READER'S GUIDE

The Final EIS/EIR is organized to assist the reader's understanding of the complex operations at Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore.

Organization of Documents

The EIS/EIR is divided into five volumes and two companion reports:

Volume I. This volume contains the Final EIS/EIR, which in part relies on the detailed information in the appendices, and comprehensively discusses the proposed action, the alternatives, and the existing conditions and impacts of the proposed action and the alternatives.

Volume II. This volume contains the Final EIS/EIR technical appendices which provide technical support for the analyses in Volume I and also provide additional information and references. Appendix E was originally identified in the Implementation Plan to discuss site contamination and environmental restoration activities. This information is in sections 4.17, 4.18, and 5.1.15. Appendix E will not be used in the Final EIS/EIR.

Volume III. This volume contains the Final EIS/EIR technical appendices F through M. Appendix L has been revised to reflect public information activities since publication of the Draft EIS/EIR. These appendices provide technical support for the analyses in Volume I and also provide additional information and references.

Volume IV. This volume contains copies of the written comments and transcripts of individual statements at the public hearing and the responses to them.

Volume V. This volume of attachments contains copies of exhibits submitted by speakers at the public hearing or submitted to the project office as part of the written comments.

EIS/EIR Executive Summary. This report summarizes the proposed action and the alternatives, and their respective impacts on the environment.

Mitigation Monitoring and Reporting Program document. As required by CEQA, UC has developed this program as a part of the Final EIS/EIR process. This is a program for implementing and monitoring the progress of measures taken to mitigate the significant impacts of the proposed action. It identifies the Laboratory component responsible for implementing each of these measures, when mitigation monitoring will begin and end, and who will verify that the mitigation measure is implemented as planned.

Changes from the Draft EIS/EIR

Volume IV contains public comments and responses. Where responses to public comments have initiated changes that appear in the Final EIS/EIR Volumes I, II, and III, they have been so noted in the comment response. All changes, including correcting typographical errors, making grammatical improvements, and further clarifying information in the Draft EIS/EIR, have been made to improve the usefulness of the document to the decision maker and to be responsive to the public. These changes are shown in shaded text (as is this paragraph) in Volumes I, II, and III. These changes are not material to the analyses or conclusions presented in the Draft EIS/EIR. Because Volumes IV and V contain comments and responses on the Draft EIS/EIR, these volumes have no shaded text.

Glossary of Terms

There is a complete glossary of terms used at the end of Volume I and an appendix-specific glossary at the end of each appendix. Although some technical terms are defined within the text, the glossaries provide a quick reference source for technical terminology. Throughout the EIS/EIR and its supporting appendices, different systems of measurement are used to describe quantities, volumes, concentrations, distances and other factors. This is often done to report data as they are found in referenced documents or to be consistent with technical conventions. To assist the reader, a conversion table of equations is also provided at the end of the Glossary section of Volume I.

References

In Volume I, references appear at the end of each section. In Volumes II and III, references are placed at the conclusion of each appendix. In Volume IV, references appear at the end of the comments and responses. A complete set of reference materials, as well as additional background information, is available for public review at the Livermore Public Library, 1000 S. Livermore Avenue, Livermore, California, and at the UC Berkeley Charles F. Doe Library, Government Documents Section, 350 Main Library Annex, Berkeley, California.

Associated EIS/EIR Documents

In preparing the Draft EIS/EIR, two supporting documents were produced and made available to the public:

- The *Community Relations Plan for the Environmental Impact Statement and Environmental Impact Report for Continued Operations of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore* which establishes the program for community input and involvement in the EIS/EIR process.
- The *Implementation Plan for the Environmental Impact Statement and Environmental Impact Report for Continued Operations of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore* which summarizes the proposed action, the alternatives, and comments received during the EIS/EIR scoping process. It also summarizes the issues addressed in the Final EIS/EIR and provides an initial outline of the document.

Copies of these plans are available for public review at the above libraries, as well as at the information depositories listed in Appendix M.

FOREWORD

This Environmental Impact Statement/Environmental Impact Report (EIS/EIR) analyzes the environmental impacts of the proposed action: the continued operation, including near-term (within 5 to 10 years) proposed projects, of Lawrence Livermore National Laboratory (LLNL) and Sandia National Laboratories, Livermore (SNL, Livermore). The proposed action, therefore, necessarily includes current operations plus programmatic enhancements and facility modifications in support of research and development missions established by the Congress and the President. While the U.S. Department of Energy (DOE) owns both Laboratories, LLNL is operated and managed by the University of California (UC), a public agency, for DOE, and SNL, Livermore is operated and managed for DOE by the Sandia Corporation for DOE., a wholly owned subsidiary of AT&T.

The Secretary of Energy has established a DOE policy for preparing and updating sitewide Environmental Impact Statements (EIS) for DOE facilities. In 1990, DOE's environmental assessment ("Tiger Team") found that the existing 1982 sitewide EIS for LLNL and SNL, Livermore should be updated. In response to the Secretary's policy and to the assessment findings, this document, which complies with the National Environmental Policy Act (NEPA) (42 U.S.C. Section 4321 et seq.), has been prepared.

UC is considering renewing its contract with DOE for continued management and operation of LLNL. This document, which complies with the California Environmental Quality Act (CEQA), has been prepared for the proposed 1992 contract renewal.

DOE and AT&T have announced that AT&T will not seek to renew its contract to operate Sandia National Laboratories, which includes SNL, Livermore. The current contract does not end until September 30, 1993, until which time AT&T will continue to operate SNL, Livermore. DOE will select another contractor to manage and operate Sandia National Laboratories, including SNL, Livermore.

As encouraged by NEPA and CEQA, DOE and UC decided to prepare a joint EIS/EIR to avoid duplication of effort. This EIS/EIR has been prepared pursuant to NEPA (42 U.S.C. 4321 et seq.), the Council on Environmental Quality (CEQ) implementing regulations (40 C.F.R. 1500–1508), DOE NEPA Guidelines (52 Fed. Reg. 47662), CEQA (Public Resources Code section 21000 et seq.), the State CEQA Guidelines (14 C.C.R. section 15000 et seq.), and the guidelines in the UC *Procedural Handbook and Model Approach for Implementing the California Environment Quality Act* (May 1991), hereafter referred to as the UC CEQA Handbook.

The purpose of this EIS/EIR is to:

- Evaluate environmental impacts of the proposed action and the impacts of alternatives to the proposed action. It would also identify mitigation measures to avoid or offset such impacts, and ensure that these impacts are considered in the DOE and UC decision-making process; and
- Provide broad environmental evaluation of sitewide issues so that subsequent environmental analyses can focus on specific issues regarding proposed actions through a process known as tiering (40 C.F.R. 1508.28; and California Public Resources Code sections 21068.5 and 21093).

DOE is also preparing two programmatic EISs to examine national issues that may also relate to future operations of LLNL and/or SNL, Livermore. They are:

- Programmatic Environmental Impact Statement for the Integrated Environmental Restoration and Waste Management Program. That document, for which the Notice of Intent was published on October 22, 1990 (55 Fed. Reg. 42633), will analyze alternative means for managing DOE's hazardous, radioactive, mixed, and other wastes; transportation issues regarding waste disposal; and environmental restoration of DOE sites. It will also describe environmental restoration activities required in the event of decommissioning and decontamination of DOE facilities, including nuclear weapons complex sites.

Programmatic Environmental Impact Statement for Reconfiguration of DOE's Nuclear Weapons Complex. That document, for which the Notice of Intent was published on February 11, 1991 (56 Fed. Reg. 5590), will compare environmental consequences of reconfiguration strategies for the DOE nuclear weapons complex against the consequences of maintaining the existing configurations.

The Council on Environmental Quality's NEPA implementing regulations limitpermit some interim actions during preparation of a programmatic EIS. Major interim actions, however, can only be undertaken if they are justified independent of the programmatic EIS, if they will not prejudice the programmatic EIS, and if they are accompanied by adequate environmental impact statements (40 C.F.R. 1506.1(c)). The proposed action meets all of these requirements. The programmatic EISs taken together will address operations beyond the near term (within 5 to 10 years) of the entire nuclear weapons complex. When the programmatic EISs are completed, DOE and UC will examine the need for additional NEPA/CEQA documentation to reconcile any changes not already evaluated in this EIS/EIR.

This EIS/EIR addresses only those LLNL and SNL, Livermore operations within California. LLNL manages operations at several locations: the LLNL Livermore site, LLNL Site 300, facilities located at DOE's Nevada Test Site (NTS), and several offsite leased properties. These offsite leased properties are generally not separately addressed in the EIS/EIR because they provide support services (e.g., administration) similar to those found in facilities onsite. LLNL-related operations contribute few, if any, environmental effects at these sites. LLNL activities at NTS are not discussed for NEPA purposes because they are covered within other NEPA documentation. They are not discussed for CEQA purposes because they have no significant environmental effects in California. SNL, Livermore operates only the Livermore site in California. This EIS/EIR discusses LLNL and SNL, Livermore separately where appropriate. The distinction between sites results from differences in materials handled, operations, facility sizes, potential for environmental impact, and the need to separate LLNL operations for CEQA coverage.

The Draft EIS/EIR was published for public information and review and distributed by UC on March 11, 1992, (starting the 90-day comment period) and issued by DOE on April 3, 1992. Both DOE and UC comment periods ended June 11, 1992. By the end of the comment period, more than 700 comments on the Draft EIS/EIR had been received from nearly 200 individuals, groups, and agencies. These comments were received both at a public hearing on April 30, 1992 and in correspondence. These comments are reproduced in their entirety in Volume IV with additional supporting exhibits provided separately in Volume V. Responses to the commentor's questions are provided in Volume IV, with changes made to the body of the document as indicated in the responses. These changes, along with comments from internal reviews, have been incorporated into the Final EIS/EIR.

SECTION 1 PURPOSE AND NEED FOR THE PROPOSED ACTION

1.1 PURPOSE AND NEED FOR THE PROPOSED ACTION

Pursuant to the Atomic Energy Act of 1954, as amended, the U.S. Department of Energy (DOE) is responsible for nuclear weapons research and design, as well as other energy research and development. DOE's Lawrence Livermore National Laboratory (LLNL) and Sandia National Laboratories (SNL), Livermore undertake research and development missions established by the Congress and the President. To implement these research and development missions, continued and increased LLNL and SNL, Livermore operations are necessary.

The LLNL mission is to serve as a national resource of scientific, technical, and engineering capability with a special focus on national security. This mission includes research and development, strategic defense, arms control and treaty verification technology, energy, the environment, biomedicine, the economy, and education.

Although the primary mission of SNL, Livermore is national security, with principal emphasis on development and engineering of non-nuclear systems and components associated with nuclear weapons, SNL, Livermore has evolved into a multiprogram laboratory undertaking a wide variety of research and development activities. These activities range from national security issues to support of the national energy program.

DOE recognizes that in recent years there has been a significant change in the world's political environment. In scoping this EIS/EIR, DOE considered whether or not to include in the proposed action or the alternatives, a change to the basic mission of the Laboratories as currently established by Congress and the President. Indeed, in late 1991, the Secretary of Energy chartered an Advisory Board Task Force to begin to examine the future activities of the national laboratories, including LLNL and SNL, Livermore. Comprised of non-DOE personnel with extensive knowledge of energy and defense issues, the Task Force recommended that in addition to the Laboratories' continued activities in energy and defense, capacities in science and technology also be brought to bear on the environmental cleanup of DOE facilities. While the Secretary can encourage the evolution of the agency toward a new set of missions—in part developed by independent task forces and other citizen recommendations—any change to DOE's missions must come from the President and Congress.

The goals of an agency, as defined by its enabling legislation, determine the universe of the proposed action and the reasonable alternatives. Although, as described below, DOE has initiated an effort to determine in the long term how the National Laboratories capabilities can best be employed to serve the Nation's research needs, that effort has not yet reached the point of formulating any specific proposals for consideration by Congress and the President. Furthermore, currently there are no specific proposals by Congress or the President for any changes in DOE's missions. Thus, at the present time, the alternative of excluding all nuclear weapons research and design activities and replacing them with other non-nuclear weapons activities, as suggested by many commentors, is too speculative to be meaningfully evaluated. The scope of this EIS/EIR, therefore, must necessarily be tied to the evaluations of alternative ways of achieving DOE's currently mandated missions including its nuclear weapons mission.

Nevertheless, DOE is considering what activities necessary to support DOE's nuclear weapons mission should be carried out at LLNL and SNL, Livermore. The Secretary of Energy has proposed to reconfigure the nuclear weapons complex to be smaller, less diverse, and more economical to operate. As part of this proposal DOE is examining whether certain weapons research, development, and testing activities now taking place at the National Laboratories should be consolidated. DOE is preparing a programmatic EIS on its reconfiguration proposal. The Reconfiguration PEIS will address the long-term mission of LLNL and SNL, Livermore; in contrast, this EIS/EIR addresses the near-term continued operation of LLNL and SNL, Livermore. The focus of possible new long-term missions cannot be addressed until after completion of the Reconfiguration PEIS. Therefore, identification and description of new missions for LLNL and SNL, Livermore and analysis of associated environmental effects would be highly speculative and beyond the scope of this EIS/EIR. However, this document is expected to facilitate the environmental assessment of future changes in missions or activities. Such changes would be reviewed against this EIS/EIR and further NEPA and/or CEQA review efforts undertaken if appropriate. This could include the preparation of a supplemental EIS/EIR.

1.2 NEED FOR THE EIS UNDER NEPA

The National Environmental Policy Act (NEPA) establishes environmental policy, sets goals, and provides means for implementing the policy. NEPA contains provisions to ensure that federal agencies adhere to the letter and spirit of the act. The key provision requires preparation of an Environmental Impact Statement (EIS) on "major Federal actions significantly affecting the quality of the human environment" (40 C.F.R. part 1502.3). NEPA ensures that environmental information is available to public officials and citizens before decisions are made and actions are taken (40 C.F.R. part 1500.1(b)).

In 1982, DOE prepared an EIS for the LLNL and SNL, Livermore sites (DOE, 1982). That document provided environmental information for DOE's decision to "operate the Livermore sites at the present level of effort which is consistent with national security and defense policy" (47 Fed. Reg. 44,836). The Record of Decision based on the 1982 EIS concluded that work at the two Laboratories was essential to the national need for research and development in the nuclear weapons program and other basic energy research. DOE made the commitment to operate the facilities to reduce further environmental, health, and safety impacts, to the extent practical.

The DOE Tiger Teams that reviewed LLNL and SNL, Livermore in February 1990 and in May 1990, respectively, recommended that the 1982 sitewide EIS be updated (DOE, 1990b; DOE, 1990c). Accordingly, the Secretary of Energy authorized the preparation of this new EIS.

DOE is the responsible agency for preparing NEPA sections of this document, and as such is lead federal agency for this EIS/EIR project. The Secretary of Energy must decide whether to select the proposed action as described and analyzed in this EIS/EIR, or select an alternative action. The DOE NEPA Implementing Procedures (59 FR 15122, April 24, 1992, to be codified at 10 CFR Part 1021) require DOE to prepare a Mitigation Action Plan for any commitments in its Record of Decision to mitigate adverse environmental impacts associated with the selected action (section 1021.331).

1.3 NEED FOR THE EIR UNDER CEQA

In 1970, California enacted the California Environmental Quality Act (CEQA), Public Resources Code sections 21000–21177, to preserve and enhance the state's environment. CEQA requires preparation of an Environmental Impact Report (EIR) to provide information enabling public agencies to consider environmental effects of projects. The Office of Planning and Research has prepared guidelines for implementing CEQA, 14 C.C.R. sections 15000–15387. Pursuant to these guidelines, this document is being prepared as a programmatic EIR.

In 1987, the University of California (UC) prepared an EIR to evaluate potential environmental impacts of the contract renewed with DOE to operate and manage LLNL (UC, 1987). The Notice of Determination published September 18, 1987, stated: "It has been determined that this project as mitigated will not have significant effect on the environment. Mitigation measures incorporated into the project include educating and training LLNL employees on environmental issues; evaluating new facilities and operations during planning stages; monitoring soil, air, water, wastewater, and vegetation in the community to verify compliance with permit limitations and to assure that there has not been any environmental degradation; minimizing waste streams; processing, decontaminating, storing, packing, treating and transporting all hazardous waste; and supporting cleanup of hazardous waste spills at the Livermore site and Site 300." This decision was challenged by the Southern California Federation of Scientists, et al., and the litigation was settled in February 1990.

The University of California is the CEQA lead agency for the project. The Regents of the University of California must decide whether to renew the contract with DOE for operation and management of LLNL, and to approve the proposed action as described in this EIS/EIR. The current contract expires September 30, 1992. As CEQA lead agency, the Regents of the University of California must adopt findings after certifying the Final EIR and before approving the renewal of its contract with DOE. These findings must describe significant adverse effects; state whether mitigation is feasible and, if so, describe feasible measures or explain why mitigation is infeasible; and identify alternatives and explain why environmentally advantageous alternatives, if any, are infeasible. Additionally, a mitigation monitoring program must accompany the findings.

1.4 USE OF AN INTEGRATED EIS/EIR DOCUMENT AND PROCESS

Both NEPA and CEQA encourage preparation of joint environmental documents where appropriate. DOE and UC are issuing this joint EIS/EIR to avoid duplication of effort and to coordinate impact assessments; however, the EIS/EIR will support two separate and different decisions. DOE's decision under NEPA involves evaluation of EIS/EIR information regarding both LLNL and SNL, Livermore, while UC's decision under CEQA will focus exclusively on EIS/EIR information regarding LLNL. The EIS/EIR includes separate sections required by CEQA and by NEPA; these sections are individually identified where they occur.

In accordance with CEQA and the UC CEQA Handbook, four descriptive categories are used in this document to discuss and analyze environmental impacts: less than significant, significant, significant and unavoidable, and beneficial. These categories have been created and assigned to individual impacts only for the purposes of compliance with CEQA requirements, and thus are used here only in a CEQA context. Under NEPA, the significance of environmental impacts determines the need for the NEPA document. Once that decision has been made, specific impacts are not categorized according to level of impact in an EIS.

DOE and UC have conducted an extensive program to promote public and intergovernmental involvement in this EIS/EIR. Appendix L describes the public information and intergovernmental affairs activities in support of this EIS/EIR.

1.5 FUTURE ENVIRONMENTAL DOCUMENTATION

The impacts addressed in this EIS/EIR bound research and development activities and support functions within the envelope of the proposed action (see Section 3). For actions or impacts beyond the scope of this document, further environmental documentation will be prepared. In appropriate cases, however, future environmental documents will be tiered to this EIS/EIR.

1.6 EIS/EIR SCOPING PROCESS

On October 5, 1990, DOE published a Notice of Intent (NOI) in the Federal Register (55 Fed. Reg. 41048) to prepare a joint EIS/EIR. Subsequently, on October 8, 1990, UC filed a Notice of Preparation (NOP) with the California Office of Planning and Research to prepare a joint EIS/EIR. Both the NOI and the NOP were sent to the California State Clearinghouse for distribution to agencies within the state.

Consistent with NEPA (42 U.S.C. 4321 et seq.) CEQ regulations (40 C.F.R. parts 1500–1508), and CEQA guidelines (14 C.C.R. Section 15083), DOE and UC conducted an early and open process to identify and determine the scope of issues to be addressed in the EIS/EIR. Both the NOI and NOP invited interested parties to attend a public scoping meeting on November 15, 1990, in Livermore, California, and to submit written comments until the close of the comment period then set for November 30, 1990. Subsequently, in response to a request from the public, DOE and UC extended the deadline for submission of written comments to December 15, 1990.

During the EIS/EIR scoping process, DOE and UC received a total of 282 comments from 61 members of the public; interested groups; and federal, state, and local officials. Eleven of the 282 comments received were statements either supporting or opposing the operation of LLNL and SNL, Livermore. The substance and disposition of the comments are discussed in the EIS/EIR Implementation Plan (DOE and UC, 1991). Table 1-1 provides a summary of the issues raised through the EIS/EIR scoping process.

1.7 COMMENTS ON THE DRAFT EIS/EIR AND RESPONSES TO COMMENTS

There were 704 comments on the Draft EIS/EIR received from 200 individuals, groups, and agencies. The comments were received both from speakers at a public hearing on April 30, 1992, and as correspondence received during a 90-day comment period that lasted until June 11, 1992. A list of the issues raised through this EIS/EIR public comment process is presented in Table 1-2. These comments are reproduced in their entirety in Volume IV with additional supporting exhibits provided separately in Volume V. Answers to the commentors questions are provided in Volume IV with changes made to the body of the document as indicated in the responses. These changes, along with comments from internal reviews, have been incorporated into this Final EIS/EIR.

1.8 RELATIONSHIP OF SITEWIDE EIS/EIR AND THE COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT (CERCLA)

Both the LLNL Livermore site and LLNL Site 300 are on the EPA Superfund National Priorities List. Environmental restoration activities at the LLNL Livermore site are being conducted pursuant to a CERCLA Federal Facilities Agreement made by EPA, DOE, the Department of Health Services (now the Department of Toxic Substances Control) and the San Francisco Bay Area Regional Water Quality Control Board. Environmental restoration activities at LLNL Site 300 are being conducted pursuant to an Interim Agreement made by EPA, DOE, and UC, signed in October 1991. In addition, a CERCLA Federal Facility Agreement for LLNL Site 300 has been negotiated and was signed in June 1992.

Remedial investigations are complete at the LLNL Livermore site and are continuing at LLNL Site 300; therefore, this EIS/EIR includes information on the environmental restoration activities at both sites. An environmental assessment has already been prepared for the LLNL Livermore site as part of the remedial investigation/feasibility study (RI/FS) process (Isherwood et al., 1990). DOE is currently reviewing this process. It is expected that appropriate environmental documentation will be prepared for LLNL Site 300 as part of the Site 300 RI/FS process. Future environmental restoration activities at both sites up to the time a decision is made on the cleanup activities (the CERCLA Record of Decision), not covered by other specific NEPA documentation, are covered by this EIS/EIR. Environmental restoration activities are intended to incorporate NEPA values into the CERCLA process under DOE Orders. DOE Order 5400.4 states that it is DOE policy to integrate the procedural and documentation requirements of CERCLA and NEPA wherever practical. Nothing in this documentation is intended to represent a statement on the legal applicability of NEPA to remedial actions under CERCLA.

Table 1-1 Issues Raised Through the EIS/EIR Scoping Process

Issues	Number of Comments
Topical or Issue-Oriented Comments	
Air quality issues	6
Alternative actions	17

Community and institutional issues	8
Comprehensive Test Ban Treaty and nuclear weapons	12
Cost and benefits of the project	10
Emergency preparedness issues	4
Environmental releases and monitoring	23
Fish and wildlife issues	8
Health and safety issues	13
Land use issues	7
Mitigation measures	7
Need for the project	6
Nevada Test Site issues	7
Noise issues	1
Perceived psychological and social issues	8
Power line and low frequency radiation	1
Prehistoric and historic sites	1
Procedural issues	14
Project description	9
Regulatory compliance and oversight	14
Remediation, decontamination, and decommissioning	13
Risk assessment and accident analysis	12
Seismology issues	2
Sewage issues	8
Threatened and endangered species	5
Traffic and transportation issues	10
Waste management	40
Water resources	5
Statements in Opposition or Support	11
Total:	282

Table 1-2 Issues Raised Through the Draft EIS/EIR Public Comment Process

Issues	Number of Comments
Policy issues	255
Materials and waste management	116
Site contamination and remediation	58

Releases/public health hazards	42
Accident scenario analysis	39
Out of scope comments	25
U-AVLIS	16
Traffic and transportation	17
Air quality	16
Occupational protection	13
Ground water	13
Geology	12
Comments in general support or opposition	10
Mitigation measures	9
EIS/EIR alternatives	8
Environmental compliance	8
Socioeconomic characteristics	6
Miscellaneous	41
Total:	704

SECTION 1 REFERENCES

DOE, 1982, *Final Environmental Impact Statement, Lawrence Livermore National Laboratory and Sandia National Laboratories—Livermore Sites, Livermore, California*, DOE/EIS-0028, U.S. Department of Energy, Washington, DC, July 1982.

DOE, 1990a, National Environmental Policy Act, Secretary of Energy Notice, SEN-15-90, Washington, D.C, February 5, 1990.

DOE, 1990b, *Tiger Team Assessment of the Lawrence Livermore National Laboratory*, DOE/EH-0142, Washington, DC., April 1990.

DOE, 1990c, *Tiger Team Assessment of the Sandia National Laboratories, Livermore, California*, Washington, DC., August 1990.

DOE, 1991, National Environmental Policy Act Compliance Program, Order 5440.1D, U.S. Department of Energy, Washington, D.C., February 22, 1991.

DOE and UC, 1991, *Implementation Plan for the Environmental Impact Statement and Environmental Impact Report for Continued Operations of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore*, DOE/SF-500, U.S. Department of Energy and University of California, September 1991.

Isherwood, W. F., C. H. Hall, and M. D. Dresen, 1990, *CERCLA Feasibility Study for the LLNL Livermore Site*, UCRL-AR-104040, Lawrence Livermore National Laboratory, Livermore, CA, December 1990.

UC, 1987, *Final Environmental Impact Report for the University of California Contract with the Department of Energy for Operation and Management of Lawrence Livermore National Laboratory*, SCH-85112611, University of California, Berkeley, CA.

SECTION 2 - OVERVIEW

This section presents a general overview of LLNL and SNL, Livermore, including descriptions of the location, history, and existing programs and operations of the facilities. More specific information is found in Section 4 and Appendix A.

2.1 AN OVERVIEW OF LLNL

2.1.1 Location of LLNL

Most LLNL operations are located at the Livermore site near Livermore, California. LLNL also operates Site 300 near Tracy, California, and conducts limited activities at several leased properties near the Livermore site. LLNL also has leased offices in Los Angeles, California, and Germantown, Maryland.

LLNL Livermore Site

The LLNL Livermore site, occupying a total area of approximately 1.3 sq miles (821 acres), is located about 40 miles east of San Francisco at the southeast end of the Livermore Valley in southern Alameda County, California. The City of Livermore's central business district is located about 3 miles to the west. Figure 2-1 and Figure 2-2 show the regional location of the LLNL Livermore site and its location with respect to the City of Livermore.

The various leased properties near the LLNL Livermore site, shown on Figure 2-2, include a storage area and office space at the Camp Parks facility in Dublin; a hangar at the Livermore Municipal Airport for an airplane that travels to and from DOE's Nevada Test Site, located north of Las Vegas, Nevada; a combination office, childcare, and classroom facility at Almond Avenue Site in Livermore; a storage warehouse with a service shop for the assembly of laser components at Graham Court in the City of Livermore; and a combination office and training center at 2020 Research Drive in Livermore. These properties are considered part of the LLNL Livermore site for purposes of discussion in this document.

Again, these offsite leased properties are generally not separately addressed in the EIS/EIR because they provide support services (e.g., administration) similar to those found in facilities onsite. Although LLNL conducts some operations at the Nevada Test Site, these operations are covered in separate NEPA documentation for that site and are not addressed in this EIS/EIR. LLNL activities at NTS are not discussed for CEQA purposes because they have no significant environmental effects in California (ERDA, 1977).

LLNL Site 300

LLNL Site 300, located about 15 miles southeast of Livermore in the sparsely populated hills of the Diablo Range, is primarily a non-nuclear high explosives test facility. The site covers approximately 11 sq miles (7000 acres), with about one-sixth of the site in Alameda County, and the remainder in San Joaquin County as shown in Figure 2-2.

2.1.2 History of LLNL

LLNL Livermore Site

Before World War II, when the LLNL Livermore site was part of the Wagoner Ranch, cattle grazing was the dominant land use. The Navy purchased the site in 1942, establishing the Livermore Naval Air Station as a flight-training base and engine overhaul facility. Runways were constructed diagonally across the site together with a rectangular grid street system along the southern portion of the site (UC, 1987). Facilities such as barracks and maintenance areas were constructed in this southern portion.

The transition from Navy operations to a research facility began in 1950 when the California Research and Development Corporation (a subsidiary of Standard Oil, Inc.), authorized by the Atomic Energy Commission (AEC), began construction of the Materials Test Accelerator facility on the Livermore site. In 1951, the University of California Radiation Laboratory in Berkeley, California, operated for the AEC by UC, began using some of the old Navy facilities in support of AEC-sponsored nuclear weapons research conducted by the Los Alamos Scientific Laboratory (now the Los Alamos National Laboratory) in New Mexico, also managed by UC.

In 1952, the AEC established the University of California Radiation Laboratory, Livermore site, LLNL's predecessor, as a second laboratory dedicated to nuclear weapons research. Since then, UC has managed and operated the Lawrence Livermore National Laboratory for the Department of Energy (DOE) and its predecessor agencies, the Atomic Energy Commission from 1952 to 1975 and the Energy Research and Development Agency from 1975 until 1977 (DOE, 1982).

LLNL Site 300

To support the activities at the LLNL Livermore site, the AEC needed a high explosives test site, and to provide a public safety buffer zone, the site had to be located in a remote area. Yet, for program reasons, the site had to be relatively close to the LLNL Livermore site. In 1953, the AEC purchased the first 4000 acres of LLNL Site 300 and began high explosives testing in support of LLNL's mission in 1955. In 1957, 3000 acres were added to the site. In 1973, however, 100 excess acres were transferred to the California Department of Fish and Game for wildlife habitat. In 1991, 14 acres were added to the site.

2.1.3 LLNL Programs

LLNL's mission is to serve as a national resource of scientific, technical, and engineering capability with a special focus on national security. Over the years, this mission has evolved to include a wide variety of activities, such as (LLNL, 1991c):

- Research, development, and test activities associated with all phases of the nuclear weapons life cycle and related tasks;
- Strategic defense research emphasizing kinetic- and directed-energy weapons;
- Non-proliferation, arms control, treaty verification technology, and international security;
- Inertial confinement fusion for weapons physics research and for civilian energy applications;
- Atomic vapor laser isotope separation for defense and commercial applications;
- Magnetic fusion, including leadership of the United States effort on the International Thermonuclear Experimental Reactor;
- Other energy research in basic energy sciences, atmospheric sciences, fossil energy, and commercial nuclear waste;
- Biological, ecological, atmospheric, and geophysical sciences relevant to weapons, energy, health, and environmental issues, including assessment and guidance in the event of accidents and other emergencies;
- Charged-particle beam and free-electron laser research for defense and energy applications;
- Advanced laser and optical technology for military and civilian applications;
- Support of the Intelligence Community, the U.S. Department of Defense (DOD), the Nuclear Regulatory Commission (NRC), and other federal agencies;
- Technology transfer through patent and licensing of laboratory-developed technology, collaborative research with United States industry, and industry participation and partnership in LLNL programs;

- Science education through pre-college, university, and postgraduate programs; and
- Participation in the nationally directed initiative to understand the human genome at the molecular level, particularly gene ordering in the chromosomes, and molecular genetic toxicology and reproductive effects.

Current major programs are: Defense and Related Programs, Laser Fusion (also called Inertial Confinement Fusion), Laser Isotope Separation, Magnetic Fusion Energy, Biomedical and Environmental Research, Energy and Resources, and Environmental Restoration and Waste Management. These programs, which are discussed below, fulfill their missions through arrangements with scientific and institutional support organizations, scientific and technical personnel throughout the federal government, other national laboratories, and universities and industry throughout the world. Programs are conducted with a commitment to preserving the environment; ensuring employee and community health; and complying with applicable environmental, safety, and health regulations. In general, Laboratory facilities are grouped by program as illustrated in Figure 2-3.

Defense and Related Programs

The Defense Program's mission is to ensure that the nuclear weapons in the nation's stockpile are safe, secure, reliable, and effective. The program develops and maintains the capabilities and technologies required to offer a range of options for future weapons systems, provides insight into possible developments in the field of nuclear weapons, and provides technical support for national objectives in verification and arms control. The major LLNL program elements are (LLNL, 1991c):

Nuclear Design

This subprogram carries out theoretical and experimental research in the physics of fission and thermonuclear explosives. It is responsible for exploring new concepts for advanced development of nuclear explosives and for maintaining a basic understanding of weapons phenomena.

Nuclear Test—Experimental Science

This subprogram is responsible for conducting experimental underground detonations of nuclear weapons designs at the Nevada Test Site in a safe manner. It also performs physics experiments and measurements, including radiochemical measurements in support of these experiments.

Military Applications

This subprogram is responsible for the advanced development of weapons systems, including physics and engineering, as well as surveillance in production, stockpile, and retirement. It is also responsible for the Advanced Conventional Weapons Program, and for analysis related to both nuclear and conventional weapons systems.

Strategic Defense Initiative

The mission of this project is to conduct research for the technological advancement of a strategic defense system known as Brilliant Pebbles. This defense concept would ultimately place small spacecraft into a low earth orbit; these spacecraft would be capable of detecting and destroying ballistic missiles through high velocity collisions.

Non-Proliferation, Arms Control, and International Security

The Non-Proliferation, Arms Control, and International Security (NAI) directorate's primary mission is to manage LLNL interaction with DOE and other U.S. government agencies concerning matters of international issues including support for the foreign policy and foreign intelligence communities. Using LLNL's knowledge and capabilities in nuclear and non-nuclear technologies, NAI advises the government on interpretation of foreign weapons developments and on issues involved in the negotiation of arms control treaties. A major effort is devoted to developing an improved understanding of, and means of preventing, foreign nuclear weapons proliferation. This directorate also conducts the Laboratory's Treaty Verification projects, providing technical advice and assistance to arms control policy makers, and conducts studies on weapons systems and their effects.

The NAI also manages the LLNL Emergency Preparedness and Response Program, maintaining preparedness for onsite emergencies and providing technical support to federal agencies in responding to nuclear-related offsite emergencies.

Laser Fusion (Inertial Confinement Fusion)

In Laser Fusion, an array of high-power lasers focus on a tiny sphere containing a mixture of deuterium and tritium gases. The goal is to compress the gases to a high enough temperature for a long enough time period for the deuterium and tritium nuclei to fuse and release significantly more energy than is contained in the high-powered lasers.

The near-term mission of the Laser Fusion program is to provide a laboratory capability to study problems important to thermonuclear weapons design and performance. The long-term goal is to develop Inertial Confinement Fusion reactors for commercial power, space propulsion, and other military and civilian applications (LLNL, 1991c).

The areas investigated include details of thermonuclear burn; the radiation, thermodynamic, and hydrodynamic properties of materials at high temperatures and densities; the physics principles of advanced nuclear weapon concepts; the physics of nuclear effects; and the vulnerability of mechanical and electrical systems to those nuclear effects (LLNL, 1991c).

The mission of the Advanced Laser Applications program element is to exploit the investment made by DOE (and other agencies) and to apply the information gained from research to advanced technology development in solid-state lasers and electro-optics, charged-particle beams and accelerators, and image and signal processing.

Laser Isotope Separation

The goal of the Atomic Vapor Laser Isotope Separation (AVLIS) program is to develop and demonstrate a process for the separation of isotopes of various materials (LLNL, 1991b). In this process, a material consisting of a mixture of isotopes is heated and vaporized. Laser light directed on the vapor selectively ionizes isotopes of interest, which are then collected on electrically charged plates.

Another goal of the Atomic Vapor Laser Isotope Separation program is to develop potential applications for the defense and commercial sectors. DOE is studying additional applications for AVLIS technologies in the general areas of isotope separation, beam separators, lasers, and electro-optics with the key objective of commercializing these technologies to support U.S. industrial competitiveness.

The DOE Uranium-Atomic Vapor Laser Isotope Separation (U-AVLIS) program is designed for research, development, and demonstration of an advanced technology to enrich uranium for nuclear reactor fuel. The U-AVLIS Program is at an advanced stage of technology development with sufficient development of laser, separator, and uranium processing technologies to support demonstration of the technology with plant-scale systems and hardware.

The major objectives of the plant-scale technology demonstration are to validate the technology and engineering feasibility and to determine the validity of projected plant-scale economics. The plant-scale demonstration system referred to as the Uranium Demonstration System (UDS) is composed of four major subsystems: (1) separators, (2) lasers, (3) feed preparation, and (4) product processing. These subsystems currently exist at two DOE sites: the laser and separator subsystems are located at LLNL and the uranium feed and product processing subsystems are located at the Oak Ridge Gaseous Diffusion Plant (ORGDP) site near Oak Ridge, Tennessee.

Demonstration of uranium enrichment was conducted in 1991 and is in process in the 490 Building Complex at LLNL. Lower-level research and development (R & D) activities are expected to continue after the demonstration in support of uranium enrichment technology development and deployment. An environmental assessment (EA) for the demonstration of U-AVLIS at LLNL and a Finding of No Significant Impact, completed in May 1991, discussed the potential impacts to onsite and offsite environments predicted during the conduct of the Uranium Demonstration System at LLNL (LLNL, 1991b).

The collective goal of the U-AVLIS Program is to develop and demonstrate an integrated technology for low-cost enrichment of uranium for commercial nuclear reactor fuel. Information and data from demonstrations at both LLNL and Oak Ridge will be used in concert with an Environmental Impact Statement (EIS), economic assessments, and other information to support a decision by the U.S. government on whether or not to deploy a U-AVLIS production plant (DOE, 1990).

Magnetic Fusion Energy

The Magnetic Fusion Energy Program assists in the development and understanding of magnetic fusion technology, which is part of the international effort to harness the potential of thermonuclear fusion for use as commercial energy production (LLNL, 1991c). In magnetic fusion, a cloud (plasma) of ions and electrons confined by magnetic fields is heated by electromagnetic induction. If a plasma of deuterium and tritium can be kept at a sufficiently high temperature for a long enough period, their nuclei will fuse and yield energy.

The primary thrust of fusion development is to demonstrate the successful confinement of a burning thermonuclear plasma under conditions expected in a power-producing fusion reactor. The technical approach to achieving this goal is through development of the Tokamak concept (in which an axial magnetic field is superimposed on a toroidal [doughnut-shaped] magnetic field) (LLNL, 1991c).

DOE has also given LLNL the lead role in directing the United States effort in support of the International Thermonuclear Energy Reactor (LLNL, 1991c).

Biomedical and Environmental Research

The mission of the Biomedical and Environmental Research Program is to understand the potential health and environmental consequences of the development and use of various energy sources. In particular, LLNL is finding ways to identify and measure genetic damage as an indicator of human health effects. LLNL is also examining local and global-scale environmental changes involving the atmosphere, and studying a variety of ecological effects resulting from energy production and use (LLNL, 1991c).

The area of greatest growth in current biological research is the human genome initiative, an international effort to map the human genetic code. LLNL has been designated as one of three DOE Human Genome Research Centers and is participating in the international effort to construct a physical map of the DNA in the 23 pairs of human chromosomes. Such a map is expected to help identify and isolate genes involved in a multitude of human diseases with the goal of understanding the causes and finding treatments.

Environmental research comprises fundamental research in the development of long-term payoff energy technologies and technologies for the remediation of waste-contaminated soil and ground water. Closely related to this is risk analysis and management; predicting the transport, diffusion, deposition, transformation, and atmospheric effects of pollutants; and modeling atmospheric processes.

Energy and Resources

LLNL carries out major research in reactor safety, basic energy sciences, fossil energy, and conservation and renewable energy. As part of this research, LLNL is assisting DOE in meeting safety requirements for certain small reactors that are much smaller than production or commercial reactors and may thus use different procedures to ensure safe operation (LLNL, 1991c).

LLNL research in basic energy sciences includes projects in materials sciences, chemical sciences, and geosciences. The materials sciences projects are directed toward fundamental understanding of important materials and processes. Chemical sciences projects model the chemical kinetics of combustion in laboratory and applied environments, with emphasis on hydrocarbon fuels. LLNL geosciences projects are concerned with the source mechanisms of earthquakes in the western United States, the physical and mechanical properties of rocks, a predictive chemical model for petroleum generation, and investigation of volcanic systems.

LLNL fossil energy research focuses on producing liquid fuels from nonpetroleum sources such as shale, gas, and coal.

