsurface VOCs identified at the southeastern corner of this facility (see Thorpe *et al.*,

1990). The Appendix G analysis has demonstrated that ground water will be impacted by the migration of VOCs through the vadose zone by gaseous diffusion alone. Consequently, remediation at this site will be required. Aqueous advection was not considered at Building 518 due to the lack of site-specific data, as discussed in the response to Comment A7m. We plan to acquire Building 518 Area infiltration data through vadose zone gaseous and liquid monitoring boreholes. The results of these investigations will be available to all interested parties.

***Comment A7m(xii):***

*Appendix G assumes that the ground surface is completely open.*

**Response A7m(xii):**

The response to Comment A7m addresses this comment.

***Comment A7m(xiii):***

*The results in Appendix G modeling appear to conflict with known facts. The predictions of Appendix [G]...that a peak concentration of 15-20 ppb of TCE will develop beneath the vadose zone contamination in the Building 518 area after approximately 60 years. It follows from this that the vadose zone concentrations of TCE at Building 518 are not currently a source to ground water contamination.*

**Response A7m(xiii):**

The TCE concentrations in the vadose zone in the Building 518 Area are not currently a source of VOCs above MCLs in ground water, but Appendix A modeling results predict that the TCE could impact ground water above MCLs based on transport by vapor diffusion only.

***Comment A7m(xiv):***

*Errors apparently being on the side of minimizing the predicted ground water contamination potential...[were made in Appendix G].*

**Response A7m(xiv):**

The responses to Comments A7m, A7m(vi), A7m(vii), and A7m(ix) address this comment.

***Comment A7m(xv):***

*Inorganic contaminants and radionuclides were apparently not considered much of a vadose zone transport issue if they were not yet found in the ground water.*

**Response A7m(xv):**

For the RI, contaminants in ground water were emphasized because their volume and areal extent greatly exceed that found in the unsaturated zone.



**Comment A7m(xvi):**

*There is no analysis of tritium transport in the vadose zone, which is important in the case of Building 292, if not also at other locations.*

**Response A7m(xvi):**

An analysis of Building 292 tritium fate and transport through the vadose zone to ground water is currently in progress. Results of this analysis will be available to all interested parties when complete. All ongoing investigations and new information will be updated in the LLNL *Monthly Progress Reports*. Refer also to the response to Comment A7t.

**Comment A7m(xvii):**

*The interrelationship between vadose zone cleanup and groundwater cleanup times and costs was not addressed.*

**Response A7m(xvii):**

For the purposes of providing initial estimates of ground water cleanup times, we assumed that no significant additional transport of contaminants to ground water would occur during the time required to clean up the vadose zone. This assumption is justified if the cleanup of the vadose zone occurs over a short time period relative to the time required to clean up the saturated zone. We believe this assumption is justified since vadose zone cleanups tend to be of relatively short duration (months to years), and ground water cleanups may require decades.

**Comment A7n:**

*The environmental impacts have been calculated in such a way that the number looks small as a threat to an individual. Collective effects should be put in these papers that you are writing, in addition to the threat to one person. If you don't know math, one part in a million sounds very small. But if it is exposing six million people, that is not such a small number anymore. And if it is exposing the whole world, that number is mighty big. Also, I notice that the impacts are only for humans. Not for any of the rest of the biological system around here at all. And, in addition, if you can assume that this EPA code calculates a reliable expectation number, it allows you to operate under a very deep shadow.*

*As you may gather, I don't agree with some of the limits on many of the chemicals that EPA has. I think they are wrong because many of them have been demonstrated not to have a threshold before they become effective. I mentioned one a while ago and there are many others. You will see the effect of these chemicals in some long time delay just like in radiation. And the evidence is that this threshold notion in toxic materials is a misnomer. I would like to see more extensive impacts on the whole biosystem.*

*Transcript p.142; MC-98*

*Transcript p.142; MC-99*

*Transcript p.142; MC-100*

*Transcript p.144; MC-101*

Transcript p.144; MC-102

### Response A7n:

The Baseline Public Health Assessment (Layton *et al.*, 1990) characterized the populations on and near LLNL and identified sensitive subgroups which may be present (i.e., children, workers). It further identified potential human exposure pathways to contaminants (i.e., inhalation, ingestion, surface contact). The calculated risk from a reasonable maximum exposure to contaminants is described as it relates to an individual as opposed to an entire population or city, because the potential risk is only applicable to those who are exposed. At this time, population estimates are not appropriate since no one is currently exposed to identified contaminants of concern and since exposure in the future is not likely.

Carcinogenesis, unlike many noncarcinogenic health effects, is generally thought to be a phenomenon for which risk evaluation based on the presumption of a threshold is inappropriate. For this reason, EPA assumes that there is essentially no level of exposure to a potentially carcinogenic chemical or ionizing radiation that does not pose a finite probability, however small, of generating a carcinogenic or genetic response. No dose is thought to be risk-free. Thus, in setting exposure limits for chemical carcinogens and radioactive contaminants, EPA strives to set levels that are the lowest feasible.

For limits set for such contaminants in drinking water, EPA established Maximum Contaminant Level Goals (MCLGs) and Maximum Contaminant Levels (MCLs) under the Safe Drinking Water Act. MCLGs are nonenforceable health goals which are to be set at levels at which no known or anticipated adverse effects on the health of a person occurs, and which allow for an adequate margin of safety. MCLGs are strictly health-based levels and are derived from toxicological data. For carcinogens, the nonthreshold assumption is used and EPA, by policy, sets the MCLG at zero in accordance with a recommendation by Congress.

MCLs, which are used as cleanup standards at LLNL, are the Federally enforceable limits for contaminants in drinking water. MCLs are set as close to the MCLGs as is feasible. In this case, "feasible" means with the use of the best available technology, treatment techniques, and other means, and with the consideration of the costs of applying those technologies. Furthermore, the setting of MCLs takes into consideration the availability of analytical detection methods. For carcinogens, EPA also evaluates the health risks that are associated with various levels of the contaminants with the goal of ensuring that the risks at the MCL fall within the one-in-a-thousand to one-in-a-million risk range that the EPA considers protective of public health and therefore achieves the overall purpose of the Safe Drinking Water Act and the Superfund law. Most regulatory action in a variety of EPA programs generally target this range using conservative models that are not likely to underestimate risk. EPA seeks to ensure that the health risks associated with MCLs for carcinogenic contaminants are not significant.

An Environmental Risk Assessment was conducted to determine any current or potential ecological impacts from the introduction of hazardous materials found at LLNL into the ecosystem and from their subsequent spread throughout the food chain. This assessment can be found in the RI (Thorpe *et al.*, 1990). Currently, there is no potential risk of ecological impacts related to the consumption of ground water because no ground water containing contaminants is present at the surface, either onsite or offsite. No perennial streams exist at or near the site; thus, no streams receive flow from ground water.

**Comment A7o:**

*In your sampling protocol, do you send samples out to all those who do your analysis on sort of a round robin with standardized samples so that you can check on amounts, methods, sensitivity, accuracy, and consistency?*

*Transcript p.70; MQ-12*

**Response A7o:**

We perform checks on analytical laboratory quality assurance by collecting 10% of the monitor well samples as split samples. This means that two samples are collected from the same monitor well and analyzed at different laboratories. Duplicate samples are also collected, i.e., two samples are collected from the same monitor well and analyzed at the same laboratory.

To check the analytical methods, sensitivity, and accuracy, known standards are sent to contract laboratories on a periodic basis. In addition, LLNL's contract analytical laboratories are certified by the State of California. The LLNL Quality Assurance Project Plan and Standard Operating Procedures contain additional information on project quality assurance.

**Comment A7p:**

*Do all of these methods have a sensitivity that is many times greater than the EPA threshold on these various chemicals? I doubt this threshold for chemicals. The more I learn about toxicity, the more I find that this threshold for toxicity of chemicals is another myth like the old radiation myths. Now it is agreed that there is no threshold to radiation. Many chemicals have no threshold. As a matter of fact, people at LLNL are suspicious of this.*

*Transcript p.70; MQ-13*

**Response A7p:**

Almost all of the EPA methods for the LLNL compounds of concern have sensitivities that are many times more sensitive than LLNL's cleanup standards. As better analytical instruments become available, the sensitivity of the EPA methods may increase. Table 1 summarizes the LLNL cleanup standards and the analytical method detection limits (MDLs) for the compounds of concern at LLNL.

Table 1. LLNL cleanup standards and method detection limits (MDLs) for LLNL compounds of concern.

Constituent	LLNL cleanup standards (ppb)	MDLs (ppb)
PCE	5	0.5
TCE	5	0.5
1,1-DCE	6	0.5
cis-1,2-DCE	6	0.5
trans-1,2-DCE	10	0.5
1,1-DCA	5	0.5
1,2-DCA	0.5	0.5
Carbon tetrachloride	0.5	0.5
Total THM	100 <sup>a</sup>	0.5
Benzene	1.0	0.5
Ethyl benzene	680	0.5
Toluene	100 <sup>b,c</sup>	0.5
Xylenes (total)	1,750 <sup>d</sup>	0.5
Ethylene dibromide	0.02	0.01
Chromium <sup>+3</sup>	50	5
Chromium <sup>+6</sup>	50	10
Lead	50	2
Tritium	20,000 pCi/L	1,000 pCi/L

<sup>a</sup> Total trihalomethanes; includes chloroform, bromoform, chlorodibromomethane, and bromodichloromethane (California Drinking Water Requirement).

<sup>b</sup> This is a proposed value, which means it is not enforceable by law.

<sup>c</sup> Nonenforceable Department of Toxic Substances Control Action Level.

<sup>d</sup> MCL is for either a single isomer or the sum of the ortho, meta, and para isomers.

**Comment A7q:**

*Request for a list of all of the Main Site chemicals and their molecular forms, regardless of whether they are primary or if they are a part per million. The commenter wants to see them even if they are a part per billion.*

*Transcript p.73; MQ-14*

**Response A7q:**

A list of the LLNL Livermore Site chemicals and their concentrations is included in Appendix M of the RI, which is available at the LLNL Visitors Center or the Livermore Public Library. A list of the molecular formulas for these compounds is shown in Table 2.