The Laboratory's geothermal project supports DOE in the development and demonstration of geophysical techniques to monitor subsurface processes in geothermal fields, the development of seismic imaging methods for use in volcanic terrains, and the development of technologies needed for measurements in geothermal fields.

LLNL also has the responsibility for designing an engineered barrier system for the candidate waste repository at Yucca Mountain, Nevada. LLNL activities include development of design concepts for the system, characterization of candidate container materials, analysis of the near-field underground environment of the potential repository, and development of models to predict the behavior of emplaced nuclear waste.

Environmental Restoration and Waste Management

The Environmental Restoration and Waste Management Program's mission is twofold: to clean up contaminated soils and ground water; and to properly transport, treat, store, and dispose of wastes generated by LLNL operations (LLNL, 1991c).

Scientific and Institutional Support

An Environmental Technology Program was organized in late FY 1989 to develop, demonstrate, test, and evaluate technologies for reducing the costs and increasing the effectiveness of environmental restoration and waste management efforts. The program at LLNL emphasized characterization of contamination and hazardous wastes, development and demonstration of innovative clean-up technologies, waste treatment and waste minimization, process improvements, robotics, and educational programs. The work will include laboratory experiments, temporary pilot facilities, and field tests and demonstrations.

Scientific support organizations such as Physics, Engineering, Computation, and Chemistry and Materials Science provide assistance to various LLNL programs, while institutional support organizations provide the services needed to operate LLNL. These services include plant maintenance and construction, and technical information services. Institutional support organizations also provide security, administer occupational safety, protect employee health, and minimize the impact of LLNL operations on the environment and the public (LLNL, 1991c). (See Appendix A for additional details on scientific and institutional support organizations.)

2.1.4 LLNL Operations, Personnel, and Facilities

This section describes the operations, personnel, and facilities associated with current LLNL activities.

Operations

LLNL is a research laboratory with the infrastructure necessary to support its operations and personnel. Like a small town, LLNL has many of its own services such as police, fire, and medical departments. Cafeteria, banking, and limited shopping services are also available onsite. Electrical, sewerage, engineering, maintenance, and waste management activities support operations. Research is conducted using a variety of settings, from use of computers, to small bench lab experiments, to major facilities dedicated to experiments. To fulfill its mission LLNL uses state-of-the-art equipment and materials. (Additional operations and materials used onsite are described in Section 4 and in Appendix A.)

Personnel

As of September 1991, approximately 9300 UC employees and 2100 non–UC personnel, including DOE personnel and contractors, were located at LLNL. Of these, approximately 11,200 are located at the LLNL Livermore site and 200 at LLNL Site 300. Of the total UC employees, approximately 23 percent are scientists, 15 percent are engineers, 11 percent are management and administration, 29 percent are technicians, and 22 percent are other support staff, such as security, fire, and maintenance. Currently, 61 percent of these UC employees live within the neighboring cities of Livermore, Pleasanton, Tracy, and Manteca (LLNL, 1991a). The remaining 39 percent are distributed throughout the

Bay Area and the Central Valley.

Existing LLNL Livermore Site Facilities

Operations at the LLNL Livermore site occupy 5.9 (adjusted for FY 1992) million gross sq ft of facilities, which includes existing space and areas under construction (LLNL, 1991c). This space is distributed among approximately 600 buildings, of which 350 are temporary structures. (See Appendix A for a more detailed description of LLNL facilities.)

LLNL Livermore site space is categorized into four use types: office/drafting, light laboratories/shops, heavy laboratories, and miscellaneous, including a fire station, a medical facility, and cafeterias.

Office/Drafting Areas

Offices house about 75 percent of the staff and are the most densely populated areas. LLNL Livermore site office space generally contains desks, chairs, file cabinets, computers and tables. Drafting areas generally are larger, containing drafting tables and chairs, and computer support equipment. Office and drafting areas constitute approximately 35 percent of the LLNL Livermore site total assignable space (i.e., usable work space excluding restrooms, hallways, elevators, etc.).

Light Laboratories/Shops

The light laboratories/shops, typified by smaller equipment and apparatus, house most of the remaining staff at the LLNL Livermore site. Light laboratories exist in many buildings throughout the laboratory and are generally characterized as wet or dry. Wet laboratories support a wide variety of chemical analyses, while dry laboratories support activities such as laser optics research. Most light laboratories conduct direct research, while shops may be devoted to supporting research or the Laboratory overall. LLNL shops are similar to those found at many large self-contained facilities, and include auto repair, maintenance, instrument repair and calibration, machine, paint, carpentry, and plating shops. Approximately 37 percent of the LLNL Livermore site assignable space consists of light laboratories/shops.

Heavy Laboratories

These facilities usually have high-bay construction, overhead cranes, and, in some cases, shielding. In most cases, heavy-laboratory space is adjacent to light-laboratory space. While scientists, technicians, and support staff work in these areas, usually their office space is elsewhere. An example of this type of building is Building 391 which houses the NOVA laser system. Heavy laboratories make up only approximately 8 percent of the LLNL Livermore site assignable space.

Miscellaneous Uses

Uses not belonging to the previous three groups are in this category. It includes the fire station, medical facility, cafeterias, administrative computer facilities, storage, and office support (conference rooms, auditoriums, classrooms, etc.). Adequate miscellaneous space is as important for effective Laboratory operation as office and laboratory space. This use constitutes approximately 20 percent of the LLNL Livermore site assignable space.

Existing LLNL Site 300 Facilities

LLNL Site 300 consists of approximately 340,000 sq ft of facilities within 63 buildings and 6 temporary structures. LLNL Site 300 is similar to the LLNL Livermore site in the types of facilities supporting the site's high explosives test activities. Generally, the site consists of 2 remote firing areas and 25 magazines to store high explosives, supported by a chemistry processing area and an administrative complex. The facilities at LLNL Site 300 include wet and dry laboratories and office space. In addition to laboratory, shop, and office space, LLNL Site 300 also has a fire station, medical services, cafeteria, storage facilities, and office support facilities.

LLNL Site 300 is primarily a high explosives test facility supporting LLNL Defense Programs in research, development, and non-nuclear testing associated with design and other aspects of nuclear weapons. This work involves processing explosives, including the preparation of new explosives and the pressing, machining, and assembly of components. It also includes hydrodynamic testing for experimental verification of computer codes, obtaining data on material behavior, evaluating the quality and uniformity of implosion, and evaluating performance of post–nuclear-test design modifications (LLNL, 1991c).

In addition, LLNL Site 300 operates a large accelerator in support of the Laser Programs for the development of high gradient accelerators and free electron lasers for civilian and military applications. Other programs based at the LLNL Livermore site including the Environmental Restoration and Waste Management Program have operations at LLNL Site 300. (See Appendix A for a more detailed description of LLNL Site 300 facilities.) Because of the large areas devoted to high explosives testing, LLNL Site 300 is almost entirely a high security area.

2.2 AN OVERVIEW OF SNL, LIVERMORE

2.2.1 Location of SNL, Livermore

Sandia National Laboratories (SNL), Livermore, is located on 413 acres next to and south of the LLNL Livermore site. Figures 2-1 and 2-2 show the regional location of SNL, Livermore and its location with respect to the City of Livermore. Land to the north is occupied by LLNL.

2.2.2 History of SNL, Livermore

In 1949, ordnance engineering was separated from nuclear design activities. Los Alamos Scientific Laboratories (now the Los Alamos National Laboratory) in New Mexico retained the nuclear design responsibility and Sandia Laboratory was established in Albuquerque to take charge of the ordnance engineering activities. Since that time Sandia National Laboratories (SNL), operated for DOE by Sandia Corporation , a wholly owned subsidiary of AT&T, has provided engineering, research, and development for the nuclear weapons program. In 1956, SNL established the Livermore location to provide a closer relationship with LLNL design work (SNL, 1989). The facility evolved into an engineering research and development laboratory by the early 1960s and into a multiprogram engineering-science laboratory during the 1970s. Currently about 60 percent of SNL, Livermore's effort is in support of DOE defense programs; 10 percent is research and development in energy technologies; and 30 percent is for agencies other than DOE, principally DOD.

DOE and AT&T have announced that AT&T will not seek to renew its contract to operate Sandia National Laboratories, which includes SNL, Livermore. The current contract does not end until September 30, 1993, until which time AT&T will continue to operate SNL, Livermore. DOE will select another contractor to manage and operate Sandia National Laboratories, including SNL, Livermore.

2.2.3 SNL, Livermore Programs

SNL, Livermore applies its scientific, technical, and engineering capabilities to meet its primary national security mission with principal emphasis on the development and engineering of non-nuclear systems and components associated with nuclear weapons. This includes generating new weapons designs, developing new weapons systems, and designing and implementing manufacturing and assembly procedures for these new weapons systems. SNL, Livermore has evolved into a multiprogram laboratory undertaking multidisciplinary fundamental and applied research and development activities in the fields of science and technology. In doing so, it interacts closely with scientists and engineers in universities, industry, and other laboratories.

More specifically, in fulfilling its mission, SNL, Livermore performs:

- Engineering research and development for all levels and phases of the nuclear-weapons life cycle;
- Tasks related to national security, including nuclear materials safeguards and security, treaty verification and control, intelligence on foreign technologies and weapons systems, waste management, and programs in support of the DOD;
- Basic and applied research and development for national energy programs:
    - Development and application of laser diagnostic techniques to study fundamental physics and chemistry of combustion that support more applied work including:
        - research in fundamental Otto and diesel engine combustion processes
        - investigation of pulse combustion phenomena
        - experiments in toxic disposal using supercritical oxidation
        - coal combustion studies related to fouling and slagging and characterization
    - Magnetic-confinement fusion energy, mainly on plasma/material interactions; and
    - Fundamental and applied research related to materials and geosciences.

Weapons Programs

These programs conduct research, development, and engineering associated with nuclear weapons. Activities include the evaluation of new weapon concepts, component research and development, and design definition; nuclear safety, command and control, and survivability; testing and weapons effects simulation; nuclear directed-energy weapon concepts; and production support and stockpile surveillance (SNL, 1989).

Other DOE Defense Programs

These programs include the development of verification and control technologies to support arms reduction agreements and to provide intelligence on foreign technologies and weapon systems and concepts and systems for nuclear materials safeguards and security (SNL, 1989).

Energy Research and Development

SNL, Livermore studies conservation and renewable energy sources, basic energy sciences, fossil fuel technologies, magnetic fusion energy, waste management issues. In addition, there is research into the fundamental chemistry and physics of combustion including interactions between combustion products and the atmosphere (SNL, 1989). Energy research programs are conducted with universities through a visiting scientist and postdoctoral fellowship program, and with industry throughout the world.

Scientific and Institutional Support

Scientific, engineering, and technical support organizations assist various programs in the laboratory. They include Physics, Engineering, Computations, and Chemistry and Materials.

Institutional support organizations provide all the services needed to operate a research and development facility, such as plant maintenance and construction and technical information. They also provide security, medical services, employee and occupational safety services, and monitor and assess SNL, Livermore operations to minimize the impacts on the environment and the public.

2.2.4 SNL, Livermore Operations, Personnel, and Facilities

This section describes the operations, personnel, and facilities associated with current SNL, Livermore activities.

Operations

SNL, Livermore is a fully operational research laboratory with the infrastructure necessary to support its operation. Like LLNL, SNL, Livermore could be described as a small town. It has its own police and medical departments. Its emergency fire service is provided by LLNL. There are electrical, sewage, engineering, maintenance, and waste-handling activities to support operations. Research and development activities range from computer modeling to small bench-scale experiments and major facilities dedicated to experiments. Like LLNL, SNL, Livermore uses state-of-the-art equipment and specialized personnel to support its research goals. (Additional operations and materials used onsite are described in Section 4 and Appendix A.)

Personnel

As of 1990, approximately 1100 full-time and part-time employees and 400 contractor employees were employed by SNL, Livermore. Of this total, 10 percent are management, 70 percent are technical staff, and 20 percent are support staff such as administrative, security, fire, and maintenance. Sixty-nine percent of SNL, Livermore employees, including temporary employees, live within the neighboring cities of Livermore, Pleasanton, Tracy, and Manteca (SNL, Livermore, 1991). The remaining 31 percent are distributed throughout the Bay Area and the Central Valley.

2.2.4.1 Existing SNL, Livermore Facilities

Siting of facilities involves consideration of various criteria, including security and infrastructure. Location of facilities by program at SNL, Livermore is illustrated in Figure 2-4. Operations occupy 830,000 gross sq ft of facilities at the SNL, Livermore site. (See Appendix A for a more detailed discussion of SNL, Livermore facilities.)

Laboratory buildings are commonly categorized into four types: office/drafting, light laboratories/shops, test facilities, and miscellaneous.

Office/Drafting Uses

Offices and drafting areas house about 28 percent of the Laboratory's staff and are the most densely populated of the four use types. Office space at SNL, Livermore generally contains desks, chairs, file cabinets, computers, and tables. Drafting areas generally are larger containing drafting tables and chairs, and computer support equipment. Offices and drafting areas constitute approximately 31 percent of SNL, Livermore assignable space.

Light Laboratories/Shops

Constituting approximately 43 percent of SNL, Livermore assignable space, the light laboratories house most of the remaining staff and provide a work space for smaller equipment and apparatus. Light laboratories exist in many buildings throughout the site. A wide variety of functions ranging from traditional chemical analyses to combustion-related research employing state-of-the-art laser diagnostic techniques occurs in light laboratories. Most light laboratories conduct direct research, while shops may be devoted to support research or the Laboratory overall. SNL, Livermore shops include machine, model, maintenance, test assembly, carpentry, and plating shops. These shops make up approximately 5 percent of SNL, Livermore assignable space.

Heavy Laboratories

Heavy laboratories at SNL, Livermore include a test facility capable of testing components containing small quantities (less than a lb) of high explosives, a facility in which the explosive-containing components can be safely detonated, high-pressure test facilities, a large centrifuge, and mechanical shake tables and shock testers. Heavy laboratories make up approximately 3 percent of SNL, Livermore assignable space.

Miscellaneous Uses

Uses not in the three groups mentioned above fall into the miscellaneous category, including computer rooms, storage, medical, library, and office support (conference rooms, auditoriums, classrooms, etc.). Adequate miscellaneous space is as important for effective Laboratory operation as adequate office and laboratory space. This use constitutes approximately 18 percent of the Laboratory's assignable space.

SECTION 2 REFERENCES

DOE, 1982, *Final Environmental Impact Statement, Lawrence Livermore National Laboratory and Sandia National Laboratories—Livermore Sites, Livermore, California*, DOE/EIS-0028, U.S. Department of Energy, Washington, D.C., July 1982.

DOE, 1990, *Uranium Enrichment Enterprise, 1990 Strategy Report*, U.S. Department of Energy, Washington, D.C., March 1990.

ERDA, 1977, *Final Environmental Impact Statement Nevada Test Site*, Nye County, Nevada, Energy Research and Development Administration, ERDA-1551, September 1977.

LLNL, 1991a, *Employee Residence Analysis* (computer printout), Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1991b, *Environmental Assessment for Demonstration of Uranium-Atomic Vapor Laser Isotope Separation (U-AVLIS) at Lawrence Livermore National Laboratory*, Lawrence Livermore National Laboratory, Livermore, CA, May 1991.

LLNL, 1991c, *Institutional Plan FY 1992–1997*, UCAR 10076-10, Lawrence Livermore National Laboratory, Livermore, CA, December 1991.

SNL, 1989, *Institutional Plan, FY 1989–FY 1994*, Sandia National Laboratories, Albuquerque, NM and Livermore, CA.

SNL, Livermore, 1991, *On-Roll Counts by City*, (computer printout), Sandia National Laboratories, Livermore, Livermore, CA.

UC, 1987, *Final Environmental Impact Report for the University of California Contract with the Department of Energy for Operation and Management of Lawrence Livermore National Laboratory*, SCH-85112511, University of California, CA.

SECTION 3 - PROPOSED ACTION AND ALTERNATIVES

This section presents a brief description of the proposed action including LLNL and SNL, Livermore near-term (within 5 to 10 years) proposed projects. Reasonable alternatives to the proposed action (section 3.2), and alternatives considered but eliminated from detailed review (section 3.3) are also presented. Comparison of the impacts of the proposed action and the alternatives are included in Tables 3-10 and 3-11 at the end of this section. Although the alternatives are developed to meet separate NEPA and CEQA requirements, DOE and UC may consider and select any appropriate alternative within the scope of each of their authorities.

3.1 PROPOSED ACTION

The proposed action for the purposes of the EIS is the continued operation of LLNL and SNL, Livermore[(1)] including near-term (within 5 to 10 years) proposed projects. The proposed action, therefore, necessarily includes current operations plus programmatic enhancements[(2)] and facility modifications pursuant to research and development missions established for the Laboratories by Congress and the President.

The proposed action for the EIR is the renewal of the contract between DOE and UC for UC's continued operation and management of LLNL from October 1, 1992, through September 30, 1997.

The nature of a sitewide EIS and a programmatic EIR encourages disclosure of any projects known or planned at the time of preparation. The proposed projects included in the proposed action are listed in subsequent tables in this section. The proposed action includes projects identified and discussed for which very little definite information exists; these are characterized as "tentative" under the Funding Status column of Table 3-1. Appropriate environmental documentation will be prepared for these tentative projects when they can be thoroughly described and analyzed. Other proposed projects would be reviewed for further environmental documentation if they are approved for funding and if this document does not adequately cover their construction and operations.

The proposed action at both LLNL and SNL, Livermore includes such routine activities as infrastructure and building maintenance, minor modification to buildings, general landscaping, road maintenance, and similar support activities.

For purposes of defining this EIS/EIR's proposed action, it is assumed that along with the proposed projects, there would be increases in certain areas that may have the potential to impact the environment. For example, there would be increases in the number of personnel onsite. Also, the information available shows that the amounts of certain radioactive materials may increase slightly under the proposed action, while a decrease in the LLNL Livermore site plutonium and tritium inventories would contribute to a decrease in the total inventory of other radioactive materials. Because accurate chemical usage or waste generation levels cannot be predicted with certainty in a research setting, this EIS/EIR assumes that they would increase over the next 10 years in the same proportion as the gross square footage under the proposed action. The projected increases are discussed in section 4.15 for each site, and may be found in Table 4.15-1 for the LLNL Livermore site, Table 4.15-2 for LLNL Site 300, and Table 4.15-3 for SNL, Livermore. Actual increases in square footage may be lower because some projects would replace existing facilities resulting in no net increase in space.

The list of facilities used for projecting the increased growth in square feet at the Laboratories is based on information available in January, 1992. The facilities listed, regardless of funding status, constitute the total square footage of development planned as part of this proposed action. The names and funding status of the facilities may vary from year to year in response to changing funding levels and programmatic needs. The overall projection of a 9 percent increase in square footage for LLNL and a 6 percent increase for SNL, Livermore is expected to bound the actual increases.

As represented by near-term (within 5 to 10 years) proposed projects, the proposed action has characteristics described below.

Table 3-1 LLNL Livermore Site Program ProjectionsNew Facilities Under the Proposed Action

Project Name	Proposed Gross Sq Ft	Funding Status[a]	Map Loc.[b]	Principal Use		
				Office	Lab and Research	Misc.
Decontamination and Waste Treatment Facility (DWTF)	91,400	Funded (in Redesign)	F3	Yes		Yes
Atmospheric Emergency Response Facility	40,000	Proposed	P1	Yes	Yes	
ICF Users Support Facility	89,500	Proposed	P15	Yes	Yes	
Verification, Intelligence, and Special Technology Analysis (VISTA) Center (formerly Foreign Technology Assessment Center)	46,700	Proposed	P16	Yes	Yes	
Genomics Research Laboratory	41,140	Proposed	P18	Yes	Yes	
Hazards Control Health & Safety Facility	35,000	Proposed	Not available	Yes	Yes	
Waste Minimization Project	7,500	Proposed	Not available		Yes	
Hazards Control Fire Sciences Facility	7,000	Proposed	P4	Yes	Yes	
Atomic Physics Research Lab	45,000	Proposed	Not available	Yes	Yes	
Non-Proliferation Annex (formerly Treaty Verification Center)	20,000	Tentative	P17	Yes	Yes	
Mixed Waste Treatment Facility	20,000	Tentative	P19			Yes
Earth Sciences Building	75,700	Proposed	Not available	Yes	Yes	
Plutonium Facility Increment V	15,000	Proposed	P20	Yes	Yes	Yes

[a] For funding status, proposed indicates planned but not yet funded projects, and tentative indicates that funding is uncertain.
[b]For map locations, see Appendix A, Figure A-8.

3.1.1 LLNL Livermore Site

Proposed new facilities at the LLNL Livermore site would add approximately 530,000 gross sq ft, increasing current developed space by approximately 9 percent as described below. Consistent with existing space use, the new facilities would be mostly light laboratory and office space. Table 3-1 provides general information about these proposed building projects. New facilities will comply with the Secretary of Energy's 10-point initiative to modernize DOE facilities to meet current and future environmental, safety, and health standards (DOE, 1989).

Examples of the largest proposed new facilities include:

- The Decontamination/Waste Treatment Facility (DWTF) would replace and upgrade current LLNL Livermore site waste management facilities used to process, treat, and store hazardous, radioactive, and mixed wastes. The approximately 91,400 sq ft DWTF waste management complex will consist of several buildings of varying size and function and will substantially expand LLNL's capability for treating these wastes. The DWTF would receive LLNL-generated medical, hazardous, low-level radioactive, and low-level mixed wastes for consolidation, processing, treatment, and packaging before shipment and disposal offsite. Increased onsite waste treatment would substantially decrease the volume of offsite waste shipments.
- The Inertial Confinement Fusion Users Support Facility would include administrative and clean-room areas, and would house approximately 80 laboratory and support personnel. This facility would provide a laser optics support laboratory and clean room assembly areas. The project would support the ongoing inertial confinement fusion program by providing experiment preparation and support areas for the inertial confinement fusion users of LLNL's NOVA facility (LLNL, 1991a). The building design would include safety, energy conservation, and environmental considerations. This facility will total approximately 89,500 sq ft.
- The Earth Sciences Building would provide approximately 75,700 sq ft of office and light laboratory space for approximately 270 people, and space for interdisciplinary environmental restoration and waste management research, development and technology, energy, and defense program activities.
- The Verification, Intelligence, and Special Technology Analysis (VISTA) Center (formerly the Foreign Technology Assessment Center or FTAC) would provide approximately 46,200 sq ft of space in an addition to Non-Proliferation, Arms Control, and International Security Program's, Building 261. The building would provide capability for conducting intelligence and treaty verification analysis with full access to all levels of required source information.

(Additional information on all projects included in the proposed action is presented in Appendix A).

The projected near-term increase of approximately 530,000 gross sq ft, or 9 percent over the 10 year period, is used to provide a conservative analysis of environmental impacts from the proposed action. Again, actual increase in square footage may be lower because some projects may replace existing facilities resulting in no actual increase in space. Additionally, funding constraints through the near-term are expected to eliminate or severely restrict projected construction.

Based on an assumed 20 percent increase in employment over 10 years, DOE anticipates that the increase in personnel would be 2050 for the proposed action.

It is estimated that the administrative limit for tritium use in Buildings 298, 331, and 391 would be a total of 10 g divided among the three buildings with no single building having more than 5 g. Use of tritium in small amounts as listed in Table A-23 in Appendix A would remain substantially the same. The administrative limits by facility for uranium would remain the same (see Table 4.15-1 for facility administrative limits).

LLNL is currently reducing the plutonium administrative limit for the combined Buildings 332 and 334 from 700 kg to 200 kg, with the inventory (actual inventory quantities are classified) being reduced accordingly. The reduction would be accomplished by shipping inventory to an offsite DOE facility and is targeted for completion during FY 1993.

Projected chemical and waste amounts have been calculated solely for the purposes of defining the proposed action in this EIS/EIR. Actual amounts of chemicals used and wastes generated are expected to be less than projected here because these projections do not take into account waste minimization plans, mitigation measures, permits, and regulatory constraints. It is anticipated that these minimization plans and mitigation measures would reduce the inventory of hazardous and radioactive material and wastes.

Estimated increases in chemical inventories and waste over the next 10 years are based on the assumed 9 percent increase in gross square footage. Thus, it is projected that the chemical inventory would increase by 19,000 gal and 210,000 lb. Radioactive waste is projected to increase by 2000 gal (liquid low-level wastes), 26,000 lb (solid low-level wastes), and 240 cu ft (solid transuranic wastes); hazardous waste by 28,000 gal (liquid wastes) and 51,000 lb (solid wastes); mixed waste by 2100 gal (liquid wastes) and 4600 lb (solid wastes); and medical waste by 230 lb (solid wastes).

In addition to new facilities, the proposed action would result in new operational programs, as well as programs to upgrade and maintain existing facilities (LLNL, 1991b). Table 3-2 provides general information about these proposed programs. They include significant operational changes, enhanced conservation efforts, environmental health improvements, improvements in security and facility-type safety measures, improvements in materials handling, and physical plant improvements.

Operational changes under the proposed action include the following: (1) reduction of the tritium administrative limit to no more than 5 g in Building 331 and no more than 5 g combined in Buildings 298 and 391, which would support tritium research and target development/fabrication (B298), and house the NOVA Upgrade/National Ignition Facility (B391). The total administrative limit for tritium is 10 g for all three buildings. (2) technological upgrades to the plutonium facility in Building 332 to provide new equipment, capabilities, and state-of-the art gloved enclosures to facilitate LLNL's weapons-oriented plutonium research effort; and (3) additional contained firing capabilities of detonating up to 20 kg of high explosives in Building 191, the High Explosives Application Facility, currently limited to 10 kg.

Conservation efforts under the proposed action would focus on retrofitting various buildings for energy conservation. Conservation projects include installation of high-efficiency lighting systems; enhanced heating, ventilation, and air conditioning control systems; cogeneration systems; thermal energy storage; and devices that use alternate fuels.

Proposed projects to protect environmental health at the LLNL Livermore site and the nearby vicinity include the Hazards Control Health and Safety Facility, which would provide laboratory space, health and safety training classrooms, a central health and safety library, and additional support functions for LLNL programs. Retention tank upgrades, repair, and maintenance are proposed as preventive measures against the accidental release of potential contaminants into the environment. Decontamination and restoration of Building 292, former site of the Rotating Target Neutron Source (RTNS) Facility and Building 212, the site of the prototype of RTNS-2 would allow the buildings to be converted to other uses. Rehabilitation of the sanitary sewer system would minimize both infiltration of waters and exfiltration of sewage.

Proposed emission and effluent systems upgrades to the Nuclear Chemistry Facility, Building 151 would include replacing the existing exhaust system with a central scrubbed exhaust manifold and stack with continuous monitoring, and upgrading the existing retention system with a double contained system and leak monitor. Structural upgrades to other LLNL Livermore site stacks are proposed to increase air emissions monitoring capability, thereby improving environmental health.

Among the proposed action's new safety and security measures is a vital upgrade of the existing LLNL Livermore site fire-alarm system with new, low-voltage components. Additional renovation, replacement, and seismic upgrades, including refurbishment of the existing Hazards Control Facility in Building 253, would replace older structures and facilities, thereby improving facility safety. DOE has proposed acquisition of East Avenue between South Vasco and Greenville roads to improve security at the LLNL Livermore site.

Projects that would improve the handling of hazardous materials at the LLNL Livermore site include the Waste Minimization project, which would provide resources for the Engineering Department's waste minimization effort in Buildings 322 and 141. The proposed Mixed Waste Treatment Facility (MWTF) and Decontamination and Waste Treatment Facility (DWTF) would replace some, and upgrade other, LLNL facilities that process, treat, and store hazardous, radioactive, and mixed wastes. The Integrated Demonstration Facility, tentatively proposed by LLNL, would be a research and development center for demonstrating best available technologies for treating LLNL mixed waste.

Table 3-2 LLNL Livermore Site Program Projections Upgrades and Operational Modifications Under the Proposed Action

Project Name	Funding Status	Map Loc.[a]	Project Description
Building 332 and 334 Plutonium Administrative Limits	Proposed	P3	Decrease plutonium administrative limits from 700 kg to 200 kg
Building 331 Tritium Limits	Proposed	M1	Decrease tritium limits from 300 g to 5 g[b]
NOVA Upgrade/National Ignition Facility Planning & Design	Proposed	Not available	Laser upgrade design/modification to handle tritium target activities
Modification for Energy Management	Proposed	Multiple locations	• High-efficiency lighting systems • Enhanced HVAC control system • Cogeneration system • Thermal energy storage • Alternate fuel projects • Energy conservation retrofits
Building 212 and 292 Decontamination	Proposed	P2	Decontaminate and restore two buildings, former sites of Rotating Target Neutron Source Test Facility
Plutonium Facility B332 Upgrade	Proposed	P3	65 percent of 25,000 sq ft for major improvement, new equipment, and state-of-the-art glove boxes
Upgrade Fire Alarm System	Proposed	Multiple locations	Replace existing system with new low-voltage components
Building Electrical Code Improvement	Proposed	Multiple locations	Upgrade of low-voltage systems on 565 labs, support, and general purpose facilities at LLNL Livermore site and LLNL Site 300
B191 Hazardous Firing Upgrade	Proposed	P5	Additional firing tanks for differing experiments
B131 General and Environmental	Proposed	P6	Electrical and mechanical portion of building upgrade
NW Low Conductivity Water Station	Proposed	P7	11 MW addition to existing 33 MW Northwest Station
B322 Plating Facility Upgrade	Proposed[c]	P8	Upgrade B322 to a closed system operation.
Nano Scale Materials Facility Upgrade	Proposed	Not available	8000 sq ft refurbish facilities
B321 General and Environmental Upgrade	Proposed	P9	Machining operations upgrade
Replace Deteriorating Offices	Proposed	P10	New office space, replace B213, B319, T2175, T2177

B141 General Upgrade	Proposed	P11	Modernization of B141 with emphasis on printed wiring code facility
Retention Tank Upgrade	Proposed	P12	Modern retention tanks for B241, B281, and B227
B151 Effluent System Upgrade	Proposed	P13	Replace fume hoods and single wall glass system.
B253 Refurbish/Replace	Proposed	P14	Hazards Control Building Major Refurbishment. Refurbish structural/HVAC/electrical/roofing
East Avenue Acquisition	Proposed	Portion of East Ave.	Acquire East Avenue between Vasco Road and Greenville Road
Fusion Target Tritium Limits	Proposed	M2	Increase Building 298 tritium limits to 5 gb
NOVA Upgrade/National Ignition Facility Tritium Limits	Proposed	M3	Increase Building 391 tritium limits to 5 gb
Integrated Demonstration Facility	Proposed	P19	Research and development center for demonstrating best available technologies for treating LLNL mixed wastes

[a] For map location, see Appendix A, Figure A-8.

[b] No more than 5 g in any one facility; no more than 10 g among Buildings 298, 391, and 331.

[c]For funding status, proposed indicates planned but not yet funded projects.

3.1.2 LLNL Site 300

The proposed LLNL Site 300 projects would add approximately 32,000 sq ft to the existing total of 350,000 sq ft resulting in a net increase in facility space of approximately 9 percent. This increase is from construction of the Contained Firing Facility and the fire station upgrade. Table 3-3 provides general information about this and other proposed building projects. Table 3-3 also includes information on the proposed replacement of Fire Station No. 2 (DOE, 1990). Table 3-4 includes information on program upgrades and modifications. Again, new facilities will be designed pursuant to the Secretary of Energy's 10-point initiative to modernize DOE facilities to meet current, and accommodate future, environmental, safety, and health standards.

Examples of proposed new facilities, upgrades, or operational changes include (LLNL, 1991b):

- The Contained Firing Facility would consist of three related structures for firing of up to 60 kg of energetic high explosives in a safe and environmentally sound manner. The three structures, a firing chamber, support facility, and diagnostic equipment facility would be built onto the existing firing-table site adjacent to Building 801. The firing chamber would confine the detonation of cased high explosives materials used in various laboratory experiments. The chamber would be steel-lined for shrapnel protection and would have a variety of diagnostic and observation port penetrations for various tests. The support facility would provide a staging area for experiment preparation, storage for equipment and materials used, and a personnel area for lockers, toilets, and decontamination showers. The diagnostic equipment facility would have nonbearing, tilt-up reinforced concrete panel walls supported by a rigid steel-frame system. It would contain all of the unique instrumentation and devices needed for monitoring, recording, and performing the required experiments.
- The Explosives Waste Storage Facility Project would consist of the rearrangement of four existing high explosives storage units for the storage of explosive wastes. A new prefabricated metal building, to be located in a previously paved area, would be used for storing explosives-contaminated solid wastes (including packing

material, discarded paper, and plastic labware) and ash from thermal treatment processes. Each of the four earth-covered magazines is capable of storing up to 10,000 lb of a single type of explosives or a maximum of 1000 lb of a mixture of several types of explosives (LLNL, 1992).

- A new Explosive Waste Treatment Facility which would replace the high explosive waste open burning facility at Building 829. The present facility would then be closed through a formal RCRA closure procedure. This facility would include an open detonation table and open burn units for treatment of pieces of explosive waste; a propane-fueled burn cage for treatment of clarifier filter bags containing explosives waste, small pieces of explosives, and reactive contaminated trash; and a burn pan with a removable cover for burning bulk pieces and explosive powders.

High explosive wastes to be burned at this new facility are expected to be the same or less than the amounts currently treated in the Building 829 High Explosive Burn Facility. This new facility would burn explosive dry solid wastes consisting of high explosives-contaminated solid materials and packaging, and powders and small pieces of high explosives. The estimated annual quantity to be burned is 4000 lb. Additionally, approximately 1000 lb of high explosive clarifier waste sludge would be burned annually.

- The Cheap Access to Orbit experiment (CATO) would involve developing a two-stage gas gun to propel projectiles into orbit. As a potentially cost effective and practical method of placing metric-ton payloads into earth orbits, the gun would propel projectiles made of lightweight alloys and polymers (aluminum, polymer, and resin) weighing as much as 10 kg at velocities up to 7 km/second using methane and hydrogen as propellants. The CATO gun will fire projectiles horizontally into an earthen berm shielded with concrete. The projectile would be propelled approximately 50 ft within the CATO gun before hitting the berm. Gun detonation would be initiated by an electric spark in the combustion chamber containing a methane air mixture. The experiment would be fired, on average, once a week, for a total of about 50 firings annually. After the 3-year experiment is completed, the CATO system would be dismantled.
- The Flash X-Ray Upgrade II would include the construction of a new Flash X-Ray generator providing increased capability for studying explosive testing. The project would require significant design effort to achieve multiple pulsing, and include both the construction of an accelerator and its housing structure.
- The Fire Station No. 2 replacement project, scheduled for FY 1994, would replace the existing station, which is over 30 years old. The proposed fire station would provide approximately 5500 sq ft of space, composed of three apparatus bays with 14-ft high roll-up doors for an ambulance, pumper, and patrol vehicle, living quarters for five fire fighters, a dayroom, an office, and an equipment decontamination area.

It is estimated that the increase in personnel would be 50 employees. The projected changes in the administrative limits for radionuclides listed in section 4.15 apply to both the LLNL Livermore site and LLNL Site 300. The assumed increases in chemical inventory and waste at LLNL Site 300 are based on the projected 9 percent increase in gross square footage. Thus, it is projected that the chemical inventory would increase by 7600 gal of liquid, 9000 lb solid, and 171,000 cu ft of gas. Radioactive waste is assumed to increase by 27,000 lb (solid wastes); hazardous waste by 3700 gal (liquid wastes) and 3300 lb (solid wastes); mixed waste by 180 lb (solid wastes) and high explosive waste by 405 lb (solid wastes). LLNL Site 300 generates approximately 12 lb medical waste per year; the assumed increase would amount to approximately 1 lb. As with the LLNL Livermore site, the assumed chemical and waste amounts have been calculated solely for the purposes of defining the proposed action in this EIS/EIR. These assumptions do not consider waste minimization plans, mitigation measures, permits, and regulatory constraints.

Table 3-3 LLNL Site 300 Program Projections New Facilities Under the Proposed Action

Project Name	Proposed Gross Sq Ft	Funding Status	Map Loc.[a]	Principal Use		
				Office	Lab/ Research	Misc.
Explosives Waste Treatment	Not available	Proposed[c]	P5		Yes	Yes

Facility[b]						
Contained Firing Facility (CFF)	26,500	Budgeted	F1		Yes	Yes
Fire Station No. 2 Replacement	5,500	Proposed	P2	Yes		Yes

[a] For map location, see Appendix A, Figure A-12.
[b]An open-air high explosives burn and detonation facility.
[c] For funding status, proposed indicates planned but not yet funded projects.

Table 3-4 LLNL Site 300 Program Projections Upgrades and Operational Modifications Under the Proposed Action

Project Name	Funding Status	Map Loc.[a]	Project Description
Cheap Access to Orbit Experimental Tests (CATO)	Proposed[b]	P3	Develop two-stage gas gun to propel projectiles into orbit.
Flash X-Ray Upgrade II (FXR-11)	Proposed	P1	Construct new flash x-ray generator
Upgrade Retention Tank System	Proposed	Not available	Modernize retention tanks at selected facilities
Explosives Waste Storage Facility	Proposed	P4	Rearrange existing magazines to store explosives wastes
Cooling Tower Modifications	Proposed	Multiple locations	Reduce or eliminate water discharges to surface water courses
LLNL Site 300 Tritium Use	Multiple Locations	P3	Resume tritium use at the firing tables with an administrative limit of 20 mg.

[a] For map location, see Appendix A, Figure A-12.
[b]For funding status, proposed indicates planned but not yet funded projects.

3.1.3 SNL, Livermore

SNL, Livermore planned projects consist mainly of two types: construction and operational modifications. The new projects under the proposed action are listed in Table 3-5, and the proposed projects involving upgrades, operational and maintenance projects, and operational modifications are described in Table 3-6 (SNL, 1989). The construction projects are expected to add approximately 50,000 sq ft to the existing 830,000 sq ft, resulting in an increase in developed space of about 6 percent. The new facilities would consist predominantly of light laboratory and office space. As with LLNL, the new facilities would be designed pursuant to the Secretary of Energy's 10-point initiative to modernize DOE facilities to meet current, and accommodate future, environmental, safety, and health standards (DOE, 1989). For example, the replacement of trailers and temporary buildings with permanent laboratories and offices would provide necessary space for research work using state-of-the-art equipment and procedures.

It is assumed that the increase in personnel would be 15 employees. The assumed increases in chemical inventories and waste are based on the projected 6 percent increase in gross square footage. Thus, it is projected that the chemical inventory would increase by 210 gal of liquids, 380 lb of solids, and 11,900 cu ft of compressed gases. Radioactive wastes would increase by 460 gal of liquids and 540 lb of solids; hazardous waste by 240 gal of liquids and 380 lb of solids; mixed waste by 15 lb (liquid scintillation cocktail waste) and 4 lb (solid waste); and medical waste by 7 lb. It is also estimated that there would be no net increase in the overall administrative limits for tritium. These assumed chemical and waste amounts have been calculated solely for the purposes of defining the proposed action in this EIS/EIR. These assumptions are not reduced by the projected increase in gross square footage from nonlaboratory space, nor do they consider waste minimization plans, mitigation measures, permits, and regulatory requirements. Specifically, the Environment, Safety and Health Enhancement Project would decrease waste emission and should result in decreases in both chemical usage and waste generated.

The only projects planned for the site are the:

- Environment, Safety and Health Enhancement Project, which would involve construction of three new environment, safety, and health-related facilities. The first is an Environment, Safety and Health Management Facility of about 35,000 sq ft providing space for environment, safety, and health offices, laboratories, and training facilities. The second is a Waste Processing Facility which would add about 10,000 sq ft for waste processing, packaging, and shipment. It would also provide space for material washdown and decontamination and recyclable material processing. The third, a 5000 sq ft Hazardous Material Storage Facility would consist of several modules to store different types of hazardous materials.
- Another project in the initial planning phase is the Center for Environment Technologies Research. The purpose of the center would be to research, identify, and develop advanced thermomechanical treatment technology to minimize or process waste generated at DOE weapons production facilities. The nature of materials handled and the research to be conducted in this facility may necessitate future NEPA review. Refer to Appendix A for more information on these projects.

In addition, SNL, Livermore management is committed to reducing the tritium limit to 0 g and to decontaminating and decommissioning the Tritium Research Laboratory. A transition to alternative uses would occur in conjunction with this proposed operational modification. The decontamination and decommissioning operations are planned to be performed over a 3-year period, and would be done in accordance with appropriate DOE Orders and federal and state of California laws and guidelines. The tritium inventory is planned to be 0 g in the fall of 1993. Experiments are being relocated to other DOE facilities, subject to establishment of experimental capabilities at those other facilities. SNL, Livermore would still maintain technical expertise in tritium work but would not perform tritium experimentation onsite. The work to be relocated to this facility has not been identified. When it is, the appropriate environmental review and analysis will be undertaken (see Appendix A, section A.3.5.3).

Table 3-5 SNL, Livermore Program Projections New Facilities Under the Proposed Action

Project Name	Proposed Gross Sq Ft	Funding Status	Map Loc.[a]	Principal Use		
				Office	Lab/ Research	Misc.
Environment, Safety & Health Enhancement Project	50,000	Proposed[b]	P1	Yes	Yes	Yes

[a]For map location, see Appendix A, Figure A-17.

[b] For funding status, proposed indicates planned but not yet funded projects.

Table 3-6 SNL, Livermore Program ProjectionsUpgrades and Operational Modifications Under the Proposed Action

Project Name	Funding Status	Map Loc.[a]	Project Description
Tritium Research Lab Tritium Limits	Funded	M1	Building 968 tritium limits reduced to 0 g
Decommissioning	Pending		Decontaminate and decommission Building 968
East Avenue Acquisition	Proposed[b]	Portion of East Ave.	Acquire East Avenue between Vasco Road and Greenville Road
Center for Environmental Technologies Research	Proposed	P2	Thermomechanical technology research

[a] For map location, see Appendix A, Figure A-17.

[b] For funding status, proposed indicates planned but not yet funded projects.

3.2 EIS/EIR ALTERNATIVES

3.2.1 No Action

This alternative is continued operation, including those LLNL and SNL, Livermore projects already authorized and funded through FY 1992 (Table 3-7, Table 3-8, and Table 3-9). Programs and projects would continue at their present (FY 1992) level, but no proposed or tentative projects (as listed in Tables 3-1, 3-2, 3-3, 3-4, 3-5, and 3-6) would be added except those required to maintain the existing infrastructure or those required to comply with statutes and regulations for completion of environmental remediation activities at the site. LLNL environmental restoration activities are being done pursuant to CERCLA agreements. SNL, Livermore environmental restoration activities are being done in accordance with CERCLA, but pursuant to orders of the California Regional Water Quality Control Board.

The no action alternative at both LLNL and SNL, Livermore includes routine activities such as infrastructure and building maintenance, minor modification to buildings, general landscaping, road maintenance, and similar support activities. As in the proposed action, the tritium limit at the Tritium Research Laboratory (Building 968) would be reduced to 0 g and the building decontaminated and decommissioned under the no action alternative.

Employment and funding levels, adjusted for inflation, would remain at FY 1992 levels. No new projects except those funded by the end of FY 1992, those required to maintain the existing infrastructure, and those required to comply with statutes and regulations (e.g., remediation of inactive sites) would be included. A range of physical plant maintenance activities are part of this alternative. These include roof replacements for over 100 buildings, rehabilitation of over 6.5 miles of roads and more than 2.51 million sq ft of parking lots at the LLNL Livermore site and SNL, Livermore site, and upgrading low-voltage electrical systems in 565 Laboratory buildings.

The no action alternative could cause schedule modifications or delays, changes in funding priorities, less flexibility in responding to new program initiatives, and other potential program impacts. This could result in only the partial fulfillment of the research and development missions established by Congress and the President.

Table 3-7 LLNL Livermore Site Program Projections Upgrades, Operational, and Maintenance Projects Under the No Action Alternative

Project Name	Funding Status	Map Loc.*	Project Description
Building 332 and 334 Plutonium Limits	Not Applicable	P3	Decrease plutonium administrative limits from 700 g to 200 g
Building 331 Tritium Limits	Not Applicable	M1	Decrease tritium limits from 300 g to 5 g
Electric Power System Replacement and Upgrades	Funded	Multiple locations	Electrical replacements and upgrades to the electrical utility infrastructure
Infrastructure Modernization	Funded	Multiple locations	Low Conductivity Water (LCW) System Rehabilitation • New 3×30,000-gal water tanks will replace old 100,000-gal tank • Cooling tower system upgrade • Construction activity at B325 Domestic Water System Upgrade • 8000 linear ft 16-inch water supply line • 700,000-gal water storage tanks at SNL, Livermore • Upgrade Zone 7 back-up supply • Demolish 206,000-gal tank
Sanitary Sewer System Rehabilitation	Funded	Multiple locations	Approximately 27,321 linear ft—Inversion lining Approximately 21,905 linear ft—Replace
Roof Replacement	Proposed	Multiple locations	Roofs over 100 buildings to be replaced
Civil Infrastructure Modernization	Proposed	Multiple locations	13 miles of roadway repair/overlay 2.51 million sq ft of parking lots repair/overlay
Stack Construction and Monitoring Upgrade	Proposed	Multiple locations	Mechanical modifications to combine existing stacks on facilities with multi-emission sources
Office Addition to Building 332	Funded	F1	Addition of 13,000 sq ft of office space and secondary alarm station
Laser Guide Star Experiment	Funded	F2	Research and demonstration of laser technology to overcome atmospheric distortion in use of astronomic telescopes

* For map location, see Appendix A, Figure A-8.

Table 3-8 LLNL Site 300 Program Projections Upgrades, Operational, and Maintenance Projects Under the No Action Alternative

Project Name	Funding Status	Map Loc.*	Project Description

Site 300 Facilities Revitalization— Phase I (SFR-I)	Funded (in Construction)	Multiple locations	B802 High-Speed Optics Facility 3,860 sq ft B802 Addition, Bunker Support Facility 960 sq ft B802, Central Control Post, at Route 3 and 4 "Y" Diagnostic Equipment for Bunkers 801 and 851 Route #3 upgrade and alignment; intersection Route #3 and Linac Road, Do-all Road, "Y" intersection at Route 3 and 4 9,500 ft of 10-inch pipeline from the Thomas Shaft and possible water treatment 211,600-gal Water Tank 11, next to Tank 8 2,400 ft of 10-inch pipeline among GSA, Tank 8, and Tank 11
LLNL Site 300 Tritium Use	Proposed	Multiple Locations	Resume tritium use at the firing tables with an administrative limit of 20 mg.

* For map locations, see Appendix A, Figure A-12.

Table 3-9 SNL, Livermore Program Projections Upgrades, Operational, and Maintenance Projects Under the No Action Alternative

Project Name	Funding Status	Map Loc.*	Project Description
Main Electrical Service and Switchgear	Funded	F1	Replacement system for power supply
Tritium Research Lab Tritium Limits Decommission	Funded Pending	M1	Building 968 tritium limits reduced to 0 g Decontaminate and Decommission Building 968
Infrastructure Modernization	Requested	Multiple locations	Roof Replacement for Buildings 914, 916, 912, 920, 921, 922, 972, 973, 978 Renovation of mechanical equipment Buildings 911, 912, 913, 914, 916 820,000 sq ft paved area resurfacing Site fire water system renovation Site natural gas distribution system repair
Site Seismic Modernization	Requested	Multiple Locations	Site seismic evaluation and modification for over 40 permanent buildings

* For map locations, see Appendix A, Figure A-17.

3.2.2 Modification of Operations

This alternative is to modify LLNL and SNL, Livermore operations, including near-term (within 5 to 10 years) proposed projects, to reduce adverse environmental impacts. Modification of operations is broadly defined as the scaledown of operations and/or the application of alternative technologies and management strategies (formerly two alternatives as described in the Notice of Intent, 55 Fed. Reg. 41048). Selection of this alternative would require study to ensure that the missions of both LLNL and SNL, Livermore would continue to be met.

To identify potential modifications to be discussed, existing operations at LLNL and SNL, Livermore were evaluated for their environmental impact. The criteria for selection were:

- Operations with a potential for, or a history of, greatest worker exposure (see Appendix C).
- Operations with the greatest potential impact to the public, based on accident analyses (see Appendix D).
- Operations historically generating the greatest quantities of transuranic waste, low-level waste, mixed waste, or waste restricted from land disposal (see Appendix B).

Some major facilities meeting the above-described criteria are:

- LLNL Building 321C, housing some of LLNL Materials Fabrication shops, where radioactive materials are machined and formed. Building 321C was selected because of the mixed wastes generated there.
- LLNL Building 511, Crafts Shop, where operations generate hazardous wastes. Building 511 was selected because the wastes generated are restricted from land disposal.
- LLNL Building 322, Plating Shop, where large quantities of various incompatible chemicals are in use. Building 322 was selected because of the potential for impact to the public based on accident analyses (see Appendix D).

Among the operations at these selected facilities, candidates for potential modification of operations are:

- Waste management operations at the two Laboratories might be combined at LLNL's waste management complex. This might be accomplished through regulatory means allowing LLNL and SNL, Livermore to apply for the same EPA identification number or by LLNL modifying its RCRA Part B permit to accept SNL, Livermore wastes. This alternative management strategy could allow possible increased efficiencies which would reduce exposures during handling, treating, and packaging wastes prior to being shipped offsite. Additionally, under this alternative, more efficient methods of waste treatment could be evaluated at a centralized waste management complex.
- Operations in the plating shop, Building 322, might be modified and the building structurally reinforced to prevent the mixing of incompatible chemicals if a severe (i.e., greater than 0.9g) earthquake were to occur.
- Buffer zones to the east of the LLNL Livermore site and SNL, Livermore might be acquired to reduce fenceline exposures and to preclude the development of residential and/or industrial areas immediately downwind of the two Laboratories.

These examples of possible modifications are illustrative of various options being considered. If any of these examples were selected, more detailed engineering and environmental evaluations would be prepared; this could include study to ensure there would be no impacts to LLNL and SNL, Livermore missions from this alternative. Nothing would preclude the implementation of any of these modifications if the proposed action is adopted.

3.2.3 Shutdown and Decommissioning

This alternative is the phaseout of all research and development operations at LLNL and SNL, Livermore with the eventual shutdown and decommissioning of all facilities.

Shutdown means an orderly phaseout of programmatic research and development efforts. Phased shutdown is estimated to take 5 years. This estimate is based on periods for planning, environmental documentation of the impact of closing facilities, and phaseout of programs and shutdown of facilities. The Laboratories would require a caretaker staff during and after shutdown to maintain the decommissioning, environmental restoration and compliance infrastructure. The caretaker staff would continue operation and maintenance of LLNL and SNL, Livermore support functions including security, utilities, shipping and receiving; environmental, safety, and health protection; and other services.

Decommissioning means the restoration or destruction and disposal of contaminated facilities. Decommissioning and environmental compliance activities would start during shutdown and continue for an estimated 5 years beyond shutdown. Radioactive and other hazardous sources would be removed and transported to other DOE or commercial facilities as appropriate. During this time, individual facilities would be decontaminated as they are vacated. LLNL and SNL, Livermore would be restored so that facilities could be conveyed unrestricted to new owners or operators in a phased transfer, and in accordance with applicable regulatory limits. The subsequent fate of the various programs is not considered here because it is beyond the scope of this EIS/EIR. Should this alternative be selected, the possible transfer of these programs elsewhere would be considered in another NEPA document.

The projects to be eliminated and the facilities to be shut down are those in existence in FY 1992. Those projects and facilities required to comply with statutes and regulations (e.g., remediation of inactive sites) would continue.

This alternative would require a legislative redirection of DOE's mission, a new initiative to significantly restructure and consolidate the national laboratories, or both. It is therefore not likely to be implemented within the timeframe of this EIS. However, it has been included for comparison with other alternatives and to provide the decision maker with an alternative if the environmental impacts from the proposed action or any of the alternatives are determined to be unacceptable. Section 5 provides an overview of the environmental and socioeconomic consequences of closing LLNL and SNL, Livermore. Specific actions that may be proposed to implement this alternative would have to be addressed, as appropriate, in subsequent NEPA or CEQA documents.

3.2.4 Discontinue University Management of LLNL

The alternative to UC's continuing management and operation of LLNL is the "no project" alternative, under which the UC Regents discontinue management and operation of LLNL. If this were to happen, it is assumed that DOE would select another contractor to manage and operate LLNL at the same operational level described in this EIS/EIR proposed action, or at the level of operations selected by DOE as an alternative through the EIS process.

3.3 ALTERNATIVES ELIMINATED FROM DETAILED REVIEW

Phaseout/Relocation of the Nuclear Weapons Program

Any decision to phase out and relocate weapons work at LLNL and SNL, Livermore would have to be made in the context of the entire nuclear weapons complex. Relocation of weapons functions is one of the issues DOE is addressing in a Programmatic EIS for Reconfiguration of DOE's Nuclear Weapons Complex (56 Fed. Reg. 5591). That document will address the future of weapons work at LLNL and SNL, Livermore. If the EIS for Reconfiguration results in changes in LLNL or SNL, Livermore operations, those changes would have to be addressed, as appropriate, in subsequent NEPA or CEQA documents. (See the discussion in section 1.1).

Transition from Nuclear Weapons Research to Other Research

The transition from nuclear weapons research to other research would involve phasing out the nuclear weapons program at LLNL and SNL, Livermore. This possibility cannot be examined until decisions have been made following completion of the Programmatic EIS for Reconfiguration of DOE's Nuclear Weapons Complex. For DOE and UC to project the environmental impacts of new or unknown programs without specific knowledge of those programs and their operations is speculative and beyond the scope of the EIS/EIR.

Relocation of Operations Within Existing Site Boundaries

Although relocating operations with the greatest impacts to new locations within the current LLNL or SNL, Livermore site boundaries may reduce environmental impacts and provide some limited environmental benefits, it would also involve new environmental impacts at the new locations. In addition to the potential impacts associated with construction, there would be impacts from the shutdown and cleanup of the old facility. These new impacts would add to continuing impacts from the relocated facility further removed from some but closer to other populations. It is considered, therefore, that the net environmental improvement, if any, would be so insignificant that this alternative is not reasonable when compared to the significant costs and potential for contamination associated with it.

Continued University Management Under a Modified Contract

This alternative considers the effect of UC negotiating a modified contract with DOE that would exclude certain operations or responsibilities, or scale down operations at LLNL. The environmental effects of this alternative would depend upon the specific contract modifications. Because this option is considered to be similar to the modification of operations alternative, the effects are bounded by analysis of the proposed action and its alternatives as previously defined.

3.4 COMPARISON OF PROPOSED ACTION AND ALTERNATIVES

The comparison of the impacts associated with the proposed action and alternatives are summarized in Table 3-10 and Table 3-11 for LLNL and SNL, Livermore respectively. These impacts are discussed more extensively in Section 5.

In accordance with CEQA and the UC CEQA Handbook (UC, 1991), four descriptive categories are used in the EIS/EIR to discuss and analyze environmental impacts: less than significant, significant, significant and unavoidable, and beneficial. These categories have been created and assigned to individual impacts only for the purposes of compliance with CEQA requirements, and thus are used here only in CEQA context. Under NEPA, the significance of environmental impacts determines the need for the NEPA document. Once that decision has been made, specific impacts are not categorized according to level of impact in an EIS.

SECTION 3 REFERENCES

DOE, 1989, *Secretary of Energy Agreement on 10-Point Initiative*, Washington, D.C., June 27, 1989.

LLNL, 1991a, *Budgeted and Proposed Future Projects*, Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1991b, *Institutional Plan FY 1992–1997*, UCAR 10076-10, Lawrence Livermore National Laboratory, Livermore, CA, December 1991.

LLNL, 1992, *Description of Proposed Projects for Explosives Waste Storage Facility and Explosive Waste Treatment Facility, Lawrence Livermore National Laboratory*, Livermore, CA, January 1992.

SNL, 1989, *Institutional Plan, FY 1989–FY 1994*, Sandia National Laboratories, Albuquerque, NM and Livermore, CA.

UC, 1991, *Procedural Handbook and Model Approach for Implementing the California Environmental Quality Act*, Long Range Development and Environmental Planning Division, University of California, CA.

SECTION 4 - DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 ENVIRONMENTAL SETTING/EXISTING CONDITIONS

This section describes the environmental setting and existing conditions associated with the current operations of the Lawrence Livermore National Laboratory (LLNL) and Sandia National Laboratories, Livermore (SNL, Livermore). The information presented in this chapter forms a baseline impact analysis (or assessment) for use in evaluating the environmental impacts associated with implementing the proposed action and the alternatives. Refer back to Section 2 of this EIS/EIR for an overview of the sites.

4.10 AIR QUALITY

This section discusses air quality regulations and existing emissions of criteria air pollutants, hazardous air pollutants, and toxic air contaminants.

4.10.1 Criteria Air Pollutants

Regulatory Authority for Criteria Air Pollutants

Applicable federal, state and local statutes and regulations and the regulatory agencies responsible for enforcement are listed in Table C-1 in Appendix C.

Federal and state air quality standards were established for six ambient air pollutants. These are referred to as criteria air pollutants. The pollutants are ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulates (both fine particulate matter [PM_{10}] and total suspended particulates [TSP]), and lead (Pb) (see Table 4.10-1). Additionally, California has established state ambient air quality standards for sulfates, hydrogen sulfide, and visibility-reducing particles.

Existing Criteria Air Pollutant Monitoring

The Bay Area Air Quality Management District operates ambient air monitors in the Livermore Valley for criteria pollutants. This monitoring is conducted to determine the area's ambient air quality and to determine the area's compliance with federal and state ambient air quality standards. To maintain compliance with these standards, monitoring in an area must demonstrate that pollutant levels do not exceed those shown in Table 4.10-1. When an area meets compliance standards it is classified as an "attainment" area under federal law. Pollutant concentrations measured by downtown Livermore's monitoring station are shown in Table 4.10-2. These data demonstrate that the Livermore area meets all ambient air quality standards except for ozone and PM_{10}.[1] Ozone forms when nitrogen oxides and certain hydrocarbons chemically react under the effect of strong sunlight. Particulate matter less than 10 micrometers in diameter is called PM_{10}. It consists of small particles that remain suspended in air and may include materials such as dust, soil particles, pollens, and molds.

When an area does not meet the ambient air quality standard for a criteria air pollutant, it is classified as being in nonattainment. The Clean Air Act Amendment of 1990 has defined classification levels for ozone nonattainment areas. The Bay Area Air Quality Management District has classified the Livermore area as "moderate" for ozone nonattainment which requires the enactment of a plan to achieve attainment. A plan was adopted in 1991 and will continue to be implemented through 1997 at which time if attainment is not achieved the area may be reclassified as a "serious" ozone nonattainment area and the reclassification may result in implementing a more stringent attainment plan. There are no levels of classification for PM_{10} nonattainment areas and no PM_{10} attainment plan has been adopted by the State of California as of early 1992.

The California Air Resources Board conducts criteria pollutant monitoring for the San Joaquin Valley Unified Air Pollution Control District. Based on these measurements, the district is classified as a nonattainment area for ozone and PM_{10}. LLNL Site 300 emissions are subject to the San Joaquin Valley Unified Air Pollution Control District monitoring and regulations.

The criteria pollutant emission rates for sources permitted in 1990 are presented in Table 4.10-3.

These rates were estimated based on actual material usage (such as boiler fuel and solvents for degreasers) and established emission factors.

Due to changes in stationary source operations (such as variation in materials used), the existing setting was projected to 1992 using estimates of material usage in the permitted stationary sources and application of emissions factors. The LLNL Livermore site estimated emissions are 3.2 lb/day of particulate matter, 183 lb/day of volatile organic compounds, 1 lb/day of sulfur oxides, 118 lb/day of nitrogen oxides, and 24 lb/day of carbon monoxide. The LLNL Site 300 estimated emissions are 5 lb/day of particulate matter, 14 lb/day of volatile organic compounds, 3 lb/day sulfur oxides, 52 lb/day of nitrogen oxides, and 11 lb/day of carbon monoxide. The SNL, Livermore estimated emissions are 0.35 lb/day of particulate matter, 14.1 lb/day of volatile organic compounds, 0.01 lb/day of sulfur oxides, 18.7 lb/day of nitrogen oxides, and 2.4 lb/day of carbon monoxide.

Permitted Stationary Sources

LLNL Livermore Site

The LLNL Livermore site held 192 permits in 1990 for stationary sources issued by the Bay Area Air Quality Management District. These permits were Permits to Operate for the following operations:

96	Boilers
51	Solvent cleaners
12	Particulate capture devices (baghouses or cyclones)
6	Cleaning/refurbishment devices
4	Printing presses
4	Oil shale experimental equipment
3	Paint spray booths
2	Vapor recovery systems
2	Ground water stripping systems
2	Ovens
1	Gasoline station recovery system
1	Fire test cell
1	Wet scrubber
7	Miscellaneous sources

LLNL Site 300

LLNL Site 300 held nine permits in 1990 from the San Joaquin Valley Unified Air Pollution Control District for stationary sources. These permits were Permits to Operate for the following operations:

5	Diesel fired boilers
2	Gasoline station vapor recovery systems
1	Paint spray booth
1	Sawdust collector baghouse

SNL, Livermore

SNL, Livermore held 16 permits in 1990 for stationary sources issued by the Bay Area Air Quality Management District. These permits were Permits to Operate for the following operations:

1	Vapor degreaser
10	Boilers
1	Baghouse
1	Incinerator
1	Spray booth
2	Solvent cleaners

Mobile Sources

Mobile sources consist of vehicular traffic that is attracted to the LLNL Livermore site, LLNL Site 300, and SNL, Livermore. The estimated traffic volumes at the LLNL Livermore site, LLNL Site 300, and SNL, Livermore are 21,000, 4900, and 3700 trips per day respectively. This traffic releases criteria pollutants such as nitrogen dioxide and carbon monoxide. The emissions from the mobile sources are primarily localized and exhibited in the ambient monitoring data from the Livermore Monitoring Station. A further description of the existing traffic in Livermore and Tracy is presented in section 4.13. The estimated 1-hour carbon monoxide ambient concentration due to traffic near the LLNL Livermore site is 3.3 ppm. This ambient carbon monoxide concentration is based on air quality modeling of the emissions from the existing traffic volume in the LLNL Livermore area.

Table 4.10-1 National and State of California Ambient Air Quality Standards (AAQS)

Pollutanat	**Average Time Period**	**California Standards**	**National Standards**
Ozone	1 hour	0.09 ppm	0.12 ppm
Carbon Monoxide	8 hour	9.0 ppm	9.0 ppm
	1 hour	20.00 ppm	35.00 ppm
Nitogen Dioxide	Annual Average	---	0.053 ppm
	1 hour	0.25 ppm	---
Sulfur Dioxide	Annual Average	---	0.03 ppm
	24 hour	0.05 ppm	0.14 ppm
	3 hour	---	0.50 ppm
	1 hour	0.25 ppm	---
Suspended Particulate Matter (PM_{10})	Geometric Mean	30 $\mu g/m^3$	---
	Arithmetic Mean	---	50 $\mu g/m^3$
	24 hour	50 $\mu g/m^3$	150 $\mu g/m^3$
Lead	30-day Average	1.5 $\mu g/m^3$	---
	Calender Quater	---	1.5 $\mu g/m^3$

Source: California Air Resources Board (CARB) 1985-1990
Note: The AAQS for PM_{10} replaced the AAQS fro TSP.

Table 4.10-2 Livermore Old First Street Ambient Air Monitoring Station Criteria Pollutant Monitoring Data for 1985–1990

				Carbon Monoxide[b] (ppm)		Nitrogen Oxide[a] (ppm)			Particulate Matter Less than 10 microns[c] (mg/m^3)			Lead[d] (mg/m^3)			
Year	1st High	2nd High	Avg.	1st High	2nd High	1st High	2nd High	Annual Avg.	1st High	2nd High	Annual Avg.	1 Qtr	2 Qtr	3 Qtr	4 Qtr
1985	0.15	0.14	0.019	5.3	4.9	0.1	0.1	0.021	---[e]	---[e]	---[e]	0.12	0.08	0.07	0.1
1986	0.14	0.13	0.022	4.9	4.5	0.1	0.1	0.021	84	67	30.7	0.11	0.08	0.09	0.16
1987	0.15	0.15	0.017	3.6	3.5	0.12	0.09	0.022	87	75	30	0.15	0.17	0.33	0.09
1988	0.15	0.14	0.020	4.4	4.1	0.14	0.12	0.023	69	61	33.3	0.06	0.06	0.07	0.07
1989	0.14	0.13	0.022	4.4	4.3	0.1	0.09	0.022	108	88	37.4	0.06	0.03	0.04	0.1
1990	0.13	0.12	0.023	4.5	4.1	0.09	N/A	0.020	137	84	27.4	0.06	0.05	0.06	0.07

[a] Hourly average.
[b] 8-hour mean.
[c] 24-hour average.
[d] Quarterly means.
[e] Monitor not established until 1986 (CARB, 1985–1990).
N/A = Not available.
Note: No ambient sulfur dioxide measurements are available from the Livermore Air Monitoring Station.
Source: CARB 1985–1990.

Table 4.10-3 Daily Emission Rates of Criteria Pollutants from LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

Pollutant	LLNL Livermore Site		LLNL Site 300		SNL, Livermore	
	Tons/Day	lb/Day	Tons/Day	lb/Day	Tons/Day	lb/Day
Particulates	0.0035	7	0.0020	4	0.0005	1
Volatile organic compounds	0.0313	62.6	0.0011	2.2	0.006	12
Sulfur dioxide	0.0024	4.8	0.0018	3.6	<0.001	<2
Nitrogen dioxide	0.0834	166.8	0.0259	51.8	0.0135	27
Carbon monoxide	0.0172	34.4	0.0056	11.2	0.001	2

Chlorofluorocarbons	0.0449	89.8	0.0032	6.4	---*	---*

* Included in the volatile organic compound totals.

Source: LLNL, 1991f; BAAQMD, 1991.

4.10.2 Hazardous Air Pollutants

National Emissions Standards for Hazardous Air Pollutants

Toxic air contaminants are regulated at the federal level by the National Emission Standards for Hazardous Air Pollutants (NESHAP) established under section 112 of the Clean Air Act, which specifically requires the U.S. Environmental Protection Agency (EPA) to set "health based" emissions standards for hazardous air pollutants. The EPA has established standards for inorganic arsenic, beryllium, mercury, asbestos, radionuclides, vinyl chloride, benzene, and coke oven gas from a variety of operations, most of which are not performed at the Laboratories. The EPA has delegated responsibility for enforcing these standards to California except for those pertaining to radionuclides. California, through the State Implementation Plan, has delegated enforcement authority to the local air districts such as the Bay Area Air Quality Management District and San Joaquin Valley Unified Air Pollution Control District.

Existing Hazardous Air Pollutants at LLNL and SNL, Livermore

Inorganic Arsenic, Asbestos, Benzene, Coke Oven Emissions, Mercury, and Vinyl Chloride

Neither of the Laboratories performs operations for which inorganic arsenic, benzene, coke oven emissions, mercury, or vinyl chloride NESHAP requirements have been set. Applicable NESHAP requirements for asbestos, primarily notifications of regulatory agencies and implementation of emission controls during demolition and renovation activities involving asbestos materials, are met.

Beryllium

LLNL Livermore Site. Beryllium is the only nonradioactive material regulated by NESHAP for which the LLNL conducts ambient air monitoring. Beryllium is regulated under the NESHAP and the Bay Area Air Quality Management District regulations. There are currently no applicable San Joaquin Valley Unified Air Pollution Control District regulations for beryllium.

The Bay Area Air Quality Management District's standard for an ambient monthly maximum concentration for beryllium is 0.01 µg/m3 (1000×10^{-5} µg/m^3). As seen from Table 4.10-4, which shows average monthly concentrations of airborne beryllium at the LLNL Livermore site perimeter for the last 5 years, LLNL's beryllium concentrations average less than 0.58 percent of the district's monthly maximum.

LLNL Site 300. LLNL monitors beryllium at Site 300. Concentrations are shown in Table 4.10-5. Although there are no applicable San Joaquin Valley Unified Air Pollution Control District standards, for comparison purposes, these values average 0.42 percent of the NESHAP standard as enforced by the Bay Area Air Quality Management District. LLNL also operates a beryllium air monitor at the firehouse in Tracy, California, located 10 km northeast of LLNL Site 300. Average monthly concentrations from 1986 through 1990 are given in Table 4.10-6. Average monthly concentrations in Tracy are 0.52 percent of the Bay Area Air Quality Management District ambient monthly concentration guideline of 0.01 mg/m^3.

SNL, Livermore. There are no emissions of beryllium from SNL, Livermore.

Radionuclides

All people are exposed to varying levels of natural and artificial radiation. In the vicinity of LLNL and SNL, Livermore, the typical annual radiation dose from natural sources is about 0.3 rem effective dose equivalent per year (NCRP, 1988). Background radiation doses are received from a number of various types of exposures (see Figure 4.10-1). Contributors to the annual background radiation dose include:

• Radon and its short-lived progeny	0.200 rem	(200 mrem)
• Naturally occurring radionuclides in the body (mainly potassium-40)	0.040 rem	(40 mrem)
• Cosmic radiation	0.030 rem	(30 mrem)
• Terrestrial radiation	0.030 rem	(30 mrem)

In addition, most people are commonly exposed to other artificial sources of radiation, which include:

• Medical x rays	0.039 rem	(39 mrem)
• Nuclear medicine procedures	0.014 rem	(14 mrem)
• Consumer products (e.g., television screens, smoke detectors, glazed pottery, luminous dials)	0.010 rem	(10 mrem)
• Other miscellaneous sources (e.g., air travel)	0.002 rem	(2 mrem)

Federal regulations for emissions of radionuclides into the air (40 C.F.R., Part 61) limit the effective dose equivalent offsite for a member of the public to no greater than 0.01 rem (10 mrem) per year. If a release point has the potential to result in a radiation dose offsite to a member of the public of 0.0001 rem (0.1 mrem) or greater, the release point must be monitored.

LLNL. Pursuant to a compliance order from the EPA, LLNL submitted an action plan, dated May 23, 1991, to the EPA. LLNL has initiated a plan to investigate and model all radionuclide stack emissions to demonstrate compliance with NESHAP. Quarterly progress reports are forwarded to the EPA.

SNL, Livermore has demonstrated compliance with the revised National Emission Standards for Hazardous Air Pollutants (NESHAP) published in December 15, 1989, 40 C.F.R. 61. The total radionuclide emission to the atmosphere for site operations in 1990 resulted in maximum offsite radiological dose of 0.15 mrem, effective dose equivalent (as compared to the NESHAP standard of 10 mrem). SNL, Livermore has completed a comprehensive, sitewide NESHAP assessment to determine compliance with the monitoring requirements of the NESHAP rule. Maximum inventory quantities and potential airborne release pathways were evaluated. This assessment concluded that all emission sources subject to the NESHAP rule were adequately monitored.

Ambient Monitoring for Radionuclides

LLNL Livermore Site and SNL, Livermore

Because of the proximity of the LLNL Livermore site and SNL, Livermore, the environmental protection organizations of the two Laboratories conduct a joint environmental monitoring program. The LLNL Livermore site, acting for SNL, Livermore as well, maintains six continuously operating high volume airborne particulate (HI-Vol) samplers on the perimeter of the site and 11 elsewhere in the Livermore Valley. The Laboratory analyzes the filters from these samplers for alpha, beta, and gamma radioactivity. During 1990, most of the gross alpha determinations were at or near the detection limit. Gross beta activity was also quite low at less than 1×10^{-15} mCi/mL. Most of this observed activity results from naturally occurring radioisotopes and their decay products. Of the radionuclides for which monitoring data are provided in Table 4.10-7, 7Be, 40K, 226Ra, 228Ra, and 228Th occur naturally. LLNL analyzes these radionuclides to ensure that any releases will be detected, and to identify background trends in the LLNL environs.

DOE publishes Derived Concentration Guidelines (DCGs) for radionuclides in air and water. Derived Concentration Guidelines are concentrations of radionuclides in air (or water) that, if inhaled (or consumed) continuously throughout the year, would result in an effective dose equivalent of 0.05 rem (50 mrem) per year. This is one-half of DOE primary radiation protection standard for the public of 0.1 rem (100 mrem) per year. NESHAP regulations (40 C.F.R., part 61) limit the radiation dose to a member of the public from airborne releases of radionuclides to no greater than 0.01 rem (10 mrem) per year effective dose equivalent. Thus, the concentrations for radionuclides released from the facilities may not exceed 20 percent of the Derived Concentration Guideline. The applicable Derived Concentration Guidelines for the monitored gamma emitters are presented in Table 4.10-7; the monitored concentrations for each isotope represent only a small percentage of the applicable Derived Concentration Guideline.

The LLNL Livermore site also analyzes some air filters specifically for plutonium-239, uranium-235, and uranium-238. During 1990, a sampler located on the southeast perimeter of the site measured the highest concentration of plutonium at 2.15×10^{-17} mCi/mL. This amount represents 0.11 percent of the Derived Concentration Guideline for Pu in air, which is 2.0×10^{-14} µCi/mL. Table 4.10-8 presents 1990 results for these radionuclides.

LLNL also analyzes samples at 19 locations specifically for ambient concentrations of tritium that might result from activities at the site. The results of tritium monitoring at the LLNL Livermore site perimeter are presented in Table 4.10-9. The average concentration of tritium in air at various locations at the site perimeter ranged from 0.66×10^{-11} to 1.84×10^{-11}mCi/mL with an overall average of 1.33×10^{-11} mCi/mL. SNL, Livermore also samples tritium at four onsite locations and obtains results similar to those at the LLNL Livermore site. At sampling locations throughout the Livermore Valley the tritium concentration averaged 0.54×10^{-11}mCi/mL. These concentrations can be compared with the Derived Concentration Guidelines for tritium of 10^{-7} mCi/mL.

LLNL Site 300

At LLNL Site 300 ambient monitoring is conducted to determine airborne radionuclide contributions from explosives testing and to identify trends in the environmental concentrations of radionuclides. Uranium-235 and plutonium-239 are not used at LLNL Site 300 and the observed airborne concentrations of these isotopes are attributable to their natural abundance or from the resuspension of global fallout from nuclear weapons testing. The ambient monitoring data indicate that during 1990 the location with the highest average concentration of plutonium-239 experienced levels approximating 0.04×10^{-17} mCi/mL. For uranium-238, during the same period the highest average ambient concentration was 9.86×10^{-5} mg/m3; uranium-235 was measured at approximately 9.33×10^{-7} mg/m3 for its highest average concentration at the site.

The Derived Concentration Guidelines for 239Pu, 238U, and 235U respectively are 2×10^{-14}, 1×10^{-13}, and 1×10^{-13} mCi/mL. The monitored concentrations at Site 300 are well below these guidelines and also comply with the NESHAP limits.

Radionuclide Exposure and Risk Calculations

For purposes of this EIS/EIR, potential exposures and risks associated with routine emissions of radionuclides from the LLNL Livermore site and SNL, Livermore were calculated using the EPA-approved model AIRDOS, specified in the regulations mentioned above. These computer models are used to predict potential atmospheric transport, exposures, and doses for radionuclides most likely to be emitted from routine laboratory operations. Population exposure figures were converted to dose using conversion and weighting factors specified by the EPA in NESHAP. For purposes of this document radionuclide doses associated with air emissions are reported as "annual effective dose equivalent" measured in units called "rem" or "millirem" (1 rem is equal to 1000 mrem). The models estimate weighted dose equivalents to specified body organs and the effective dose equivalent to the whole body of a hypothetical/maximally exposed individual (MEI). For purposes of these modelling exercises, this hypothetical member of the public is assumed to reside continuously (i.e., 24 hours/day, 365 days/year) at the point of highest ground-level radionuclide concentration for a specified time period (i.e., 1 year). While residing at this point, the MEI is also assumed to consume locally produced foodstuffs in equilibrium with the airborne concentrations of the radionuclides and to derive 1 percent of the drinking water supplies from water in equilibrium with the airborne concentrations.

For purposes of this EIS/EIR, in addition to doses calculated for the maximally exposed individual, doses were also predicted for the population at large. This dose, called the "collective effective dose equivalent," is calculated for the total population living within a 50 mile radius of a site (e.g., the LLNL Livermore site). This dose is obtained by assuming the 50-mile radius area is divided into sectors, projecting the average individual dose for each sector, multiplying that projected average sector dose by the actual number of individuals living in the area and then adding these sector doses for the entire area. The collective dose is reported in units of person-rem. Typically, U.S. Census figures are used for the actual population data. For this document, the 1990 Census population, which was determined to be approximately 6.3 million people in the actual 50-mile radius from the Laboratories was used to calculate the collective dose.

The risk of developing fatal cancer was calculated using the modeled dose estimates described above and "risk estimators" suggested by the International Commission on Radiological Protection and other organizations, which suggest that the average risk factor for exposure to ionizing radiation is about 500 fatal cancers per million "person-rem" of effective dose equivalent exposure (see Appendix C, section C.3.3).

The exposure and risk characterization process provides worst case estimates. The models are based on conservative assumptions that typically project significant overestimates of actual risks. Thus, the calculated doses do not represent those actually received by any member of the public. In fact, actual doses received and risks incurred would be considerably less than those presented in this document. Details concerning both exposure and risk determinations are found in Appendix C.

For 1990, radiation doses were modeled for the combined emissions of tritium, nitrogen-13, and oxygen-15 from the LLNL Livermore site and SNL, Livermore (See Table 4.10-10). The 1990 estimated collective radiation dose equivalent was almost entirely attributable to tritium released from the Hydrogen Research Facility (Building 331) at LLNL and the Tritium Research Laboratory (Building 968) at SNL, Livermore. In 1990, 1282 Ci of tritium were released into the atmosphere from LLNL, 700 Ci of which was tritiated water, and 295 Ci of tritium were released from SNL, Livermore, 244 Ci of which was tritiated water. The discharge of tritium from SNL, Livermore includes the evaporation of tritiated water that exceeds the concentration limits for discharge into the sewer systems. Water exceeding the concentration limit is collected and evaporated. The vapors emitted from the evaporation are discharged through the stack near the Tritium Research Facility, Building 968. Under the regulations of the State of California no more than 100 Ci of tritiated water is allowed to be discharged annually from the evaporator which is permitted by the EPA and Bay Area Air Quality Management District. The maximum radiation dose calculated at the "fenceline" of the facility was 0.25 mrem. At the point of maximum offsite exposure, the point the model assumes a person actually resides, the dose was also estimated as 0.25 mrem. The EPA standard for such emissions is 10 mrem/year effective dose equivalent. For 1990 the dose to the maximally exposed individual assumed to reside offsite at the highest concentration of radionuclides and to consume radiation-contaminated foodstuffs and water was 0.25 mrem.

The 1990 estimated collective dose equivalent for the general population living within a 50-mile radius of the LLNL Livermore site and SNL, Livermore was 31 person-rem. The AIRDOS model calculates risk from several possible sources of exposure including inhalation of air, contact with ground services, immersion in water, drinking contaminated water, and ingestion of food produced locally and contaminated with radionuclides. The calculated contribution to total dose is about 14 percent from inhalation and 86 percent from ingestion. Based on these percentages and the 1990 estimated collective dose equivalent of 31 person/rem, about 4 person/rem is due to inhalation with the remaining 27 person/rem attributed to ingestion sources including locally grown foods, assuming all food is produced locally. This radiation dose is calculated to result in about 1 chance in 70 of causing one fatal cancer in the population of 6.3 million persons. As a comparison, the collective population dose from natural sources of radiation in the same time period was estimated to be 1.9×10^{6} person-rem and this would result in about 950 fatal cancers (see Appendix C).