**Table 2. LLNL Livermore Site constituents and their molecular formulas (where applicable).**

Constituent	Element/ionic species/formula
Antimony	Sb
Arsenic	As
Barium	Ba
Benzene	C <sub>6</sub> H <sub>6</sub>
Beryllium	Be
Boron	B
Bromodichloromethane	CHBrCl <sub>2</sub>
Bromoform	CHBr <sub>3</sub>
Bromomethane	CH <sub>3</sub> Br
Cadmium	Cd
Carbon tetrachloride	CCl <sub>4</sub>
Chlorobenzene	C <sub>6</sub> H <sub>5</sub> Cl
Chloroethane	C <sub>2</sub> H <sub>5</sub> Cl
Chloroform	CHCl <sub>3</sub>
Chloromethane	CH <sub>3</sub> Cl
4-chloro-3-methylphenol	ClC <sub>6</sub> H <sub>3</sub> (CH <sub>3</sub> )OH
Chromium (total)	Cr
Trivalent chromium	Cr <sup>+3</sup>
Hexavalent chromium	Cr <sup>+6</sup>
Copper	Cu
Dibromochloromethane	CHBr <sub>2</sub> Cl
1,2-dichlorobenzene	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>
1,4-dichlorobenzene	C <sub>6</sub> H <sub>4</sub> Cl <sub>2</sub>
Dichlorodifluoromethane	CCl <sub>2</sub> F <sub>2</sub>
1,1-dichloroethane	Cl <sub>2</sub> CHCH <sub>3</sub>
1,2-dichloroethane	ClCH <sub>2</sub> CH <sub>2</sub> Cl
1,1-dichloroethylene	Cl <sub>2</sub> C=CH <sub>2</sub>
cis-1,2-dichloroethylene	ClCH=CHCl

trans-1,2-dichloroethylene	$\text{ClCH}=\text{CHCl}$
total-1,2-dichloroethylene	$\text{ClCH}=\text{CHCl}$
1,2-dichloropropane	$\text{CH}_3\text{CH}(\text{Cl})\text{CH}_2\text{Cl}$
Dichlorotrifluoroethane	$\text{C}_2\text{HCl}_2\text{F}_3$
2,4-dimethylphenol	$\text{C}_8\text{H}_9\text{OH}$
Ethylbenzene	$\text{C}_6\text{H}_5\text{C}_2\text{H}_5$
Ethylene dibromide	$\text{CH}_2\text{BrCH}_2\text{Br}$
Freon 113	$\text{CFCl}_2\text{CF}_2\text{Cl}$
Iron	Fe
Lead	Pb
Manganese	Mn
Mercury	Hg
Methyl ethyl ketone	$\text{CH}_3\text{COCH}_2\text{CH}_3$
Methylene chloride	$\text{CH}_2\text{Cl}_2$
Naphthalene	$\text{C}_{10}\text{H}_8$
Nickel	Ni
Nitrate	$\text{NO}_3$
Phenanthrene	$\text{C}_{14}\text{H}_{10}$
Phenol	$\text{C}_6\text{H}_5\text{OH}$
Pyrene	$\text{C}_{16}\text{H}_{10}$
Selenium	Se
Silver	Ag
Sulfate	$\text{SO}_4$
1,1,2,2-tetrachloroethane	$\text{Cl}_2\text{CHCHCl}_2$
Tetrachloroethylene	$\text{Cl}_2\text{C}=\text{CCl}_2$
Toluene	$\text{C}_6\text{H}_5\text{CH}_3$
1,1,1-trichloroethane	$\text{CH}_3\text{CHCl}_3$
1,1,2-trichloroethane	$\text{ClCH}_2\text{CHCl}_2$
Trichloroethylene	$\text{ClCH}=\text{CCl}_2$
Trichlorofluoromethane (Freon 11)	$\text{CFCl}_3$
2,4,6-trichlorophenol	$\text{Cl}_3\text{C}_6\text{H}_2\text{OH}$
Total xylene isomers	$\text{C}_6\text{H}_4(\text{CH}_3)_2$
Zinc	Zn

C = Carbon

F = Fluorine

H = Hydrogen

Br = Bromine

O = Oxygen

S = Sulfur

Cl = Chlorine

N = Nitrogen

**Comment A7r:**

*The precision with which LLNL has estimated the total contaminant mass in the compartments of the site is uncertain. This information is crucial to evaluating the likelihood of cleanup success and should be estimated and presented in the PRAP.*

Letter #1; WC-26  
Transcript p.114; MC-51

**Response A7r:**

As noted in the FS, two methods were used to estimate the sitewide VOC mass in ground water and saturated sediments at LLNL. The first method involved estimating the area and thickness of permeable sediments containing VOCs within a given region, and multiplying by the average total VOC concentration in ground water within that region, to yield the total mass of VOCs. The additional VOC mass sorbed to sediments was calculated by assuming a retardation factor of 1.5. The sum over all regions of the dissolved and sorbed masses equals the total mass of VOCs.

The second method to determine VOC mass utilized the volume calculating feature of the Interactive Volume Modeling (IVM) software (Dynamic Graphics, 1989). Using IVM, both ground water and sediment concentrations were interpolated and contoured in three dimensions, and a total volume within a particular concentration range and corresponding VOC mass was calculated. As reported in the FS, the mass estimated by these two methods differed by about 2%. This small difference indicates that the precision of estimating volumes of the VOC plumes by these methods is good.

Both mass calculation methods use interpretations of the subsurface distribution of VOCs. By necessity, the concentration distribution is estimated by interpolating data between wells. As such, the estimated distribution is an artifact of both the actual distribution of VOCs and the location of the wells where concentrations are measured. Although our interpolation methods account for many of the hydrogeologic properties, the accuracy or precision of the interpolations are not quantifiable. Thus, the contaminant mass estimates must be regarded as semiquantitative results.

We believe the mass estimates presented in the FS are adequate for the assessment of remedial alternatives. Errors in estimated VOC mass may affect the estimated cleanup time, but probably not the basic well field configurations or treatment technologies. As cleanup progresses, the initial mass input to transport modeling and optimization of contaminant removal may be altered to match observed changes, and cleanup time estimates will be revised as necessary.

**Comment A7s:**

*The primary CERCLA documents (including the PRAP) are written to be reassuring. Because of this the objectivity of technical investigations is at risk, and the public is shut out of effective participation.*

Letter #1; WC-21

**Response A7s:**

The response to comment B1c addresses this comment.

**Comment A7t:**

*Has LLNL investigated transport from the vadose zone to ground water in the Building 292 Area?*

*Transcript p.33; MQ-1*

**Response A7t:**

LLNL has been investigating the transport of tritium in the vadose zone in the Building 292 Area by conducting a vadose zone evaluation program comprised of field studies, laboratory measurements, and quantitative tritium transport analysis. We have characterized the subsurface extent and activity of tritium, in both the vadose zone and ground water, and are studying the fate and transport of tritium at this time. All the data will be incorporated in a quantitative model that will predict the fate and transport of vadose zone tritium in the Building 292 Area.

Ongoing data collection and monitoring include:

1. Installation of subsurface monitoring devices to periodically measure the gaseous and aqueous transport of tritium, changes in soil moisture content, and changes in tritium activity in local ground water.
2. Measurement of tritium ground surface emission fluxes in both asphalted and uncovered areas, tritium transpiration, and water evapotranspiration from the ground surface to the atmosphere.
3. Measurement of select physical-hydraulic laboratory parameters on subsurface sediment samples from the LLNL site.

Results of these investigations will be presented in a planned upcoming document whose preliminary title is "Evaluation of the Fate and Transport of Contamination in the Vadose Zone at the LLNL Livermore Site," which is scheduled for release in 1993.

**Comment A7u:**

*If the PRAP is a moving target, how do you expect the community and the consultants to responsibly participate in this when things are coming at us new all the time?*

*Transcript p.52; MQ-4*

**Response A7u:**

The PRAP is not a "moving target." It is the nature of the planning and cleanup process that there will be constant evaluation and readjustment to changing conditions and new developments. However, we understand that it is difficult for the community to keep up with all project developments. For this reason, we will continue to keep the community informed of new project developments through periodic newsletters and *Monthly Progress Reports* contained in the Information Repositories. We also reiterate our commitment to support a CWG after the ROD is signed if the local community desires that such a group continue.



**Comment A7v:**

*The sensitivity of the analytical methods is not great enough to properly address the concentration levels of toxics that pose potential biological hazards. Theoretically, one molecule of some toxins or ionizing radiation can modify a particular information storage spot on DNA of that particular germ cell and affect the next generation and others to follow. Therefore, I think that the front edge of the ground water plume should be determined with much, much greater sensitivity than shown in the Lab's data sheets. See the enclosure by Professor Marc Lappe for a well documented review of the questions about biological exposures to low levels of toxics.*

*Letter #16; WC-108*

**Response A7v:**

The detection limits for the volatile organic compounds (VOCs) in ground water plumes are driven by the limits associated with the sampling and analytical techniques (e.g., gas chromatography) used to measure the contaminant concentrations—not by limits associated with toxic effects. With present analytical techniques, the detection limits for most of the VOCs dissolved in water are at or below 0.5 parts per billion (ppb). Even under the linear no threshold dose-response model used to predict the incremental probability of cancer as a function of exposure or dose to a given contaminant, the risk of cancer decreases to very small levels as the exposure levels also drop to vanishingly small levels. Thus, even though we cannot measure VOCs reliably in the parts-per-trillion range, for example, the associated health risks of potential exposures to ground waters with those levels of contaminants are also correspondingly low. This comment is also addressed under A7p.

**Comment A7w:**

*Environmental regulations with regard to both chemical and radioactive toxins are not sufficiently protective of public health. "Allowable" levels of radioactive toxins have been lowered over the years as new scientific data becomes available. It is morally and ethically wrong for EPA to try to increase the allowable levels of radioactive hydrogen in the drinking water by a factor of three. It is already too high. The DOE Order that would allow a benchmark for action to be nearly  $10^5$  disintegrations per second per liter of water is appalling. The concentrations of some radioactive and chemical toxins can be biologically and physically increased. More and more chemical toxins are being identified that have no threshold to their toxic biological hazards effects at low concentrations, like radioactive toxins. They also have long-term deleterious consequences.*

*Letter #16; WC-109*

**Response A7w:**

DOE and LLNL commit to preventing tritium in ground water from reaching the public in excess of 20,000 pCi/L, the current California and Federal tritium drinking water standard. According to U.S. EPA, exposure to this concentration of tritium in 2 liters of drinking water per day would result in a dose of 4 millirem per year. The background dose from radon, cosmic radiation, foodstuffs and other sources varies from 100 to 300 millirem per year. Thus, the dose from drinking water containing 20,000 pCi/L represents, at most, 4% of the total background dose. In addition, fate and transport modeling indicates that tritium in ground water originating from the

LLNL Site will be at least a factor ten less than 20,000 pCi/L before it reaches any drinking water supply wells.

**Comment A7x:**

*Assessments of health and environmental hazards are invariably of limited duration, scale, and scope. The hazard assessments are usually calculated as simple probability functions of about four factors. Some experts say that these kinds of probabilistic calculations are questionable because they are not testable and are more like a mathematical game of chance. Realistic hazard assessments must include other factors such as time and spatial relations among the factors. Also, it is not enough to compute probabilities; one has to operationally compare results of these computations with physical and biological reality to have meaningful force. Are the currently used hazard assessment "codes" worth their salt? Prove it to a panel of biologically informed independent experts. So much rests on their uses.*

*Letter #16; WC-110*

**Response A7x:**

There are many uncertainties associated with the prediction of the cancer risks associated with exposures to low levels of toxic substances in ground water and other environmental media. The EPA has published various documents that provide guidance regarding assessments of exposure and cancer risk. The EPA believes their risk assessment procedures are health-protective, and in uncertain cases, EPA designs its assessments to err on the health-protective side. Collectively, these documents set forth the scientific basis of risk estimation and lay out the assumptions and inferences that risk assessors are to use in quantifying the cancer risks of environmental contaminants. Issues addressed include weight-of-evidence criteria to evaluate whether a substance is a possible human carcinogen and animal bioassay data to estimate cancer-risk factors. Our risk-assessment techniques, as outlined in the Baseline Public Health Assessment, are consistent with the existing guidelines.

**Comment A7y:**

*The PRAP should be more explicit and detailed. It is too vague to be a basis for an effective ROD or cleanup. It outlines a generally reasonable approach to remediation, yet it is vague and defers most remediation details to a later time. Nothing in the NCP precludes LLNL from submitting a clearer, more complete and explicit PRAP and ROD, which is precisely what LLNL should do.*

*Transcript p.110; MC-41*

*Transcript p.115; MC-56*

*Letter #1; WC-8*

*Letter #1; WC-31*

**Response A7y:**

The regulatory agencies clearly and explicitly instructed LLNL to produce a PRAP with minimum detail and that was relatively simple so that it could be understood by nontechnical people.