Using the dose estimated for the MEI (i.e., 0.25 mrem) and the risk estimators discussed above, the lifetime risk to the hypothetical maximally exposed individual of developing a fatal cancer due to release of radionuclides from the operation of the LLNL Livermore site and SNL, Livermore during 1990 is less than 1 in 8 million. As a comparison the EPA estimates that the lifetime risk to the U.S. population attributable to one year of exposure to natural background sources of radiation is approximately 1 in 6000.

LLNL Site 300

LLNL Site 300 has two potential sources for atmospheric emissions of radioactivity: the Advanced Test Accelerator (ATA) and high explosives tests. The ATA was not operational during 1990, so this facility contributed no air emissions for this period; during 1989, 0.57 Ci each of nitrogen-13 and oxygen-15 were released at the site. Airborne test emissions cannot be monitored at the source, but are assessed through a network of ambient air monitors for radionuclides.

Because the ATA was not operational during 1990 all doses from this source were zero mrem. The results of radionuclide ambient monitoring for LLNL Site 300 were presented earlier in this subsection along with their applicable Derived Concentration Guideline's.

Table 4.10-4 Monthly Mean Concentrationa of Beryllium on Air Filters LLNL Livermore Site Perimeter for 1986–1990 All Monitoring Sites

Month	1986	1987	1988	1989	1990
January	12.3	2.0	2.9	2.6	ND
February	1.7	3.7	5.2	3.1	ND
March	4.2	3.5	2.8	5.2	ND
April	3.2	5.5	2.9	1.0	ND
May	4.6	3.4	1.9	1.6	3.4
June	6.0	4.7	1.4	4.0	4.7

July	8.9	3.4	3.4	2.3	4.7
August	5.7	5.1	4.1	6.4	1.0
September	3.3	4.8	1.3	ND[b,c]	5.3
October	5.8	4.6	6.8	ND	8.9
November	3.2	2.1	3.0	ND	7.0
December	4.2	3.0	3.4	ND	6.5

[a] $\times 10^{-5}$ µg/m^3.
[b] ND: Concentration below detection limits (<= 27×10^{-5} µg/m^3). BAAQMD Guideline 1000×10^{-5} µg/m^3.
[c] Contract laboratory analysis methods changed during September 1989–April 1990. The change in analysis method produced a higher detection limit.
Source: LLNL, 1986–1990.

Table 4.10-5 Monthly Mean Concentrationa of Beryllium on Air Filters LLNL Site 300 Perimeter for 1986–1990All Monitoring Sites

Month	1986	1987	1988	1989	1990
January	1.1	1.0	1.2	0.7	ND
February	0.4	1.3	2.2	1.4	ND
March	1.9	3.9	1.7	0.3	ND
April	1.6	5.1	2.3	1.7	ND
May	4.0	2.9	1.0	1.8	1.8

June	2.6	2.9	0.7	2.4	2.7
July	6.4	2.2	2.0	1.6	3.6
August	2.4	3.5	1.4	3.5	1.9
September	2.0	3.0	2.1	ND[b,c]	4.6
October	3.3	3.5	4.0	ND	4.9
November	1.0	2.0	1.3	ND	4.1
December	1.5	1.7	1.4	ND	4.9

[a] $\times 10^{-5}$ mg/m^3.
[b] ND: Concentration below detection limits (£ 27×10^{-5} mg/m^3). BAAQMD Guideline 1000×10^{-5} mg/m^3.
[c] Contract laboratory analysis methods changed during September 1989–April 1990. The change in analysis method produced a higher detection limit.
Source: LLNL, 1986–1990.

Table 4.10-6 Monthly Mean Concentrationa of Beryllium on Air Filters at Tracy, California, Fire Station for 1986–1990

Month	1986	1987	1988	1989	1990
January	4.9	0.3	1.0	3.2	ND[b]
February	1.7	0.7	3.6	4.0	ND
March	3.4	1.3	4.4	0.9	ND

April	3.4	5.6	3.5	ND	ND
May	9.3	1.2	2.8	0.9	3.1
June	7.8	0.6	2.1	4.0	5.1
July	5.9	0.8	3.7	2.2	4.7
August	4.8	0.6	3.4	3.9	0.8
September	2.4	5.2	2.5	ND[c]	7.0
October	7.8	4.0	11.0	ND	10.9
November	0.3	10.0	0.6	ND	8.8
December	2.4	2.5	2.3	ND	4.8

[a] $\times 10^{-5}$ mg/m^3.
[b] ND: Concentration below detection limits (£ 27×10^{-5} mg/m^3). BAAQMD Guideline 1000×10^{-5} mg/m^3.
[c] Contract laboratory analysis methods changed during September 1989–April 1990. The change in analysis method produced a higher detection limit.
Source: LLNL, 1986–1990.

SNL, Livermore. The Bay Area Air Quality Management District has interpreted section 41700 of the Health and Safety Code as the authority to regulate emissions of radionuclides from SNL, Livermore.

Table 4.10-7 Gamma Activity on Air Filters—LLNL Livermore Site Perimeter, 1990a

	^{7}Be	**^{40}K**	**^{137}Cs**	**^{22}Na**	**^{226}Ra**	**^{228}Ra**	**^{228}Th**
Month	**[10^{-13}μCi/mL±2s(%)]**	**[10^{-16}mCi/mL±2s(%)]**					
Jan.	0.48±2	<=1.36	<=0.06	<=0.06	<=0.12	<=0.26	<=0.13
Feb.	0.68±2	<=1.32	<=0.06	<=0.06	<=0.12	<=0.25	<=0.14
Mar.	0.98±2	<=1.07	<=0.05	0.13±83	<=0.09	<=0.19	<=0.12

Apr.	1.17±2	4.83±38	0.09±77	0.18±50	0.26±40	0.27±75	0.32±39
May	1.22±2	8.21±31	0.13±84	0.19±58	0.30±49	0.46±67	0.42±40
June	0.77±2	5.67±40	0.08±74	0.10±78	0.26±49	<=0.22	0.21±73
July	0.98±2	5.39±37	0.10±78	0.12±74	0.28±40	0.47±50	0.39±43
Aug.	0.79±2	5.94±42	0.12±43	<=0.04	0.35±40	0.43±67	0.27±55
Sept.	1.36±2	7.28±27	0.11±65	<=0.08	0.37±29	0.68±34	0.48±30
Oct.	1.61±2	9.40±20	0.16±39	0.11±57	0.49±28	0.56±37	0.53±26
Nov.	1.24±2	6.00±52	0.16±46	<=0.04	0.45±44	0.59±60	0.44±53
Dec.	1.36±2	<=1.41	<=0.05	<=0.05	0.28±58	<=0.22	<=0.12
Median	**1.05**[c]	**<=5.53**	**<=0.10**	**<=0.09**	**<=0.28**[c]	**<=.035**	**<=0.30**
DCG[b]	5×10^{-8}	9×10^{-10}	4×10^{-10}	1×10^{-9}	1×10^{-12}	3×10^{-12}	4×10^{-14}
% of DCG	2×10^{-4}	6×10^{-5}	3×10^{-6}	9×10^{-7}	3×10^{-3}	1×10^{-3}	8×10^{-2}

[a] All LLNL Livermore site perimeter samples composited. b DCG in mCi/mL.
[b] DCG in µCi/mL.

Table 4.10-8 Tritium in Air—LLNL Livermore Site Perimeter, 1990

Month	Sampling Locations					
	SALV	MESQ	CAFE	MET	VIS	COW
	$[10^{-11}$µCi/mL±2s(%)]					
Jan.	2.27 ± 9 2.33±4	0.80 ± 10 1.22 ± 8 1.07 ± 12 0.92 ± 12	1.88 ± 4 2.01 ± 7	0.82 ± 10 1.13 ± 13	0.91 ± 7 1.26 ± 9	1.24 ± 10
Feb.	1.09 ± 7 1.05 ± 7	1.22 ± 7 0.94 ± 8 0.64 ± 14	1.52 ± 6 1.80 ± 5	0.62 ± 12 0.23 ± 25 0.20 ± 28	1.33 ± 6 0.72 ± 10	0.83 ± 9 0.58 ± 13
Mar.	1.60 ± 7 2.00 ± 6	0.60 ± 18 0.87 ± 13	1.82 ± 6 1.73 ± 7	0.31 ± 29 0.25 ± 34 0.26 ± 33 0.49 ± 17 0.51 ± 13	1.41 ± 7 1.45 ± 8	1.07 ± 9 1.27 ± 9
April	1.25 ± 8 2.89 ± 5	0.98 ± 12 1.05 ± 13	1.52 ± 7 0.93 ± 13	0.50 ± 21 0.57 ± 17	1.68 ± 6 2.04 ± 7	0.86 ± 11 1.55 ± 8

				0.83 ± 15		1.51 ± 9
May	1.25 ± 7 1.25 ± 9	0.84 ± 12 0.47 ± 26	2.15 ± 5 0.63 ± 17	0.50 ± 19 0.26 ± 41	1.38 ± 6 1.92 ± 7	0.73 ± 11 0.69 ± 12 0.66 ± 15 0.49 ± 21
June	1.71 ± 9 1.20 ± 10	2.48 ± 7 0.65 ± 18	1.19 ± 12 1.71 ± 7	0.84 ± 18 0.31 ± 37	3.81 ± 5 2.14 ± 6 1.92 ± 6 2.15 ± 6	2.06 ± 7 1.82 ± 8 0.67 ± 15
July	1.53 ± 8 1.32 ± 8	0.54 ± 25 0.29 ± 35	0.63 ± 18 0.58 ± 19	0.16 ± 83 <=0.12	1.65 ± 8 1.74 ± 8 2.08 ± 6 2.37 ± 6	0.69 ± 18 0.65 ± 16
Aug.	1.29 ± 11 2.70 ± 5 3.03 ± 5 1.31 ± 11 1.18 ± 12	<=0.13 0.54 ± 17 0.42 ± 37	0.27 ± 45 1.16 ± 11 0.73 ± 16	0.19 ± 65 0.30 ± 28 0.38 ± 39	2.21 ± 7 1.81 ± 6 1.36 ± 10	0.74 ± 17 1.84 ± 7 0.91 ± 10 0.70 ± 19
Sept.	1.10 ± 9 1.04 ± 11 1.18 ± 10	0.33 ± 38	0.77 ± 13 0.82 ± 4	0.42 ± 24 0.33 ± 33	1.66 ± 6 1.15 ± 10	0.66 ± 13 0.95 ± 12
Oct.	1.96 ± 6 1.00 ± 6	2.27 ± 5	3.87 ± 4 3.93 ± 3	1.40 ± 9 1.26 ± 10	1.99 ± 4 2.12 ± 5	1.37 ± 7 0.89 ± 10
Nov.	2.13 ± 5 1.58 ± 7	1.31 ± 7 2.38 ± 5	6.34 ± 2 2.29 ± 5	0.94 ± 9 1.60 ± 7	1.97 ± 5 1.62 ± 6	1.16 ± 7 1.33 ± 7
Dec.	0.96 ± 8 1.55 ± 7	2.42 ± 4 1.61 ± 7	2.93 ± 3 2.80 ± 4	1.29 ± 6 1.31 ± 9 2.21 ± 6	1.13 ± 7 2.33 ± 4	0.93 ± 8 1.03 ± 8
Mean[a]	**1.63**	**1.04**	**1.84**	**0.66**	**1.77**	**1.03**
Percent of DCG[b]	**0.02**	**0.01**	**0.02**	**0.007**	**0.02**	**0.01**
Dose (μrem)[c]	**1.3×10^{-2}**	**0.8×10^{-2}**	**1.5×10^{-2}**	**0.5×10^{-2}**	**1.4×10^{-2}**	**0.8×10^{-2}**

[a] LLNL Livermore site perimeter overall average=1.33×10^{-11}μCi/mL.
[b] DCG=1×10^{-7}μCi/mL (1×10-1μCi/mL).
[c] This dose is the effective dose equivalent.

Table 4.10-9 Plutonium and Uranium Activity on Air Filters—LLNL Livermore Site Perimeter, 1990

Annual Averages			

Location	^{239}Pu			^{238}U			^{235}U		
	10-17 μCi/mL	SDM (%)	Percent of DCG[a]	10-5 μg/m^3	SDM (%)	Percent of DCG[b]	10^{-7} μg/m^3	SDM (%)	Percent of DCG[c]
SALV	0.41	143	0.021	7.11	41	0.024	4.85	44	0.001
MESQ	0.26	144	0.013	7.59	28	0.025	5.37	31	0.001
CAFE	0.14	85	0.007	9.43	28	0.031	6.50	34	0.001
MET	0.23	254	0.011	7.21	35	0.024	5.09	38	0.001
VIS	0.22	111	0.011	5.67	50	0.019	4.01	52	0.001
COW	0.17	145	0.008	7.73	33	0.026	5.44	35	0.001

[a] DCG=2×10^{-14} μCi/mL for ^{239}Pu activity in air or 2×10^{-2} pCi/m^3.
[b] DCG1=10^{-13} μCi/mL (= 0.3 μg/m^3) for ^{238}U activity in air.
[c] DCG=1×10^{-13} μCi/mL (= 0.047 μg/m^3) for ^{235}U activity in air.

Table 4.10-10 Quantities of Radioactive Airborne Effluents Released by the LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

Site and Type of Radioactive Airborne Effluent Released	Quantities Released Per Year (Ci)				
	1986	1987	1988	1989	1990
LLNL Livermore Site					
Tritium (^{3}H)					
Contribution from Building 331					
HTO	661	1246	1615	1555	700
HT	467	1388	2333	1395	581
Total from B-331:[a]	1128	2634	3948	2950	1281
Total from LLNL:[b]	1254	2751	3983	2952	1282
Nitrogen-13 (^{13}N)	56.5	31	15	21	24
Oxygen-15 (^{15}O)	56.5	31	15	21	24
LLNL Site 300[c]					
Nitrogen-13 (^{13}N)	22.5	7	5.7	0.57	0
Oxygen-15 (^{15}O)	22.5	7	5.7	0.57	0
SNL, Livermore					

Tritium (^3H)					
HTO	629	570	1047	656	244
HT	131	1257	543	178	51
Total: [a,d]	760	1828	1590	834	295

[a] Includes tritiated water vapor (HTO) and tritium gas (HT).

[b] The major source of 3H at the LLNL Livermore site is Building 331; other sources may include Buildings 292, 298, 381, 391, etc.

[c] Some tritium may be released at Buildings 801, 850, 851, etc.

[d] Building 968 is the only source of 3H at SNL, Livermore.
Source: LLNL, 1986–1990; SNL, Livermore, 1991k, 1991a; Brekke, 1990.

4.10.3 Toxic Air Contaminants

Toxic air contaminants (TAC) are airborne substances that are capable of causing short-term or long-term adverse human health affects and include both organic and inorganic chemical substances. The California Air Toxics "Hot Spots" Information and Assessment Act of 1987 (AB2588) requires facilities to submit to the local air districts a comprehensive plan, for estimating the volumes of air toxics emitted by the facility. Following approval of the plan, the facilities must submit the resulting air toxics emissions inventory to the district by a separate, specified deadline. After the district receives completed inventories, it is required to identify high-priority facilities that must prepare facility-wide health risk assessments. A health risk assessment is based on the established cancer and noncancer toxicity factors for various TACs, estimated or measured quantities of emissions from individual air pollution sources at a facility, and a "worst case" hypothetical exposure scenario that assumes an individual will be exposed for a continuous 70-year period to the facility's maximum quantity of TAC emissions. A facility operator is required to give notice to "all exposed persons" if the district concludes, based upon the risk assessment, that there is a significant health risk caused by the toxic air emissions from the facility.

Based on the emission inventory information submitted by LLNL Livermore, the Bay Area Air Quality Management District determined that projected emissions required a risk assessment. SNL, Livermore, however, was not required to perform a risk assessment based on the emission inventory submitted. The AB2588 report for LLNL Site 300 will be completed and submitted to the San Joaquin Valley Unified Air Pollution Control District after specific source emission testing is performed as required by the regulatory agency. This will complete the emission inventory. At that time the air district will determine if a risk assessment is necessary.

LLNL Livermore Site

The first step of the LLNL AB2588 emissions inventory and screening assessment process was to identify and estimate the quantities of materials that could be emitted from LLNL operations. The list of compounds that must be identified and emission factors to be used to estimate emissions are specified in the AB2588 guidelines. Potential emissions of carcinogens (8 chemicals) and noncarcinogens (9 chemicals) were estimated for each building at LLNL. The estimated emissions rates for these compounds are presented in Table 4.10-11.

The exposure assessment was developed using the EPA's Industrial Source Complex–Short Term (ISC-ST) air dispersion model. Site specific parameters such as meteorological data and building and stack heights were used in the modeling (LLNL, 1991a). The model was used to predict locations of the maximum offsite ground level concentrations from potential emissions. This information, along with toxicity information about the chemicals of concern, was then used to predict the carcinogenic risk and noncarcinogenic hazard index.

The assessment assumed that an individual is located continually for 70 years at the location of the maximum predicted offsite ground level concentration of toxic air emissions from the site (LLNL, 1991a).

The maximum carcinogenic risk for LLNL was calculated by adding the individual risk numbers for each chemical identified in Table 4.10-11. The total risk was estimated to be 3 in 1 million (LLNL, 1991a). This is below the threshold of 10 in 1 million, designated as the level of concern by the Bay Area Air Quality Management District. The maximum values for noncarcinogenic hazard indices were 0.089 for chronic exposures (i.e., exposure durations greater than 7 years) and 0.42 for short-term exposures (LLNL, 1991a). Both of these noncarcinogenic hazard indices are also below the level of concern of 1.0 developed by the California Air Pollution Control Officers Association (CAPCOA), and used by the regional air boards and local air districts (CAPCOA, 1991). The Bay Area Air Quality Management District is currently reviewing the risk assessment.

LLNL Site 300

LLNL Site 300 developed and submitted to the San Joaquin Valley Unified Air Pollution Control District a comprehensive plan and emission inventory to comply with AB2588. This plan identified the TAC from all sources at LLNL Site 300 except the high explosive waste thermal treatment unit referred to as the "Iron Horse." The "Iron Horse" is a containment device used to confine ash generated from the burning of waste explosives. Because of the design and function of the Iron Horse, no agency has developed specific source testing methods or emission estimation techniques for use in quantifying emissions from the Iron Horse. Thus, at the time the original AB2588 emission estimates were submitted for LLNL Site 300 such data were not available. The plan was deemed incomplete by the San Joaquin Valley Unified Air Pollution Control District since the TAC emissions from the Iron Horse were unavailable. The LLNL Livermore site, after consultation with applicable agencies and experts in emission testing, has submitted a source testing protocol, which may provide the absent information, to the regulatory agency. The emission inventory will be completed once emission testing procedures for the Iron Horse proposed by LLNL Site 300 are approved by the San Joaquin Valley Unified Air Pollution Control District and the California Air Resources Board. At that time the plan will be reviewed by the air district and it will be determined if a risk assessment is required. The TAC emission estimates for all sources except the Iron Horse at LLNL Site 300 are shown in Table 4.10-12.

SNL, Livermore

SNL, Livermore has submitted the emission inventory plan and an air toxic emissions inventory to the Bay Area Air Quality Management District to comply with AB2588. The air toxics (Hot Spots) plan for compliance with AB2588 was reviewed and approved by the Bay Area Air Quality Management District. Based on the emission estimates contained in the plan, no health-risk assessment was required. The estimate of TAC emissions from SNL, Livermore are presented in Table 4.10-13.

Table 4.10-11 Annual Emissions Estimates of Toxic Air Contaminants for LLNL Livermore Site

Contaminant	Baseline Condition Annual Amount (lb/year)
Chlorine	675
Ethylene glycol ethyl ether acetate	212
Fluorocarbons	28,770
Glycol ethers (other)	24
Hydrogen fluoride	<0.1

Methanol	1,230
Toluene	274
1,1,1-Trichloroethane	16,270
Xylenes	117
Benzene	196
Carbon tetrachloride	493
Chloroform	633
Dioxane (1,4-)	161
Ethylene dichloride	<1
Formaldehyde	35
Methylene chloride	738
Trichloroethylene	728

Source: LLNL, 1991a.
Note: The emission rates shown above were used to develop the human health risk and hazard indices for the LLNL Livermore site. These emission rates differ from the initial TAC emission information submitted by LLNL to the BAAQMD due to suggested changes and modifications recommended by the BAAQMD.

Table 4.10-12 Annual Emissions Estimates of Toxic Air Contaminants for LLNL Site 300

Contaminant	Projected 1992 Baseline Condition Annual Amount (lb/yr)
Arsenic	0.43
Beryllium	0.026
Cadmium	0.11
Chromium	0.014
Copper	2.9
Formaldehyde	4.2
Lead	0.092
Magnesium	0.27
Mercury	0.031

Nickel	1.8
PAH	0.23
Fuel Dispenser Gasoline	
Dispensers	110.7
Tank Loading	968.5
Spray Booths	
Glycol Ethers	117
Toluene	40
Xylene	11
High Explosive Detonation 801, 850, 851	
Ammonia	20.9
Benzene	0.18
HCL	7.3
HCN	3.9
HF	26.5
PAH	0.000003
Toluene	0.3
High Explosive Metals	
Beryllium	0.31
Nickel	0.42
Cooling Tower	
Chloroform	0.12
Sodium Hydroxide	13.3
Limited Chemistry Lab	
Ethylene Dichloride	1
Fluorocarbons	3.9
Methylene Chloride	55
Toluene	0.36
Drinking Water Chlorination	

Chlorine Hydroxide	15
Cold Cleaning	
Freon 113	721
Vapor Extraction System	
Trichloroethylene	8
Refrigerants	
R12	145
R13	80
R22	375
R113	66
R502	100
R503	70
Automotive Parts Cleaning	
Cresol	1.8
Methylene Chloride	4.8
Linear Accelerator X-Ray Equipment	
R12	580

Source: LLNL, 1990a.

Table 4.10-13 Annual Emissions of Toxic Air Contaminants for SNL, Livermore

Contaminant	Projected 1992 Baseline Condition Annual Amount (lb/yr)
Trichloroethene	1765
Gasoline Vapors	170
Chlorofluorocarbons	300

Reference: DOE, 1989e.

4.11 WATER

This section provides an overview of surface and ground water at the LLNL Livermore site, LLNL Site 300, and SNL, Livermore. Additionally, this section describes water use and flood plains at these sites. A discussion of existing contamination in the ground water at and adjacent to the sites is included in section 4.17.

4.11.1 Surface Water

LLNL Livermore Site and SNL, Livermore

Surface drainage and natural surface infiltration at the LLNL Livermore site and SNL, Livermore are generally good, but drainage decreases locally with increasing clay content in surface soils (U.S. Department of Agriculture Soil Conservation Service, 1966, 1990). While they are distinct operations managed and operated by different contractors, for purposes of this document the LLNL Livermore site and SNL, Livermore are addressed together because of their proximity. Only intermittent streams flow into the eastern Livermore Valley from the surrounding uplands and low hills, where they merge on the valley floor. Surface flow may occur intermittently from October to April, during the valley's wet season. The four major intermittent streams that drain into the eastern Livermore Valley are Arroyo Mocho, Arroyo Seco, Arroyo Las Positas, and Altamont Creek (Figure 4.11-1). Recharge to the sediments underlying the Livermore Valley is primarily from the arroyos that originate in the eastern foothills and flow across the valley. When surface flow occurs in these channels, water infiltrates into the underlying alluvium and eventually percolates to the aquifers within the Valley (Rogers, 1982; Stone et al., 1982).

The headwaters of the Arroyo Seco drainage are in the hills southeast of the LLNL Livermore site and SNL, Livermore. Arroyo Seco has a drainage length of approximately 12 miles and has a watershed area of approximately 8960 acres upstream of SNL, Livermore. The channel is well defined in the section that passes directly through the LLNL Livermore site and SNL, Livermore, and it is dry for at least 6 months of the year. In fact, during dry years, it may flow only 10–15 days/year in the LLNL Livermore site vicinity.

A field survey of watercourses and ponds was conducted for this EIS/EIR in April and May 1991. Arroyo Seco was dry during the survey, except where the channel enters the perimeter area of SNL, Livermore to the southeast. In that area there were several shallow pools with an assortment of established hydrophytic vegetation.

Arroyo Las Positas drains from the hills directly east of the LLNL Livermore site with a watershed area of approximately 3300 acres. The channel is not well defined and usually carries only storm water runoff. This channel enters the LLNL Livermore site from the east, is diverted along a storm ditch around the northern edge of the site, and exits the site at the northwest corner. A pool of standing water with established hydrophytic vegetation was found in this ditch before it exited the site.

Nearly all surface water runoff at the LLNL Livermore site is discharged into Arroyo Las Positas; only surface runoff along the southern boundary and some storm drains in the southwest corner of the LLNL Livermore site drain into Arroyo Seco. All surface runoff from SNL, Livermore is discharged into Arroyo Seco. All of the abovementioned intermittent stream channels join west of the two sites. Regional drainage is through the southwestern part of the Livermore Valley into the San Francisco Bay through Alameda Creek.

Other natural and artificial bodies of water present in the eastern Livermore Valley are shown in Figure 4.11-1. There are more than 30 assorted ponds located in and around the eastern Livermore Valley, 20 of which are located within a 5-mile radius of the LLNL Livermore site. The majority of the small ponds are used for private water storage for livestock watering; some have other uses, such as ornamental. The Patterson Reservoir is located approximately 0.8 mile to the northeast of the LLNL Livermore site. This reservoir covers an area of 3.23 acres and contains a volume of about 100 acre-feet. The South Bay Aqueduct is an open canal that circles the Livermore Valley and delivers water to the south San Francisco Bay Area. Several ponds in the area were dry or nearly dry at the time of the April–May 1991 field survey because of recent drought conditions. The pond situated on the LLNL Livermore site called the Drainage Retention Basin receives local runoff. This basin was dry at the time of the survey. During extremely wet times this basin can overflow through culverts into the LLNL storm drains to the diverted course of Arroyo Las Positas. A second basin constructed by LLNL to recharge treated ground water is located in the west perimeter area at SNL, Livermore. This basin was dry during the survey period.

LLNL routinely performs surveillance monitoring of waters for the LLNL Livermore site and surrounding regions of the Livermore Valley (LLNL, 1990d, 1991f). The waters monitored in the Livermore Valley include lakes and aqueducts, tap water, storm water runoff, and water supply wells. The samples are collected on a quarterly basis and are analyzed for gross alpha and beta radiation, tritium, and nonradioactive pollutants, including solvents, metals, and pesticides (LLNL, 1990d, 1991f). Water samples are collected from five surface water sources, an onsite swimming pool, and four domestic water supplies, one onsite at LLNL, and four offsite. In addition to the historical rainfall collection location for the LLNL Livermore site, 16 new locations have been established for a special assessment of tritium in rain and storm water. Rain samples are collected after each rainstorm and storm water samples are collected during the storm. Tritium released into the atmosphere from the LLNL Livermore site and SNL, Livermore may become entrained in raindrops that pass through the plume. The incident rainfall may accumulate and remain in standing pools of water at the ground surface. The rainfall that accumulates in pools represents an additional potential source of exposure due to inhalation and absorption through the skin for several days following a rain before the water evaporates or percolates into the ground. Currently, the storm water runoff monitoring program includes sampling of nine locations during the period of active surface water flow that follows the first major storm event of the rain season. Acetone and other organics have been found sporadically at various locations.

Gross alpha and beta activities in these surface and domestic water samples collected in 1990 were below EPA and DHS maximum contaminant levels. Tritium activities exceeded the maximum contaminant level for drinking water (20,000 pCi/L) in storm water runoff at the LLNL Livermore site. The range of tritium concentrations in storm water runoff detected at the LLNL Livermore site was 130 pCi/L to 57,000 pCi/L. Storm water is not drinking water and the maximum contaminant levels are used for comparison and trend analysis only. These concentrations may also be compared with the DOE discharge limit for discharges to sanitary sewers, which is 1×10^{-2}mCi/mL.

The highest tritium activity concentration detected for surface water bodies was 1090 pCi/L in the onsite swimming pool (LLNL, 1991f). The estimated annual (effective) dose assuming that a person consumed 2 L of water per day containing this tritium concentration would be 0.056 mrem (LLNL, 1991f).

An evaluation of the rain to surface water pool exposure pathway was conducted to determine the relative contribution to dose. Assuming exposure for 10 days a year (24 hours per day) to standing pools of rainwater with a concentration of 3.2×10^{3} pCi/L (maximum observed average concentration in rainwater at the site boundary during 1990), and a water intake rate through inhalation and absorption through the skin of 220 mL/day (NCRP, 1979), the resulting dose is estimated to be 4×10^{-7}rem (0.0004 mrem)/year, compared to the annual dose limit of 0.01rem (10 mrem) for atmospheric releases. The calculation of radiation doses for tritium releases into the atmosphere using AIRDOS-PC, and presented in Section 4.10, assumes that all water inhaled or absorbed through the skin is in equilibrium with the tritiated water vapor in the air. Thus the doses presented here are a subset of the AIRDOS-PC calculations and are not additive.

None of the water production wells monitored contained tritium concentrations that were above the maximum contaminant level, and all were near background levels. Nonradioactive contaminants were generally not present at detectable levels in storm runoff. Acetone was detected at four locations with the highest concentration being 16 mg/L. Solvents were detected in trace quantities. Both solvents and acetone were below the maximum contaminant levels. Metals were not detected above normal background levels expected for water that has been in contact with soil (LLNL, 1991f).

LLNL Site 300

An inventory of surface waters and wetlands at LLNL Site 300 was made in late April to early May 1991 and is presented on Figure 4.11-2. A discussion of wetlands is presented in section 4.9.4. Figure 4.11-2 shows all springs and pools at LLNL Site 300. There are no perennial streams at or near LLNL Site 300. The canyons that dissect the hills and ridges at LLNL Site 300 drain into intermittent streams. The majority of the intermittent streams onsite drain to the south to Corral Hollow Creek, also intermittent, which runs along the southern boundary of LLNL Site 300 toward the east into the San Joaquin Valley. Some of the canyons in the northeast section of the site drain to the north and east toward Tracy in the San Joaquin Valley. During the survey, only Corral Hollow Creek contained a small flow. A minor amount of drainage in the northwest portions of LLNL Site 300 is to the Livermore Valley.

Naturally occurring springs show both the presence of flowing water or wet soils where the water table at that point is close to the surface, and the presence of distinct hydrophytic vegetation (cattails, willow) described in section 4.9. There are 24 flowing springs onsite with a single-flowing spring located just offsite along the north fence on the Alameda/ San Joaquin County line. Another producing spring is located on adjacent State of California property along the south border of LLNL Site 300. This spring is located east of the pistol range and has been excavated to allow a year-long artificial pond to accumulate. The flow from this spring originates from an artesian well which is allowed to discharge into the pond. There are also at least three nonflowing springs onsite with resident hydrophytic vegetation and wet soils.

A single vernal pool was identified in the northwest corner of the site. This pool had both distinctive vegetation and wet soils just below the surface, but was dry. Many other dry pools were noted, but vegetation and dry soils distinguished them as ephemeral pools.

Several areas of surface water discharge were observed onsite near cooling towers or other process runoff areas (Figure 4.11-2). These artificial runoff areas have the same characteristics as natural springs because they contain running water and support hydrophytic vegetation. A single surface source was noted originating from the Building 834 complex at the time of the survey; here, the vegetation was present but the soils were all dry. The General Services Area at LLNL Site 300 has one sewage treatment pond and an overflow basin located on the southeast border of the site.

The Environmental Monitoring Group conducts routine monitoring for surface and domestic water in the vicinity of LLNL Site 300. Surface water samples are collected quarterly from Corral Hollow Creek, a rainfall collection location near Bunker 812, in the center of LLNL Site 300, and from a number of water production wells (both active and inactive). Surface water samples are collected and analyzed for gross alpha, gross beta, and tritium activity. Water supply wells are sampled quarterly for gross alpha, gross beta, tritium activity, volatile organic compounds, and metals (beryllium, chromium, copper, and lead).

As discussed in section 4.17, effluent from ground water treatment systems and sewer and cooling tower discharges are also monitored periodically according to NPDES requirements.

Gross alpha and beta activities in the surface water samples collected in 1990 were below EPA and DHS maximum contaminant levels. The highest concentration of tritium in water (54.7 pCi/L) occurred in rain that was collected on December 15, 1990. This tritium activity represents 0.003 percent of the maximum drinking water contaminant level for tritium of 20,000 pCi/L.

Low levels of tritium (less than 25.6 pCi/L) were detected in onsite and offsite drinking water supply wells in 1990. The doses from the active onsite water supply wells (wells 18 and 20) are equal to, or less than 0.0004 mrem. Doses from active offsite water supply wells (wells CARNRW2, CDF-1, CON-1, and GALLO-1) are equal to or less than 0.0006 mrem. All tritium activities in these water supply wells are a fraction of the maximum drinking water contaminant level for tritium level of 20,000 pCi/L. For additional discussions on ground water contamination at LLNL Site 300, see section 4.17.

4.11.2 Ground Water

4.11.2.1 Regional Hydrogeology

LLNL Livermore Site and SNL, Livermore

The majority of Livermore Valley sediments are water-bearing and transmit ground water in varying degrees. In contrast, the uplands generally do not yield ground water in sufficient quantities to constitute a ground water resource (California Department of Water Resources, 1974). The Livermore Valley has been divided into a series of 12 ground water subbasins based on the location of faults, topography, and other hydrogeological barriers that affect ground water occurrence, movement, and quality (Figure 4.11-3). While they are distinct operations managed and operated by different contractors, for purposes of this document LLNL Livermore and SNL, Livermore sites are addressed together because of their proximity.

The LLNL Livermore site and SNL, Livermore lie primarily within what are called the Spring and Mocho I subbasins. The water-bearing sediments in the Livermore Valley include late-Pleistocene to Holocene-age alluvial sediments, generally less than 200 ft (61 m) thick, which overlie Plio-Pleistocene alluvial and lacustrine Livermore Formation sediments up to 4000 ft (1219m) thick (Thorpe et al., 1990).

The Livermore Formation consists of beds of gravel, sand, silt, and clay of varying permeabilities. Sandy-gravelly layers alternate with fine-grained, relatively impermeable layers, and ground water can be both confined and semiconfined.

Stream runoff from precipitation and controlled releases from the South Bay Aqueduct, direct rainfall, irrigation, and treated ground water infiltration recharge the Livermore Valley ground water basin (Isherwood et al., 1990). In addition, stream channels and ditches, and gravel pits west of the City of Livermore are important sources for shallow, alluvial aquifer recharge (WESCO, 1988). Ground water is naturally discharged from the basin at Arroyo de la Laguna, located over 11 miles southwest of the LLNL Livermore site. Some minor discharges also occur at springs, including those along Arroyo Las Positas near its confluence with Altamont Creek (Isherwood et al., 1990). Recharge occurs primarily in uplands east and southeast of the LLNL Livermore site and SNL, Livermore. Stream recharge may contribute up to 61 percent by volume of recharge to the basin (Thorpe et al., 1990).

In general, most ground water in the basin flows toward the west central portions of the valley. Ground water generally moves east to west within the Livermore Valley; ground water near the center of the Livermore Valley moves toward the Amador subbasin and terminates in a large ground water depression near gravel mining areas located west of the City of Livermore (Thorpe et al., 1990). This ground water depression is created by extraction of ground water for drinking water use and dewatering for gravel mining. Horizontal hydraulic gradients in the basin vary from about 0.0002 to 0.02 ft/ft (California Department of Water Resources, 1974). Vertical gradients within the Livermore basin are generally downward with lower hydraulic head in deeper sediments. Vertical gradients are typically less than 0.05 ft/ft except in areas of significant pumping. The vertical gradients in the vicinity of California Water Service Company production wells and central Livermore wells are about 0.2 ft/ft.

Pumping ground water for agricultural uses has historically accounted for the major withdrawal of ground water from the Livermore Valley ground water basin. As the valley has become increasingly urbanized, a shift in ground water users has caused the amount of pumping for municipal use and gravel quarrying to exceed agricultural withdrawals in the Livermore Valley. In the vicinity of the LLNL Livermore site, agricultural withdrawals are still a major source of drawdown (Thorpe et al., 1990; Dresen et al., 1991).

LLNL Site 300

LLNL Site 300 lies on the eastern flank of the Diablo Range (Lamarre, 1989). Most surface runoff and most ground water flows toward the San Joaquin Valley. Runoff that concentrates in Elk Ravine and Corral Hollow Creek recharges local bedrock aquifers here. The regional ground water table beneath LLNL Site 300 largely occurs within sandstone and conglomerate beds of the Neroly Formation, and ground water moves through both pores and fractures (McIlvride et al., 1988; Raber and Carpenter, 1983). A deep confined aquifer (400 to 500 ft (122 to 152 m) deep) is present beneath the southern part of LLNL Site 300 within the lower Neroly Formation sandstones, and this confined aquifer provides the LLNL Site 300 water supply (Lamarre, 1989). Pumping tests performed in the LLNL Site 300 water supply wells (McIlvride et al., 1990) affirm the integrity of the aquitard separating the shallow and deeper aquifers within the lower Neroly Formation. In addition to the regional aquifers, local perched aquifers containing small amounts of water occur in some deposits within the Neroly Formation and the marine Tertiary sequence (see Webster-Scholten et al., 1991). These localized perched aquifers are not potential water supply sources.

4.11.2.2 Local Hydrogeology

The following section describes the local hydrogeology for the LLNL Livermore site, LLNL Site 300, and SNL, Livermore.

Waterbearing Units

LLNL Livermore Site and SNL, Livermore

Figure 4.11-4 shows the major waterbearing units beneath the LLNL Livermore site. Similar waterbearing sediments are found beneath SNL, Livermore. These waterbearing units include deposits formed during the late Pleistocene to Holocene and are composed of shallow heterogenous, unconsolidated alluvium and deep fluvial and lacustrine sediments (Thorpe et al., 1990). The permeable sediments, shown as lenses on Figure 4.11-4, are separated by low-permeability silt and clay layers, generally 15 to 60 ft (5 to 18 m) thick. These silt and clay layers may comprise a regional confining layer. The confining layer slopes westward and varies in depth from about 60 ft (18 m) beneath the eastern edge of the LLNL Livermore site to about 400 ft (122 m) near the western site boundary (Thorpe et al., 1990).

LLNL Site 300

Two regional aquifers or major waterbearing zones have been identified at LLNL Site 300: an upper water table aquifer in the sandstones and conglomerates of the Neroly Formation, and a deeper confined aquifer located in Neroly sandstones just above the Neroly/Cierbo contact (UC, 1987). Both aquifers have permeable zones layered with lower permeability claystones, siltstones, or tuffs. Many of the sandstones are fine grained and silty and contain fractures. Ground water flow is both intergranular and fracture flow. In addition to the two regional aquifers, several perched aquifers have been identified, some of which give rise to springs. Extensive perched aquifers are present beneath the Pit 7 area and the Building 834 Complex (Raber and Carpenter, 1983). In addition, shallow Quaternary alluvium and undifferentiated Tertiary nonmarine sediments are locally waterbearing such as at the General Services Area (see Figure 4.11-5) and these local aquifers are generally unconfined or water table aquifers.

Occurrence of Ground Water

LLNL Livermore Site and SNL, Livermore

Depth to ground water at the LLNL Livermore site varies from about 110 ft (34 m) in the southeast corner to 30 ft (9 m) in the northwest corner. The water table surface in June 1991 is shown in Figure 4.11-6. The depth to ground water at SNL, Livermore in March 1991 ranged from 110 ft (34 m) in the northwest corner near the Fuel Oil Spill to 122 ft (37 m) in the vicinity of the Navy Landfill in the southern portion of the site. Perched aquifer ground water levels ranged from about 24 ft (7 m) near Arroyo Seco to about 45 ft (14 m) at the Navy Landfill site (SNL, Livermore, 1991e). Figure 4.11-5 (Geologic cross section A-A¢ through the southern General Services Area) shows waterbearing units typically found at LLNL Site 300.