At the PRAP stage of the CERCLA process, the issue to be decided by the Federal facility and the regulatory agencies, with input from the public, is selection of a conceptual remedy. The specifics of that remedy follow the ROD in other documents.

Other comments related to Comment A7y follow in Comments A7y(i) through A7y(vii) below.

The post-ROD documents (the Remedial Action Implementation Plan and the Remedial Design/Remedial Action documents) will contain the details of remedial action.

*An explicit and detailed PRAP document is desirable for the following reasons:*

***Comment A7y(i):***

*Very few Superfund sites have actually been cleaned up. This, combined with the technical difficulties and scale of the LLNL site argues for not merely meeting EPA minimum guidance in order to achieve a cleanup.*

**Response A7y(i):**

The response to Comment A7y addresses this comment.

***Comment A7y (ii):***

*There are virtually no formal opportunities for public comment at a Superfund site after this point. Since the PRAP is the formal basis for public comment, the quality of that comment will be dependent upon the quality of the PRAP. A vague PRAP evokes vague comments that are likely to be dismissed.*

**Response A7y (ii):**

LLNL intends to consider all comments and not dismiss any comments. In addition, LLNL and DOE requested that the public evaluate and comment on all remedial alternatives considered, and the contents of the Administrative Record, which includes the FS. The PRAP summarized the salient parts of the FS. LLNL is committed to continued community involvement in the ground water cleanup, if there is sufficient interest.

The responses to Comments B1c, C3b, C4a, and C4b also address this comment.

***Comment A7y(iii):***

*Because the ROD is the primary point of reference for resolving future cleanup disputes, it should be as detailed as possible and embody clear commitments.*

**Response A7y(iii):**

Future cleanup disputes, if any, will be addressed via the CWG with regulatory agency oversight. The post-ROD documents, the Remedial Action Implementation Plan and the Remedial Design/Remedial Action documents, will contain the details of remedial action.

**Comment A7y(iv):**

*The FFA for this site is particularly weak. The regulatory agencies cannot sue DOE or LLNL for failure to remediate. Failure of DOE to fund the cleanup is considered force majeure, a sufficient excuse from the obligations of the agreement. The FFA contains no deadlines for remedial action or measures of remedial success. Thus, the ROD needs to contain explicit and detailed commitments. This is especially the case since DOE, the responsible party, is the lead agency on this site.*

**Response A7y(iv):**

The FFA binds LLNL/DOE to the corrective action requirements under RCRA and the response requirements under CERCLA and to meet or exceed all Applicable or Relevant and Appropriate Requirements (ARARs). The FFA includes stipulated penalties for failure to meet agreed upon deadlines and milestones and failure to comply with a term or condition of the agreement that relates to an interim or final remedial action. In addition, there are other enforcement options as well under the FFA. The post-ROD documents, the Remedial Action Implementation Plan (RAIP) and Remedial Design (RD), will contain more specific deadlines for remedial actions than those in the FFA.

**Comment A7y(v):**

*Because the cleanup is likely to take a long time, and interest in this site at this time is probably the highest it ever will be, it is desirable to codify commitments in the PRAP and ROD in the greatest detail possible.*

**Response A7y(v):**

The CERCLA documents for the LLNL site have been prepared according to the National Contingency Plan and in cooperation with the overseeing regulatory agencies. LLNL commits to continue to support the involvement of the community in the project.

**Comment A7y(vi):**

*The PRAP represents the last opportunity to incorporate new information and evolving perspectives into the primary CERCLA documents prior to the ROD. Even Project staff have said that their source investigation and evaluation of new remediation technologies are not yet complete. The information in the RI/FS/PRAP is about 2 years old. For this reason, the PRAP, if limited to a summary of the RI/FS, will inevitably not reflect LLNL's most current thinking. The new information that has been developed should be, at a minimum, published elsewhere and summarized in relevant detail in the PRAP.*

**Response A7y(vi):**

The new information will be published as it becomes available in *Monthly Progress Reports*, as Technical Reports, and in subsequent CERCLA documents. These documents will be available for public review. If new information shows there are actual health risks, the remedy will be augmented or modified to address them.

**Comment A7y(vii):**

*Most importantly, the vagueness of the present PRAP masks a great deal of uncertainty about the technical feasibility of the cleanup alternative preferred, the estimated cleanup time, how various remedial designs might affect this, the ability of the wells shown to give the cleanup time estimates given, in the vadose zone cleanup decision process, and in the exact means of plume capture and whether this is actually still possible. These issues have not been addressed by LLNL staff. To allow a vague PRAP to stand is to allow the difficult questions that are, or ought to be, at the heart of the ROD to remain unanswered until after that ROD is entered.*

**Response A7y(vii):**

The state-of-the-art is such that the answers to these questions will only come after we have begun to extract and treat ground water and monitoring the effects. It is LLNL's intention to monitor the entire process carefully. We will respond to the field data by modifying the pumping schedules and installing new extraction wells to make sure that the remediation is conducted as effectively and quickly as possible.

As discussed in the response to Comment A7y(ii), selection of the remedial alternatives was based on the entire Administrative Record, not just the PRAP. LLNL and DOE encouraged the public to review and comment on the entire Administrative Record. The selected alternatives were chosen based on review of available technologies, and LLNL and DOE are confident that they are the most appropriate remedies for the site.

**A8. Cleanup Alternatives/Technologies/Costs****Comment A8a:**

*Enhanced aerobic biodegradation should be considered for the Gasoline Spill Area, for its cost-effectiveness and speed.*

*Letter #1; WC-41*

**Response A8a:**

LLNL studies show that biodegradation is currently occurring in the Gasoline Spill Area. The gasoline contaminated sediments above the water table are slowly being metabolized by the naturally occurring bacteria. Physical and chemical conditions in the saturated sediments below the water table limit the ability of bacteria to degrade the gasoline. These conditions, namely, limited oxygen availability, higher contaminant concentration, and lower numbers of naturally occurring bacteria, are being studied to find ways to enhance the degradation rate. Naturally occurring bioremediation is less expensive, compared to other methods, but can be very slow and limited by toxic thresholds of the organisms to the contaminants. Enhanced biodegradation may be used in the Gasoline Spill Area to cleanup remaining gasoline after dewatering and venting and/or steam injection remove the higher concentrations.

All ongoing investigations and new information will be reported in the LLNL *Monthly Progress Reports*.

**Comment A8b:**

*LLNL should use its best efforts to locate and use an offsite granular activated carbon (GAC) regenerator, rather than simply disposing of the spent GAC.*

*Letter #1; WC-44*

**Response A8b:**

This comment is addressed in the PRAP in the second paragraph on page 17, where it states that "...the GAC will be shipped offsite where it will be commercially regenerated to destroy or recycle, if possible, the absorbed contaminants."

**Comment A8c:**

*The offsite impacts of remedial technologies need to be considered. Of considerable interest to this project and to cleanups of this type generally would be an analysis of the environmental cost of cleanup technology choices.*

*Letter #1; WC-45*

**Response A8c:**

The offsite impacts and environmental costs of remediating ground water at LLNL may include energy use, materials use, and further processing and disposal of hazardous materials. The consumption of electricity for the mix of chosen technologies, granular activated carbon, air stripping, and UV/oxidation, is approximately 3.0 million kilowatt-hours (kW-h), which is less than 1% of the electricity usage at the LLNL site annually.

The treatment systems will initially require about 8,500 pounds of activated carbon and an annual renewal of about 40,000 pounds of activated carbon. The UV/oxidation systems at Treatment Facilities (TF) A, B, E, and F will require about 103,000 pounds of hydrogen peroxide annually. If metals are treated at TFD, this system will require an initial 20 cubic feet of anion resin and about thirty-five 55-gallon drums of caustic for regeneration, resulting in the disposal of about 70 drums of regeneration waste annually. These quantities of energy and materials are required to treat about 165 million gallons of water annually to extremely low concentrations. The FS contains details regarding processes and costs of carbon regeneration and ion exchange resin disposal/regeneration.

Another way to look at the relative costs of remediation is to compare the costs of remediating and monitoring the plume with the cost of plume monitoring only. With no treatment, the present-worth cost of monitoring for 200 years is \$10 million; with treatment, the present-worth cost is about \$90 million. In comparison with the energy and material uses given above for cleanup, the use of energy and materials for treatment, if required, at the point of water use in downtown Livermore, using air stripping technology is 200,000 kW-h of electricity, about 7% of the energy use for the seven planned onsite treatment facilities.

**Comment A8d:**

*Contaminated water should not be returned to the ground. Out of sight is not out of mind or body tissue.*

Letter #5; WC-58

**Response A8d:**

As described in the PRAP, the cleanup objectives and all remedial alternatives involving the treatment of ground water require discharge concentrations to be below the limits shown in Table 1 of the PRAP. These discharge limits are below State and Federal MCLs for PCE, 1,1-DCE, 1,2-DCE, total trihalomethanes, benzene, ethylbenzene, toluene, total xylenes, hexavalent chromium and lead. The discharge limits for TCE, 1,1-DCA, ethylene dibromide, total chromium, and tritium are equal to the Federal and/or State MCL. (Note that the discharge limit for EDB is now 0.02 ppb, the same as its MCL, rather than the 5 ppb shown in Table 1 of the PRAP). The discharge limits for 1,2-DCA and carbon tetrachloride are higher than the MCL, but are specified for LLNL by the RWQCB. Based on our current understanding of risks associated with these trace concentrations, they do not pose a significant public, occupational, or environmental hazard.

**Comment A8e:**

*There aren't enough monitoring wells to the west of the LLNL site, which will make it hard to detect any "rogue" VOC contaminants that may have bypassed the screened intervals in the wells on Vasco Road and to define either the northern portion of the Arroyo Seco plume or the southern portion of the northwest offsite plume.*

Transcript p.115; MC-57  
Letter #1; WC-32

**Response A8e:**

LLNL agrees that the northern boundary of the offsite PCE plume is not as well defined as other portions of the plume, due to a lower density of monitor wells. LLNL has installed as many wells as the property owners in this area have permitted. All of this land is scheduled for residential development. Additional wells may be installed after development plans are finalized.

Existing monitor well data and sediment sampling for this area indicate that VOC concentrations are low, and that VOCs occur in a limited number of water-bearing zones. We anticipate that after city streets are in place, LLNL will be able to install several piezometers and/or monitor wells to ensure that these VOCs are remediated.

LLNL presented very strong evidence that the VOC plume near the intersection of Vasco Road and Patterson Pass Road does not originate from either the LLNL site or from any LLNL activities (Iovenitti *et al.*, 1991). If LLNL is found to be the source of chromium in this area, LLNL will incorporate this area into the Remedial Design.

**Comment A8f:**

*The extraction well network proposed is too sparse, and may result in dewatering of the aquifer, and an inability to adequately extract and treat all of the contaminated ground water.*

*Letter #1; WC-34*

**Response A8f:**

Extraction wells will be installed in phases, and the spacing will be based on *observed*, not predicted extent of capture. The capture estimates shown in the PRAP and FS were our best estimates of expected well performance at the time these reports were prepared, and will be verified with field observations. Well locations will be adjusted, if necessary, to ensure complete capture of contaminated ground water.

**Comment A8g:**

*The discharge limits contained in Table 1 of the PRAP are not all clearly protective of health and the environment. A number of them greatly exceed the maximum contaminant levels for drinking water. Unless there is some limitation on quantity or other kind of limitation, there is no way of knowing that these are protective. Also, the contaminants listed are not sufficiently inclusive.*

*Transcript p.116; MC-59*

*Letter #1; WC-35*

**Response A8g:**

The discharge limits for carbon tetrachloride and 1,2-DCA shown in Table 1 of the October 1991 PRAP are correct. A more recent RWQCB Order (No. 91-091) than that cited in Table 1 of the PRAP, specifies a 0.02 ppb discharge limit for EDB (its MCL) rather than the 5 ppb shown in Table 1. Specific discharge limits exist in LLNL's NPDES permit only for PCE, EDB, and benzene. Footnote "b" in Table 1 explains that the other compounds in Table 1 are included in the 5 ppb total VOC limit. LLNL intends to comply with this recent Applicable or Relevant and Appropriate Requirement (ARAR), which has been promulgated by the California RWQCB. However, LLNL will clean up the *in situ* ground water to the lower of the State or Federal MCLs in Table 1, or 0.5 ppb for both 1,2-DCA and carbon tetrachloride.

Freon is not included in Table 1 because it does not occur anywhere in LLNL-area ground water in concentrations above the MCL. The California MCL for Freon 113 is 1,200 ppb. Since Freon is a VOC, it is also included in the 5 ppb total VOC discharge limit.

**Comment A8h:**

*When you air strip, what is the half-life of the contamination that is released into the air? How long are the contaminants in the air before they are back on the ground or in someone's lung?*

*Transcript p.68; MQ-10*



**Response A8h:**

LLNL will employ activated carbon to filter the effluent air stream so that the concentrations of contaminants in air released to the atmosphere are nondetectable. Although we are not releasing measurable quantities of VOCs into the atmosphere during our pilot studies, literature states that any VOCs that do reach the atmosphere quickly photodegrade with a half-life on the order of days.

**Comment A8i:**

*What are the equilibrium constants of the catalytic oxidation reaction? Does it go to completion? If so, what proof do you have that it goes to completion? Just half of it might be oxidized.*

*Transcript p.69; MQ-11*

**Response A8i:**

Catalytic destruction efficiency is a function of catalyst temperature, influent concentrations, catalyst configuration, and residence time (chamber volume/flow rate). Allied-Signal, Inc., has developed a catalyst that retains its destruction efficiency in the presence of halogenated hydrocarbons. They have investigated the destruction efficiency as a function of the above-mentioned variables for a variety of contaminants, including benzene, toluene, carbon tetrachloride, 1,1,2-trichloroethane, chlorobenzene, and 1,2-dichlorobenzene (Lester, 1989). Catalytic oxidizers are currently operating on sites with excellent operation and destruction efficiencies (King, Buck & Associates, 1990 and 1991).

Allied Signal, Inc.'s, results indicate that the catalytic oxidizer can achieve destruction efficiencies of >98% for benzene, toluene, ethylbenzene, and xylene; >90% for trichloroethylene, 1,2-dichloroethane, and ethylene dibromide; and >95% for all other fuel hydrocarbons (Mack Buck, Personal Communications, March 13 and May 17, 1991).

If the operating catalytic oxidation system does not perform to ARARs, LLNL will augment it with proven technologies such as GAC or substitute another proven technology.

**Comment A8j:**

*Why have you selected UV/oxidation for some areas and air stripping for other areas?*

*Transcript p.77; MQ-15*

**Response A8j:**

As discussed in the FS and on page 31 of the PRAP, ultraviolet light (UV)/oxidation-based treatment technology was selected for use at the four treatment systems where the influent compounds and concentrations are effectively treated by this technology, i.e., at TFA, TFB, TFE, and TFF. UV/oxidation has the advantage of destroying most contaminants, converting them to harmless compounds. However, it is not effective on single carbon-bond compounds such as 1,1,1-trichloroethane, 1,1-dichloroethane, chloroform, and Freon 113. Where the influent water will contain significant concentrations of these compounds (at TFC, TFD, and TFF), air stripping

with GAC polishing will be used because it can efficiently treat the compounds and concentrations expected at these facilities at lower cost.

**Comment A8k:**

*Have you considered the possibility of formation of dioxins from the catalytic oxidation process as it applies to chlorinated organics? Are there any plans for sampling the offgas from that process? If you sample the offgas and do find dioxins, do you have a contingency plan?*

*Transcript p.77; MQ-16*

**Response A8k:**

LLNL is planning to use catalytic destruction rather than thermal oxidation because thermal oxidation of benzene in the presence of chlorinated compounds can produce dioxin. Results of testing catalytic oxidation units in operation show no production of tetrachlorodibenzo-para-dioxin (TCDD or dioxin). Past studies show excellent destruction rates of dichlorobenzene, which is essentially half of a dioxin molecule, by catalytic oxidation. Any dioxin formed is destroyed by the catalyst. We will perform treatability tests of destruction efficiency versus operating parameters prior to starting a new treatment system to insure that we construct a system that meets all regulatory requirements.

LLNL will continue to test, by sampling influent and effluent streams, all new treatment facilities to insure proper destruction and/or removal of contaminants. We will take corrective action whenever a discharge limit is exceeded. Depending on the circumstances, we may lower the flow rate which would increase residence time, increase temperature, or filter the effluent with activated carbon.

**Comment A8l:**

*According to an article in the Valley Times, more than 90% of the cost of the cleanup will go to paying staff and consultants. Why are the labor costs so high when there is obviously a lot of equipment that is needed, as well. Also, is the total 50-year cost quoted in that article—\$103 million—correct?*

*Transcript p.83; MQ-19*

**Response A8l:**

The estimated costs of the ground water remediation are specified in summary form in the PRAP and in detail in the FS. The costs are shown over a 50-year period, and are indeed labor intensive. The labor costs involve implementing, monitoring, and optimizing the cleanup over the entire duration of the cleanup. In addition, development and evaluation of new and innovative cleanup technologies and approaches are labor-intensive tasks. The estimated \$103 million present-worth cost quoted in the article is correct.

**Comment A8m:**

*The PRAP should include an accurate map of the piezometric surface LLNL expects its ground water remediation to create. Such a map should include selected streamlines with time markers to its extraction wells and from recharge facilities. It should be a product of a realistic aquifer model—as opposed to the map LLNL presents in the PRAP.*

*Letter #1; WC-42*

**Response A8m:**

The results and figures presented in the PRAP reflect simplified, analytical modeling conducted for planning and budgeting purposes. Models of this type are not generally capable of providing accurate predictions of a complex piezometric surface. A more complex, numerical flow and transport model has been developed to answer such questions. The numerical model and associated publications are discussed in the response to Comment A7g. All ongoing investigations and new information will be reported in the LLNL *Monthly Progress Reports*.

**Comment A8n:**

*As it currently stands, the PRAP really only looks at one actual cleanup option. Two of the alternatives presented (no action and deferred action) appear to not meet the requirements of CERCLA or the NCP. Alternative #2 takes so long to remediate the site, even under LLNL's optimistic assumptions, that in reality it is just a containment, and not a remediation option. Thus, the NCP requirement that the PRAP compare sufficiently thought-out alternatives, is not met. LLNL personnel argue that the PRAP is not meant to carry the detail that Tri-Valley CARES would prefer—but since the FS does not provide sufficient detail, either, the PRAP or some other formal addition to the record that is subject to public comment must do so.*

*In addition, the cleanup time projected in that one actual option – 53 years – is much too lengthy. There is concern about changes, etc. in contaminants over that time period and what guarantee LLNL can make that the cleanup will be accomplished in that time frame. One person suggested cutting that estimate in half. Thus, the PRAP should look at faster, more aggressive cleanup alternatives. The PRAP should look at more capital-intensive approaches. The preferred cleanup plan should be compared against these. Suggested cleanup time estimates are: 50 years; 30 years; and 20 years. More rapid cleanup plans may be more cost-effective over the life of the project.*

*Transcript p.96; MC-12  
Transcript p.111; MC-44  
Transcript p.120; MC-69  
Transcript p.126; MC-80  
Letter #1; WC-11  
Letter #1; WC-16  
Letter #3; WC-49  
Letter #4; WC-54  
Letter #4; WC-55  
Letter #5; WC-57  
Letter #7; WC-65  
Letter #9; WC-73  
Letter #10; WC-78  
Letter #12; WC-86*

Letter #13; WC-95  
Letter #15; WC-106

**Response A8n:**

We continue to evaluate the effects of using more extraction/injection wells, and varying well locations and pumping rates over time to expedite cleanup. Regulatory deadlines necessitated that we present a limited number of pump-and-treat strategies in the FS and PRAP. Within the general pump-and-treat framework outlined in the PRAP, there is latitude to adjust the extraction and injection rates and patterns to try and enhance cleanup times, and LLNL is planning to incorporate such enhancements into the Remedial Designs. We agree that more vigorous extraction and injection can probably enhance cleanup times, and may also lower overall costs over the lifetime of the project. As previously stated, recent ground water transport simulations indicate a 30-year cleanup time may be achievable using about 35 extraction locations and 15 recharge locations, with a different subset of wells being used at various times.

There are many technical issues related to remediation speed and likelihood of success, such as limited and sparse environmental data; complex and uncertain geology, hydrology, and chemistry; diffusive transport of contaminants, how to best monitor the progress of cleanup, economic trade-offs, i.e., upfront equipment and well costs versus longer operating costs, etc. These issues are not unique to LLNL and exist at many, if not most, CERCLA sites. Forecasting the effectiveness of a cleanup strategy like pump-and-treat strains the current limits of scientific knowledge of environmental processes. LLNL is aware of the uncertainties inherent in these predictions, and in response, we continue to investigate means of reducing these uncertainties.

Although the primary goal of Alternative No. 2 is containment, it is still a viable cleanup strategy that takes longer than Alternative 1 because active source remediation with extraction wells in the source areas is not included.

**Comment A8o:**

*Is there a time period when DOE and LLNL are going to reduce the concentration of toxics in ground water?*

Letter #13; WC-93

**Response A8o:**

As specified in the PRAP, the current projected time period for cleanup for the Livermore site is about 50 years. We hope to be able to reduce this time significantly by incorporating new technologies and approaches that develop in the future. As stated in the response to Comment A7a, recent modeling results indicate that use of 35 extraction locations and 15 recharge locations, with a different subset of wells being used at various times, may be able to reduce the cleanup time to about 30 years. To enable this, LLNL must have a ROD that allows flexibility to incorporate the new developments.

**Comment A8p:**

*A recent article by two scientists from the Oak Ridge National Lab reported that the pump and treat method has never been found to permanently clean up ground water to cleanup goals because of continuing contribution of contaminants in the soil or vadose zone. That being the case, the Lab should aggressively pursue vadose zone cleanup wherever practical, particularly in areas of high concentration or hot spots. The PRAP should address this possibility and specify what it would do if it finds that cleanup is not going as planned.*

*Transcript p.106; MC-29*

**Response A8p:**

As stated on pages 11 and 27 of the PRAP, LLNL plans to remediate vadose zone contamination to prevent migration to ground water above MCLs (Dresen *et al.*, 1991). The responses to Comments A4m and A7m also address vadose zone cleanup and investigations.

LLNL and DOE are committed to aggressively pursuing vadose zone cleanup in areas of high concentrations. Contingency plans are a required part of the post-ROD Remedial Design documents.