Ground water beneath the eastern Livermore Valley has generally been rising (WESCO, 1988; Thorpe et al., 1990) because there has been a decrease in volume of ground water pumped for agricultural uses and by LLNL over the past 20 years (California Department of Water Resources, 1974; Stone et al., 1982). Ground water levels rose more rapidly from 1979 through 1981 in response to artificial recharge due to releases of surface water from the South Bay Aqueduct into Arroyo Seco (WESCO, 1988). From 1981 to 1987, ground water levels at the LLNL Livermore site and

SNL, Livermore rose an average of 13 ft (4 m) in wells measured over that period (Thorpe et al., 1990). As a result of abnormally low rainfall from 1987 through 1991, ground water levels at the LLNL Livermore site and SNL, Livermore have stopped rising, and have declined in many wells (Thorpe et al., 1990). For example, monitor wells at SNL, Livermore have generally shown a decline of about 10 ft (3 m) between 1986 and 1991 (SNL, Livermore, 1991e).

LLNL Site 300

Ground water elevation in the Neroly, lower blue sandstone aquifer at LLNL Site 300 is controlled largely by geologic structure (Figure 4.11-7). Ground water occurrence in local perched aquifers is often dictated by geologic structure, including faulting and dip of layers or strata, the permeability and impermeability of alternating bedrock units, and recharge and discharge.

The majority of the hydrographs for LLNL Site 300 showed decreases during the period between mid-1984 and early 1989 (Buddemeier et al., 1987c; Lamarre, 1989). Declines ranged from 13 ft (4 m) to less than 2 ft (1 m). A rise in water levels (due to high-intensity rainstorms) was observed during the winter of 1985–1986 in some wells.

The general water level decline, plus the rapid rise discussed above, may be related to rainfall patterns over LLNL Site 300. Peak winter rainfall has declined constantly since the 1983–1984 winter, although there was higher rainfall during the 1985–1986 winter. The variability in ground water level declines across LLNL Site 300 may be attributed to the variation in monitor well zones of completion because some wells are completed in highly variable perched zones, and others in relatively stable deeper aquifers. The general ground water level decline observed in the LLNL Site 300 area is consistent with the trends observed at the LLNL Livermore site and vicinity, at SNL, Livermore, and throughout the Alameda County Flood and Water Conservation District, Zone 7 (Buddemeier et al., 1987c; Lamarre, 1989). As discussed in McIlvride et al. (1990), it is unlikely that declines are the result of drawdowns in water supply wells, because the aquifers in the General Services Area are reportedly not in communication with the shallow aquifers.

Ground Water Flow

LLNL Livermore Site and SNL, Livermore

Ground water at the LLNL Livermore site and vicinity generally flows westward (Thorpe et al., 1990). Ground water from the northern half of the LLNL Livermore site eventually discharges to Arroyo Las Positas near First Street, about 1.5 miles northwest of the site. Ground water from the southern half of the LLNL Livermore site and SNL, Livermore may flow westward through the mapped gap between the Mocho I and Mocho II subbasins (see Figure 4.8-3), about 1.5 miles west of the LLNL Livermore site, where it may continue to flow westward toward the municipal well field near central Livermore. The majority of sediments are hydraulically continuous between the Mocho I and Mocho II subbasins (Sorensen et al., 1984). Although the magnitude and direction of ground water flow in the Mocho I–Mocho II gap are uncertain, it is conservatively assumed that at least some ground water from the LLNL Livermore site exits the Mocho I subbasin in this area (Thorpe et al., 1990).

In addition to the general westerly flow, there is a southwesterly ground water flow in the southeast area of the LLNL Livermore site. The ground water gradient is steepest near the northeast corner of the LLNL Livermore site and at the southeast corner near the Las Positas fault (about 0.15 ft/ft), and decreases to between 0.001 and 0.005 ft/ft west of the site (Thorpe et al., 1990). Hydraulic heads in wells at the LLNL Livermore site decrease with increasing depth, indicating downward vertical gradients (Isherwood et al., 1990). The vertical component of the hydraulic gradient reportedly increases in and near the regional confining layer. Vertical gradients are typically lower in the shallow saturated alluvium west of the site where the confining layer in the Lower Member of the Livermore Formation is deeper, and increase near the eastern margin of the site where the confining layer is closer to the ground surface. Vertical gradients generally range from as high as 0.23 ft/ft (downward) near the eastern margins to less than 0.03 ft/ft (downward) at the western edge of the LLNL Livermore site.

Based on the results of extensive long-term hydraulic testing, the hydraulic conductivity of sediments beneath the site is highly variable, with a geometric mean of 4.3 ft/day (Isherwood et al., 1990). Aquifers in the southwest quadrant of the LLNL Livermore site and the adjacent offsite area have the highest average hydraulic conductivity. There is a greater abundance of coarse-grained deposits in the area, possibly the location of ancient channels of Arroyo Seco

(Thorpe et al., 1990). In contrast, the southeast quadrant of the area including the LLNL Livermore site and SNL, Livermore has the lowest average hydraulic conductivity and the greatest abundance of fine grained sediments. Based on pumping tests, there also appears to be more vertical connection between aquifers in the southwest corner and offsite from the LLNL Livermore site and SNL, Livermore.

Estimated ground water flow rates beneath the LLNL Livermore site range from about 1 to 75 ft/year. The wide range in flow rates reflects the broad range of ground water gradients, and lithologies and associated hydraulic conductivities for the affected aquifer (Upper Member of the Livermore Formation). Aquifer tests performed by LLNL in the vicinity of SNL, Livermore indicate hydraulic conductivities ranging from 3.3 ft/day to about 52 ft/day (Brown and Caldwell, 1990). The observed hydraulic gradient is about 0.003 ft/ft with a general northwesterly ground water flow direction. The calculated ground water velocity for the Upper Member of the Livermore Formation at SNL, Livermore is therefore 16 to 295 ft/year.

LLNL Site 300

The direction of ground water flow in the deep confined aquifer at LLNL Site 300 is thought to be controlled primarily by the sandstone beds there (Raber and Carpenter, 1983). North of the Patterson Anticline, as far as the Elk Ravine fault, flow directions are thought to be generally to the northeast also along the beds (see Figure 4.11-7). South of the anticline flow is generally southeasterly, with a more eastward component in the vicinity of the General Services Area (UC, 1987).

Estimated ground water flow rates in the Shallow Quaternary alluvial gravels at the General Services Area (see Figure 4.11-5) range from 1 to 10 ft/day (or about 365 to 3650 ft/year). The estimates of ground water flow rates for bedrock aquifers at LLNL Site 300 range from about 0.008 to 4 ft/day (or from about 2.9 to 1460 ft/year). Similarly, the wide range of estimated flow rates reflects the broad range of ground water gradients, and lithologies and associated hydraulic conductivities.

4.11.2.3 Water Use

LLNL Livermore Site and SNL, Livermore

Water used at the LLNL Livermore site is purchased primarily from the City of San Francisco Hetch Hetchy Aqueduct system and from the Alameda County Flood and Water Conservation District, Zone 7. In 1990, 259.8 million gal of water (93.4 percent) were derived from the Hetch Hetchy aqueduct and 19.57 million gal of water (6.6 percent) were derived from Zone 7 (Thorpe et al., 1990). At the LLNL Livermore site, water is primarily used for industrial cooling processes, sanitary systems, and irrigation. Minor amounts of water are used for drinking, manufacturing, washing, system filters, boilers, and a swimming pool (Thorpe et al., 1990). Water used at SNL, Livermore is included in the metered totals of the LLNL Livermore site. The SNL, Livermore estimated usage ranges from 13.5 to 18.7 percent of the total combined usage of the LLNL Livermore site and SNL, Livermore (LLNL, 1990i).

Water for commercial, residential, and agricultural use in the vicinity of the LLNL Livermore site and SNL, Livermore is derived from private wells, Zone 7, City of Livermore wells, and California Water Service Company (CWSC) wells (Figure 4.11-8). The CWSC municipal water supply for Livermore comes from the Mocho II subbasin (Thorpe et al., 1990).

Ground water from the Mocho II subbasin is extracted from five supply wells located west of the LLNL Livermore site. This well water is blended with water purchased from Zone 7 and distributed to about 9500 people near central Livermore. The closest CWSC well (9Q1) is located about 2 miles west of the LLNL Livermore site (Figure 4.11-8). This well is 576 ft (176 m) deep. The remainder of households in the City of Livermore are served by water from Zone 7 (Thorpe et al., 1990).

Ten private active domestic supply wells are known to be located in the vicinity of the LLNL Livermore site and SNL, Livermore (Figure 4.11-8). Well 14A11 is the closest domestic well, located about 600 feet (183 m) south of East Avenue (Thorpe et al., 1990). The well inventory identified ten wells used for agriculture (including watering lawns and gardens) and industrial supply (Thorpe et al., 1990). Of these, well 14B1 is located nearest the LLNL Livermore site, about 200 ft (61 m) south of East Avenue. The main agricultural ground water user in the vicinity is the Wente Brothers Winery. Ground water for the winery is pumped from Well 14C3 during periods of peak water demand. Twenty-five other wells were used until recently for domestic or agricultural supply.

Thirty-one wells (including 6 monitoring wells and 25 other wells), which were potentially affected by or could have potentially served as vertical conduits for ground water contamination, were permanently sealed by LLNL between 1984 and 1990 (McDonald et al., 1991). Users were then connected to the municipal water system. Table 4.11-1 summarizes public and private well information for the LLNL/SNL vicinity.

LLNL Site 300

The locations of active and inactive water supply wells at LLNL Site 300 and in the vicinity are shown on Figure 4.11-9. Water used at LLNL Site 300 is derived from two ground water supply wells (W-18 and W-20) located in the southeastern part of the site (see Figures 4.11-5 and 4.11-9). Approximately 29.8 million gal of water were extracted from these wells in 1990, with more than 99 percent of the water pumped from supply well W-20. Another potable water supply well (Ranger well) is located offsite on private land near the south central border of LLNL Site 300 (Taffet et al., 1991). This well supplies water to the Carnegie Vehicle Recreation Park. Well 1, located in the northern portion of LLNL Site 300, is used as an emergency backup well for firefighting only. Four offsite wells are located south of the General Services Area on private rangeland. Two of the wells (CON2 and GALLO1) are currently inactive. The other two offsite wells (CDF-1 and CON-1) are active. Well CDF-1 operates intermittently to fill a pressure tank that supplies the nearby Castle Rock Department of Forestry living quarters and office. Well CON-1 is pumped intermittently and supplies the nearby Connolly Ranch, mainly for stock watering.

4.11.2.4 Background Ground Water Quality

LLNL Livermore Site and SNL, Livermore

Ground water in the vicinity of the LLNL Livermore site and SNL, Livermore is generally suitable for use as a domestic, municipal, agricultural, and industrial supply; however, industrial and agricultural uses of some shallower ground water may be limited by its marginal quality. Furthermore, ground water less than about 300 ft (91 m) deep is usually unsuitable for domestic use without treatment (Thorpe et al., 1990).

Water quality data representative of wells screened in the aquifers system under investigation at the LLNL Livermore site and SNL, Livermore vicinity are shown in Table 4.11-2 (Thorpe et al., 1990). Ground water in the vicinity is mostly a calcium-bicarbonate type, with sodium-chloride waters to the northeast (Thorpe et al., 1990). The maximum concentrations observed for most metals exceed EPA drinking water maximum contaminant levels (MCLs); however, the maximum concentrations are usually from limited areas. Elevated levels of sodium, hardness, total dissolved solids, specific conductance, and nitrate also exceed EPA water quality standards. High concentrations of boron, chloride, and sulfate also limit the use of this ground water for irrigation. Samples from the Mocho I and II subbasins (see Figure 4.8-3) have shown that some ground water is classified as Class II and Class III for irrigation, largely due to high boron concentrations (Thorpe et al., 1990). The high bicarbonate and calcium concentrations may limit the use of this ground water for livestock. High concentrations of chromium, lead, and manganese may limit the discharge of this ground water to surface water drainages.

Ground Water Contamination

Volatile organic compounds including perchloroethylene, trichloroethylene, 1,2-dichloroethylene, 1,1-dichloroethylene, 1,1,1-trichloroethane, 1,2-dichloroethane, 1,1-dichloroethane, carbon tetrachloride, and chloroform have been detected in the ground water onsite and around the LLNL Livermore site. In 1990, DOE and UC sponsored a Baseline Public

Health Assessment to address the future public health risk absent any cleanup (Thorpe et al., 1990). The assessment estimated the maximum individual exposure concentrations over a 70-year lifespan for both existing and hypothetical impacted offsite wells. Hypothetical exposures to volatile organic compounds were estimated for ingestion of tap water, inhalation of volatilized compounds during showers, and absorption through the skin from bath water. Hypothetical irrigation exposures resulted from ingestion of home-grown fruits and vegetables watered with contaminated well water and the inhalation of compounds volatilized during sprinkler irrigation (Thorpe et al., 1990).

An estimated maximum cancer risk from domestic use of the municipal supply well in downtown Livermore was 0.2 in a million. The maximum "health conservative fatal lifetime" cancer risk (i.e., using the most conservative assumptions) from domestic use of the same water supply was 1 in 1000, but the contaminated ground water may not reach municipal wells and be available for consumption for another 270 years. The highest predicted risk was 2 in 1000 for exposure to contaminated well waters from a potential well that might be drilled 250 ft west of the LLNL Livermore site. No members of the public are currently exposed to volatile organic compounds from the use of wells near the LLNL Livermore site.

To be more conservative, risks are estimated assuming no remediation occurs (see section 4.19). LLNL is working with the EPA and the State of California to identify appropriate remediation (see section 4.17) (Thorpe et al., 1990).

At SNL, Livermore benzene contamination was found at concentrations of up to 3 ppb in ground water samples in three wells until May 1986. In all subsequent ground water sampling investigations at the fuel oil spill site since May 1986, benzene has not been detected in any well. Two of the wells where benzene was detected in ground water samples have since gone dry.

LLNL Site 300

Ground water quality in the area of LLNL Site 300 has a relatively high concentration of total dissolved solids, though variability in natural water quality has been observed (UC, 1987). Sodium bicarbonate water is most common in water supply wells and sodium sulfate water is most common in springs. The amount of total dissolved solids ranges from 400 ppm to 4000 ppm in local ground water. Table 4.11-3 shows the range of concentrations for major cations and anions observed in monitor wells and supply wells. Some ground water samples had elevated concentrations of arsenic, fluoride, nitrate, and uranium; however, only arsenic exceeded the maximum contaminant levels in two monitor wells (Raber and Carpenter, 1983; Carlsen, 1991).

<u>Ground Water Contamination</u>

LLNL is currently investigating and identifying the characteristics of the ground water contamination at LLNL Site 300. These investigations are discussed in section 4.17. There is one area, the GSA area, where ground water contaminated with trichloroethylene (TCE) and perchloroethylene (PCE) has migrated offsite in two plumes (Ferry, Lamarre, and Landgraf, 1990).

Evaluations were performed to estimate the potential risks from the General Service Area plumes. After examining the potential routes of exposure, it was determined that potential trichloroethylene and perchloroethylene exposure could occur only through ingestion of ground water; therefore, the only potential exposure sources are water-supply wells. Three private water supply wells (one inactive well, one active well used by the California Department of Forestry, and one by the Connolly Ranch) are located near the plume area. These wells continue to be free of contaminants (McIlvride et al., 1990).

The future worst-case concentrations in the GSA offsite receptor drinking water supply wells were estimated to be 15 µg/L for trichloroethylene and 2.5 µg/L for perchloroethylene. The estimated trichloroethylene concentration in these ground water plumes exceeds the California Department of Toxic Substances Control Maximum Contaminant Level of 5 µg/L. The estimated perchloroethylene concentration is one half of that department's Applied Action Level of 5 µg/L. LLNL is currently performing a baseline public health assessment similar to that undertaken for the LLNL Livermore site. The results of this assessment (and the other risk assessments) will be presented in the Site Wide Remedial Investigation report for LLNL Site 300 that is currently being prepared. The risk assessments will address the additive risks due to all potential and actual chemical releases at LLNL Site 300.

Table 4.11-1 Public and Private Wells in the LLNL Livermore Site and SNL, Livermore Vicinity That Were Investigated During the LLNL Inventorya

State Well Name	Flow Rate (gpm)	Owner	Use	Comments
2J1	N/A	Salinas Reinforcing	Irrigation Industrial[b]	Not currently in use
2K1	N/A	Capital Metals	Irrigation[b]	Not currently in use
3H1	N/A	PG&E	Irrigation[b]	Not currently in use
3P1	N/A	N/A	Landscape irrigation	Free of VOCs[c]
3P2	N/A	Layton	Landscape irrigation	Not tested
9L1, 9P1, 9Q1	>300[d]	CA Water Service	Public water supply wells[e]	Free of VOCs
10F1	>100[d]	Hexel Corp.	Industrial[e]	Not tested
10F2	>100[d]	Hexel Corp.	Industrial[e]	Not tested
14A11	N/A	Phillips	Domestic[e]	Free of VOCs
14B1	>25	Bargman	Swimming Pool[f]	Free of VOCs
14B4	N/A	Speral	Domestic[f]	Free of VOCs
14C2	10[g]	Wente Bros.	Domestic[f]	Free of VOCs
14C3	>500[h]	Wente Bros.	Crop irrigation[f]	Free of VOCs
14H1	N/A	Miller	Domestic[f]	Free of VOCs
14H2	N/A	Freyendal	Domestic[f]	Free of VOCs[c]
15A1	5[g]	Casen	Landscape irrigation[b]	Temporarily out of service
15A5	N/A	McGowan	Landscape irrigation[b]	Not tested
15A10	>10[g]	Livermore Preschool	Landscape irrigation[b]	Not tested
15A11	N/A	Fitzgerald	Landscape irrigation[b]	Temporarily out of service

15B1	40[h]	Leeds	Landscape irrigation[b]	Not tested
15B2, 15B3	30–50[g]	Almond Circle Homeowners Association	Landscape irrigation[b] swimming pool and drinking water	Very limited domestic use
15B4	N/A	Mena	Domestic Supply[b]	Not tested
16B1, 16C1	>200[d]	California Water Service	Public water supply wellse	Not tested
18D1	N/A	Williams	Domestic[f]	Free of VOCs[c]
AND[i]	10[g]	Anderson	Domestic supply[j]	Free of VOCs
BRO[i]	40[g]	Broadman	Landscape irrigation Livestock and garden[k]	Free of VOCs

[a]See Figure 4.11-8 for well locations.

[b] Not sampled for VOCs. Well is located more than 0.25 mi from LLNL VOC plume.

[c] LLNL monitoring shows that this well is free of VOCs.

[d] Information regarding estimated flow rate from current owner/user.

[e]Sample for VOCs by owner. Well is located more than 0.25 mi from LLNL VOC plume.

[f]Sampled during LLNL quarterly monitoring. Well is located within 0.25 mi of VOC plume.

[g] Based on existing records of Alameda County Flood Control and Water Conservation District, Zone 7.

[h] Wente activated well in July 1991.

[i] No existing state well name.

[j] Sampled for VOCs by LLNL on May 24, 1989. Well is located more than 0.25 mi from LLNL VOC plume. Sample data does not appear in Appendix D.

[k] Sampled for VOCs by LLNL in 1984. Well is located more than 0.25 mi from LLNL VOC plume. Sample data does not appear in Appendix D.
N/A = information not available. Source: Thorpe et al., 1990.

Table 4.11-2 Inorganic Chemical Water Quality Standardsand Composition of Ground Water at the LLNL Livermore Site and Vicinitya

Parameter	EPA Drinking Water Maximum Contaminant Level	Irrigation Water		Livestock Feeding Water		Fish and Aquatic Life	Range of Background Concentrations Found in Water Samples
		Threshold[b]	Limiting[c]	Threshold[b]	Limiting[c]	Limiting[c]	
Arsenic	0.05[d,e]	---	1.0[f]	0.1[g]	1.0[f]	1.0[f]	<0.001–0.027 (MW-358)[h]
Barium	1.0[d,e]	---	---	---	---	5.0[f]	<0.0001–2.1 (MW-315)
Bicarbonate	---	---	---	500[g]	500[g]	---	<1–816 (GSW-5)

Boron	---	---	0.5[f]	---	---	---	<0.2–9.1 (MW-8)
Cadmium	0.01[d,e]	---	---	5[g]	---	---	<0.0001–0.17 (MW-364)
Calcium	---	---	---	500[g]	1000[g]	---	4.4–315 (MW-8)
Chloride	500[i,e] (250 recommended)	100[f]	350[g]	1500[f]	3000[g]	---	3–610 (MW-8)
Chromium (total)	0.05[d],SUP>e	---	---	5.0[f]	---	0.05[f]	<0.0001–0.56 (11A1)
Copper	1.0[i,e]	0.1[g]	1.0[g]	---	---	---	<0.0001–0.09 (MW-314, 364)
Fluoride	1.4–2.4[d,j,e]	10.0[f]	---	1.0[f]	6[g]	1.5[f]	Not detected 1 ppm L.O.D.
Hydrogen sulfide	1.0[k]	---	---	---	---	---	Not analyzed
Iron	0.3[i,e] (recommended)	---	---	---	---	---	<0.02–6.7 (18D1)
Lead	0.05[d,e]	---	---	---	---	0.1[f]	<0.001–0.27 (GSW-403.6)
Magnesium	---	---	---	250[g]	500[g]	---	0.29–79 (MW-552)
Manganese	0.05[i,e] (recommended)	0.5[f]	---	10.0[f]	---	1.0[f]	<0.01–11 (18D1)
Mercury	0.002[d,e]	---	---	---	---	---	<0.001–0.05 (MW-276)
Nitrate (as NO_3)	10[d]	---	---	200[g]	400[g]	---	<0.44–71 (MW-355)
Selenium	0.01[d,e]	---	---	---	---	---	<0.001–0.014 (MW-2)
Silver	0.05n[d,e]	---	---	---	---	---	<0.0001–0.08 (MW-406)
Sodium	20[i]	60[g]	80[g]	1000[g]	2000[g]	---	21–430 (MW-8)
Sulfate	500[i,e]	200[f]	1000[g]	500[f]	1000[g]	---	1.7–900 (18D1)
Zinc	5[i,e] (recommended)	--- n	---	---	---	---	<0.01–0.26 (MW-114)
TDS	1000[i,e]	500[g]	1500[g] n	2500[g]	5000[g]	---	117–1770 (MW-8)
pH (units)	6.5–8.5[i]	7.0–8.5	6.0–9.0	6.0–8.5	5.6–9.0	---	5.8–11.3 (MW-205)
Specific	1600[i,e]	2000[g]	3000[g]	---	---	---	174–3130

Conductance (µmhos/cm)	(900 recommended)						(MW-8)

[a] All units are mg/L (ppm) unless noted.
[b] Threshold: a concentration at which a given beneficial use is not damaged to any measurable degree.
[c] Limiting: a concentration at which the beneficial use is severely inhibited.
[d] U.S. EPA, 1988.
[e] California Code of Regulations (1977), Title 22.
[f] McKee and Wolf (1963). g Todd, D.K. (1980).
[g]Todd, D.K. (1980).
[h] Monitor well with highest concentration is shown in parentheses.
[i] National Secondary Drinking Water Regulations (U.S. EPA, 40 C.F.R. 142, rev. 7/19/79-8/27/80).
[j] Maximum recommended concentration is temperature-dependent.
[k] Critical concentration dependent on crop and/or animal type.
Source: Thorpe et al., 1990.

Table 4.11-3 Inorganic Water Quality Data for LLNL Site 300 and Vicinity

Parameter	Minimum Value*	Maximum Value	General Range
Sodium	29	560	30–300
Potassium	2	15	2–14
Calcium	3	170	10–120
Magnesium	0.9	110	1–50
Nitrates (as NO_3)	<0.4	120	<04–100
Chlorides	29	550	30–300
Sulfate	13	590	30–270
Carbonate	<0.6	144	0.6–20
Bicarbonate	130	540	130–400
TDS	310	1400	310–1400
Specific Conductance	n390	3350	390–2200
pH	6.7	8.8	6.7–8.8

* Values are in mg/L (ppm), except specific conductance (mmhos/cm) and pH (pH units).

4.11.3 Floodplains

LLNL Livermore Site and SNL, Livermore

A floodplain is defined as the valley floor adjacent to a streambed or arroyo channel that may be inundated during high water (Linsley et al., 1982). Flood insurance studies were performed for the Federal Emergency Management Agency to determine flood hazards in the Alameda County area, and to identify the approximate limits of the 100-year floodplain. These floodplains were incorporated in the Flood Insurance Rate Maps (FEMA, 1981; 1986). Maps depicting the 100-year floodplains for the LLNL Livermore site and SNL, Livermore are presented in Appendix G (Figures G-3 and G-4). Arroyo Las Positas and Arroyo Seco, dry for most of the year, are the two potential sources of flooding onsite. Localized flooding is most likely to occur during the rainy season from October to April. Open ditches and storm drains that are designed for a 10-year storm event drain both sites. Most of the LLNL Livermore site ultimately drains to the north into Arroyo Las Positas, and a small percentage of land in the southwest corner drains southward to Arroyo Seco. All of SNL, Livermore drains into Arroyo Seco.

Arroyo Las Positas is an intermittent stream that drains approximately 3300 acres in the northeastern and eastern hills above the LLNL Livermore site. This arroyo has a maximum predicted 100-year base flood peak flow adjacent to the LLNL Livermore site of 822 cu ft/second (Holmes and Narver, Inc., 1985). The 100-yr floodplain broadens as it approaches the LLNL Livermore site from the east from 100 ft wide to 1500 ft wide covering Greenville Road. The spreading is due to the shallow channel depth that cannot contain the 100-year flood. The 100-year flood flow is contained within the Arroyo Las Positas channel as it is conveyed northward along the eastern site perimeter and then westward along the northern boundary of the LLNL Livermore site. As the Arroyo approaches the northwest corner of the site, the 100-year flood flow exceeds the channel banks to a width of 120 ft. Storm flow within the northern perimeter channel combines with the western area drainage at the northwest corner of the site. The flow is conveyed to the north, beyond the site, within a drainage easement managed and maintained by LLNL. Approximately 1000 feet to the north, storm flows are directed westward along the Western Pacific Railroad right-of-way.

Arroyo Seco is an intermittent stream that drains the foothills to the southeast of SNL, Livermore. It has a drainage length of approximately 12 miles and has a watershed area of approximately 8960 acres upstream of SNL, Livermore. The channel is narrow and shallow as it enters SNL, Livermore from the east and reaches a depth of 20 ft further downstream as it leaves the site to the northwest. Storm water from SNL, Livermore is collected and channeled to Arroyo Seco through gutters, culverts, and open ditches. Arroyo Seco has a 100-year base flood peak flow of 1220 cu ft/second that is contained within the channel through most of the site (Holmes and Narver, Inc., 1985). This flood would breach the channel banks at one location approximately 3000 ft upstream of East Avenue. There is no overbank flooding from Arroyo Seco as it passes through the LLNL Livermore site property because the channel is deep and able to contain the flood waters.

LLNL Site 300

LLNL Site 300 is primarily on undeveloped land characterized by steep hills and deep ravines. A floodplain analysis was conducted for this site to determine the depth and width of inundation due to the 100-year storm event. Details of this analysis are presented in Appendix G. Three drainages (Oasis/Draney, Elk, and Middle) serve as pathways for stormwater runoff and were used as representative drainages for the analysis. The watersheds associated with three of these ravines are presented in Appendix G (Figure G-2) and the peak runoff was computed using the U.S. Army Corps of Engineers Hydrologic Engineering Center Flood Hydrograph Package (U.S. Army Corps of Engineers, 1981). The computed hydrographs at the outlet of each basin provide the peak flows for the 100-year flood event. The results indicated peak flows of 91 cu ft/second for Middle Canyon (13.9-ft width), 367 cu ft/second (19.5-ft width) for Elk Ravine, and 355 cu ft/second (19.6-ft width) for Oasis/Draney Canyon.

Based on the results, there are no floodplains on LLNL Site 300 as the 100-year base flood event is contained within all channels. However, due to the steep slopes and high runoff potential velocities within these channels could be excessive during a storm.

4.12 NOISE

This section presents the current noise conditions at and in the vicinity of the LLNL Livermore site, LLNL Site 300, and SNL, Livermore, and discusses criteria by which noise levels at the sites and within communities surrounding each of the sites are evaluated. This section includes a general discussion of noise measurement methods and criteria; noise regulations or guidelines of relevant federal, state, and local agencies; and existing noise conditions and sources on and adjacent to all three sites. Occupational noise is discussed in Appendix C.

4.12.1 Noise Description Methods

The primary methods used in this EIS/EIR to measure or describe noise levels and standards are community noise levels, and sound pressure and exposure levels. These and other related methods are described below.

Community Noise Level Measurement

Community noise levels are measured in terms of the "A-weighted decibel," abbreviated dBA or dB(A). A-weighting is a frequency correction that correlates overall sound exposure levels with the frequency response of the human ear. Additional units of measurement have been developed to evaluate longer-term characteristics of sound. The Equivalent-Continuous Sound Level (Leq) is a single-number, average representation of the fluctuating sound level, in decibels, over a specified period of time.

The Community Noise Equivalent Level (CNEL), the noise and land use compatibility criterion most widely used in California, represents an average of all measured noise levels obtained over a specified period of time. In this EIS/EIR, this criterion is used to describe noise levels associated with vehicular traffic and airports. The Community Noise Equivalent Level scale represents a time-weighted, 24-hour average noise level based on the A-weighted decibel. "Time-weighted" refers to the fact that noise that occurs during certain sensitive time periods is weighted more heavily in calculations. This scale includes a 5-decibel upward adjustment for sounds occurring in the evening (defined as 7 p.m. to 10 p.m.) and a 10-decibel upward adjustment for sounds occurring in the late evening and early morning (defined as 10 p.m. to 7 a.m.).

Another noise description method widely used is the Day-Night Average Level (Ldn), which includes only the 10-decibel adjustment for events occurring during the night (defined as 10 p.m. to 7 a.m.) but does not include an evening-hour adjustment. The Community Noise Equivalent Level and Day-Night Average Level are often considered to be nearly identical noise description methods with only small differences. Typical indoor and outdoor noise levels generated by various activities are listed in Figure 4.12-1.

Sound Pressure and Exposure Levels

Potential noise and blast-waves associated with high explosives testing at LLNL Site 300 are evaluated by LLNL using "sound pressure level" and "sound exposure level" criteria (Kang and Kleiber, 1991). Sound pressure level takes into account potential structural damage; and sound exposure level is used to account for potential human reactions to noise such as duration of the sound pulse, frequency of detonations within a short period of time, annoyance, pain in the eardrum, and energy content of the pulse in the audible range (10 hertz and higher).

Blast waves produced by high explosive detonations can cause physical damage both to humans and to residential structures. The "threshold of feeling" is reached at approximately 120 decibels (dB), and the "threshold of pain" is reached at approximately 140 dB (Kang and Kleiber, 1991).

4.12.2 Federal, State, and Local Noise Criteria

Federal, state, and local governments have established noise standards and guidelines to protect citizens from potential hearing damage and various other adverse physiological and social effects associated with noise. DOE facilities are subject to federal noise standards. The State of California and local noise standards are not applicable to onsite operations at LLNL or SNL, Livermore; however, they are applicable to surrounding city and county jurisdictions.

Federal Laws and Regulations

DOE is subject to the requirements of the federal Noise Control Act of 1972, as amended (42 U.S.C sections 4901 et seq.), which establishes the means for coordination of federal noise control research, setting noise emission standards, and providing information to the general public.

Additionally, LLNL has set a maximum allowable peak sound pressure level of 126 dB, not to be exceeded "in populated areas" (Kang and Kleiber, 1991). This level is for single impulse noises and is within the safe limit for both humans and structures (see discussions above under "Sound Pressure and Exposure Levels") and was set to protect residential areas and other sensitive receptors in neighboring communities. No parallel standard has been established by SNL, Livermore since current operations do not require it.

State of California Office of Noise Control Standards

The State of California adopted noise standards do not apply to onsite operations at LLNL and SNL, Livermore, but are applicable to surrounding jurisdictions. These state standards regulate noise levels for motor vehicles, sound transmission, and occupational environments.

The state has also developed land use compatibility guidelines for community noise (California Office of Noise Control, 1976). Following these guidelines, establishing residences, churches, libraries, hospitals, and schools in areas exceeding 70 dB CNEL is normally unacceptable. These facilities are conditionally acceptable in areas that measure between 60 and 70 dB CNEL. Professional and commercial office buildings are normally unacceptable in areas exceeding 75 dB CNEL, and are conditionally acceptable in areas that measure between 67 dB and 77 dB CNEL. These guidelines, however, can be modified to reflect sensitivities of individual communities to noise.

Local Agencies

To evaluate the potential effects of noise from LLNL and SNL, Livermore operations on surrounding communities, the local noise standards for the surrounding jurisdictions are presented below. While compliance with these standards is not required within the boundaries of the LLNL sites or SNL, Livermore, they are briefly discussed because they set noise levels and assist in determining compatibility of uses in surrounding areas.

<u>County of Alameda</u>

In its Community Noise Ordinance, the County of Alameda has set exterior noise standards to regulate noise generated within unincorporated areas of the county (County of Alameda, 1988). These standards are applicable to areas northeast, east, south, and southwest of the LLNL Livermore site and SNL, Livermore and areas west and southwest of LLNL Site 300. The standards, shown in Table 4.12-1, correlate types of land use with minutes of exposure to various dBA levels, by time of day. Each of the county noise level standards is reduced by 5 dBA when applied to simple tone noises, noises consisting primarily of speech or music, or recurring impulsive noises that are generated within areas of county jurisdiction.

Noise sources associated with construction are exempted from the noise standards provided the construction activities do not take place before 7 a.m. or after 7 p.m. Monday through Friday, or before 8 a.m. or after 5 p.m. on Saturday or Sunday.

<u>County of San Joaquin</u>

The County of San Joaquin has adopted a noise ordinance and noise level guidelines (County of San Joaquin, 1978a) for land uses within its unincorporated territory. In the Ordinance Code of San Joaquin County for Zoning and Subdivision Regulations (Ordinance Nos. 2831 and 3005), the county has set noise limits for various land uses, summarized as follows (County of San Joaquin, 1988):

- The sound level within the Commercial-Manufacturing, Restricted-Manufacturing, Manufacturing-1, and Manufacturing-2 zones must not exceed 75 dB Ldn at property lines of the property being developed.
- No sound level must exceed 65 dB Ldn at property lines of properties that abut areas developed as residential, areas zoned residential, or areas shown for residential use on the General Plan.
- No sound level must exceed 65 dB Ldn at the property lines of properties that abut local parks, schools, hospitals, homes for the care of the aged and infirm, and rest homes.

The county also adopted the California Airport Noise Standards, which set the 65 dB CNEL and Ldn maximum exterior noise level for residential land uses, and the California Sound Transmission Control Standards, which require developers within areas of 60 dB CNEL and Ldn to submit acoustical studies demonstrating that a 45 dB CNEL and Ldn will be achieved (County of San Joaquin, 1978a).

City of Livermore

The City of Livermore has adopted the noise level guidelines from "Guidelines for the Preparation and Content of Noise Elements of the General Plan," prepared by the California State Office of Noise Control (1976) in its noise element. These guidelines are applicable to areas within the City of Livermore that are west and north of the LLNL Livermore site and west and northwest of SNL, Livermore. The city's goals regarding noise include (City of Livermore, 1977a):

- The establishment of noise levels within residential areas to allow citizens to pursue normal residential activities without the intrusion of excessive noise and its adverse effects.
- The establishment of noise levels within commercial, industrial, and other nonresidential areas to protect residential areas from increased noise levels.
- The establishment of noise levels within commercial, industrial, and other nonresidential areas to protect a single use or activity from the adverse effects of another.
- The establishment of noise levels within industrial and commercial areas to protect the health and welfare of area workers and members of the general public who may be on the premises.
- The establishment of public education programs, regulations, or political actions to reduce levels of noise generated by mechanical and other equipment.
- The adoption of design standards and the design of alternative devices to assist in achieving the goals of reducing noise to acceptable levels where the prevention or reduction of noise levels cannot be accomplished by existing methods.

In Chapter 9.36 of its noise ordinance, the City of Livermore prohibits operation of loud equipment (such as pile drivers and pneumatic hammers) in construction, demolition, or other repair work between 8 p.m. and 7 a.m. (City of Livermore, 1987).

City of Tracy

The City of Tracy General Plan noise element is based on the 1978 noise element prepared by the San Joaquin Council of Governments, as adopted by the City of Tracy in January 1979. The city adopted the noise level guidelines from "Guidelines for the Preparation and Content of Noise Elements of the General Plan," prepared by the California State Office of Noise Control (1976) and outlined in the above discussion of provisions of the City of Livermore noise element. The City also adopted the California Airport Noise Standards and the California Sound Transmission Control Standards (City of Tracy, 1982). While the City of Tracy is not directly adjacent to LLNL Site 300, its proximity to high explosive testing at LLNL Site 300 warrants its discussion.

Table 4.12-1 County of Alameda Noise Standards for Noise-Sensitive and Commercial Land Uses

Cumulative Number of Minutes in any 1-Hour Time Period	Noise Level Standard (dBA)			
	7 a.m. to 10 p.m.		10 p.m. to 7 a.m.	
	Noise Sensitive*	Commercial	Noise Sensitive	Commercial
30	50	65	45	60
15	55	70	50	65
5	60	75	55	70
1	65	80	60	75
0	70	85	65	80

* Noise-sensitive land uses include residences, schools, hospitals, churches, and public libraries.
dBA = A-weighted decibel.
Source: County of Alameda, 1988.

4.12.3 Existing Noise Conditions

LLNL Livermore Site

Onsite Noise

Noise sources within the LLNL Livermore site include onsite vehicular traffic and stationary noise sources such as heating, ventilating and air-conditioning equipment (cooling towers, motors, pumps and fans, etc.). The High Explosives Application Facility (Building 191) at the LLNL Livermore site, and construction activities are also considered occasional noise sources.

The High Explosives Application Facility (Building 191) is an indoor high explosives research facility that tests explosives. A noise study (Miller, 1989) was conducted to evaluate exterior noise associated with explosions at this facility. The highest recorded sound pressure level, from a range of explosive weights up to 8 kg, was 99.3 dB due west of Building 191 at Vasco Road (Miller, 1989). This single impulse noise is below the LLNL 126 dB established limit to protect surrounding populated areas.

Noise generated at the LLNL Livermore site is not subject to regulation by local governmental agencies, in this case the City of Livermore and County of Alameda. However, it is DOE and UC policy to cooperate with local agencies whenever feasible. Noise generated at the LLNL Livermore site is typical of a research and development facility, and is not in conflict with land use compatibility noise guidelines for the surrounding areas within the City of Livermore and County of Alameda. These agencies do not have land use compatibility guidelines for impulse- type noises, such as those occasionally generated at the HEAF. However, the LLNL standard is aimed at protecting surrounding populated areas from such noises.

Offsite Noise

Offsite noise sources adjacent to the LLNL Livermore site include vehicular traffic along local roadways and occasional aircraft flybys.

The nearest offsite noise-sensitive receptors to the LLNL Livermore site include single-family residences east of Greenville Road, approximately 200 ft from the site's eastern boundary, and a residential development west of Vasco Road, approximately 200 feet from its western boundary.

SNL, Livermore

Noise generated at SNL, Livermore is not subject to regulation by local governmental agencies, in this case the City of Livermore and County of Alameda. However, it is DOE policy to cooperate with local agencies whenever feasible. Noise generated at SNL, Livermore is typical of a research and development facility, and is not in conflict with land use compatibility noise guidelines for the surrounding areas within the City of Livermore and County of Alameda. These agencies do not have land use compatibility guidelines for impulse-type noises such as those generated at the pistol and rifle firing range. Thus, no conflict with local noise regulations occurs.

Onsite Noise

Noise sources at SNL, Livermore include onsite vehicular traffic and stationary noise sources such as heating, ventilating and air-conditioning equipment (cooling towers, motors, pumps and fans, etc.). The pistol and rifle firing range at SNL, Livermore and construction activities are also considered occasional noise sources.