**Comment A8q:**

*Vadose zone cleanup, as proposed in the PRAP, is limited to only the Gasoline Spill area and one adjacent area. Contamination may very well be moving from the soil into the ground water. One of the reasons ground water cleanups have not been lasting cleanups is due to contaminant migration from the vadose zone to the ground water. Thus, LLNL should put more emphasis on vadose zone cleanup. For one thing, it is cheaper and easier to clean up while it is still in the vadose zone.*

*Transcript p.123; MC-75*

**Response A8q:**

We agree that vadose zone cleanup is an important element of the overall remediation. The PRAP states that two, possibly three, areas (the Gasoline Spill Area, Building 518 Area, and possibly Trailer 5475 Area) will require vadose zone remediation. The PRAP clearly states on p.3, "...that an additional site (Trailer 5475 in the East Taxi Strip Area)...[may be] added to the list [of vadose zone remediation areas] when soil investigations are complete." Although the additional detailed Trailer 5475 investigations are not yet complete, available data indicate vadose zone cleanup will be conducted in that area.

Results of the vadose zone fate and transport study described in the response to Comment A8p will determine if additional LLNL areas require vadose zone remediation.

**A9. Other PRAP Issues****Comment A9a:**

*The PRAP conflicts with DOE cleanup goals; there are problems with the internal consistency of the DOE 5-Year Plan, which specifies a 30-year cleanup goal, but also states that it will initiate remediation at LLNL in the year 2019.*

*Transcript p.120; MC-70*

**Response A9a:**

This comment refers to an error in the 1991 DOE five year plan that indicated cleanup would begin in the year 2019. LLNL and DOE plan to implement the full cleanup described in the ROD in 1995. The PRAP states that it may take about 50 years to reduce residual contaminant concentration in ground water levels below MCLs, using the 18 initial extraction locations in the preferred remedial alternative that is summarized in the PRAP. However, DOE and LLNL are continually looking at innovative technologies to optimize the cleanup. DOE and LLNL have an ongoing optimization and engineering analysis program to find more efficient and faster ways to cleanup the site in support of Secretary Watkin's 30-year cleanup goal and the DOE's 30-year clean up goal, as stated in the Five Year Plan. This 30-year cleanup goal is based on the existence of new technologies in the future that could be utilized to permit more efficient and quicker cleanup. As mentioned in the response to A7a, recent simulation indicates that a 30-year cleanup may be achievable using more extraction and recharge locations.

**Comment A9b:**

*The PRAP needs to include provisions for keeping abreast of new technologies; what criteria it would use to reconsider the technical solutions; and the criteria for modifying the PRAP, including any public involvement that would be required pursuant to modifying the PRAP.*

*Please describe in detail procedures, or a process, whereby LLNL intends for new developments to be incorporated into the CERCLA process, and how the public will be informed and involved in decisions. Please describe what kind of actions would trigger a reopening of the RI, FS, PRAP, or ROD.*

*Transcript p.106; MC-30*

*Transcript p.113; MC-47*

*Letter #1; WC-20*

**Response A9b:**

LLNL is committed to keeping abreast of, if not developing, new remediation technologies. LLNL will consider incorporating future new technologies if there are significant cost or technical benefits, such as shorter cleanup times, lower operation and maintenance costs, or better contaminant destruction efficiencies. The public will be informed of such developments and participate in the decision making process through *Monthly Progress Reports* and CWG meetings. We do not foresee any circumstance that would trigger a formal re-opening of the RI, FS, PRAP, or ROD. The ROD may be amended, as indicated by EPA guidance, to incorporate subsequent actions, e.g., if vadose zone investigations warrant additional remedial action as required by CERCLA, amendments to the ROD would involve public review and comment.

**Comment A9c:**

*LLNL needs to provide additional budgetary information (e.g., past LLNL funding requests to DOE and DOE's ultimate funding response) to enable the public to better evaluate the probability of a successful cleanup at the Main site. These budget documents are matters of public record and are vital to understanding the constraints under which GWP staff operate. Please make this information available to the public as part of the suite of documents supporting the PRAP.*

*Letter #1; WC-47*

**Response A9c:**

LLNL funding requests to DOE for environmental restoration work and DOE's ultimate funding response to LLNL are a matter of public record and are available to the public through the LLNL Budget Office (510-423-2890).

**Comment A9d:**

*The PRAP and supporting documents do not mention decontamination of existing structures at LLNL. When is the decontamination and decommissioning of Buildings 212, 281, 292, and 412E expected to be completed? Have any decommissioning plans, other than those for Building 281, been prepared? The CERCLA documents should reference these plans.*

*During the initial decontamination phases (spent fuel removal, removal or irradiated components, and removal of radioactive fluids) at Building 281, were there any releases of radioactivity into the air, soil, or ground water? If yes, please describe the releases in detail. Were these and related decon operations at other buildings (e.g., the hot cells and industrial-scale nuclear chemistry operations that were a feature of the early years of this site) ever investigated thoroughly as potential sources in the RI? It appears not.*

*Letter #1; WC-38*

**Response A9d:**

To date, only Building 281 has been granted DOE approval for decommissioning. Preliminary decontamination has been completed at Buildings 212, 281, 292, and 412E. There is currently no DOE funding for writing decommissioning plans, nor for performing the final decommissions of these buildings. During the initial decontamination of Building 281, there were no releases of radioactivity to the environment. Building 212 was investigated as a potential source in the RI. Buildings 281, 292, and 412E were not identified as being potential sources by the source ranking system developed for the RI, so they were not investigated. Since the RI, however, those buildings have undergone preliminary evaluations, and it appears that only Building 292 has experienced a significant environmental release. Releases occurred in this area when a pipe froze and burst in December 1990, and during previous tank overflows. The piping has been sealed to prevent future releases. The tank has been taken out of service and sealed from future use.

**Comment A9e:**

*Does the PRAP as written, which is highly conceptual, meet EPA's standards for documents of this sort?*

*Transcript p.51; MQ-2*

**Response A9e:**

Yes, since it has been approved by all overseeing regulatory agencies, including U.S. EPA.

**B. RI/FS Documents****B1. Deficiencies in the RI/FS****Comment B1a:**

*Problems with the PRAP are rooted in deficiencies raised in the RI/FS. In its comments, Tri-Valley CAREs directs its comments to the entire RI/FS/PRAP sequence, where those comments are germane to the selection of a remedy.*

*Letter #1; WC-4*

**Response B1a:**

Both the RI and FS were based on data available at the time they were written, and both have been accepted by the regulatory agencies, including EPA.

**Comment B1b:**

*The RI/FS/PRAP obscures the import of local areas of contamination by blending them in with sitewide statistical summaries, saying that they are not significant over the site as a whole. You can generate a lot of nondetects in a statistical analysis by having such a large site and a large number of samples.*

*Where are the inorganic contaminants shown in Appendix P of the RI found on the Site?*

*The use of the 99th percentile to represent maximum concentrations is affected by the number of non-detects also included in the statistical analysis, as was done to select compounds of concern for the risk assessment.*

*The analysis of trends in concentration in monitor wells, the exclusion of data less than the MCL is of particular concern. It would be difficult to find a better way to make it impossible to tell where the plume is expanding. An analysis of contaminant trends in the "leading edge" of the plume is needed.*

*Transcript p.115; MC-55*

*Letter #1; WC-30*

**Response B1b:**

As referenced in Appendix P of the RI, the locations of the inorganic compounds shown in Appendix P are shown in Figures 5.2-11 and 5.2-12 in Chapter 5 of the RI.



Regarding the use of the 99th cumulative percentile to summarize maximum concentrations, the 99th percentile is used to represent the upper-bound concentration of a particular substance, as opposed to using the single maximum reported value, to avoid being unduly influenced by a single extreme value. This extreme value may be an "outlier" and unrepresentative of a true maximum. Although isolated extreme values may be "true" and therefore cause for concern, extreme values may also be the result of sample handling errors or analytical variability. Extreme values are usually reanalyzed for verification, and all wells are sampled on a quarterly to yearly schedule. We collect duplicate samples for 10% of all sampled wells and send them to a second laboratory for analysis. These duplicates check data precision. Test standards are also sent on a periodic basis to the contract analytical laboratory to check data accuracy, as described in Standard Operating Procedure 4.6, QA/QC Requirements for Data Generated by Analytical Laboratories (Rice *et al.*, 1990.)

Since it is derived from the distribution of all reported concentrations, the 99th percentile will always be less than or equal to the maximum reported value.

In the RI, 99th cumulative percentiles were compared to regulatory limits to determine if a substance should be included in the risk assessment. However, as is stated on page 5-9 of the RI: "to ensure that a substance was not omitted from consideration, we also compared maximum reported concentrations to the respective Federal and/or State regulatory limits..."

Regarding the use of sitewide versus localized sample sets when using statistics to make decisions, most of the statistical analyses in the RI were done to identify compounds of concern for the Baseline Public Health Assessment, a task for which sitewide summarization is appropriate. More localized sample sets are indeed more appropriate for site-specific investigations with smaller-scale objectives.

Local source areas are investigated fully and are a part of ongoing activities of the ERD. Source investigations cease when the data show that the concentrations and distribution of hazardous materials within the vadose zone are not currently, nor in the future, expected to result in concentrations in ground water exceeding an MCL, or present a risk to employees working in the area. When complete, the source investigation results are reported in the LLNL Ground Water Project *Monthly Progress Reports*, including all analytical results obtained during the characterization.

Enforceable regulatory cleanup levels (MCLs) exist only for ground water. Since exposure to LLNL's surficial soils does not present a health risk to site workers or the public, hazardous materials in the soil are only of concern if data indicate that migration would result in ground water concentrations greater than an MCL. No further work is planned in source areas in which the data indicate that significant migration to ground water is unlikely.

Regarding the exclusion of wells from the VOC trend analyses (see page 4-212 of the RI), if the average concentration of VOCs in the well is less than the MCL, it was excluded from trend analysis for two reasons. First, analytical variability is greater among samples with lower concentrations, particularly near the method limits of detection. By eliminating wells with average concentrations below the MCL, the "noisiest" data are excluded, so fewer false trends are identified. Second, since MCLs are identified as ARARs, regions with wells that have concentrations less than MCLs are not a target for cleanup actions and are therefore of less

concern. Admittedly, some information on concentration trends may be selectively ignored by using this criteria, but the utility of that additional information is questionable.

**Comment B1c:**

*Primary CERCLA documents are not objective and/or are written to be reassuring to the general public. Because of this, the objectivity of technical investigations is at risk and, at the same time, the public is shut out of effective participation.*

Transcript p.113; MC-48

**Response B1c:**

Significant effort is made in the primary CERCLA documents to make them as nontechnical and understandable as possible. For example, a separate fact sheet was prepared to facilitate understanding of the PRAP. These efforts are not meant to be "reassuring to the public." Objectivity of the LLNL work is provided by internal and external peer review from experts in the fields of hydrogeology, the vadose zone, and modeling. The primary CERCLA documents are written to be factual and as complete as the current data allow.

The public has assuredly not been shut out of effective participation in the CERCLA process. In addition to reporting project activities and findings in the *Monthly Progress Reports*, LLNL/DOE have spent considerable time and effort preparing the CERCLA documents and helping the community understand these documents and the ongoing work by making presentations and answering questions at CWG meetings. In addition, LLNL/DOE have offered to continue to work with the community beyond the requirements of CERCLA by supporting the interested community members after the ROD is signed (see PRAP Section 6.5, page 41).

**B2. Timing**

**Comment B2a:**

*Tri-Valley CAREs didn't receive the Remedial Investigation report in a timely manner—until after the (RI) formal comment period had already passed—so they could not submit comments on this document.*

Letter #1; WC-1

**Response B2a:**

LLNL explained to Tri-Valley CAREs at the February 7, 1990, CWG meeting, that there were delays in the printing of the RI report. LLNL offered to photocopy certain sections of the RI for Tri-Valley CAREs if requested. No such request was made. In addition, Tri-Valley CAREs was reminded at the February 7 meeting that draft copies of the RI were available for their review in the LLNL Visitor's Center and at the Livermore Public Library. In addition, the RI was the subject of a CWG meeting on June 28, 1989, 5 months before the draft RI was issued. LLNL source investigations, a major part of the RI, were the subject of the subsequent August 30, 1989, CWG

meeting. Numerous community questions and issues were addressed by LLNL staff at these meetings.

## **C. Community Relations**

### **C1. Community Work Group**

#### ***Comment C1a:***

*The Community Work Group wishes to continue to function as an advisory group to the LLNL Main site Superfund cleanup. They wish to remain part of the LLNL community relations program as outlined by SARA, for the foreseeable future. LLNL has indicated a willingness to continue supporting the group beyond the ROD. This should be made official, possibly by updating the community relations plan or other relevant documents. Another commenter said that, in his opinion, the CWG has been an effective forum for providing technical information to interested parties and provides the Lab with valuable community input that it otherwise would be difficult to get.*

*Transcript p.96; MC-13  
Transcript p.109; MC-36*

#### **Response C1a:**

LLNL has made a commitment to continue supporting a community work group if there is sufficient community interest in its continuation. LLNL will gauge community interest in this activity during the community relations reassessment process described below.

EPA's Superfund guidance requires that community relations needs are formally reassessed, and the Community Relations Plan is revised after the ROD is signed. The purpose of the reassessment is to determine, through one-on-one interviews with CWG members and a cross section of the community, such things as: community understanding of the project, community interest and information needs, and the best ways to continue working with the community as the project moves into the post-ROD stages. LLNL plans to conduct this reassessment shortly after the ROD is signed, probably by July or August of this year. All aspects of the community relations program will be reviewed in light of information from the interviews, and the community relations program will be revised accordingly. All of the original CWG members will be asked whether they consider the CWG to be a useful forum, how it could be improved, whether they want to continue their involvement, and the names of others who might be interested in this group.

Based on the information from the interviews, LLNL will revise the community relations program and meet with the current CWG to discuss the findings of the reassessment process. LLNL expects that the interview process will yield useful suggestions for improving community involvement/public participation.

## C2. Technical Advisors

### *Comment C2a:*

*Request for DOE to provide funding to the CWG to hire its own technical advisor, produce publications, etc, as appropriate.*

*Transcript p.97; MC-14*

### **Response C2a:**

Environmental restoration funds are used strictly for remedial investigation and cleanup. DOE does not have the authority to provide funding to the CWG in support of their involvement in the Ground Water Project at LLNL Livermore site. There is, however, a Technical Advisory Grant (TAG) of \$50,000 that EPA is authorized under CERCLA to extend to nonprofit community groups actively involved in the Environmental Restoration Program at an NPL site. This TAG is granted by EPA to one community group per Superfund site upon request and proof of eligibility. Tri-Valley CAREs was awarded a TAG to fund the work they do in support of the ground water cleanup project at the LLNL Livermore site.

## C3. Future Public Comment Periods and Meetings

### *Comment C3a:*

*The ROD should codify provisions for a public meeting and 30-day public comment period on the ROD. The Lab should issue a formal response to comments received during that period. Community acceptance should be a factor in finalizing these documents.*

*Transcript p.97; MC-15*

*Transcript p.150; MC-107*

### **Response C3a:**

LLNL and DOE have decided against conducting a formal public comment period, but does plan to meet with the CWG shortly after the ROD is issued to address community concerns. At that meeting, LLNL and DOE will answer questions the group has about the ROD and discuss plans for post-ROD technical activities. This meeting will be open to the public, as are all CWG meetings. Once all CWG members have had an opportunity to discuss their viewpoints, members of the public can also ask questions.

LLNL and DOE have three reasons for not holding a formal public comment period on the ROD:

1. A public comment period provides a formal opportunity for the public to comment on proposed plans or information. For LLNL's Ground Water Project, that formal opportunity was provided from October 18 through December 18, 1991, including a 30-day extension granted in response to a request from some community groups to do so. The proposed cleanup plans codified in the ROD for the LLNL site do not vary in a significant way from the plan presented for public comment during October through December 1991. Therefore, there is no new information about the project on which the public can comment.

2. In the past, these meetings with the CWG have provided the most effective means of two-way communication and feedback between LLNL and those members of the public who are most interested in the Ground Water Project.
3. A public comment period and a public meeting on the ROD are not required by the Superfund law unless the cleanup remedy presented in the ROD was significantly different from that presented during the PRAP, and/or the differences could not have been reasonably anticipated by the public based on the information presented during the PRAP comment period. Neither of these apply to LLNL.

The responses to Comments C3b and C4a also address this comment.

### **Comment C3b:**

*Because the Remedial Design phase of the cleanup will be significant in determining the completeness and achievability of the cleanup, and because community input after the ROD does not receive the same weight as comments and concerns submitted before the ROD, the ROD should codify provisions for a public meeting and public comment period on the Remedial Design.*

*Transcript p.97; MC-15  
Transcript p.117; MC-63  
Transcript p.139; MC-95  
Transcript p.150; MC-107*

### **Response C3b:**

Community input has been a factor in LLNL's technical decisions since the beginning of the Ground Water Project investigations. LLNL has made community relations a project priority, beginning with coordinating plans for offsite well sampling, continuing through the voluntary establishment of a CWG, and the release of draft documents for public review. Indeed, LLNL has gone far beyond the basic Superfund community relations requirements. As the project moves into the post-ROD activities, LLNL will continue to balance community concerns and the technical, legal, and policy issues that also need to be addressed.

As stated in the ROD, LLNL will continue to support a CWG or other formal group process that assures community input, if the community assessment interviews show that there is sufficient community interest. If such a group process continues, LLNL will ensure that there is community input on the Remedial Design documents by holding community group meetings contemporaneous with regulatory agency review of the Draft RD documents. Background material would be provided to group members well in advance of each meeting. All community group meetings would continue to be open to the public. LLNL would send out announcements of each meeting to the area newspapers in advance of the meeting date. As it has done since the project began, LLNL will consider community input received in subsequent revisions of those documents. Given that the community group meetings have provided a vehicle that has worked well in the past for soliciting *meaningful* community input, LLNL prefers to continue using these meetings for soliciting community input during the Remedial Design phase of the project.

In addition, DOE/LLNL are willing to meet with Tri-Valley CAREs' Technical Advisors, once they have had a chance to review the Remedial Design documents. By providing an opportunity

for a frank discussion with the advisors, LLNL believes that it can best meet the common goal of producing design documents that reflect the concerns of that segment of the interested community.

LLNL also will publish information related to the Remedial Design documents in a timely issue of the project newsletter, the Ground Water *Update*. The *Update* will clearly state where people can go to review copies of the Remedial Design documents, and who they can call for more information.

Finally, during the course of the community assessment interview process described in the response to Comment C1a, DOE/LLNL will work to identify any additional community relations activities that might be useful to conduct upon the release of the Remedial Design documents.

The response to Comment C4e also addresses this comment.

#### **C4. General Community Relations**

##### ***Comment C4a:***

*How can the community participate in the process in a legal sense following the close of the formal public comment period on the PRAP?*

*Transcript p.51; MQ-3*

##### **Response C4a:**

There are no provisions in CERCLA/SARA for "legal" participation following the public comment period on the PRAP unless the ROD is significantly different from the PRAP or is amended at a later date. However, LLNL intends to involve the community in the future, as discussed in the responses to comments C1a, C3b, and C4b.

##### ***Comment C4b:***

*The ability of the community in general and the CWG in particular to monitor and participate in the Superfund process should not end with the November 6, 1991 meeting. It should continue on well past that date.*

*Transcript p.97; MC-16*

##### **Response C4b:**

As stated in response to Comment C1a, DOE/LLNL have committed to continue providing opportunities for community involvement in the project. DOE/LLNL have also committed to supporting a CWG if the community desires that such a group continue. With regard to the general community's ability to monitor and participate in the Superfund process, LLNL has provided a number of community relations opportunities:

- **Attendance at Community Work Group Meetings.** All CWG meetings are open to the public. LLNL sends out announcements of each meeting to the area newspapers, well in advance of the meeting date.

- **Ground Water Update.** Published on a regular basis since 1988, the *Update* is a newsletter that provides comprehensive information on the status of the Ground Water Project and upcoming meetings. The *Update* is distributed to a mailing list of over 1,800 individuals, groups, and elected and agency officials.
- **Community Letter.** A number of CWG members have expressed an interest in information that goes beyond the scope of responsibilities of the Ground Water Project. For this reason, LLNL's Public Affairs Department is seeking funding for a regular mailing to the public that includes information on a broad range of LLNL-related environmental topics.
- **Tours.** The public is always welcome to request tours of the Ground Water Project and other environmental facilities. LLNL has provided a number of tours of Ground Water Project facilities to CWG members, the press, and other interested members of the public. These tours are available by calling 510-294-9797.
- **One-on-One and Small Group Meetings.** Ground Water Project staff are now, and have always been, available to meet with interested individuals or groups.
- **Information Line.** For over 4 years, LLNL has made staff available to handle telephone inquiries regarding Ground Water Project questions and concerns. The current LLNL contact for the Ground Water Project is Pat Post. Her number is 510-423-4255. LLNL also has a community hotline for other information: 510-422-9797.
- **Information Repositories/Administrative Record.** Since 1988, LLNL has established and maintained two locations where the public can review key documents produced by the Ground Water Project or other LLNL staff. Those repositories are located at the Livermore Public Library and at the LLNL Visitors Center on Greenville Road. In addition, the Administrative Record, which contains all documents that provide a basis for the technical cleanup decisions for the Ground Water Project, is available at the LLNL Visitors Center.

LLNL plans to reassess the community relations program for the Ground Water Project once the ROD is signed. The purpose of the reassessment will be to determine, through one-on-one interviews with CWG members and a cross section of the community, such things as community understanding of the project, community interest and information needs, and the best ways to continue working with the community as the project moves into the post-ROD stages.

Based on the information from the interviews, LLNL will revise the community relations program and meet with the current CWG to discuss the findings of the reassessment process. LLNL expects that the interview process will yield useful suggestions for improving community involvement/public participation in the project.

#### ***Comment C4c:***

*LLNL has not been responsive to oral and written comments from Tri-Valley CAREs and its Technical Advisors. The final PRAP differs little from the June version and incorporates none of the comments offered throughout 1991 by Tri-Valley CAREs and its advisors. For example, at the July 25, 1991, meeting with LLNL and Weiss Associates staff, many of our hydrologic concerns*

were discussed. LLNL Ground Water Project staff found many of these concerns to be well-taken, and orally pointed to work that has been or is being done to address the issues raised. Yet little of this work has been published in the Administrative Record; nor has it been incorporated into the primary CERCLA documents. These issues remain largely unresolved.

Transcript p.105; MC-27

Transcript p.110; MC-38

Transcript p.110; MC-39

Letter #1; WC-2

Letter #1; WC-5

#### **Response C4c:**

LLNL has devoted significant staff time and resources to discussing the comments and concerns of Tri-Valley CAREs and its Technical Advisors. Refer to the response to Comment C4e for more details. LLNL has responded in writing to all comments on the FS. In addition, as stated in the response to Comment A1b, and in our January 29, 1992, letter to Marylia Kelley of Tri-Valley CAREs, our records indicate that LLNL's responses to the April 8, 1991, comments from Peter Strauss were sent to Mr. Strauss along with the revised PRAP on June 24, 1991. We sent an additional copy of our responses to Mr. Strauss' comments to Marylia Kelley on January 29, 1992.