The pistol firing range is located at the southern end of the site and is used periodically (approximately 3 times per week) by the SNL, Livermore security forces. Results of two firing range noise studies are presented below.

Offsite Noise

The nearest offsite noise-sensitive receptors to SNL, Livermore include the single-family residence between SNL, Livermore and Tesla Road, located approximately 400 ft from the southern boundary of the SNL Livermore.

Offsite Field Measurements. The Hazards Control Division of SNL, Livermore conducted a sound level survey of the SNL, Livermore pistol and rifle range on February 26, 1987. The survey was based on a realistic firing condition for impulse and steady-state sound levels (SNL, Livermore, 1987). Based on the survey, the maximum firing range peak sound pressure level was approximately 87 dBA at the SNL, Livermore southern property line location closest to the nearest offsite residence. Opposite this residence, at a location across Tesla Road, the peak sound pressure level was approximately 85 dBA. The estimated peak sound pressure level at that residence was between 85 and 87 dBA. Traffic-related noise at this residence was estimated to be between 50 and 57 dBA.

The maximum measured steady-state firing range sound pressure level was 65 dBA at the SNL, Livermore south property line location closest to the nearest offsite residence; it was 61 dBA at the location across Tesla Road opposite this residence. The estimated steady-state firing range sound pressure level at the closest offsite residence was between 61 and 65 dBA. The actual 8-hour, time-weighted average sound levels would be appreciably lower than the levels stated above because the total gunfire time encompasses a relatively small fraction of the day (SNL, Livermore, 1987). Since the field study was conducted, SNL, Livermore has modified the firing range by lowering its elevation and by adding a baffle over the top of the range to reduce noise levels.

Offsite Noise—LLNL Livermore Site and SNL, Livermore Combined

While they are distinct operations managed and operated by different contractors, for purposes of this discussion the LLNL Livermore site and SNL, Livermore are addressed together because of their proximity.

Another field measurement survey was conducted on April 25, 1991, to document existing noise levels in the vicinity of the LLNL Livermore site and SNL, Livermore. Measurements were conducted at the 10 locations shown in Figure 4.12-2 for 15 or 20 minutes (depending on fluctuations in noise levels) using a Larson Davis Sound Level Meter (Model 700). Measurements represent ground-floor receptors, except where otherwise indicated. Results of the survey are presented in Table 4.12-2.

The results of the survey show that, at most monitored locations, vehicular traffic was the dominant noise source and noise levels measured near noise-sensitive receptor locations in the vicinity of the sites fall within the acceptable noise level range established by the City of Livermore and County of Alameda. At sites near the SNL, Livermore pistol and rifle firing range (Site Nos. 7, 8, 9, and 10 as shown in Table 4.12-2 and Figure 4.12-2), gunshots were audible, but were not as loud as vehicular traffic. Site 7 was in a residential neighborhood just south of East Avenue. The ambient noise level at this location was measured at 56 dB Leq. Ambient noise levels at the other three sites were measured at 64, 64, and 63 dB Leq, respectively. Although the noise measurements did not distinguish the gunshots at the firing range from vehicular traffic along the roadways, the latter constituted most of the ambient noise monitored. Traffic noise levels were measured much closer to the roadways and were generally higher than the traffic noise levels at 270 ft north of Tesla Road, as measured by the Hazards Control Division of SNL, Livermore in February 1987 (SNL, Livermore, 1987).

Calculated Existing Roadway Traffic Noise

Table 4.12-3 lists both the calculated distances from the roadway centerline to the existing CNEL (in dBA) and the CNEL value at 50 ft from the centerline of the near travel lane for all major arterials in the study area.

Table 4.12-3 shows that along most roadways in the project vicinity, existing vehicular traffic noise levels do not result in the 70-dB CNEL noise contour extending beyond roadway limits, except along Vasco Road between I-580 and Patterson Pass Road, and along East Avenue west of Buena Vista Avenue.

LLNL Site 300

Onsite Noise

Major noise sources within LLNL Site 300 include high explosives testing, vehicular traffic, and stationary noise sources such as heating, ventilating and air-conditioning equipment (cooling tower, motors, pumps and fans, etc.) A pistol and rifle firing range and construction equipment are also considered to be occasional noise sources.

Noise generated at LLNL Site 300 is not subject to regulation by local governmental agencies, in this case the Counties of San Joaquin and Alameda. However, it is DOE and UC policy to cooperate with local agencies whenever feasible. Noise generated at LLNL Site 300 is typical of a research and development facility, and is not in conflict with land use compatibility noise guidelines for the surrounding areas within the Counties of San Joaquin and Alameda. These agencies do not have land use compatibility guidelines for impulse-type noises, such as those occasionally generated at the pistol and rifle firing range and by high explosives testing at the site. However, the LLNL standard of 126 dB is aimed at protecting surrounding populated areas from such noises.

High Explosives Testing Noise. For determining noise from explosive events at LLNL Site 300, a number of factors have been considered. These include explosive weight, atmospheric attenuation, local topography, and weather conditions. Among these factors, weather conditions, represented by wind-velocity and temperature distributions as functions of altitude, play a dominant role in establishing explosive weight limits at LLNL Site 300 (Kang and Kleiber, 1991). Using computer codes that consider local weather conditions, LLNL is able to predict or project (within the limitations of this state-of-the-art methodology) the noise impact to a given downrange distance from the blast location (Kang and Kleiber, 1991).

To monitor noise concerns, LLNL has established a noise monitoring system in the City of Tracy using a network of six noise monitoring stations and a data collection system controlled by LLNL Site 300 staff. See Figure 4.12-3 for the locations of City of Tracy noise monitoring stations. The stations monitor peak noise levels for a period of 90 seconds starting at detonation. Weather conditions at LLNL Site 300 are also monitored before each test, and, as noted above, the results are incorporated into the determination of the weight limit for each high explosive test.

The results of a sampling of noise monitoring activities associated with high explosives testing at LLNL Site 300 demonstrate that noise levels have not exceeded the LLNL peak noise standard of 126 dB in surrounding populated areas or areas proposed for future development. The highest recorded (peak) noise levels for the years 1988 through 1990 at each monitoring station are shown in Table 4.12-4. (See the discussion of the LLNL environmental monitoring program in Appendix C.)

In addition to monitoring noise at stations in Tracy, LLNL monitors noise at the LLNL Site 300 boundary or in other nearby areas east of the site. Peak noise levels measured during the 220-lb test at locations A, B, and C were 121, 118.8, and 106 dB, respectively (Kang and Kleiber, 1991). The corresponding peak noise level measured in the City of Tracy was 106 dB (Kang and Kleiber, 1991). These values are lower than the thresholds of damage for humans and structures.

On May 21, 1991, LLNL Site 300 personnel conducted a 470-lb test at Bunker 801. A noise measurement at a location approximately 1 mile from the detonation point (Location E in Figure 4.12-3) showed a peak noise level of 121.7 dB (Kleiber, 1991b). Another location 1.2 miles from the detonation point (Location D in Figure 4.12-3) measured 118.9 dB (Kleiber, 1991b). Both readings were below the LLNL 126-dB maximum allowed noise level.

Offsite Noise

Major offsite noise sources near LLNL Site 300 include off-road vehicles using the Carnegie State Recreation Area south of LLNL Site 300, vehicular traffic along Corral Hollow Road, and occasional aircraft flybys.

The closest offsite noise-sensitive receptor is a single-family residence west of the LLNL Site 300 western boundary, approximately 1 mile from the site's southwestern boundary. In addition, residential areas, schools, churches, and hospitals in the City of Tracy are considered potential noise-sensitive receptors for the noise associated with the high explosives testing.

Table 4.12-5 presents the results of a field measurement survey conducted on July 25, 1991, to document weekday ambient noise levels in the vicinity of LLNL Site 300. The study results indicate that the ambient noise levels along Corral Hollow Road/Tesla Road are influenced by vehicular traffic and range from 56 to 66 dBA Leq. Therefore, the measured noise levels fall within the acceptable range for noise sensitive uses established by the Counties of San Joaquin and Alameda. At the time of the survey, no noticeable noise was being generated by the firing range at LLNL Site 300 or at the Carnegie State Recreation Area. Higher ambient noise levels would be expected at the monitoring sites along Corral Hollow Road/Tesla Road during weekend periods when the Carnegie State Recreation Area has the greatest off-highway vehicle activity.

Offsite Facilities

Livermore Municipal Airport

The number of takeoffs and landings made by the LLNL plane at the Livermore Municipal Airport is conservatively estimated to be 520 annually, less than 0.22 percent of the airport's total annual operations. Noise associated with LLNL flights, therefore, represent a minimal contribution to the airport noise contours.

City of Tracy Municipal Airport

LLNL transports materials into and out of Tracy Municipal Airport on less than three flights per month (32 total flight operations in 1990), representing approximately 0.1 percent of the airport's annual flight operations. Therefore, noise associated with LLNL flight operations represents a minimal contribution to the airport's noise generation.

LLNL Day-Care Center

Assuming no attenuation from sound walls or other structures, the LLNL Day-Care Center at the Almond Avenue School in the City of Livermore, is located inside the conditionally acceptable noise range of 60 to 70 dB CNEL contour which results from traffic along East Avenue.

Table 4.12-2 LLNL Livermore Site and SNL, Livermore Offsite Ambient Noise Measurement

Results (April 25, 1991)

Figure 4.12-2 Map Reference	Location	Time	Leq (dBA)*	Description
1	Corner of Shannon and Patterson Pass Road	11:15 a.m. to 11:35 a.m.	64	Ambient noise dominated by vehicular traffic
2	Corner of Patterson Pass Road and Marathon Drive	11:45 a.m. to 12:05 p.m.	59	High-pitched sound from the LLNL Livermore site audible
3	Corner of Lupin Way and Greenville Road	12:15 p.m. to 12:35 p.m.	58	Ambient noise dominated by vehicular and pedestrian traffic
4	Corner of East Avenue and Vasco Road	12:45 p.m. to 1:05 p.m.	69	Ambient noise dominated by vehicular traffic and construction work at the LLNL Livermore site
5	Corner of Daphne Street and Vasco Road	1:15 p.m. to 1:35 p.m.	63	Ambient noise dominated by vehicular traffic
6	Corner of Vasco Road and Patterson Pass Road	1:50 p.m. to 2:10 p.m.	66	Ambient noise dominated by vehicular traffic
7	Corner of East Avenue and Graham Court	6:00 p.m. to 6:15 p.m.	56	Ambient noise dominated by vehicular traffic; gunfire from target practice at SNL, Livermore audible
8	Corner of Vasco Road and Tesla Road	6:20 p.m. to 6:35 p.m.	64	Ambient noise dominated by vehicular traffic; no gunfire audible; intervening hills
9	Corner of Tesla Road and Greenville Road	6:40 p.m. to 6:55 p.m.	64	Ambient noise dominated by vehicular traffic; gunshots audible, but not as loud as traffic noise
n	Corner of Greenville Road and East Avenue	7:00 p.m. to 7:15 p.m.	63	With direct line-of-sight to the firing range, bursts of gunshots audible; little traffic noise

* Noise measurements were made following procedures outlined in the Federal Highway Administration manual "Sound Procedures for Measuring Highway Noise" Final Report DP-45-1R (Federal Highway Administration, 1981). Measurements represent ground-floor receptors, except where otherwise indicated.
Leq = Equivalent Noise Level.
dBA = A-weighted decibel.

Table 4.12-3 Existing Roadway Noise Levels in the Vicinity of the LLNL Livermore Site and SNL, Livermore

Roadway Segment	Distance from Roadway Centerline to CNEL (in feet)*			CNEL 50 Feet from Centerline of the Near Travel Lane (dBA)
	70 CNEL	65 CNEL	60 CNEL	
First Street, N. Mines Road to Las Positas Road	< 50	96	207	68.6

Vasco Road, I-580 to Patterson Pass Road	65	131	279	69.0
Vasco Road, Patterson Pass Road to East Avenue	< 50	73	157	66.8
Vasco Road, East Avenue to Tesla Road	< 50	< 50	58	60.2
Greenville Road, I-580 to Patterson Pass Road, (4 lanes)	< 50	65	132	64.0
Greenville Road, I-580 to Patterson Pass Road, (2 lanes)	< 50	< 50	73	61.7
Greenville Road, Patterson Pass Road to East Avenue	< 50	< 50	67	61.2
Greenville Road, East Avenue to Tesla Road	< 50	< 50	< 50	56.5
East Avenue, west of Buena Vista Avenue	54	111	237	68.4

* Existing traffic noise levels have been calculated using the Highway Noise Prediction Model, FHWA-RD-77-108 (Federal Highway Administration, 1978). Model input data include average daily traffic levels, day and night percentages of autos and medium and heavy trucks, vehicle speeds, ground attenuation factors, and roadway widths. Traffic volumes and vehicle fleet mix percentages are based on the traffic study prepared for this EIS/EIR (TJKM Transportation Consultants, 1992).

Table 4.12-4 Highest Recorded (Peak) Noise Levels at LLNL Site 300 Monitoring Stations in Tracy

	dB (flat response)*		
Station Number*	**1988**	**1989**	**1990**
2	107	106	98
3	100	100	101
4	105	107	107
5	104	103	107
6	103	108	108
7	107	105	112

* Figure 4.12-3 shows the approximate locations of these monitoring stations. The number 1 monitoring station was co-stationed with the number 4 monitoring station, and was configured for flat response. This was done to compare

readings with the standard A-weighted configuration. The flat configuration would normally produce somewhat higher readings.
dB = Decibel.
Source: Kleiber, 1991a, 1991c.

Table 4.12-5 LLNL Site 300 Offsite Ambient Noise Measurement Results (July 25, 1991)

Figure 4.12-3 Map Reference	Location	Time	Leq (dBA)*	Description
F	Along eastern LLNL Site 300 boundary	11:15 a.m. to 11:30 a.m.	59	No dominant noise sources
G	Next to Corral Hollow Road approximately 0.75 mile west of I-580	9:05 a.m. to 9:20 a.m.	60	Ambient noise dominated by earth-moving equipment operating at Corral Hollow landfill (0.50 mile from monitoring site)
H	Next to Corral Hollow Road approximately 2 miles east of I-580	9:35 a.m. to 9:50 a.m.	56	Ambient noise dominated by overflying hawk
I	Next to Corral Hollow Road across from Carnegie State Recreational Vehicle Area	12:50 p.m. to 1:05 p.m.	66	Ambient noise dominated by wind and a few vehicles on roadway
J	Next to Tesla Road approximately 0.50 mile west of Alameda/San Joaquin County Line	1:15 p.m. to 1:30 p.m.	64	Ambient noise dominated by wind and a few vehicles on roadway

* Noise measurements were made following procedures outlined in the Federal Highway Administration manual "Sound Procedures for Measuring Highway Noise" Final Report DP-45-1R (Federal Highway Administration, 1981). Measurements represent ground-floor receptors, except where otherwise indicated.
Leq = Equivalent Noise Level.
dBA = A-weighted decibel.

4.13 TRAFFIC AND TRANSPORTATION

This section presents evaluations of both onsite and offsite traffic conditions at the LLNL Livermore site, LLNL Site 300, and SNL, Livermore (TJKM Transportation Consultants, 1992). Existing traffic conditions in the project vicinity are summarized below. This section also includes a description of the Livermore and Tracy municipal airports. More detailed information on both traffic and transportation issues can be found in Appendix K.

4.13.1 Regional and Local Circulation System

LLNL Livermore Site and SNL, Livermore

Due to the proximity of the two sites, and the fact that some LLNL Livermore site personnel park at SNL, Livermore, it was considered infeasible to conduct separate traffic analyses for the two sites. The respective increment of traffic (i.e., vehicle trips per day) contributed by each Laboratory was determined based on existing and projected personnel numbers at each facility. However, while it is acknowledged that the two Laboratories are distinct operations managed and operated by different contractors, the evaluation of Laboratory-related traffic effects on the local circulation network was conducted for the two Laboratories combined, due to the difficulty in distinguishing between LLNL- and SNL, Livermore-related traffic at a given intersection or roadway segment. A separate analysis was performed for LLNL Site 300 because of its distance from the other Laboratory sites.

Site Access

As shown in Figure 4.13-1, regional access to the LLNL Livermore site and SNL, Livermore is primarily from Interstate 580 (I-580) by the Vasco Road and Greenville Road interchanges. The LLNL Livermore site is accessed by security gates along Vasco Road, East Avenue, and Greenville Road. SNL, Livermore is accessed via security gates along East Avenue. A description of the geometrics (i.e., features of the roadway design) of the various roadways in the vicinity of the LLNL Livermore site and SNL, Livermore is provided in Appendix K.

Regional Transportation Improvements

There are currently two regionally important transportation projects proposed or underway. They are the extension of the Bay Area Rapid Transit District (BART) rail transit to Dublin and Pleasanton, and the proposed Mid-State Tollway project (see Figure 4.13-1). More information regarding these transportation projects is included in Appendix K. Although both projects would have an effect on Tri-Valley traffic, neither is in the immediate vicinity of the LLNL Livermore site and SNL, Livermore. Consequently, neither the BART extension nor the tollway project is expected to have a significant effect on traffic at the key intersections or roadway segments studied in the traffic analysis.

LLNL Site 300

Site Access

Regional access to LLNL Site 300 is primarily from I-580 by the Corral Hollow Road interchange (see Figure 4.13-1). LLNL Site 300 is accessed from a series of two security gates at the main entrance off Corral Hollow Road. Corral Hollow Road, which becomes Tesla Road at the Alameda County/San Joaquin County line, runs in a generally east-west direction between the City of Livermore and I-580 in San Joaquin County. Thus, this roadway provides access between LLNL Site 300 and the LLNL Livermore site, although access is also provided via I-580 between the sites. A description of the geometrics of Tesla Road/Corral Hollow Road is provided in Appendix K.

4.13.2 Local Existing Traffic Conditions

Traffic Generation and Distribution—LLNL Livermore Site and SNL, Livermore

Existing 24-hour average daily traffic counts at all entrances to the Laboratory sites were collected (TJKM Transportation Consultants, 1992). Average daily traffic is defined as the total number of cars passing over a segment of roadway, in both directions, on a typical day. In this report, all average daily traffic volumes are two-way counts at the indicated locations. Average daily traffic for the LLNL Livermore site and SNL, Livermore is estimated to be approximately 23,960 and 3100 vehicle trips, respectively.

The estimated distribution of the LLNL Livermore site trips is as follows: 32 percent at Westgate Drive, 23 percent at Southgate Drive, 8 percent at West Perimeter Drive, 14 percent at Mesquite Way, 20 percent at East Gate Drive, and 3 percent at the truck entrance on East Avenue. The SNL, Livermore trip distribution at its three access gates is as follows: 43 percent at the west gate, 29 percent at the east gate (Thunderbird Lane), and 28 percent at the main gate.

Based on the actual 24-hour average daily traffic counts conducted in 1991 to determine total personnel trips, the average number of trips per person for the LLNL Livermore site and SNL, Livermore is approximately two trips per person per day (TJKM Transportation Consultants, 1992).

Existing peak hour traffic counts show that LLNL Livermore site and SNL, Livermore traffic contributes a high proportion of the vicinity's daily traffic in the a.m. peak hour (i.e., the peak traffic period in the morning). The existing trip distribution patterns show the Vasco Road corridor to be the most heavily utilized. The distribution of the a.m. peak-hour traffic from the Laboratories is as follows: 38 percent on Vasco Road, 28 percent on Greenville Road towards the I-580 freeway, 30 percent on East Avenue, 2 percent on Patterson Pass Road, and 2 percent on Greenville Road (towards Tesla Road).

Traffic Generation and Distribution—LLNL Site 300

The estimated average daily traffic volume at LLNL Site 300 is approximately 700 vehicles per day. The distribution of LLNL Site 300 traffic on Corral Hollow Road is estimated to be 60 percent to the east towards Tracy and 40 percent to the west towards Livermore.

The estimated average daily traffic volume at LLNL Site 300 is based on an average trip rate of 3.5 trips per person per day, which was derived from actual 24-hour average daily traffic counts conducted at the LLNL Site 300 main entrance (TJKM Transportation Consultants, 1992). It should be noted that this trip rate differs from the trip rate calculated for the LLNL Livermore site and SNL, Livermore. Both average trip rates were calculated from actual traffic counts at the respective sites. The lower average trip rate for the LLNL Livermore site and SNL, Livermore is partially due to the current ridesharing and public transportation opportunities available to these personnel.

Average Daily Traffic Volumes of Key Roadways—LLNL and SNL, Livermore

A description of the geometrics of the 18 key roadway segments evaluated in the recent traffic study (TJKM Transportation Consultants, 1992) is included in Appendix K. Existing average daily traffic volumes and traffic count locations for the 18 roadway segments are shown in Figure 4.13-2.

Peak-Hour Conditions at Key Intersections—LLNL and SNL, Livermore

The criterion for evaluating traffic conditions in the vicinity of the LLNL Livermore site and SNL, Livermore is that used by the City of Livermore: a congestion condition exceeding a peak-hour volume-to-capacity (V/C) ratio of 0.85 per average day at a major intersection is considered unacceptable. A V/C ratio of 0.85 corresponds to level of service (LOS) D (LOS D includes the range of V/C ratios from 0.81 to 0.90). LOS describes the operating conditions that occur on a lane or roadway when accommodating various traffic volumes.

LOS is described by a letter rating system from A to F, with LOS A indicating stable flow and little or no delays, and LOS F indicating jammed conditions and excessive delays. In San Joaquin County (for evaluation of LLNL Site 300 traffic conditions), the existing LOS C standard is used (LOS C encompasses the range of V/C ratios from 0.71 to 0.80). Traffic congestion conditions exceeding LOS C (LOS D and worse) are considered to be unacceptable. Appendix K discusses LOS ratings and also provides a discussion of the relationship between V/C ratio and LOS.

Both a.m. and p.m. peak-hour traffic conditions were examined at 16 key intersections and the I-580 interchanges at Vasco Road and Greenville Road near the LLNL Livermore site and SNL, Livermore, and at the I-580 interchange at Corral Hollow Road near LLNL Site 300. Figure K-3 in Appendix K identifies the locations of the study intersections. The "peak hour" is defined as the four busiest consecutive 15-minute periods, in the morning and in the evening, and typically occurs during commute periods.

Intersection operations were evaluated using a method of intersection capacity analysis known as the Intersection Capacity Utilization method. A more detailed description of this methodology is provided in Appendix K. As discussed earlier in this section, peak-hour intersection conditions are reported as V/C ratios, and LOS are reported using a letter rating system and corresponding descriptions of intersection traffic flow, delay, and maneuverability. This rating system is also described in Appendix K.

Table 4.13-1 presents existing a.m. and p.m. peak-hour V/C ratios and LOS ratings for each study intersection. As shown in this table, two study intersections currently operate at levels of service that exceed a V/C ratio of 0.85 (LOS D) in the p.m. peak hour, including: First Street at Las Positas Road and First Street at North Mines Road. A design study is currently underway for the First Street area in the City of Livermore to widen First Street (from north of North Mines Road to the I-580 eastbound on-/off-ramps) from the existing two lanes to four or six lanes (TJKM Transportation Consultants, 1992). If implemented, these improvements would improve the LOS of study intersections along First Street at Las Positas Road and North Mines Road to acceptable city standards, as well as further improve the LOS at First Street and Southfront Road (TJKM Transportation Consultants, 1992).

Additional information regarding existing traffic conditions at study intersections is found in Appendix K.

4.13.3 Study Area Traffic Accident History

LLNL Livermore Site and SNL, Livermore

A review of Statewide Integrated Traffic Records System accident reports was made for 1988, 1989, and 1990 to determine the accident history at intersections in the vicinity of the LLNL Livermore site and SNL, Livermore. The results of the analysis indicated that three Vasco Road intersections (at Preston Avenue, Brisa Street and Vaughn Avenue) have experienced relatively high accident rates and have already been targeted for safety improvements by the City of Livermore. The planned improvements are described in Appendix K.

Additional improvements (described in the previous section) contemplated by Caltrans and the City of Livermore for the First Street corridor between North Mines Road and Southfront Road are expected to improve traffic operations and reduce accidents at these intersections. No further analysis has been conducted for this EIS/EIR for the identified accident areas.

LLNL Site 300

Accidents in the vicinity of LLNL Site 300 occur between I-580 and the Alameda/San Joaquin County Line at a rate of approximately four accidents per year. There is no recurring location for these accidents, which consist primarily of property damage caused by single-driver accidents.

Table 4.13-1 Existing Levels of Service at Key Intersections

Intersection ID Number (Refer to Figure K-3)	Intersection Location	A.M. Peak Hour		P.M. Peak Hour	
		V/C	LOS	V/C	LOS
1	I-580 SB Off-Ramp at Corral Hollow Road	0.20	A	0.24	A
2	I-580 NB Off-Ramp at Corral Hollow Road	0.23	A	0.18	A
920	I-580 WB Off-Ramp at Springtown Boulevard	0.85	D	0.84	D
922	I-580 EB Off-Ramp at First Street	0.75	C	0.84	D
894	First Street at Southfront Road	0.84	D	0.67	B
684	First Street at Los Positas Road	0.84	D	0.89	D
615	First Street at North Mines Road	0.82	D	0.87	D
655	East Avenue at S. Livermore Avenue	0.57	A	0.66	B
588	East Avenue at North Mines Road	0.58	A	0.69	B
617	East Avenue at Vasco Road	0.61	B	0.62	B
671	East Avenue at Greenville Road	0.34	A	0.42	A
924	I-580 WB Off-Ramp at Vasco Road	NA	NA	NA	NA
926	I-580 EB Off-Ramp at Vasco Road	NA	NA	NA	NA
575	Vasco Road at Preston Avenue	0.62	B	71	C
583	Vasco Road at Patterson Pass Road	0.70	BA	0.62	B
616	Vasco Road at Westgate Drive	0.47	A	0.53	A
591	Vasco Road at Mesquite Way	0.41	A	0.47	A
16	I-580 EB Off-Ramp at Southfront Road	NA	NA	NA	NA
15	I-580 WB Off-Ramp at Northfront Road	NA	NA	NA	NA
928	Greenville Road at Altamont Pass Road	0.70	B	0.35	A
931	Greenville Road at Southfront Road	0.70	B	0.43	A
581	Greenville Road at Patterson Pass Road	0.75	C	0.60	A

NB = northbound; WB = westbound; EB = eastbound; SB = southbound.

V/C = volume-to-capacity ratio.
LOS = level of service, ranging from A (stable flow-very slight or no delay) to F (forced flow-excessive delay).
NA = not applicable; no intersections exist at this interchange at the present time.

V/C	LOS	V/C	LOS
0.00–0.60	A	0.81–0.90	D
0.61–0.70	B	0.91–1.00	E
0.71–0.80	B	1.00+	F

Source: TJKM Transportation Consultants, 1992.

4.13.4 Onsite Circulation and Parking

LLNL Livermore Site

External Access

Vehicle access to the LLNL Livermore site is currently provided at six locations (see Appendix K for more detailed discussion on these access points). Existing inbound and outbound traffic volumes at these gates are shown in Figure 4.13-3. Also shown in Figure 4.13-3 are the pedestrian gates on East Avenue that provide access between the LLNL Livermore site and SNL, Livermore.

Onsite Street Network

The existing internal circulation network of the LLNL Livermore site is also depicted in Figure 4.13-3 (Appendix K provides a more specific description of onsite streets). A 1986 traffic circulation and access study for the LLNL Livermore site identified and recommended mitigations for onsite access and circulation problems (TJKM Transportation Consultants, 1986). Appendix K provides a summary of the recommendations from this study.

In recent (1991) discussions with LLNL Facilities Planning staff, two existing onsite circulation problems were identified (TJKM Transportation Consultants, 1992): (1) a.m. peak-hour queuing and delays at the intersections of Westgate Drive and Avenues A and B; and (2) p.m. peak-hour queuing in the eastbound exiting lanes at Eastgate Drive. Peak-hour turning movement counts were taken at all three intersections. Based on these counts and on field observation, traffic currently has no difficulty moving through the Westgate Drive intersections during the a.m. peak period, and queuing is minimal (TJKM Transportation Consultants, 1992). Growth in the northwest quadrant may create adverse conditions in the future.

Based on a recent (1991) p.m. peak-hour turning movement count, the intersection of Greenville Road at Eastgate Drive/Lupin Way is approaching design capacity. This results in long delays for the eastbound-to-northbound left-turn movement out of the LLNL Livermore site. The reserve capacity for this movement is 24 vehicles. Reserve capacity is the unused capacity of a vehicle travel lane (i.e., the number of additional vehicles that could make a particular turning movement before that movement reaches capacity). Although the intersection does not yet meet peak-hour traffic signal warrants, future onsite traffic conditions may require additional analysis at this location.

Onsite Parking

The latest parking demand was evaluated by LLNL in 1988 in a Parking Master Plan (LLNL, 1988). Utilizing this information as a base, and updating the parking demand based on the current number of personnel, the current parking stall deficit is 923 onsite personnel parking stalls. There are also 962 assigned government vehicles located onsite, including those assigned to the Protective Force Division. Based on updated estimates from the 1988 report which take into account the current number of government vehicles and stalls onsite, a deficit of 107 stalls is identified for government vehicles (LLNL, 1988). (See Appendix K for more details on parking calculations.)

Onsite Accident History

No accidents or Statewide Integrated Traffic Records System reports for onsite traffic accidents were reviewed for this traffic analysis. According to the LLNL Planning and Development Department and the Protective Force Division, the majority of onsite accidents take place in the onsite parking lots. Parking lot accidents are not typically mitigated by physical street improvements. It should be noted that although the security division reported approximately seven serious onsite traffic accidents during the 3-year evaluation period, there were not enough accidents occurring at any one location to prompt a trend analysis.

LLNL Site 300

Access to LLNL Site 300 is through a series of two security gates at the main entrance on the north side of Corral Hollow Road. The current average daily volume count at the main gate is 700 vehicles. Vehicular access around LLNL Site 300 is limited to parking lots and roadways in the southeast corner of the site near the General Services Area. There are 185 parking stalls designated at LLNL Site 300, including those used by government vehicles. On an average day, there are 50 to 60 empty stalls; therefore, adequate parking is available. Figure K-7 in Appendix K depicts the access and circulation in the General Services Area. Access to roadways in the northern limited area is restricted.

Because of speeding vehicles on Corral Hollow Road, access problems have been identified at the LLNL Site 300 main gate area. Improvements including reconfiguration of the internal gate structure and parking areas near the main entrance, and relocation of the main entrance slightly to the west of its present location, are currently underway. Construction began in July 1992 and is projected to be completed by November 1992.

SNL, Livermore

SNL, Livermore personnel, restricted from driving on the SNL, Livermore facility, must park in lots adjacent to East Avenue or near the Combustion Research Facility on Thunderbird Lane. LLNL personnel may also park in these lots. There are a total of 2000 personnel parking stalls in these lots. Additional parking stalls for government vehicles are provided within the SNL, Livermore grounds. No parking stall deficiencies are currently identified at SNL, Livermore. Existing 1991 parking lot driveway counts for SNL, Livermore are shown on Figure 4.13-3. As a result of the onsite driving restrictions at SNL, Livermore, no evaluation was made of its onsite circulation or traffic accident history.

4.13.5 Alternate Modes of Transportation

Public transit service is available directly to the LLNL Livermore site and SNL, Livermore by the local Wheels bus service and by BART Express. Appendix K provides more information regarding routes for these services.

LLNL Livermore Site

LLNL conducts a ridesharing program as part of its in-house energy management program that began in 1976. A ridesharing program goal is to reduce the onsite traffic and parking problems at the LLNL Livermore site facility. There is a designated onsite rideshare coordinator who maintains a database of individuals participating in the program which currently consists of more than 474 carpools with an estimated 700 riders, and 43 vanpools with an estimated 565 riders (LLNL, 1991g). The Stockton Metropolitan Transit District also provides six buses (three from Manteca, two from Stockton, and one from Tracy) driven by LLNL drivers, offering ridesharing opportunities to approximately 115 LLNL Livermore site and SNL, Livermore personnel from outlying cities.

Taxis (i.e., on-call shuttlevans) and energy-efficient carts provide onsite transportation alternatives within the LLNL Livermore site. As of 1991, the taxi fleet consisted of 9 taxis (12 to 15 passengers), 3 buses (27 to 37 passengers), 2 station wagons, and 1 van (LLNL, 1989g). More than 700 Laboratory bicycles are also located throughout the facility for onsite travel. It is estimated that the total use of these bicycles amounts to more than 500 miles per day (LLNL, 1991g).

LLNL Site 300

There are currently 26 carpools with an estimated 49 riders, and 2 vanpools with an estimated 14 riders operating at LLNL Site 300. Parking stalls are reserved for these vehicles onsite. There are also 155 government vehicles assigned to LLNL Site 300. Currently there is no public bus service to the site, although a shuttle service is available between the LLNL Livermore site and LLNL Site 300.

SNL, Livermore

Although there is no formal ridesharing program at SNL, Livermore, an informal rideshare matching program, facilitated through a weekly newsletter, supports two vanpools with an estimated 19 riders and 20 carpools with an estimated 60 riders. SNL, Livermore personnel can also participate in the ridesharing opportunities provided by the Stockton Metropolitan Transit District buses discussed above. Onsite transportation is provided via approximately 200 bicycles and 131 gasoline-powered and electrically powered carts. Fifty government vehicles are assigned for use by specific SNL, Livermore departments onsite, including Protective Services. A bus stop turnaround, utilized by the Wheels and BART Express bus services, is provided onsite.

4.13.6 Aircraft Operations

Some passengers and materials bound to and from LLNL and SNL, Livermore move through the Livermore Municipal Airport, which provides service to the LLNL Livermore site and SNL, Livermore. LLNL maintains an aircraft with an associated service facility at the Livermore Municipal Airport. Materials also move through the Tracy Municipal Airport, primarily servicing LLNL Site 300. In addition, both Laboratories occasionally receive and ship materials via flight operations at the Alameda Naval Air Station, near Oakland, and Castle Air Force Base, near Merced, California.

Livermore Municipal Airport

Located south of I-580, just within the western boundary of the City of Livermore, the Livermore Municipal Airport occupies approximately 400 acres and has been in operation at the existing location since 1965. Based on air traffic counts taken in the early 1970s, the city constructed an FAA Air Traffic Control Tower in 1973, installing an instrument landing system 6 years later.

LLNL, then known as the University of California Radiation Laboratory, Livermore Site, began contract flight operations at the airport in 1954 at a previous location. Subsequently, LLNL began operating and housing a Fairchild F-27F aircraft at the airport in 1968. With a 40-passenger capacity, the LLNL aircraft is one of the largest aircraft regularly using the airport (City of Livermore, 1975).

For the 12 months preceding February 1991, the airport logged a total of 233,405 flight operations (takeoffs and landings); this compares to 227,952 operations from February 1989 to February 1990, and to 209,391 operations for the 12-month period prior to that (Maestas, 1991). The annual LLNL-related flight operations at the Livermore Municipal Airport are estimated to be 520 (approximately 10 takeoffs and landings per week).

Tracy Municipal Airport

Located approximately 3 miles southwest of the City of Tracy, the Tracy Municipal Airport occupies about 309 acres, less than half of which has been developed for aviation use. Constructed on city property by the U.S. Army Air Corps in 1943 as a training base during World War II, the airport was transferred by the Army to civilian use in 1946 (City of Tracy, 1975).

The total annual operations (takeoffs and landings) at the airport, estimated from fuel sales and observations of based aircraft, is approximately 56,750. A new 20-year master plan for the Tracy Municipal Airport is in preparation (Pellegrino, 1991a, 1991b). LLNL-related flights were estimated to be 32 in 1990: 12 flights for the LLNL plane plus 20 flights by Ross Airlines, a DOE contract air service.

4.14 UTILITIES AND ENERGY

This section discusses the utilities and energy supplies and consumption for LLNL Livermore site, LLNL Site 300, and SNL, Livermore. In several cases the LLNL Livermore site and SNL, Livermore receive utility services and energy resources through the same regional supply systems. While they are distinct operations managed and operated by different contractors, for purposes of this document the LLNL Livermore site and SNL, Livermore are addressed together because of their proximity. Even so, utility and energy usage is discussed separately for the LLNL Livermore site, LLNL Site 300, and SNL, Livermore as often as is feasible.

4.14.1 Water Consumption

Overall water consumption for the three Laboratory sites has cumulatively decreased during the past 5 years, with a relative decrease for each site (Figure 4.14-1).

LLNL Livermore Site

The primary source of domestic water for the LLNL Livermore site is the City of San Francisco's Hetch Hetchy water system. An alternate backup source is Zone 7 of the Alameda County Flood Control and Water Conservation District (LLNL, 1991j). The LLNL Livermore site consumed an average of 261.8 million gal per year from 1986 through 1990. The water consumption rates, however, have declined steadily since 1986, down to 223 million gal in 1990.

Offsite Leased Properties

Additionally, there are four offsite leased properties that are significant water consumers: Vasco Road; Camp Parks; 2020 Research Drive; and Almond Avenue. These facilities have consumed about 3.1 million gal per year. The greatest water consumer is the Almond Avenue facility, which used a total of 7,658,024 gal between October 1987 and March 1991 or about 2,241,372 gal per year. The facility at 2020 Research Drive used 2,523,476 gal from November 1987 to March 1991 or about 757,042 gal per year; the Vasco Road facility used 638,014 gal during the period of March 1986 to March 1991 or about 127,602 gal per year; and the Camp Parks facility used 67,720 gal between April 1986 and March 1991 or about 13,774 gal per year. The City of Livermore provides water to 2020 Research Drive and Vasco Road facilities, whereas the California Water Services Company provides water to Almond Avenue. These properties are considered part of the LLNL Livermore site for purposes of discussion in this document.

LLNL Site 300

LLNL Site 300 is supplied with water from a system of wells. The existing capacity of usable wells is approximately 930,000 gal per day. The 5-year water consumption average for LLNL Site 300 is 31.8 million gal per year. The 1990 consumption was 30 million gal. LLNL Site 300 will be supplied with water pumped from the City of San Francisco's Hetch Hetchy water supply system by late 1993. The capacity of this new water supply is estimated to be 500,000 gal per day, with the capability of expanding to 1.2 million per day (LLNL, 1990b).

SNL, Livermore

As with the LLNL Livermore site, the primary source of domestic water for SNL, Livermore is the City of San Francisco's Hetch Hetchy water system. An alternate backup source is Zone 7 Alameda County Flood Control and Water Conservation District (LLNL, 1991j). SNL, Livermore consumed an average of 65.6 million gal per year from 1986 through 1990. The water consumption rates, however, have declined steadily since 1986, down to 56 million gal per year in 1990.

4.14.2 Electricity Consumption

Total cumulative electricity consumption for LLNL and SNL, Livermore increased by 38,244,520 kilowatt-hours between 1986 and 1990. As shown on Figure 4.14-2, LLNL Livermore site uses the largest amount of electricity, followed by SNL, Livermore and LLNL Site 300. Electricity consumption for each facility increased between the years 1986 and 1989, but total cumulative electricity use decreased slightly from 1989 to 1990.

LLNL Livermore Site

Electrical power is supplied to the LLNL Livermore site and the offsite leased properties by Pacific Gas and Electric Company and the Western Area Power Administration. Electricity consumption increased each year between 1986 and 1990. The electrical energy used at LLNL is devoted almost entirely to the operation of office buildings and research laboratory facilities. Under DOE Guideline definitions of "building" and "metered process," LLNL space is classified as approximately 50 percent "building" and 50 percent "metered process" load. There are no single, dominant energy-consuming activities (such as an accelerator operation) or energy-intensive processes or installations (LLNL, 1991g). Based on 1990 records, the LLNL Livermore site consumes about 321.3 million kilowatt-hours per year (Hale, 1991). This represents only an estimated 3 percent of the total annual demand for residential, commercial, industrial and other consumers in Alameda County.

Offsite Leased Properties

The offsite leased properties (Camp Parks; 2020 Research Drive; Vasco Road; Greenville Road; and Almond School) are part of the LLNL metered and/or building process load. In addition, the Mocho Pumping Station is included in the metered and/or building process load. Cumulatively, electricity consumption by the offsite leased properties has increased steadily since 1986.