Portions of the PRAP were significantly revised or augmented in response to community comments and concerns. These include additional information regarding tritium on pages 7 and 10; revision of Figure 6 showing the area where tritium exceeds its MCL in ground water; clarification of the plans to avoid recharging treated ground water if it should contain tritium above the MCL on page 17; and addition of Section 6.5 on page 41 describing the post-ROD activities.

LLNL has listened to each and every comment and suggestion from the public, but not all suggestions can be implemented due to technical or economic considerations. Moreover, LLNL has gone to great lengths to consistently and oftentimes repeatedly explain to Tri-Valley CAREs and the public the reasons why their suggestions can or cannot be incorporated into the Project documents and plans. We acknowledge that Tri-Valley CAREs and LLNL do not agree on a number of issues, many of which are related to LLNL's decision to adhere to regulatory standards and guidelines for Superfund cleanups.

The response to Comment A7a contains information on the reporting of ongoing LLNL Ground Water Project activities.

Although LLNL believes it has adequately responded to Tri-Valley CAREs, we are open to discuss any issues that you feel are still unresolved.

#### **Comment C4d:**

*The PRAP provides for no suggested means of public or regulatory agency involvement in ongoing decisions about the site. Investigations into possible sources of ground water contamination, as well as contamination in the vadose zone, are on-going at LLNL. However, there are no explicit means of reporting this work to the public and the regulatory agencies short of analyzing the raw data in the monthly reports. The community wants to know on an ongoing basis*



*what is really being done; not just what is being studied to be done. Even if informed, no one outside LLNL has any formal means of providing input into ongoing decisions about remediation other than the EPA, whose formal input is confined to one review every 5 years. LLNL should institutionalize a mechanism whereby the community has an ongoing consultative/advisory role.*

*Transcript p.109; MC-36*

*Transcript p.113; MC-46*

*Transcript p.138; MC-94*

*Letter #1; WC-19*

*Letter #13; WC-111*

#### **Response C4d:**

Progress of ongoing source investigation work, not just the raw data, is summarized in the LLNL Ground Water *Monthly Progress Reports*, and more detailed summaries of completed investigations are also included in these documents. The documents are available to the public at the LLNL Visitors Center and at the Livermore Public Library. Copies of the documents are also sent to all regulatory agencies. Regulatory agencies are also notified, in writing, prior to the initiation of field investigations in any particular area. The overseeing regulatory agencies will monitor additional investigations and help identify any additional remedial actions that might be necessary prior to the 5-year review.

LLNL will continue to work with the community through the life of the project. Once the ROD is signed, LLNL will conduct a formal reassessment of community relations needs for the Livermore site environmental restoration activities. The Superfund program requires this process following agreement on the PRAP and the ROD.

The responses to comments C3a and C3b also address this comment.

#### **Comment C4e:**

*LLNL needs to respond to written comments submitted by Tri-Valley CAREs and their Technical Advisors on the PRAP.*

*Letter #1; WC-2*

#### **Response C4e:**

The comment letter refers to four sets of comments on the PRAP submitted to LLNL by Tri-Valley CAREs' technical advisors between April and September 1991. Of those four, LLNL responded to the first set of comments submitted by MHB Associates on April 8, 1991, regarding the draft PRAP. LLNL included its response to the MHB letter as an attachment to the June 24, 1991, copy of the Draft Final PRAP. In a distribution dated June 24, 1991, LLNL sent copies to a number of individuals, including Peter Strauss of MHB Associates.

This is the first time that LLNL has heard that neither Tri-Valley CAREs nor MHB Associates received their copies. We sent new copies to both parties on January 29, 1992, as described in the responses to Comments A1b and C4c.

With regard to the three subsequent sets of comments, LLNL made it clear to Tri-Valley CAREs and its Technical Advisors—both prior to and during the July 25, 1991, meeting with Tri-Valley CAREs, its advisors, and DOE—that they would receive written responses to those submissions sometime after the close of the PRAP public comment period in fall 1991. In addition, LLNL has told Tri-Valley CAREs on several occasions that: LLNL appreciates comments and concerns regarding draft versions of the technical documents, but the process of providing *written* responses is extremely costly and time-consuming. Responding to written comments requires the involvement of not simply Ground Water Project technical staff, but LLNL senior managers, DOE staff and managers in the San Francisco regional office, and DOE staff and managers in Washington, D.C. The problem of devoting resources to handle this task is exacerbated by the highly technical nature of many of the comments that Tri-Valley CAREs' advisors tend to submit—the answers often require extensive research.

In fact, LLNL offered to convene the July 25 meeting precisely because it wanted to avoid the time-consuming process of trading comments and responses back and forth. LLNL made three key members of the Ground Water Project team available for the entire day, along with three levels of LLNL management, two senior DOE officials, four LLNL contractors, and an international expert on vadose zone investigations and ground water flow and transport modeling. In so doing, LLNL hoped to share information and reach some understandings that would be difficult to achieve in the trading of written comments. LLNL believes that such an exchange proved to be very fruitful, and heard similar feedback from many of the participants.

Moreover, LLNL has discussed a number of the issues raised by Tri-Valley CAREs and its Technical Advisors at CWG meetings, which were often attended by one of the advisors.

Because the process of trading written questions and answers does not appear to have been successful, and because LLNL recognizes the value of working with the Technical Advisors as the project moves into the post-ROD phase, LLNL would like to establish a process whereby Ground Water Project and DOE staff would meet with the Technical Advisors following the release of draft and final documents. If they wish, the Technical Advisors can submit written comments to LLNL at least several weeks prior to each of those meetings, to give LLNL time to consider the questions. A Tri-Valley CAREs representative could also attend these meetings. These meetings would occur within 30 days following the release of project documents, to provide sufficient time to incorporate Technical Advisor concerns, as appropriate, into subsequent drafts. LLNL cannot, however, commit to written responses to the Advisors' questions, as described above. In addition, experience has shown that face-to-face meetings provide the best means of ensuring effective communication. Moreover, by providing an opportunity for LLNL to meet separately with Tri-Valley CAREs and the Technical Advisors, LLNL also hopes to reduce the likelihood that issues of primary interest to Tri-Valley CAREs and the Technical Advisors will not consume the limited meeting time of the more broad-based CWG members. These meetings should be coordinated through Karen Anderson, the Ground Water Project Community Relations Coordinator. She can be reached at 415-882-3056.

**Comment C4f:**

*Cleanup progress needs to be publicly published on a regular basis and checked by outside experts.*

Letter #10; WC-83

**Response C4f:**

Progress of the LLNL Livermore Site cleanup will be published in Monthly Progress and Annual Reports required by LLNL's FFA. It will be formally reviewed by the regulatory agencies every 5 years, as specified in the ROD.

**Comment C4g:**

*Requests from Western States Legal Foundation, East Bay Women for Peace, the Marin County SANE/Freeze, and U.C. Labwatch to extend the public comment period on the PRAP by 30 days.*

Letter #14; WC-100

**Response C4g:**

The public comment period was extended by 30 days from November 18 to December 18, 1991, in response to these requests.

**D. Federal Facility Agreement (FFA)/CERCLA****D1. FFA****Comment D1a:**

*The Federal Facilities Agreement (FFA) does not give the regulatory agencies very much basis for any kind of action should things fall between the cracks. The schedules in the FFA are mostly document production schedules and not actual cleanup milestones. Also, EPA and the other regulatory agencies agreed not to sue LLNL or DOE over the cleanup. If DOE does not fund the cleanup, that would be sufficient cause for LLNL not to clean up.*

Transcript p.74; MC-3

**Response D1a:**

The response to Comment A7y(iv) addresses this comment. The LLNL FFA is a legally binding agreement that contains provisions for stipulated penalties if LLNL does not meet FFA requirements for primary activities, such as issuing the PRAP. All signatories to the FFA have worked closely with one another in the past and are committed to continuing to do so in the future, to achieve an effective, expeditious, and environmentally sound restoration of the LLNL site.

In addition to setting document schedules, the FFA gives the regulatory agencies the responsibility to review and modify FFA document content.

## D2. Relationship between the FFA and CERCLA

### *Comment D2a:*

*The relationship of the preferred alternative to other LLNL environmental programs and laws is unclear at best and may be at odds with the FFA and CERCLA. Under the FFA, this program is integrative of all environmental laws. CERCLA requires that LLNL make all RCRA requirements an ARAR at the site. One of the RCRA requirements in Section 3016 is a 2-year reporting of all sites at which hazardous waste has ever been disposed of at the site. This is not in the PRAP.*

*Transcript p.113; MC-45  
Letter #1; WC-18*

### **Response D2a:**

The LLNL Environmental Protection Department ensures that LLNL can meet its environmental responsibilities as stipulated in environmental legislation (including CERCLA), regulations, and DOE orders, and collaborates with LLNL programs to maintain adequate protection of the environment.

Toward this end, the Department:

- Develops and maintains LLNL environmental policies, plans, guidelines, and practices.
- Educates and trains LLNL employees on environmental issues and responsibilities, and informs management about pending changes in environmental regulations impacting the Laboratory.
- Guides LLNL programs in complying with environmental laws and regulations.
- Represents LLNL to the public and to the Federal, State, and Local regulatory agencies on environmental issues.
- Helps other LLNL programs manage and minimize hazardous and radioactive waste.
- Performs environmental monitoring of LLNL operations.
- Determines the extent of environmental contamination from past activities.
- Cleans up environmental contamination to acceptable standards.
- Responds to emergencies that impact the environment and provides guidance for cleanup, sampling, and reporting.

The Department carries out this work under the direction of the Department head and Deputy Department head, who are assisted by a Department staff and four divisions: Operations and Regulatory Affairs, Environmental Measurements and Analyses, Environmental Restoration (the Ground Water Project is within this division), and Hazardous Waste Management.

RCRA Section 3016 is discussed in the Response to Comment A2j.

**E. Nuclear Weapons Research/LLNL Mission****E1. LLNL's Nuclear Weapons Design, Power Policies, and Activities****Comment E1a:**

*LLNL should stop producing radioactive waste. "Only by stopping your support of nuclear weapons and nuclear power in addition to your cleanup can you assure future safety. The way this cleanup is done concerns my safety and I think you are doing a terrible job." Also, "with your policy of promoting nuclear weapons and nuclear power, both of which produce dangerous waste, you are interfering with my job as you are interfering with every mother's job. And I am here to demand a change."*

*While DOE is planning an ambitious 53-year clean up plan, it is simultaneously planning and preparing for 50 or more years of nuclear weapon design, testing, and production. This illustrates the fundamental institutional denial inherent in all DOE and LLNL environmental assessments.*

*Transcript. p.99; MC-19*

*Transcript. p.101; MC-20*

*Transcript p. 131; MC-87*

**Response E1a:**

LLNL is a national laboratory with specific and unique capabilities to efficiently and effectively support Congressionally mandated programs, including working with radioactive materials in support of energy research, weapons development and testing, biomedical research, and environmental research. DOE has determined that LLNL is the DOE facility that can carry out such research most efficiently and effectively. Some or all of this work produces small quantities of radioactive waste. However, DOE is working hard to minimize the production of all waste at DOE facilities including LLNL and to ensure that the waste that is produced is stored, transported, treated, and disposed in a way that protects human health and the environment.

**Comment E1b:**

*LLNL should convert all its facilities to research and development of renewable energy technologies immediately.*

*Transcript p.102; MC-22*

**Response E1b:**

DOE does currently carry on research and development of renewable energy technologies at LLNL. In addition, DOE uses the unique facilities and personnel skills established at LLNL to carry on other Congressionally mandated program goals such as national defense research, basic energy research, nuclear energy research, biomedical research, environmental sciences research, environmental restoration, and other research. Some of the experience and knowledge developed in these other programs has direct or indirect benefits to renewable energy technology development.