LLNL Site 300

Electric power is supplied to LLNL Site 300 by Pacific Gas and Electric Company and the Western Area Power Administration. Total cumulative electricity consumption showed little increase between the years 1986 and 1989. Electricity use declined slightly at LLNL Site 300 during 1989 and 1990.

Based on 1990 records, LLNL Site 300 consumes about 1.5 million kilowatt-hours of electricity annually. This represents about 0.3 percent of the total estimated annual demand for San Joaquin County.

SNL, Livermore

Electric power is supplied to SNL, Livermore by Pacific Gas and Electric Company and the Western Area Power Administration. Electricity use increased slightly between the years 1986 and 1989 at SNL, Livermore, and declined slightly during 1989 and 1990.

Based on 1990 records, SNL, Livermore consumes about 38.7 million kilowatt-hours of electricity per year. This represents about 0.4 percent of the total estimated annual electrical energy demand for Alameda County.

4.14.3 Fuel Consumption

LLNL Livermore Site

As shown in Figure 4.14-3, gasoline is the primary fuel consumed at LLNL, followed by jet fuel, diesel, and LPG (liquid propane gas). The cumulative totals for LLNL show an increase in gasoline consumption, and a decrease in diesel and jet fuel consumption. LPG consumption has remained constant during the past 3 years, but reflects a decrease from 1986 and 1987 totals. The 5-year averages for LLNL are gasoline, 496,200 gal per year; diesel, 86,600 gal per year; jet fuel, 155,800 gal per year; and LPG, 10,400 gal per year.

Natural gas is supplied to the LLNL Livermore site by Pacific Gas and Electric Company. Natural gas consumption for the LLNL Livermore site increased during each year from 1986 to 1989, but decreased in 1990. The 5-year average for the LLNL Livermore site is 3.69 million therms per year. The satellite locations that use natural gas are the Vasco Road; Camp Parks; 2020 Research Drive; and Almond Avenue facilities. The cumulative total for these four facilities during 1990 is 28,800 therms. One therm is equivalent to 100,000 British thermal units (Btu). Natural gas is used mostly for comfort heating in the building category. In the metered process category, natural gas is used mostly for programmatic experimental use, and for some comfort heating as well. Continuing efforts to decrease energy use include modification to heating, ventilation, and air conditioning (HVAC) controls; the design of more efficient buildings; boiler tuneups; and other site energy conservation efforts.

LLNL Site 300

LLNL Site 300 fuel oil consumption has decreased significantly since 1986, with a 5-year average of 78,114 gal per year. Fuel oil is used mostly for comfort heating in the building category. In the metered process category, fuel oil is used for comfort heating and in some experiments. The completion of HVAC retrofit projects and mild temperatures have contributed to the overall decrease in fuel oil consumption.

SNL, Livermore

As shown in Figure 4.14-4, gasoline consumption at SNL, Livermore increased over each of the past 5 consecutive years, while diesel consumption increased from 1986 to 1988, but has been decreasing since its 1988 high. The 5-year averages for gasoline and diesel are 8734 and 9162 gal per year, respectively. At SNL, Livermore, 106 sixteen-ounce propane cylinders of LPG were used in the maintenance area during the past 5 years. The average LPG usage per year at SNL, Livermore is approximately 21 cylinders per year. Natural gas is supplied to SNL, Livermore by Pacific Gas and Electric Company. Consumption at SNL, Livermore increased during each year from 1986 to 1989, but decreased in 1990. Diesel fuel consumption followed the trend for LLNL, with a general increase between years 1986 and 1988 followed by a significant decrease in 1989.

4.14.4 Sewer Discharges

The City of Livermore sewage treatment facility currently receives a total of approximately 4.5 million gal of effluent per day. The capacity of this facility is 5 million gal of effluent per day. The facility is currently being expanded and the completion date is anticipated in 1994. When completed, the facility would be able to treat 8.5 million gal per day which is expected to be sufficient for inflow treatment for the next 10 years. Projected sewer discharge volumes could be treated at the City of Livermore treatment facility even without the proposed expansion of this facility. Therefore, the cumulative impacts associated with the Laboratories' contribution of sewage discharge is less than significant.

The City of Livermore Water Reclamation Plant (LWRP) handles sewage from LLNL and SNL, Livermore. Sewage flows through two main laterals on the east and west sides of the site, combines in a flow-measuring flume near Building 196 (located at the northwest corner of LLNL Livermore), then leaves the site and enters the City of Livermore's sewer system. Figure 4.14-5 shows the cumulative sewer discharges for the LLNL Livermore site and SNL, Livermore for the years 1986 through 1990. Current daily flows average 366,000 gal, with a peak of 710,000 gal per day. A sewer diversion facility was completed in the spring of 1991 to protect City of Livermore treatment facilities against accidental contamination (LLNL, 1991j).

LLNL Livermore Site

The 5-year sewer discharge average for the LLNL Livermore site is 113.2 million gal per year. Most discharges to the sanitary sewer system at the LLNL Livermore site are considered batch discharges, since they occur on a sporadic basis. Because these discharges occur randomly on an as-necessary basis, there is considerable variation both in the number of discharges per month and in the time of day of the discharges. One exception is the cleaning of cooling towers. Generally, each tower is emptied once a year, usually during the winter months, when demand on the towers is lower, and on weekends, when more capacity is available in the LLNL Livermore site sewer system (LLNL, 1990i).

There are four principal sources of large-volume batch discharges. They are air washes, cooling towers, boilers, and wastewater treatment/retention tanks. The amount of releases to the sanitary system varies substantially for each. These four principal sources of large-volume batch discharges are briefly discussed below (LLNL, 1990i).

Air Washes

There are 26 building air washes, which range from about 4 to 1500 gal in capacity. Each air wash is cleaned and the water released to the sanitary sewer once a year at a rate of about 15 gal per minute. Only one air wash is cleaned at a time.

Cooling Towers

There are six sets of cooling towers, with a total of seventeen cells. The cooling towers are located at Buildings 251, 291, 325, 412, 435, and 511. The cooling tower complexes have capacities ranging from 20 to 252,000 gal. Each tower is cleaned and the water released once a year. Only one tower is cleaned on a given day, and the flow is controlled to release at a rate that would not overflow the sewer monitoring weir. Unlike other discharges, the cooling towers are generally emptied on weekends and on colder days. The maximum discharge occurs when the largest tower is cleaned; that discharge includes five cells, totaling approximately 150,000 gal.

Boilers

There are 110 boilers on the LLNL Livermore site, of which 23 are steam boilers and 87 are hot water boilers. Only the steam boilers have regular blowdown release, and 8 of the steam boilers have a continuous, rather than batch, blowdown. The remaining 15 steam boilers discharge approximately 5 to 10 gal, at a rate of 5 to 6 gal per minute, three times per week. Other than the eight continuous discharges, blowdown of the boilers is a manual procedure, and only one boiler is released at a time.

All the boilers are emptied once a year for cleaning, and they could be emptied for maintenance, if necessary. There are 23 large boilers that hold an average of about 1500 gal, and there are 87 boilers that contain an average of 400 gal.

Wastewater Treatment/Retention Tanks

The LLNL Livermore site has a total of 33 buildings that have wastewater retention systems, including the liquid waste treatment area. Each of those systems contains sumps or tanks that can make releases to the sewer if concentrations of the constituents in the system meet discharge limitations; however, the contents of some of the retention systems are never released to the sewer. Most of the retained wastewater is generated at the LLNL Livermore site, but some wastewater is received from LLNL Site 300 for treatment or discharge to the sanitary sewer or for disposal as a hazardous waste.

During the period of January to July 1990, the LLNL Livermore site discharged the contents of an average of 12 retention or treatment tanks to the sanitary sewer each month. Retention tank and sump volumes range from approximately 100 to 5000 gal; the average volume released to the sewer is 1000 gal. The flow from the tanks is approximately 25 to 30 gal per minute, except for the treatment tanks at Building 514, which can discharge 100 gal per minute because of their large pumps.

When wastewater is discharged to the sewer system, it combines with other sewage from LLNL and SNL, Livermore. The combined flow leaves the LLNL Livermore site at Building 196, the Sewage Monitoring Station. The LLNL Livermore site Sewage Monitoring Station is equipped with a continuous monitoring system designed to detect radiation, excessive pH, and metals. The monitoring system does not stop the flow of wastewater to the City of Livermore, but does provide a warning that an unacceptable release may be flowing toward the Livermore Water

Reclamation Plant. Releases can be diverted into a City of Livermore holding basin for further analysis and disposition. It takes approximately 3 hours for sewage to reach the Livermore Water Reclamation Plant from the monitoring station; therefore, the city has adequate time to divert the flow if necessary (Grandfield, 1989).

To protect the Livermore Water Reclamation Plant and to minimize any cleanup that might become necessary, the LLNL Livermore site has constructed an onsite sewage diversion and retention system. This system is capable of containing approximately 200,000 gal of potentially contaminated sewage until analyses can be completed and appropriate handling methods are determined. This system would contain approximately 6 hours of total discharge from the SNL, Livermore and LLNL facilities. The system ensures that, if the alarm is triggered by the flow, all but the first few minutes of flow is retained at LLNL for evaluation of appropriate treatment for disposal.

In addition to continuous monitoring of the effluent, sewer samples are collected from both the Sewer Monitoring Station (Building 196) and the Livermore Water Reclamation Plant. Samples are analyzed daily for radioactivity and are composited monthly to determine the concentrations of specific isotopes (cesium-137 and plutonium-239) and various metals.

The 1990 annual average wastewater radionuclide concentrations (LLNL, 1991f) included 9.86×10^{-11} mCi/mL for cesium-137, 13.0×10^{-12} mCi/mL for plutonium-239, and 1.46×10^{-6} mCi/mL for tritium. A total of 0.68 Ci of tritium was released in wastewater during 1990 by LLNL and SNL, Livermore, representing 70 percent of the State limit of 1 Ci/year and approximately 0.021 percent of DOE annualized limit requiring application of best available technology to control sewer effluent releases (LLNL, 1991d). The discharges of plutonium-239 and cesium-137 represented even smaller portions of their respective DOE limits (LLNL, 1991f). The LLNL 1990 annual environmental monitoring report (LLNL, 1991f) reports that LLNL is in compliance with all regulations and guidelines governing releases of radioactivity to the sanitary sewer.

Potential exposure pathways for workers at the Livermore Water Reclamation Plant include inhalation and incidental ingestion of tritium, plutonium-239, and cesium-137 and dermal absorption of tritium (plutonium and cesium are not readily absorbed through intact skin). Using conservative exposure parameters, an effective dose equivalent of approximately 0.0002 rem from ingestion and 0.0004 rem from inhalation and absorption through the skin was estimated.

Historically, practices at the Livermore Water Reclamation Plant have resulted in soil and sediment contamination. The highest concentration of plutonium-239 in soils were at three Livermore Water Reclamation Plant locations (LLNL, 1991f). The average plutonium concentration at these locations is 86×10^{-9} mCi plutonium-239 per gram of soil, resulting in an annual effective dose equivalent of 0.000001 rem (0.001 mrem)/yr. This is 0.001 percent of the primary public radiation protection standard of 0.1 rem (100 mrem)/yr effective dose equivalent.

The effluent is sampled and analyzed quarterly for a number of specific parameters. Also quarterly, samples are collected at the point of discharge of specified metal finishing and electrical and electronic component categorical processes to ensure compliance with EPA discharge limits for those processes.

Based on this monitoring, it has been determined that Livermore Water Reclamation Plant workers may be exposed to potentially toxic substances in sewage and sludge from treatment. A risk assessment examining exposure of workers to the toxic substances in the sewage was conducted using EPA methods (EPA, 1989a, 1989b). The chemical concentrations in the sewage sludge were from the 1990 monitoring data (LLNL, 1991f). It was assumed that workers were exposed to the sewage via incidental ingestion and dermal absorption. Daily intakes were estimated for an arbitrary exposure duration of 8 hours per day, for a 5-day work week, for 7 years. Estimated daily intakes ranged from 6.3×10^{-7} mg/kg-day for zinc to 1.0×10^{-11} mg/kg-day for beryllium.

The estimated daily intakes were compared to acceptable intakes in order to estimate the hazard index. The total noncarcinogenic hazard index was at 7×10^{-5} (i.e., less than one ten-thousandth of levels that are estimated as safe). The total lifetime carcinogenic risk was calculated to be about 0.002 in a million.

LLNL Site 300

LLNL Site 300 sanitary sewage generated outside the General Services Area is disposed of through septic tanks and leachfields or cesspools at individual building locations. Sanitary sewage generated at the General Services Area is piped into an asphalt-membrane-lined oxidation pond east of the General Services Area at an average rate of 3500 gal per day (LLNL, 1991r).

Wastewater discharges from LLNL Site 300 are handled in a variety of ways. In the General Services Area, wastewater is treated and disposed of in an oxidation pond with overflow to an evaporation-percolation pond. General Services Area sewage is domestic in nature.

In the process and chemistry areas, industrial wastewater goes through a clarifier and weir system and is discharged to two Class II surface impoundments located south of Building 817. Wastewater from the chemistry buildings and photo lab rinsewaters are trucked to the clarifier/weir system for treatment prior to discharge into the surface impoundment. High explosive process waste from the machining area and pressing facility is plumbed directly to the treatment system (UC, 1987).

Cooling tower wastewater from the various LLNL Site 300 operations is currently discharged, in accordance with the prescribed permit conditions, to onsite surface water drainage courses. Discharges to surface water bodies would be eliminated at many of the cooling towers. This effluent would be disposed of via leachfields. Other industrial wastewater generated at LLNL Site 300 is stored in retention tanks, drummed, and hauled to the LLNL Livermore site for reprocessing and/or disposal.

SNL, Livermore

The sanitary sewer outfall from SNL, Livermore is located adjacent to Building 911 on the north perimeter of the site. The liquid effluent flows from SNL, Livermore into the LLNL Livermore site sewer system. In addition to monitoring total sewer outfall at LLNL Building 196, an on-line monitoring system is maintained by SNL, Livermore at the sanitary sewer outfall connection to LLNL. This system continuously measures the pH and flow of the exiting waste stream. A composite sampler continuously collects samples of the sewer effluent at the discharge point from SNL, Livermore. These samples are analyzed weekly to demonstrate compliance with the SNL, Livermore wastewater discharge permit conditions (Brekke, 1991).

At SNL, Livermore wastewater from laboratories and other operations that could adversely impact the operations of the City of Livermore Water Reclamation Plant is discharged into retention tanks. The contents of these tanks are monitored prior to discharge to the sanitary sewer to ensure that concentrations of constituents are below the limits imposed by the City of Livermore Wastewater Discharge Permit. If the contents of these tanks cannot meet that standard they are treated as hazardous waste and handled accordingly.

Wastewater that is generated by SNL, Livermore categorical processes, by the electroplating laboratory in Building 913, and by the printed wire laboratory in Building 910 must comply with the metal finishing pretreatment standards. The EPA established these discharge standards based on the best available control technology economically achievable (Brekke, 1991).

4.14.5 Conservation and Recycling

LLNL Livermore Site

The Energy Management Program is responsible for reducing LLNL overall energy consumption and reducing the impact of energy costs on Laboratory site operations. This is primarily accomplished through energy conservation, awareness, and efficiency.

DOE has mandated that LLNL will attain a goal of 10 percent energy reduction by 1995 using 1985 energy consumption as a baseline. To achieve this goal, the Energy Management Program performs studies and conducts surveys to identify opportunities for retrofit projects to reduce energy use at the Laboratory. The Energy Management Program is also responsible for the evaluation and promotion of alternate and renewable energy sources (LLNL, 1991g).

A portion of the nonhazardous waste that is generated is sold for recycling or reuse, as described in section 4.15.

LLNL is committed to reducing water use during this time of drought and to using water in a conservative manner. Beginning in 1988, LLNL began curtailing water use by implementing several water conservation measures. The following water use limitations and/or restrictions exist at LLNL:

- Reducing landscape watering to 35 percent below 1989 levels.
- Reducing blowdown in cooling towers to minimal operable levels.
- Limiting use of car wash to only that which is essential.
- Not washing down sidewalks, walkways, driveways, and so on with water.
- Using reclaimed ground water in place of potable water in cooling towers to the greatest extent possible.
- Postponing all new contracts for additional water-intensive landscaping (i.e., lawn and ground cover).
- Monitoring all water use to discourage waste or unnecessary use.

In 1988, LLNL constructed a two-cell recharge basin at SNL, Livermore to investigate the feasibility of conserving the local ground water resource through surface recharge. The recharge basin has been receiving treated ground water from treatment facility "A" since early 1989. Since then, about 6.5 million gal of treated ground water have been discharged to the eastern cell. On December 12, 1989, roughly one year from start of operation, the western cell began receiving treated water from treatment facility "A." Over 6 million gal of treated water have been discharged to the western cell through May 1990. The recharge basin has performed effectively, with an estimated 92 to 98 percent of the treated water recharged (Isherwood et al., 1990).

SNL, Livermore

The energy management organization at SNL, Livermore has developed a plan to survey the site for alternate energy capabilities and ways to reduce usage, to set goals to achieve the DOE mandated reduction of 10 percent by 1995, to increase employee awareness through bulletins and posters, and to analyze and monitor results for continued improvement. Water conservation efforts especially during the drought are achieved through cutbacks in irrigation, cooling, and domestic water use. Any new or replacement landscaping is done with conservation measures in mind, such as the use of ornamental wood chips and low water level sprinklers.

SNL, Livermore is currently conducting recycling programs in three major categories: low-level radioactive and mixed wastes, hazardous wastes, and nonhazardous wastes. The following summarizes recycling programs for these categories (SNL, Livermore, 1991m).

Low-Level Radioactive and Mixed Wastes

- Tritium used at the tritium research lab is recaptured and recycled to the maximum extent possible.
- High-level tritiated water effluent is packaged in the AL-M1 container and shipped offsite for eventual recycling.

Hazardous Wastes

- All batteries.
- Mercury and fluorescent light tubes.
- Coolants and petroleum oil containing less than 1 percent chlorinated solvents and no PCBs or metals.
- Drums containing oil residues.
- Silver from photo chemicals (fixers and developers).
- Solvents.
- Lead waste.

Nonhazardous Wastes

- A program is underway through the plant maintenance department to reduce the amount of yard waste sent to the landfill. A wood chipper would be used to mulch tree trimmings and leaves into compostable material. This end product would be used onsite and documented by the plant maintenance department. Early estimates of this waste stream are a 10 percent reduction in landfill material.
- SNL, Livermore has supported a metal recycling program for several years. Assorted metals are collected and sold to an outside vendor for sorting and recycling.
- Classified and sensitive paper waste has been in a recycle stream for the past 6 years. SNL, Livermore classified waste is sent to LLNL for processing. The waste is then shipped to a paper products manufacturer.
- A pilot paper recycling program is progressing for unclassified paper. This project would be used to design a sitewide implementation plan.
- An employee recycling program to collect aluminum soda cans has been started. This is strictly a volunteer effort and the proceeds are given to charity.

LLNL Site 300

A variety of recycling programs are currently practiced at LLNL Site 300 as described in section 4.15.

4.15 MATERIALS AND WASTE MANAGEMENT

This section provides an overview of management responsibilities regarding receipt, transfer, and shipment of radioactive, controlled, and hazardous materials and wastes as well as mixed and medical wastes at LLNL and SNL, Livermore. Additional supporting information and analyses, including a description of programs and buildings associated with use of these materials, are provided in Appendices A and B. The use of these materials historically has resulted in both their planned and inadvertent releases to the environment. The consequences of using radioactive, controlled, and hazardous materials are discussed in the sections associated with the affected media. For example, releases to the air associated with use of radioactive materials are discussed in section 4.10 and releases affecting vegetation are discussed in section 4.9. The workplace use of these materials and associated occupational exposures are discussed in section 4.16 and in Appendices A and C.

In this section, the terms "transfer" and "transferring" refer to intrasite movement of materials, and "shipment" and "shipping" to the movement of materials or waste between sites or to other offsite locations via public roads and highways, or by air. (See Appendix K for more details on hazardous materials transportation at LLNL and SNL, Livermore.)

Tables 4.15-1, 4.15-2, and 4.15-3 provide information on the administrative limits on the amounts of specific radioactive materials present in specific buildings, the quantities of chemicals (both hazardous and nonhazardous) used and/or stored at each of the sites, and the annual generation rates of various categories of waste. Only facilities with significant quantities of radioactive materials are listed in the tables; for a listing of quantities of lesser amounts, see Appendix A. LLNL is currently reducing the plutonium administrative limit for the combined Buildings 332 and 334 from 700 kg to 200 kg, the inventory (actual inventory quantities are classified) being reduced accordingly. The reduction would be accomplished by shipping inventory to an offsite DOE facility and is targeted for completion during FY 1993.

Waste generation levels cannot be predicted with certainty in a research setting because research activities do not involve constant and predictable processes. Because programs and facilities under the proposed action are projected to be similar to existing programs and facilities, it is reasonable to assume that resulting waste streams would also be similar. Therefore, the amounts of wastes generated by LLNL and SNL, Livermore operations under the proposed action are assumed to increase proportional to the increase in gross square footage at the sites. Assumed increase in waste generation in relation to increases in gross square footage are used to conservatively evaluate the impacts of the proposed action and alternatives. This approach does not consider potential reductions in future waste generation from pollution prevention and waste minimization programs, advanced treatment technologies, or reduced operations at significant waste generators.

All chemical inventory and waste generation projections are made on the conservative assumption that the chemical quantities and waste generation rates increase proportionally to the increase in gross square footage of building area at each of the three sites. The "Existing" column of Tables 4.15-1, 4.15-2 and 4.15-3 represents 1990 data that have been projected to the end of FY 1992, thus reflecting the total quantities for the no action alternative.

The "Proposed Action" column projects how these quantities are assumed to change by the end of the 10-year period of the proposed action.

Materials and waste relative to the modification of operations alternative and the shutdown and decommissioning alternative were not quantified, but were evaluated relative to the proposed action. In general, the modification of operations alternative would result in similar quantities to the proposed action. The shutdown and decommissioning alternative would result in an initial increase in waste generation; however, materials used and wastes generated would eventually decrease to near zero.

Because 1990 data are the latest actual figures available for hazardous materials and waste at the LLNL Livermore site, these figures were increased proportional to the 7.5 percent increase in square footage of space that occurred between

1990 and 1992. Similarly, for SNL, Livermore this proportional increase was 3.6 percent for increases in square feet from 1990 to 1992.

The 1990 values of LLNL Livermore site waste generated are as follows: 15,810 gal of liquid low-level radioactive waste, 185,000 lb of solid low-level radioactive waste, 2488 cu ft of solid transuranic waste, 276,800 gal of liquid hazardous waste, 425,500 lb of solid hazardous waste, 6286 gal of liquid low-level radioactive mixed waste, 41,561 lb of solid low-level radioactive mixed waste, and 2400 lb of medical waste. The latest (1990) data for SNL, Livermore waste generated are as follows: 7400 gal of liquid low-level radioactive waste, 8550 lb of solid low-level radioactive waste, 3800 gal of liquid hazardous waste, 6100 lb of solid hazardous waste, 240 lb of liquid low-level radioactive mixed waste, 70 lb of solid low-level radioactive mixed waste, and 120 lb of medical waste.

The chemical baseline in Table 4.15-1 is derived from totals reported in the 1990 Alameda County Hazardous Material Business Plan (LLNL, 1990e). For the LLNL Livermore site, the baseline totals are 195,935 gal of liquid chemicals and 2,114,880 lb of solid chemicals. In Table 4.15-2 the chemical baseline is derived from the San Joaquin County Hazardous Materials Management Plan (LLNL, 1989f). In Table 4.15-3 it is based on an inventory check made in 1991, which includes 3300 gal of liquid chemicals, 6100 lb of solid chemicals, and 190,000 cu ft of compressed gases. As discussed above, the totals have been increased by 7.5 percent for LLNL Livermore site and 3.6 percent for SNL, Livermore to project the 1992 quantities.

For LLNL Site 300, no interim construction occurred between the 1990–1991 data collection period and the FY 1992 baseline. In keeping with the conservative assumption that for purposes of this EIS/EIR materials and wastes increase proportionally to the increase in square footage, the projections in these substances for the proposed action are based on the increases in building space proposed in this document. As described in the proposed action, total growth for the period until the year 2002 is 9 percent for the LLNL Livermore site, 9 percent for LLNL Site 300, and 6 percent for SNL, Livermore. Hence, the materials and waste figures estimated for 1992 are multiplied by these total percentage increases in the proposed action to project the amount of materials and waste associated with completely implementing the proposed action.

Appendix B summarizes all 1990 data that were used as the basis for waste projections. For transuranic waste, 1989 generation rates were used for projections, since only 6 months of 1990 data was available.

The waste generation rates presented in Tables 4.15-1 through 4.15-3 represent a conservative estimate of future waste quantities. The estimates do not consider future reductions in waste generation from state- and DOE-mandated waste minimization programs, advances in waste treatment/processing technologies, or reduced operations at major waste generator facilities (e.g., the Tritium Research Laboratory).

The one area where projecting increases proportional to square footage was not used for assuming increased waste generation was the U-AVLIS program. In this case, estimated waste quantities from the Environmental Assessment performed for U-AVLIS (DOE, 1991a) were added to the projected 1992 baseline quantities at the LLNL Livermore site. U-AVLIS waste quantities included in the existing (FY 1992) volumes presented in Table 4.15-1 were: 5000 gal of liquid radioactive waste; 88,000 lb of solid radioactive waste; 11,000 gal of liquid hazardous waste; 110,000 lb of solid hazardous waste; and 16,200 gal of liquid mixed waste.

Table 4.15-1 LLNL Livermore Site, Overviewh (N/C = No Change from Existing Amounts)

	Existing (FY 1992)	Proposed Action
Gross Square Footage	5,900,000	530,000 (9% increase)
Administrative Limits for Selected Radioactive Materials[a]		(Not subject to 9% increase)
Tritium Buildings 298 and 391 (combined)	5 mg	10^c g (total)

Building 331[b]	300 g	
Plutonium[d] Building 251 Buildings 332 and 334 (combined)	2 kg 700 kg	N/C 200 kg
Uranium Building 251 Buildings 332 and 334 Building 493 (natural and depleted)	6 kg 300 kg 80,000 kg	N/C N/C N/C
Chemical Quantity[e]	(FY 1992 Annual)	(9% increase by 10th year)
Liquid	210,000 gal	19,000 gal
Solid[f]	2,300,000 lb	210,000 lb
Waste Generated[e] **Radioactive**[g]	(FY 1992 Annual)	(9% increase by 10th year)
Low-level liquid	22,000 gal	2,000 gal
Low-level solid	287,000 lb	26,000 lb
Transuranic solid	2,700 cu ft	240 cu ft
Hazardous		
Liquid	309,000 gal	28,000 gal
Solid	567,000 lb	51,000 lb
Mixed		
Liquid	23,000 gal	2,100 gal
Solid	45,000 lb	4,600 lb
Medical	2,600 lb	230 lb

[a]These figures represent radioactive materials administrative limits allowed at selected buildings. Actual inventories may be classified.

[b]Limit prior to 1992 was 300 g. Actual inventory as of September 1991 was less than 20 g.

[c]No more than 5 g in any one facility; no more than 10 g among the three buildings.

[d]Plutonium 239 or equivalent. This includes other fissile nuclides whose reactivity (for criticality safety purposes) is approximately equivalent to the reactivity of Pu-239.

[e]The projected amounts of chemicals and wastes are based on a 9 percent increase in gross square footage. These projected figures are to be used solely for analyses in this document. They neither take into account that a portion of the proposed gross square footage will be nonlaboratory space and projects replacing other buildings, nor that waste minimization plans, mitigation measures, and other regulatory requirements would limit some impacts.

[f]Compressed gases at the LLNL Livermore site are accounted for in total pounds of chemicals recorded at the site.

[g]This table reflects a 9 percent increase in radioactive waste generated under the proposed projects, even though radionuclide quantities under the proposed action may not necessarily reflect the same increase.

[h]Appendix B summarizes all 1990 data that were used as the basis for these projections. For transuranic waste, 1989 generation rates were used for projections, since only 6 months of 1990 data was available.

Table 4.15-2 LLNL Site 300, Overviewe (N/C = No Change from Existing Amounts)

	Existing (FY 1992)	Proposed Action
Gross Square Footage	340,000	32,000 (9% increase)
Administrative Limits for Selected Radioactive Materials[a]		(Not subject to 9% increase)
Plutonium	15[b] kg	N/C
Tritium	0	20 mg
Uranium (depleted) (enriched)	 No limit 130b kg	 N/C N/C
Chemical Quantity[c]	(FY 1992 Annual)	(9% increase by 10th year)
Liquid	84,000 gal	7,600 gal
Solid	100,000 lb	9,000 lb
Compressed gas	1,900,000 cu ft	171,000 cu ft
Waste Generated[c]	(FY 1992 Annual)	(9% increase by 10th year)
Radioactive[d]		
Low-level liquid	None	None
Low-level solid	300,000 lb	27,000 lb
Transuranic solid	None	None
Hazardous		
Liquid	41,000 gal	3,700 gal
Solid	37,000 lb	3,300 lb
High explosive	4,500 lb	405 lb
Mixed		
Liquid	None	None
Solid	2,000 lb	180 lb
Medical	12 lb	1 lb

[a] These figures are administrative limits allowed at selected facilities. Actual inventories may be classified.

[b] Components containing these materials are sealed and certified; special precautions are taken to ensure no external contamination can occur.

[c] The projected amounts of chemicals and wastes reflect a 9 percent increase in gross square footage. They are to be used solely for analyses in this document. They neither take into account that a portion of the proposed gross square

footage will be nonlaboratory space, nor that waste minimization plans, mitigation measures, and other regulatory requirements would limit some impacts.

[d] This table reflects a 9 percent increase in radioactive waste generated under the proposed projects, even though the actual radioactive inventory under the proposed action may not necessarily reflect the same increase. In addition, the construction of the Contained Firing Facility will greatly reduce the generation of solid low-level radioactive waste, making this projection extremely conservative.

[e] Appendix B summarizes all 1990 waste generation data that were used as the basis for these projections.

Table 4.15-3 SNL, Livermore, Overviewg (N/C = No Change from Existing Amounts)

	Existing (FY 1992)	**Proposed Action**
Gross Square Footage	830,000	50,000 (6% increase)
Administrative Limits for Selected Radioactive Materials[a]		(Not subject to 6% increase)
Tritium	50 g	0 g (decrease)
Uranium (depleted)	No limit	N/C
Chemical Quantity[b]	(FY 1992 Annual)	(6% increase by 10th year)
Liquid	3420[c] gal	210 gal
Solid	6320[c] lb	380 lb
Compressed gas	197,000[c] cu ft	11,900 cu ft
Waste Generatedb **Radioactive** [d]	(FY 1992 Annual)	(6% increase by 10th year)[f]
Low-level liquid	7670 gal	460 gal
Low-level solid	8860 lb	540 lb
Hazardous		
Liquid	3940 gal	240 gal
Solid	6320 lb	380 lb
Mixed		
Liquid[e]	250 lb	15 lb
Solid	73 lb	4 lb
Medical	124 lb	7 lb

[a] These figures represent administrative limits allowed onsite. Actual inventories of these materials may be lower than the amount stated.

[b] The projected amounts of chemicals and wastes reflect a 6 percent increase in gross square footage. These projected figures are used solely for analyses in this document. They neither take into account that a portion of the proposed gross square footage will be nonlaboratory space, nor that waste minimization plans, mitigation measures, and other

regulatory requirements would limit some impacts.

[c] These figures represent totals of representative chemicals onsite. They were selected as representative because they are typical of types of chemicals existing onsite. This list is based on an inventory check conducted in 1991. They do not represent total sitewide chemical inventories.

[d] This table reflects a 6 percent increase in radioactive waste generated under the proposed projects, even though the radionuclide inventory is not expected to increase.

[e] Quantities represent pounds of scintillation cocktails that are shipped offsite for incineration at a permitted treatment facility.

[f] In addition to this projected 6 percent increase by the tenth year, the decommissioning of the Tritium Research Laboratory would result in a one-time generation of waste. These wastes are conservatively estimated as 100,000 lb of low-level and 310 gal of low level mixed wastes. (See Appendix A, section A.3.5.3 for details.)

[g] Appendix B summarizes all 1990 waste generation data that were used as the basis for these projections.

4.15.1 Materials Management

4.15.1.1 Regulatory Setting

LLNL and SNL, Livermore operations regarding materials management are conducted pursuant to DOE Orders and to various applicable federal, state, and local laws and regulations. There is regulatory oversight by various federal, state, and local agencies.

4.15.1.2 Radioactive, Controlled, and Hazardous Materials Management

LLNL Livermore Site

Radionuclide Inventories

LLNL uses radioactive materials in a wide variety of operations including scientific and weapons research and development, diagnostic research, research on the properties of materials, and isotope separation. A listing of selected facility inventory administrative limits for fissile materials and tritium is included in Table 4.15-1. An administrative limit is the total amount of certain materials allowed in a specific building at the Laboratory. Actual inventories may be classified:

- Currently LLNL's Building 331, the Hydrogen Research Facility, has an *administrative limit* for tritium of 300 g and an *inventory* of less than 20 g. Under the proposed action, the administrative limit would be reduced from 300 g to 5 g, with the inventory reduced accordingly. A portion of the tritium operations in Building 331 might be moved to Building 298, the Fusion Target Fabrication Facility, and to Building 391, the Inertial Confinement Fusion Facility (known as the NOVA-Upgrade/National Ignition Facility). The three buildings would have a combined administrative limit of 10 g with no more than 5 g in any one building. For these facilities, the administrative limit would therefore be reduced from 300 g in one facility (Building 331) to 10 g total among three facilities (Buildings 298, 331, and 391).
- LLNL is currently reducing the plutonium administrative limit for the combined Buildings 332 and 334 from 700 kg to 200 kg, with the inventory (actual inventory quantities are classified) being reduced accordingly. The reduction would be accomplished by shipping inventory to an offsite DOE facility and is targeted for completion during FY 1993.
- The administrative limit for uranium in Building 493 limits the inventory to 80,000 kg.

Chemical Inventories

LLNL uses various chemicals in conducting its programs. Because a wide variety of research and development projects are performed, the amounts and concentrations of chemicals vary. These range from laboratory reagents to photographic chemicals, organic solvents, metals, pesticides, etc. Most research operations use small quantities of a wide variety of chemicals; however, in some operations chemicals are used in large quantities. Table 4.15-1 gives chemical inventories for the LLNL Livermore site based on an actual inventory conducted in 1990, pursuant to preparing the Alameda County Hazardous Material Business Plan. Because of the changing nature of work conducted onsite and a 7.5 percent increase in facility space since 1990, the original inventory amounts were scaled upward in proportion to the increase in space. Thus, the list should not be construed as exhaustive but does represent the types of materials found at the site. Approximately 210,000 gal and 2.3 million lb of chemicals are stored on the LLNL Livermore site[(2)].

Onsite Receipt and Distribution

For health and safety, environmental protection, security, strategic importance, monetary value, or programmatic urgency reasons, LLNL classifies certain materials as controlled materials. Some of these materials are also classified as hazardous. Examples of controlled materials include explosives, radioactive materials, special nuclear materials, classified substances and parts, and precious metals.

Hazardous materials must enter LLNL through the Receiving Group of the Supply and Distribution Department. Controlled materials are delivered directly to Materials Management Control points. Materials Management will deliver controlled materials to users only when approved safety and security procedures exist. Some Department of Transportation Class C explosives, such as detonators, are received at Materials Management control points on the LLNL Livermore site.

Onsite Transfers

Onsite management of radioactive, controlled, and hazardous materials is divided between the Materials Management Division, within the Safeguards and Security Department, which is responsible for controlled materials, including radioactive materials and explosives, and the Materials Distribution Division, within the Supply and Distribution Department, which is responsible for the receipt, storage, and transfer of hazardous materials. With the exception of controlled materials, the Materials Distribution Division handles all onsite receipt, storage, transfer, and shipment of hazardous materials (LLNL, 1991h). The Supply and Distribution Department and Materials Management Division ensure that materials are properly packaged, labeled, marked, and documented for both onsite transfer and offsite shipment. (The hazardous and radioactive materials categories and individual division responsibilities for transportation are discussed more extensively in Appendix K.)

In 1990, LLNL established the Hazardous Materials Packaging and Transportation Safety Committee to improve management of hazardous material transportation (LLNL, 1990c). The committee developed the *LLNL Onsite Packaging and Transportation Safety Manual* (LLNL, 1991p), which summarizes all major onsite transportation procedures and requirements in a single comprehensive document. Additionally, the Hazardous Material Packaging and Transportation Safety Committee initiates internal reviews of packaging and transportation activities.

LLNL onsite transfer of hazardous materials is subject to DOE Orders. In most cases these orders and related requirements provide safety procedures are equivalent to the DOT offsite shipment transport regulations (e.g., containment, communication, and control).

LLNL receives radioactive materials at the receiving area of the Supply and Distribution Department or the Materials Management Division control points. For example, special nuclear material is received directly at the vaults of the Materials Management Division. Those radioactive materials received through the Supply and Distribution Department are subsequently transferred to the Materials Management Division, which is responsible for control of these materials and their onsite transportation between buildings. Radioactive materials are stored in vaults under the control of the Materials Management Division until their transfer to the facilities where they will be used. At these individual facilities, all radioactive materials not currently being used are stored in secured areas. Radioactive materials are classified as controlled materials. Controlled materials are discussed further in section 4.15.1.3.

The Hazards Control Department, along with the Hazardous Materials Packaging and Transportation Safety Committee, develops, maintains, and provides guidance in applying safety standards for onsite transfer of hazardous and radioactive materials. Department personnel monitor both radioactive and hazardous materials for surface contamination and safety before onsite transfers (LLNL, 1991p). The Materials Management Division establishes specific procedures for onsite transfer of controlled, including radioactive, materials.

The Materials Distribution Division and the Materials Management Division move explosives on, and between, the LLNL Livermore site and LLNL Site 300. For LLNL Site 300 onsite movement of explosives, only qualified explosives handlers may handle explosives, and each operating group is responsible for transporting explosives under its control.

Vehicles transferring hazardous and radioactive materials onsite are marked with warning signs and equipped with safety equipment, such as fire extinguishers and radiation detectors. The Automotive Fleet Group within the Business Services Department regularly inspects and maintains these vehicles. Additionally, divisions planning to use these vehicles must perform their own safety inspections before use. Users may transport small quantities of hazardous materials by hand or in qualified vehicles to facilities for use. When this is done, users must follow all LLNL requirements for hazardous materials transportation and know accidental spill response procedures.

<u>Offsite Shipment</u>

LLNL has a central system for recording all offsite shipments of hazardous and radioactive materials. This system and an LLNL-oversight checklist ensure that shipments and documentation of transportation practices comply with applicable regulations and DOE Orders. The Traffic Management Section of the Supply and Distribution Department reviews all shipments of materials before shipment and ensures that the carrier is properly certified to transport hazardous or radioactive materials. LLNL conducts regular internal and external audits, and inspections and reviews of the Traffic Management Section's duties. These audits enable LLNL to identify environmental, health, and safety concerns and associated causes, and necessary corrective actions. Special shipments by DOE courier are separate from traffic management duties and are controlled through the Materials Management Division.

Proper packaging of hazardous and radioactive materials for transportation provides significant safeguards against accidental spills and releases. LLNL has a quality assurance plan for procurement of hazardous and radioactive materials shipping containers. Hazardous materials are shipped in containers meeting DOE and DOT requirements. Radioactive materials are shipped in containers certified to meet equivalent DOT and DOE requirements for normal and accident transportation conditions. (Appendix K discusses specific container types used at LLNL.)

In addition, DOT regulations require marking and labeling hazardous materials packages and containers, and placarding of transport vehicles. Should an accident occur, placards allow emergency response personnel to immediately identify hazards. Proper placarding is the responsibility of both the shipper and the carrier. Shipping papers, describing the hazardous or radioactive material and certifying that the shipment meets applicable DOT requirements, must accompany hazardous materials shipments.