**E2. Weapons Funding vs Environmental Restoration Funding****Comment E2a:**

*The amount of money it will cost to clean up the Main site is a drop in the bucket compared to LLNL's overall budget, which is approximately \$1.1 to \$1.2 billion a year. Its biggest programs and expenditures are still in the nuclear weapons area. The average nuclear test costs approximately \$40-50-60 million. So, compare the cost. They are blowing up in an average six-month period at the Nevada test site the entire cleanup budget for the Main site. It is a matter of priorities.*

*Transcript p.122; MC-73*

**Response E2a:**

DOE's budget request for environmental restoration at LLNL and other facilities is based on risk reduction, compliance requirements, and effective and efficient cleanup, not on percentage of the facility's overall budget. In some cases, like LLNL, the environmental restoration (and waste management) budget request is much smaller than the overall facility budget. However, at DOE facilities such as Hanford and Fernald, environmental restoration and waste management budgets represent most or all of the facility budget.

**Comment E2b:**

*LLNL should stop making and testing nuclear weapons and redirect that funding to ground water cleanup.*

*Transcript p.126; MC-83  
Letter #5; WC-59*

**Response E2b:**

DOE continues to support programmatic activities at LLNL as mandated by Congress, including nuclear weapons work. LLNL will also work with DOE to request adequate funding for implementation of the PRAP for cleanup of the Livermore site. DOE has determined that LLNL is the DOE facility that can carry out such research most efficiently and effectively.

**F. Other Issues****F1. General Criticism of LLNL/DOE****Comment F1a:**

*LLNL is responsible for much of the present contamination problems. It has a 39-year history of abusing all of the contaminants that are in the soil and ground water. There is nothing in the soil and ground water that LLNL does not use and has not abused.*

*I would also like to put to rest the idea that constantly floats around kind of under the surface here, that the contamination is the responsibility and result of Navy activities at the LLNL site prior to the Lab going into business. Thirty-nine years of routine mismanagement of toxic and radioactive materials at the Lab has meant storage and handling mishaps, accidental spills, and airborne*

releases of hazardous wastes and extensive contamination of the soil and ground water. For example, benzene, toluene, and xylene -- all of which are gasoline components -- were found in the vicinity of Building 403, the result of a leak of 17,000 gallons of diesel fuel into the soil. It was discovered by LLNL in 1979 but not revealed to the public until 1984 during an attempt to trace another leak. In September 1984 the California Department of Health Services (DHS) issued an order for compliance against LLNL as the result of contaminated ground water, requiring the provision of bottled water and other compliance steps. The order included a list of hazardous chemicals that were improperly stored, handled, and disposed of, that had migrated from LLNL downhill to populated areas and into the ground water of surrounding communities... In November 1984 there was an explosion of an improperly-mixed drum of waste, yet it was not reported for 11 months. DHS inspected the lab and found numerous serious violations including unmarked drums and improperly stored chemicals. A 1985 inspection found similar problems. There was a critical report by DOE's Office of Environmental Audit in December 1987, which reported accidental releases of hazardous wastes, including to the sewer system. As much as 30 per cent of the Lab's sewer outflow is lost to the surrounding soil and ground water. The Lab has also experienced significant emissions of tritium, which never was used by the Navy. In 1973 there was an accidental release of 350,000 curies of tritium into the atmosphere. In 1970, 300,000 curies released. There was a tritium leak associated with the earthquake in 1980. We have heard several references to the major 1990 tank rupture of tritium. And in November 1990, samples of rain water collected at four sites on- and off-site showed water containing tritium at close to the Federal action level. And if it is raining tritium, you can bet that tritium is getting into the ground water.

*Transcript p.118; MC-65*

*Transcript p.127; MC-86*

### **Response F1a:**

DOE and LLNL are committed to cleaning up all contaminants in concentrations above ARARs that originate from the LLNL site, regardless of whether they were released during the U.S. Navy occupancy of the site or subsequently.

### **Comment F1b:**

*LLNL provided bottled water to nearby residents after VOC contaminants were found in ground water only under pressure from the State of California.*

*Transcript p.118; MC-66*

### **Response F1b:**

LLNL immediately provided bottled water on December 16, 1983, to all residents that were using ground water in the vicinity of the area where VOCs exceeded the drinking water standards. In September 1984, 9 months after all the residents had been on regularly scheduled deliveries of bottled water, the California Department of Health Services issued an order requiring LLNL to supply bottled water to all those residents involved.

**Comment F1c:**

*Regarding the recent DOE exercise in which members of the public were asked to prioritize DOE sites for ER cleanup, it is inappropriate for DOE to be using money to ask the public what sites should be cleaned up first. How is the public to determine which sites are the worst to be cleaned up? All of the sites on the Superfund list should be cleaned up now and public should have information on what's going on at these sites—what's actually being done.*

Transcript p.137; MC-93

**Response F1c:**

DOE has launched a program to solicit public input into the prioritization of DOE Environmental Restoration projects. It is important to DOE that the public as well as other involved parties such as regulatory agencies, state and local governments, and Indian tribes be involved in establishing criteria for performance of Environmental Restoration projects. Without such input, DOE could not effectively meet the goals of the public that it has been mandated to serve and protect.

**Comment F1d:**

*LLNL/DOE are being secretive/lying about contamination problems and what they're doing. The public meeting is good so that people can put their input in and can learn the truth.*

Transcript p.104; MC-24

Transcript p.150; MC-106

**Response F1d:**

All data collected by the ground water project and all interpretations made by ground water staff have been available to the public and expressed in public meetings. LLNL and DOE disagree strongly with the first sentence of this comment.

**Comment F1e:**

*LLNL statements made at the November 6, 1991, public meeting that were meant to assure the community that LLNL does not plan to have any spills in the future and that future Lab work will be done in an environmentally sound manner caused dismay. It's not possible to build a safe, clean nuclear weapon.*

Transcript p.127; MC-85

**Response F1e:**

Some people at the public meeting misunderstood part of LLNL's response to mean that LLNL did not plan to have future accidents and had no plans to address future accidents. To clarify, the PRAP addresses only contamination currently in the subsurface. If a future release of hazardous materials occurred that could impact ground water, or that would be defined as a hazardous waste in the soil by the state, LLNL would clean up the release as part of the Ground Water Project cleanup, and/or through one of the other LLNL environmental programs.



**Comment F1f:**

*DOE needs to learn the meaning of the concept of triage, where you simply go and take care of the most seriously injured or most important patient first. There are some very important problems that need to be addressed in the order of importance. Something that affects human life is much more important than anything else.*

*Transcript p.149; MC-105*

**Response F1f:**

DOE has established a risk-based prioritization system for Environmental Restoration projects and is currently soliciting comment from the public on the system. This prioritization system analyzes the current and future risk to the public of all DOE contamination problems as well as a number of other criteria such as regulatory compliance, environmental risk (natural resource risk), socioeconomic impacts and others to quantitatively evaluate timing requirements and yearly level of effort required for each DOE Environmental Restoration project within a given DOE Congressional Environmental Restoration funding level. The primary weighting factor currently considered for the prioritization system is human health.

**Comment F1g:**

*I simply hope that people in power understand that it is an awesome responsibility to try to do something so that other people won't get cancer. I don't know how many LLNL/DOE/agency reps or people in positions of power understand the devastating nature of cancer. I think that this is a very critical time for all of us, that we are in a certain point in history where if we don't do something to make sure that the planet survives and the people survive, then the whole country is just going to suffer a great deal.*

*Transcript p.147; MC-103*

*Transcript p.147; MC-104*

**Response F1g:**

LLNL appreciates the reminder of the devastating nature of cancer.

**Comment F1h:**

*The site-wide EIR is inadequate.*

*Letter #1; WC-25*

**Response F1h:**

If this comment references the Draft EIR dated December 22, 1986, that document was replaced by an entirely new Draft EIR/EIS issued in February 1992. The commenter should review this document because it postdates the referenced sitewide EIR. The CERCLA documents produced to date more than adequately cover the soil and ground water contamination existing at the Livermore site. The sitewide EIS overlaps the CERCLA activities for ground water and soil cleanup only. Comments on the sitewide EIR/EIS should be directed to Chuck Meier.

**F2. Support for Senate Bill 1402**

*Support is urged for SB 1402, submitted by Senator Adams of the State of Washington, which proposes to set up a dedicated nuclear waste cleanup account. The bill would forbid funds from this account from being used for nuclear weapons production activities. It also would require DOE to request adequate funds from Congress to meet deadlines and milestones of cleanup agreements, or explain why it is not requesting these funds. It requires DOE to report how it spends cleanup dollars and thus would relate, for the first time, actual cleanup requirements with the respective appropriations.*

*Transcript p.135; MC-91*

**Response:**

Department of Energy personnel acting as representatives of DOE cannot directly endorse or oppose any Congressional bill (this includes SB 1402) without direction from the President or direct solicitation for testimony by Congress. However, the public is encouraged to research all legislation, and contact their respective Congressional representatives regarding their concerns and opinions.

**F3. Procedural Questions/Suggestions****Comment F3a:**

*I would like some response as to how I can petition to get the public involvement process pursuant to the ROD changed so that community input is a significant factor after the ROD (e.g., requiring a formal public comment period and meeting).*

*Transcript p.140; MC-96*

**Response F3a:**

Neither CERCLA nor the NCP has a provision for a formal public comment period or meeting in the period following the ROD, unless the ROD is significantly different from the PRAP, or is amended at a later date. However, the law requires LLNL to reassess its community relations strategy and outreach post-ROD (Remedial Design/Remedial Action and long-term operation and maintenance) by updating its Community Relations Plan. The revision of this document involves conducting community interviews, among other things, to assess the post-ROD needs of the community. LLNL believes community involvement in the process is very important and intends to continue a number of the activities that it has been providing to date, such as holding informational meetings and distributing draft documents to interested parties. In addition, LLNL/DOE have committed to supporting a CWG, if the local community desires that such a group continue, as discussed in the response to Comment C1a. The most appropriate mechanism for petitioning a formal change to Superfund's public involvement process currently included in CERCLA and the NCP is through your elected officials. Congressional reauthorization of the Superfund law is scheduled for 1994.

**Comment F3b:**

*I have seen Responsiveness Summaries done well, and some that were done horrendously. The one for the EIR implementation plan is a case study in how not to do it. In preparing the Responsiveness Summary for this PRAP meeting, you should not just lump commenters together and then characterize them any way you want to (e.g., 11 people discussed...). In a responsiveness summary, if it is going to be any good, you must list the individual comments and give an individual response.*

Transcript p.151; MC-108

**Response F3b:**

DOE/LLNL appreciate the suggestion, and believe that it has, in this Responsiveness Summary, achieved a good balance between doing a comment-by-comment response, and a "lumping" of similar comments. We decided to follow EPA Superfund Guidance for preparing Responsiveness Summary documents. That guidance states that the entity preparing such a document should consolidate similar comments according to subject categories, rather than answering each comment separately.

This Responsiveness Summary is meant to provide the reader with a good sense of the strength, nature, and range of concerns of the community. By following EPA Guidance, LLNL believes that it can best achieve that goal.

In recognition of the commenter's concern that LLNL not "just lump comments together and characterize them any way you want," LLNL took great care not to mischaracterize individual comments. In fact, where possible, the gist of the comments was taken verbatim from the original comments. To make it easier on the commenters to determine where the responses to their comments are, the coding and cross-referencing system described on pages 2 and 3 of this Responsiveness Summary was developed.

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