Hazardous materials are shipped to and from the LLNL Livermore site and LLNL Site 300 over public roads and highways, and, in limited cases, via public airports. The federal government develops transportation regulations, enforces these regulations (with state assistance), provides emergency response assistance to transportation accidents involving hazardous materials, and collects data and performs analyses on transportation of hazardous materials (Office of Technology Assessment, 1986).

In California, the California Highway Patrol regulates the transportation of hazardous materials pursuant to 13 C.C.R. sections 1 to 6.5. The California regulations incorporate by reference portions of the DOT regulations (49 C.F.R. sections 100–179, 393). The California Highway Patrol has approved routes, stopping places, and rules of the road (13 C.C.R.,Chapter 6) for transportation of explosives. Most LLNL explosives shipments occur between the LLNL Livermore site and LLNL Site 300. There are two approved explosives routes between these two sites: the first is through Corral Hollow Road (west), Tesla Road, and Greenville Road. The second is through Corral Hollow Road (east), I-580, and Greenville Road. The first route encounters less traffic, and is therefore preferred.

All explosives shipped offsite are packaged in DOT-approved containers, or containers meeting equivalent DOT and NRC standards, bearing appropriate DOT labels. Drivers of vehicles carrying explosives receive training that meets DOT requirements (49 C.F.R. 390–397) in general explosives handling safety precautions and specialized explosives transportation. Before being loaded with Class A or B explosives for shipments on public highways, a properly equipped motor vehicle must be inspected and approved by qualified personnel using an approved inspection checklist, which is then carried by the driver. Every vehicle transporting explosives carries specialized emergency equipment, including fire extinguishers and two-way radios.

LLNL Site 300

Radionuclide Inventories

A listing of facility inventory administrative limits for fissile materials and tritium is included in Table 4.15-2. Tritium uses at LLNL Site 300 firing tables would resume under the proposed action with an administrative limit of 20 mg.

Chemical Inventories

Chemical inventories for LLNL Site 300, listed in Table 4.15-2, are based on an actual inventory conducted in 1990 (LLNL, 1990e). This list, however, should not be construed as exhaustive, but does represent the types of materials found at the site. At LLNL Site 300, approximately 84,000 gal, 100,000 lb of chemicals, and 1.9 million cu ft of compressed gas are stored.

Onsite Receipt and Distribution

All controlled hazardous materials received at LLNL Site 300 are handled by the Controlled Materials Group. Explosives are received and repackaged at Building 818 for transfer in LLNL-approved containers. As at the LLNL Livermore site, hazardous materials, including explosives, arriving at LLNL Site 300 are required to meet DOT requirements. The onsite distribution must adhere to the same DOE requirements as for the LLNL Livermore site.

Onsite Transfer

All controlled materials to be transferred onsite are moved by the Controlled Materials Group. Explosives are transferred by personnel qualified to handle explosives according to requirements enumerated in the LLNL Safety and Operations Manual. Transfers must be made in explosives-qualified vehicles and drivers must adhere to the site speed limit of 35 miles per hour. Additional information on transportation of high explosives is provided in Appendix K.

Offsite Shipment

Shipments of hazardous materials from LLNL Site 300 must comply with the same DOT, DOE, and state packaging requirements as shipments from the LLNL Livermore site. Table 4.15-2 lists inventories or administrative limits for all existing facilities. Also included is a projection of the estimated inventories under the proposed action.

SNL, Livermore

Radionuclide Inventory Limits

Like LLNL, SNL, Livermore uses radioactive materials as calibration and radiation sources and in a wide variety of operations including scientific and weapons research and development, diagnostic research, and research on the properties of materials. Tritium and uranium give the highest hazard ranking to buildings that house them. SNL, Livermore's tritium administrative limit is 50 g. There are approximately 3000 kg of uranium onsite. These figures are included in Table 4.15-3.

Chemical Inventories

The types and quantities of chemicals used at SNL, Livermore in performing research and testing in support of its programs are varied. The amounts and concentrations of chemicals vary with the research conducted. They range from laboratory reagents to photographic chemicals, organic solvents, metals, pesticides, etc. The representative chemical inventory onsite is 3420 gal, 6320 lb, and 197,000 cu ft. These chemicals were selected because they are typical of what exists onsite at any given time. This list is based on an inventory check conducted in 1991 (and projected to 1992), but because of the changing nature of work conducted onsite, it is not to be construed as exhaustive.

Table 4.15-3 provides an overview of the total sitewide administrative limits for tritium and uranium radionuclides, representative inventories of chemicals, and waste generation rates. Also included is a projection of the estimated inventories, administrative limits, and generation rates under the proposed action.

Onsite Receipt and Distribution

Hazardous and radioactive materials, except explosives, are received onsite through the SNL, Livermore Property Management Division, which is responsible for transferring these materials to onsite programs and facilities. Bulk compressed gas is received at Building 918 and then distributed to a requesting organization. Outbound compressed gas containers must also go through this facility.

In 1990, SNL, Livermore reorganized its administration of materials packaging and transportation, creating several new divisions to ensure adequate self-assessments and independent oversight to meet the requirements of DOE Orders 5480.1 and 5482.1B. Additionally, SNL, Livermore instituted an oversight program to ensure that line organizations comply with DOE and SNL, Livermore hazardous material policies and procedures. Hazardous materials handlers and delivery personnel must undergo training in the hazards and safety procedures related to the types of materials with which they work (Yourick et al., 1989). SNL, Livermore requires its vendors and suppliers to adhere to all relevant onsite health and safety regulations; for example, the labeling of cryogenic (very low temperature) storage tanks onsite (SNL, Livermore, 1991c).

Consistent with this reorganization, SNL, Livermore instituted a comprehensive training program for hazardous material packaging and transportation, providing job task analysis, individual training records, acceptable performance standards, and frequency-of-training requirements. Additionally, a training database was developed to track past and future training session attendance and to identify future training needs. SNL, Livermore has also prepared a hazardous materials quality assurance plan addressing onsite transportation and handling of hazardous materials. The plan details improvements in procedures such as proper grounding of flammable liquid drums, cargo loading, and securing loads (SNL, Livermore, 1991c).

To ensure compliance with DOE Order 5480.3 regarding preparation, packaging, and transporting offsite shipments of hazardous materials, SNL, Livermore developed a *Transportation Safety Manual* (SNL, Livermore, 1991j). This manual identifies responsibilities, lines of authority, and program approval procedures. The manual further defines minimum safe packaging and training requirements, compliance with regulatory vehicle standards, and driver qualifications for the transport of hazardous materials. It also provides information about emergency response procedures (SNL, Livermore, 1991j).

SNL, Livermore has detailed onsite transportation procedures (SNL, Livermore, 1991c) in addition to those included in the *Transportation Safety Manual* (SNL, Livermore, 1991j) for transferring hazardous materials and wastes. These procedures are consistent with federal regulations and DOE Orders for offsite shipment of hazardous materials and wastes, including proper packaging of materials or wastes; marking the outside of the packaging; labeling the outside of the packaging, whenever possible, with a proper DOT label; documenting the movement with proper records; and placarding transport vehicles.

Offsite Shipment

SNL, Livermore revised its quality assurance plan along with the supporting procedures to include offsite and onsite packaging and shipping. Adherence to the quality assurance plan is verified by a series of internal audits of the packaging and transportation programs (SNL, Livermore, 1991c). The telephone system at the SNL, Livermore Security Control Center was upgraded to accommodate up to six emergency response, law enforcement, or other appropriate personnel in one conference call, thereby increasing communication capabilities to respond to a transportation emergency involving hazardous materials.

The shipping of explosives is monitored by the California Highway Patrol. Furthermore, DOE Orders require compliance with all DOT regulations regarding packaging, labeling, shipping documentation, and transportation requirements (49 C.F.R. 100–179). Specific vehicles are dedicated for transporting explosives and are equipped according to DOE *Explosives Manual* requirements. Each vehicle must be inspected by the operator before use and inspected monthly by the section supervisor. Records are kept of these inspections. Additionally, different materials must be compatible to be transported on the same vehicle.

4.15.1.3 Controlled Materials

For health and safety, environmental protection, security, strategic importance, monetary value, or programmatic urgency reasons, LLNL and SNL, Livermore classify certain materials as controlled materials. Some of these materials are also hazardous. Examples of controlled materials include explosives, radioactive materials, special nuclear materials, classified substances and parts, and precious metals.

Safe, secure transports (SSTs) are used by DOE for offsite shipment of classified special nuclear materials, including classified devices. These transports have "built-in deterrent and disabling devices and special electronically coded locks set in vault-like doors" (DOE, 1988a). These transports are operated by specially selected and trained personnel and must comply with DOE and DOT requirements for shipment of special nuclear materials.

LLNL

The Materials Management Division at LLNL provides effective control of and accountability for controlled materials, including nuclear materials, radioactive and classified parts, mock and actual high explosives, precious metals, and wastes of these materials, as directed by DOE. The Materials Management Division provides Laboratory management with timely and accurate information regarding the movement, characteristics, and locations of controlled materials in the Laboratory's possession (LLNL, 1989d). This accountability extends to providing procedures, guidance, and advice on the assaying and proper disposition of controlled materials, and preparing the required DOE reports (LLNL, 1989b).

SNL, Livermore

SNL, Livermore has a program to manage receipt, transfer, storage, and shipment of controlled materials.

At SNL, Livermore, the Property Management Division is responsible for the control, movement, documentation, and tracking of controlled materials. All controlled nuclear materials, except mechanical component assemblies containing explosives, are received through this division, which accounts for these materials as they are transferred to onsite programs and facilities.

The Property Management Division is responsible for maintaining accountability for controlled materials beginning with onsite receipt of the materials, transfer to onsite program facilities, and offsite shipments; for providing procedures, guidance, and advice on shipping and proper disposition of controlled material, including accountable nuclear materials classified as expendable nonrecyclable wastes; and for providing the required DOE reports.

The Safety Programs Department physically handles all explosive materials. Class A explosives are received by qualified explosives handlers in the Health and Safety Division at Building 981. Class B and C explosives may be received at Building 928 for later pickup by explosives handlers. All explosives are packaged for shipment by explosives handlers only in authorized explosives areas. The Property Management Division maintains accountability records for explosives containing controlled nuclear materials; the Safety Programs Department is accountable for those that do not.

The Health Protection Department assays waste packages containing controlled materials and radioactive components.

Personnel in the Health Protection Department assay for tritium in materials that are shipped offsite.

4.15.1.4 Nonhazardous Materials

LLNL Livermore Site

The Central Stores, Building 411, is located in the southeast quadrant of the LLNL Livermore site. This 69,598-sq-ft building is managed by the Supply and Distribution Department and handles all onsite receiving and storage and offsite shipment of materials (LLNL, 1991h). Material deliveries (nonhazardous, hazardous, and radioactive) are received here and sorted, and specially ordered materials are forwarded to the requesting program. Standard (nonhazardous) supply items are placed in the storage area in Building 411 and program representatives can obtain needed material from Central Stores.

LLNL Site 300

The Central Stores, Building 875, is located in the General Services Area, near the main entrance. This building, which is managed by the Supply and Distribution Department, handles all onsite receiving and storage and offsite shipment of materials. Building 875 fills the same role at LLNL Site 300 as Building 411 at the LLNL Livermore site.

SNL, Livermore

The general warehouse area, which includes general stores in Building 928, is located at the east end of the technical area. The warehouse is approximately 25,000 sq ft in area and handles the receiving and shipping for SNL, Livermore as well as general stores products and some storage. Building 928 serves the same functions for SNL, Livermore as Building 411 for the LLNL Livermore site.

4.15.1.5 Decontamination of Equipment and Facilities

LLNL

At LLNL, decontamination of equipment and facilities must be done in accordance with Laboratory safety procedures which in turn are based on DOE orders and other federal and State of California laws and guidelines. It is also the policy of LLNL that decontamination of equipment must be managed in a safe manner to assure the protection of employees. Until 1989, Building 419 served as a size reduction and solidification facility where equipment could be decontaminated and returned to service. However, Building 419 was removed from service in 1989.

Since 1989, decontamination of equipment is done at the facility where the equipment is located, provide that no hazardous waste treatment is performed as part of this process. Equipment that cannot be decontaminated is reduced in size, if necessary, and disposed of through waste management procedures. Size reduction for large pieces of equipment (e.g., gloveboxes, pumps, machining tools, and tanks) contaminated with hazardous and/or mixed waste or hazardous chemical constituents can be done in Building 612. These pieces of equipment may be vacuumed, wiped down, or steam cleaned to remove residual contaminants. The equipment is then dismantled using, for example, a plasma arc or a cutoff saw, or is taken apart with handtools. Contaminated areas of equipment exposed during dismantling are vacuumed or wiped down. Equipment contaminated with transuranic radionuclides such as plutonium is not decontaminated and, when removed from service, is managed as transuranic waste.

SNL, Livermore

At SNL, Livermore, which also follows Laboratory safety procedures based on DOE orders and other federal and State of California laws and guidelines, contaminated equipment must be decontaminated by the Environmental Protection staff before it can be serviced or used in a nonhazardous capacity. During this process, a polyethylene tank is used as a catch basin for rinse water which is subsequently pumped into drums, analyzed, and disposed of according to waste management requirements. If equipment cannot be decontaminated it is disposed of through the waste management procedures (SNL, Livermore, 1990c).

The decontamination and decommissioning of the Tritium Research Laboratory described in Appendix A, section A.3.5.3, is planned to be performed over a 3-year period, and will be completed in accordance with appropriate DOE Orders and federal and state of California laws and guidelines (see Appendix A, Decommissioning Tritium Research Laboratory, Fiscal Year 1994).

4.15.1.6 Excess Properties Salvage and Reclamation

Both LLNL and SNL, Livermore follow a similar process for the disposal of excess equipment through a policy of making this property available for other needs at the Laboratories, or to other federal and state agencies, or to be sold to reduce the cost of the Laboratories' operations. For example, at LLNL items will be appropriately screened for radiation and contamination prior to being sent to the Storage, Excess and Recycling Group for disposition. The LLNL custodian is responsible for providing an explanation of the condition of the item on an Excess Equipment Card and making arrangements for delivery of the items to Storage, Excess and Recycling.

Storage, Excess and Recycling is responsible for screening, reutilization, and disposition of items declared excess to the needs of the Laboratory.

Excess items are made available to groups within the Laboratory and to other DOE agencies, other federal agencies, to other public (non-federal) agencies, or to private agencies in the following sequence:

- Reutilization availability is announced simultaneously for 30 days to:

- Laboratory organizations
- DOE offices and contractors

- Following the 30-day wait, the Energy-Related Laboratory Equipment Program is notified that the item is available. If they choose it (normally laboratory equipment only), it is screened for an additional 60 days with universities, colleges, and other nonprofit educational institutions.
- Following the above waiting periods, the item is listed with the General Services Administration for 60 days. At this point, other federal agencies can request title and accountability for the item to be transferred to them.
- Following the General Services Administration screening period, the item is subject to a 21-day donation screening by the General Services Administration with non-federal agencies and private agencies.

Items not requested for reutilization are sold after completing the excess screening process. Disposition of surplus items can be accomplished by public sales (including auctions and Laboratory sales) or by scrap or salvage sales to vendors.

The excess and recycling operations use approximately 15, 850 sq ft of covered space and 10,000 sq ft of outside area.

4.15.2 Waste Management

This section describes waste generation, waste management practices, treatment/storage facilities at LLNL and SNL, Livermore, and offsite disposal of waste from these facilities. The waste generation rates presented in this section represent actual 1990 data based upon LLNL and SNL, Livermore records (see Appendix B). The 1990 quantities were then used to project the existing FY 1992 generation rates, as described earlier. The waste quantities discussed include radioactive, hazardous, mixed, and medical wastes. In this section and throughout this report, waste generated as a result of environmental restoration investigations (e.g., contaminated soil cuttings from well drilling) at the Laboratories during 1990 are included as part of the hazardous waste quantities. Appreciable waste quantities resulting from planned environmental restoration clean-up activities at the Laboratories are not anticipated, and therefore have not been quantified for the baseline or future waste projections. The Laboratories anticipate using in situ techniques for cleanup of large quantities of soil, while ground water would be treated onsite and discharged in accordance with National Pollutant Discharge Elimination System (NPDES) permit limits. Quantities of residual wastes, such as spent carbon from treatment units, are expected to be insignificant relative to current hazardous waste generation rates and should therefore be bounded by the conservative assumptions used to project waste quantities for the proposed action and no action alternatives.

Generally, at both Laboratories, wastes generated at individual buildings are accumulated at the point of generation. At LLNL, these wastes (with the exception of medical waste) are then transferred to waste accumulation areas where hazardous and mixed wastes may be stored for up to 90 days. At SNL, Livermore, waste accumulation areas are at the generator facilities. Wastes are collected from waste accumulation areas or retention tanks by hazardous waste technicians. The wastes are then transferred to onsite waste management facilities for treatment, storage, and/or preparation for offsite disposal. Hazardous wastes are either stored onsite before offsite shipment or shipped directly from the point of generation to various permitted treatment, storage, and disposal facilities. Low-level and transuranic radioactive wastes are currently being stored awaiting shipment to the Nevada Test Site or other DOE-approved disposal facility for storage or disposal. Mixed wastes are being stored pending availability of an approved disposal option. Medical wastes are typically collected at the generator facility before being treated onsite or shipped offsite for treatment and disposal.

4.15.2.1 Regulatory Setting

Management of hazardous, radioactive, mixed, and medical wastes generated at LLNL and SNL, Livermore is pursuant to applicable DOE Orders and federal, state, and local laws and regulations. For more details regarding the statutes and regulations and the agencies that enforce them, see Appendix B, Table B-2. As summarized in Appendix B, section B.2, LLNL and SNL, Livermore waste management programs implement sitewide plans and operating practices to comply with regulatory requirements.

<u>Waste Generation</u>

<u>LLNL Livermore Site and LLNL Site 300</u>

In addition to solid nonhazardous refuse, LLNL generates five categories of waste: radioactive, hazardous, mixed, medical, and nonsewerable industrial wastewater (as defined in Appendix B). Nonhazardous and uncontaminated refuse is collected and disposed of in a sanitary landfill. For more information on this type of waste, see sections 4.4 and 5.1.3. Four of these categories are listed in Tables 4.15-1 and 4.15-2: radioactive, hazardous, mixed, and medical. Nonsewerable industrial wastewater is waste that contains constituents at concentrations too high to allow discharge to the sanitary sewer but does not meet the criteria to be designated as hazardous waste. This waste is managed as hazardous waste by the Laboratory. Liquid effluents with contaminants below limits specified by the City of Livermore are released to the City of Livermore sewer system. Medical waste consists of biohazardous waste and sharps waste (needles, blades, and glass slides). For a more detailed description of medical waste, see Appendix B.

At LLNL the individual waste generators (e.g., researchers in various laboratories) and the waste management staff are responsible for waste management. Generators must segregate, identify, characterize, separate, package, label, document, and transfer waste to designated waste accumulation areas (LLNL, 1989b). Waste management staff assist the generators in many of the above activities and manage wastes from pickup to disposal.

LLNL strives to minimize wastes, particularly hazardous, radioactive, and mixed wastes, whenever possible. LLNL uses three methods for reducing waste generation: source reduction, recycling, and treatment (LLNL, 1990h).

Appendix B gives details relative to waste minimization efforts at LLNL.

SNL, Livermore

SNL, Livermore generates the same five categories of waste as does LLNL: radioactive, hazardous, mixed, medical, and industrial nonsewerable wastewater. The radioactive, hazardous, mixed, and medical wastes generated onsite are summarized in Table 4.15-3. Nonsewerable industrial wastes are managed as hazardous waste. For a more detailed description, including definitions of waste types and waste management terminology, see Appendix B.

At SNL, Livermore, waste generator responsibilities are the same as at LLNL. They are responsible for the characterization, segregation, packaging, and proper labeling of their waste. The SNL, Livermore waste management staff manage waste from pickup to disposal (SNL, Livermore, 1991c). SNL, Livermore has had and continues to have an active waste minimization and recycling program for radioactive and hazardous waste. In addition, a Waste Minimization and Pollution Prevention Program, as required by DOE Order 5400.1, is being implemented by line management at SNL, Livermore. This program, which relies on source reduction and recycling, establishes goals for reduction in RCRA- and California-regulated hazardous waste and solid waste over a 3-year period.

4.15.2.2 Radioactive Waste

DOE regulates LLNL and SNL, Livermore radioactive wastes pursuant to the Atomic Energy Act of 1954, as amended, through DOE Order 5820.2A and other related DOE Orders.

Radioactive waste is material containing radionuclides regulated under the Atomic Energy Act of 1954, as amended. Radioactive waste generated at the Laboratories is classified as either transuranic (LLNL only) or low-level. Transuranic waste is material contaminated with alpha-emitting radionuclides of atomic number greater than 92 and with half-lives greater than 20 years in concentrations greater than 100 nanocuries per gram. Transuranic waste is generated at LLNL from plutonium and other transuranic isotopes used in nuclear weapons research and development. Low-level waste is radioactive material not classified as high-level waste, transuranic waste, spent nuclear fuel, or specified byproduct material, as defined by DOE Order 5820.2A (DOE, 1988d).

DOE Order 5820.2A permits onsite storage of low-level and transuranic wastes until appropriate disposal becomes available. Currently, there are no regulatory restrictions on the length of time this waste may be stored onsite, provided that disposal or offsite storage options are being pursued and the waste is stored in accordance with all applicable regulations. Transuranic wastes would eventually go to the Waste Isolation Pilot Plant (WIPP) when that facility completes a 5-year test phase. Meanwhile, the Nevada Test Site is the designated interim storage site for these wastes, but will accept only waste certified according to the WIPP Waste Acceptance Criteria. Waste acceptance criteria establish procedures and requirements for the safe shipment, storage, and disposal of transuranic and low-level waste at a disposal site.

Available storage space for low-level and transuranic waste is limited by exposure considerations (i.e., radiation exposure to personnel) at a given storage location. However, radioactive wastes, unlike RCRA-regulated wastes, can be stored at various locations onsite provided that the waste is properly packaged, labeled, and monitored. Both LLNL and SNL, Livermore have sufficient space available to accommodate storage of radioactive wastes until disposal at the Nevada Test Site (low-level waste) or the Waste Isolation Pilot Plant (transuranic waste) becomes available. Tables 4.15-1 and 4.15-2 provide a breakdown of the types of wastes generated at the LLNL Livermore site and LLNL Site 300. Table 4.15-3 provides a breakdown of the types of wastes generated at SNL, Livermore.

LLNL Livermore Site

Radioactive Waste Generation

LLNL generates low-level and transuranic radioactive wastes from its research activities. In 1990, the LLNL

Livermore site generated approximately 185,000 lb of solid low-level radioactive waste such as gloves, absorbent paper, plastics, glass, and other solid materials contaminated with low-level radioactive materials. Of the 185,000 lb, approximately 136,280 lb were generated from operations in Buildings 332, 331, 175, 419, 321C, and 332B. The primary radionuclides in wastes from these buildings were plutonium-239, uranium-238, thorium-232, and mixed fission products. The remaining 48,720 lb were generated from operations located in buildings throughout the site (LLNL, 1991h). For further details see Appendix B.

In 1990, the LLNL Livermore site also generated approximately 15,810 gal of liquid low-level radioactive waste. Of this, approximately 14,220 gal were generated from operations in Buildings 235, 151, 251, and 361 (this includes wastes in retention tanks). The primary radionuclides in wastes from these buildings were uranium-238, americium-241, californium-250, and mixed fission products (LLNL, 1991m). The remaining 1590 gal were generated from operations in buildings dispersed throughout the site. For further details see Appendix B.

In 1989, the most recent full year for which figures are available, the LLNL Livermore site generated approximately 2500 cu ft of transuranic waste. Approximately 95 percent of this waste is contaminated with americium-241 and plutonium isotopes, including plutonium-238, plutonium-239, plutonium-240, plutonium-241, and plutonium-242. Nearly all transuranic waste originates in the Plutonium Facility (Building 332) and the Heavy Element Facility (Building 251) (LLNL, 1991s).

Radioactive Waste Management

Pursuant to applicable regulations and orders, radioactive wastes are treated and/or stored at the Building 514 Complex and the Building 612 Complex, both in the southeast corner of the LLNL Livermore site. The Building 514 complex contains processing equipment and storage areas for radioactive liquids. The Building 612 Complex contains solid radioactive waste processing equipment and storage for radioactive wastes (LLNL, 1989e). See Appendix B for a complete description of these facilities.

Transport of low-level radioactive wastes between the LLNL Livermore site and LLNL Site 300 must comply with DOE and DOT packaging requirements (DOE Order 5480.3 and 49 C.F.R. section 173). Transuranic radioactive wastes (see Appendix B) must meet additional packaging and certification requirements to qualify for long-term storage and eventual disposal at a DOE-licensed facility. These requirements are described in LLNL's TRU Wastes Certification Program (LLNL, 1987) and in the Nevada Test Site's waste acceptance criteria (DOE, 1988c). Currently, LLNL is developing a waste certification plan that meet these requirements for submittal to DOE. Until this plan is approved by the Nevada Test Site, radioactive waste is stored onsite.

LLNL Site 300

Radioactive Waste Generation

Approximately 300,000 lb of low-level radioactive waste were generated in 1990 (LLNL, 1991o). No liquid radioactive waste is generated at LLNL Site 300. Most LLNL Site 300 solid low-level radioactive waste is generated from the non-nuclear detonation of test assemblies on firing tables. Gravel and debris from these tables is handled as low-level radioactive waste. Currently, LLNL Site 300 low-level radioactive waste contains depleted uranium and small quantities of other radionuclides. Historically, firing table operations have periodically generated waste containing tritium, and this would likely continue.

Radioactive Waste Management

At LLNL Site 300, radioactive wastes are stored in Building 804 in the east firing area before transfer to LLNL Livermore site waste management facilities. Wastes are currently stored indefinitely pending approval of the NTS low-level waste certification plan as described above.

SNL, Livermore

Radioactive Waste Generation

SNL, Livermore generates only low-level radioactive waste at its facilities. In 1990, SNL, Livermore generated approximately 8550 lb of low-level radioactive solid waste, over 80 percent of which was tritium-contaminated materials, generated mostly at the Tritium Research Laboratory (Building 968). The remainder was depleted uranium (uranium-238) contaminated material (SNL, Livermore, 1990f).

In 1990, SNL, Livermore generated approximately 7400 gal of low-level radioactive liquid waste. This waste consisted of tritiated water from the Tritium Research Laboratory and was evaporated at an evaporator permitted by the EPA and the Bay Area Air Quality Management District. Other wastes typically generated at SNL, Livermore from weapons-related research and other research activities include tritium and uranium-238–contaminated oils and tritium-contaminated acids not containing heavy metals. Over 90 percent of radioactively contaminated liquids are generated at the Tritium Research Laboratory (SNL, Livermore, 1990f).

Radioactive Waste Management

Preparation of radioactive wastes for offsite transportation occurs at the Waste Management Facility (Building 961), where wastes are properly packaged, marked, and labeled according to DOT and EPA regulations. Some solid radioactive wastes are compacted or decontaminated and stored at Building 961, which has a waste compactor to reduce the volume of compatible low-level waste. All liquid waste requiring offsite disposal is solidified at the generation point before acceptance by the waste management staff at Building 961 (SNL, Livermore, 1990c). Currently, as described in the LLNL section above, radioactive wastes are stored until approval of Nevada Test Site waste certification plans allowing shipment to the Nevada Test Site. The certification plan and application to ship low-level radioactive waste for disposal at the Nevada Test Site has been filed by SNL, Livermore.

SNL, Livermore is currently conducting recycling programs for its radioactive wastes (SNL, Livermore, 1991m): tritium used at the Tritium Research Laboratory is recaptured and recycled to the maximum extent possible; and water effluent with tritium concentrations in excess of permitted levels is packaged in an AL-M1 container and shipped offsite for eventual recycling.

Additional information on radioactive waste generation, treatment, storage, and disposal at LLNL and SNL, Livermore is presented in Appendix B.

4.15.2.3 Hazardous Wastes

The treatment, storage, and disposal of hazardous waste and the hazardous components of mixed waste at LLNL and SNL, Livermore are regulated by the EPA. Additionally, hazardous wastes are regulated by the California Department of Toxic Substances Control.

LLNL Livermore Site

Hazardous Waste Generation

Almost all buildings at the LLNL Livermore site generate hazardous wastes, ranging from common household items such as fluorescent light bulbs, batteries, and lead-based paint to solvents, metals, cyanides, toxic organics, pesticides, asbestos, and polychlorinated biphenyls. Information on hazardous waste generation by building is contained in Appendices A and B.

In 1990, the LLNL Livermore site generated approximately 425,500 lb of solid hazardous waste. About 50 percent, 216,000 lb, was generated by operations in Buildings 511, 222, 241, 321, 231, 361, 431, 141, and 321C. The remaining 209,500 lb of solid hazardous waste were generated by operations in many buildings dispersed around the site. In 1990, the LLNL Livermore site also generated approximately 276,800 gal of liquid hazardous waste. About 70 percent, 195,500 gal, was generated by operations in Buildings 141, 325, 222, 322, 418, 175, 321, and 492 (LLNL, 1991h). The remaining 81,300 gal of liquid hazardous waste were generated by operations in many buildings throughout the LLNL

Livermore site. The site generates only small quantities of compressed waste gases annually. For more details, see Appendix B.

Onsite, LLNL transports containers of hazardous solid wastes primarily on flatbed trucks. Large quantities of liquids are transported in portable tanks, ranging in size from 330 to 1100 gal, on flatbed trucks or in steel-lined tank trucks. Trucks with self-contained pumps transfer temporarily stored wastewater from sumps or tanks. Appendix K summarizes requirements relative to these onsite transfers.

Hazardous Waste Management

The hazardous waste management facilities are located in the southeast corner of the LLNL Livermore site at the Building 514 Complex and the Building 612 Complex, and in the northeast corner of the site at Building 693. These facilities are operated under interim status provisions in accordance with RCRA. In compliance with interim status provisions, wastes may be stored for up to one year. There is also a storage area for classified hazardous waste adjacent to Building 233. Except for empty-container crushing, hazardous wastes are usually not treated before offsite shipment to a licensed treatment, storage, and disposal facility (LLNL, 1989e). Hazardous wastes are shipped through licensed commercial transporters to various permitted treatment, storage, and disposal facilities offsite.

In accordance with the interim status provisions of RCRA, LLNL has applied for a RCRA Part B permit to continue operating the hazardous waste storage and treatment facilities at the LLNL Livermore site. As part of the permitting process, LLNL performed a health risk assessment examining potential community health impacts from continued storage and treatment of hazardous wastes. A hypothetical maximally exposed individual was assumed to be born, reside, and work over a 70-year lifetime where the highest concentration of emissions are predicted from the hazardous waste storage and treatment units (Radian Corporation, 1990). Inhalation, ingestion (including soil, vegetation, wine, and water), and skin contact with soil were the primary exposure routes considered.

Additionally, the lifetime risk of developing cancer and the potential for acute and chronic noncarcinogenic effects from operating the waste storage and treatment facility were evaluated using two scenarios: very conservative and plausible-case. For the very conservative scenario, the lifetime risk of developing cancer for the maximally exposed individual from exposure to nonradiological substances associated with the waste storage and treatment facility was 0.08 in a million. The risk to the plausible-case maximally exposed individual was 0.02 in 1 million. The highest chronic and acute noncarcinogenic effects hazard indices were 0.00027 and 0.17 respectively (Radian Corporation, 1990).

Under California's Hazardous Waste Control Law, the California Department of Toxic Substances Control monitors compliance with applicable hazardous waste packaging, labeling, manifesting, transportation, and disposal requirements. All California shippers or transporters of hazardous waste must comply with these requirements.

To transport LLNL hazardous wastes, contractors must be state licensed. Additionally, in California, vehicles transporting hazardous wastes are subject to California Highway Patrol inspections, both at the terminal and on roads and highways. Table 4.15-4 lists the annual number of LLNL offsite shipments of hazardous and radioactive materials and wastes for 1987 through 1990.

LLNL Site 300

Hazardous Waste Generation

LLNL Site 300 wastes, managed by the waste management staff, range from high explosives and analytical chemicals to industrial wastewater. The generation of solid and liquid hazardous waste varies with the number and type of LLNL Site 300 experiments. In 1990, LLNL Site 300 generated approximately 37,300 lb of solid hazardous waste. Of this, approximately 29,750 lb were generated by operations in Buildings 873, 801, 829, 865, 875, and 879. The remaining 7550 lb were generated by operations in many buildings located throughout the site. In 1990, LLNL Site 300 also generated approximately 41,200 gal of liquid hazardous waste. Of this, approximately 39,000 gal were generated by operations in Buildings 865, 879, 843, 875, 872, and 801 (LLNL, 1991h). The remaining 2200 gal were generated by operations in many buildings located throughout the site. LLNL Site 300 also generated approximately 4500 lb of high explosive (HE) waste in 1990 which was processed at the Building 829 High Explosive Burn Pit Facility. For further details see Appendix B.

Hazardous Waste Management

Hazardous wastes are stored but not treated in Building 883, a RCRA-permitted storage facility, before transfer to LLNL Livermore site waste management facilities. Generally, wastes can be stored up to one year before shipment to LLNL. Waste high explosives are treated at the Building 829 Complex, a burn pit facility used for thermal treatment of these wastes. Hazardous wastes are shipped through licensed commercial transporters to various permitted treatment, storage, and disposal facilities, using licensed contractors as described for the LLNL Livermore site. Waste generating processes and waste minimization alternatives are analyzed to reduce the toxicity and/or volume of wastes generated at LLNL Site 300 (LLNL, 1990h).

SNL, Livermore

Hazardous Waste Generation

Research laboratories onsite conduct bench scale, nonproduction activities using varying amounts and types of materials. Most hazardous wastes at SNL, Livermore are generated in the electroplating, photography, and maintenance shops, and in the printed-wiring and plastic laboratories. These facilities are located in Buildings 906, 910, and 913 (SNL, Livermore, 1990f). In 1990, SNL, Livermore generated 3800 gal and 6100 lb of liquid and solid hazardous wastes (excluding waste generated from the one-time remediation of the Trudell Auto Repair Shop site). Of the total hazardous waste shipped offsite, 24,826 cu ft were from remediation activities at the Trudell Auto Repair Shop site. This remediation program is now complete. Typically, SNL, Livermore ships offsite approximately 11,000 cu ft of hazardous waste per year.

Waste Management

The packaging, transportation, and disposal of hazardous wastes are the responsibility of the Environmental Protection Department (SNL, Livermore, 1991j). Once hazardous wastes are properly identified, packaged, marked, and labeled, a trained hazardous waste technician loads, secures, and moves the wastes to the Hazardous Waste Storage Facility (Building 962-2) in a qualified vehicle, specifically designed for this work. The vehicle used to transport waste onsite is equipped with a CB radio tuned to the site security communication center. At no time during this transfer does the vehicle carrying waste use a public road (SNL, Livermore, 1991j).

SNL, Livermore operates a hazardous waste management facility, Building 962-2, under interim status pursuant to RCRA. Hazardous wastes are brought to Building 962-2 for packaging, including consolidation and/or lab packing (i.e., overpacking of small containers in absorbent material), or for storage before shipment to a licensed treatment, storage, and disposal facility. No treatment of hazardous wastes, other than compaction and crushing of empty containers and fluorescent light tubes, occurs onsite (SNL, Livermore, 1990c). Hazardous wastes are shipped through licensed commercial transporters to various permitted treatment, storage, and disposal facilities. Table 4.15-5 lists the annual number of hazardous and radioactive materials and waste shipments offsite from 1987 through 1990. Before waste is shipped offsite, the containers are inspected for compliance with DOT requirements (according to 49 C.F.R. sections 100–177) and for disposal-site waste acceptance criteria. Additional information on hazardous waste generation, treatment, storage, and disposal at SNL, Livermore is provided in Appendix B.

SNL, Livermore is currently conducting recycling programs to minimize its hazardous wastes. Wastes being recycled through the use of offsite vendors are listed below (SNL, Livermore, 1991m):

- Batteries
- Mercury and fluorescent light tubes
- Coolants and petroleum oil containing less than 1 percent chlorinated solvents and no PCBs or metals
- Drums containing oil residues
- Silver reclaimed from photo chemicals (fixers and developers)
- Solvents

- Lead waste

Table 4.15-4 Annual Number of LLNL Offsitea Hazardous and Radioactive Materials and Wastes Shipments for 1987–1990b

Hazardous, Radioactive, and Mixed Materials or Wastes	1987 Shipments	1988 Shipments	1989 Shipments	1990 Shipments
Explosives	8	53	47	12
Nonflammable Gas	23	41	47	66
Flammable Gas	3	5	10	8
Flammable Solid	8	25	27	5
Oxidizer	1	0	5	2
Poison	1	3	14	9
Corrosive Materials	1	14	15	8
Hazardous Wastes	9	49	70	175
Combustible Liquids	0	0	0	2
Flammable Liquids	3	22	22	10
Radioactive Materials Empty Packaging	32	42	28	29
Radioactive Materials—Other	82	114	132	95
Radioactive Waste for Burial	12	0	2	0
Highway Route Controlled Radioactive Materials	2	5	9	7
Total:	181	373	428	426

[a] Includes shipments to and from LLNL Site 300.
[b] Does not include vendor pickups of hazardous materials (e.g., compressed gases), which LLNL estimates to be approximately 250 shipments annually.
Source: LLNL, 1991q.

4.15.2.4 Mixed Wastes

Mixed wastes contain both radioactive and hazardous materials. DOE regulates the radioactive component of mixed waste, pursuant to the Atomic Energy Act of 1954, as amended, through DOE Order 5820.2A and other related DOE Orders. The EPA regulates the hazardous component of mixed waste.

LLNL Livermore Site

Mixed Waste Generation

In 1990, the LLNL Livermore site generated approximately 41,561 lb of solid mixed waste, of which 38,200 lb were generated by operations in Buildings 514, 321, 233, and 241. The remaining 3361 lb of solid waste were generated by operations in many buildings throughout the site. Also, approximately 6286 gal of liquid mixed waste were generated, of which approximately 5705 gal were from activities in Buildings 321C, 332, 514, 321, 161, and 419. The majority of these liquids were processed at the Area 514 Wastewater Treatment Tank Farm. The primary radionuclides in these wastes were uranium-238, americium-241, thorium-232, plutonium-239, mixed fission products, and tritium. The predominant hazardous constituents were coolants and solvents used in machining operations, toxic metals such as beryllium, decontamination solutions, and dyes (LLNL, 1991n). The remaining 581 gal of liquid mixed waste generated during 1990 were from activities in many buildings throughout the site. For more details, see Appendix B.

Mixed Waste Management

Mixed waste generated at the LLNL Livermore site may be classified as low-level mixed waste or transuranic mixed waste. Pursuant to applicable regulations and orders, mixed wastes are treated and/or stored at the Building 514 and Building 612 complexes. The Building 514 complex contains low-level radioactive and mixed waste liquid treatment equipment, the mixed-waste shredder (in Building 513), and storage areas for these wastes. The Building 612 complex has storage for low-level and transuranic mixed wastes. Several areas are used for storage of low-level mixed waste, while Building 625 is the primary storage location for transuranic mixed waste. Building 233 is used to store classified hazardous, radioactive, and mixed wastes (LLNL, 1989e). Mixed wastes are stored until DOE-approved disposal options are available.

The Nevada Test Site is the designated interim storage site for transuranic mixed waste. The Nevada Test Site must obtain, and has applied to secure, EPA RCRA permits to store mixed waste (i.e., waste containing both hazardous and radioactive constituents). The schedule for completing this process is uncertain. Thus, it may be necessary to hold all mixed transuranic wastes on the LLNL Livermore site until the WIPP completes its test phase.

As of the end of 1991, the LLNL Livermore site had available capacity for storage of mixed waste of 1860 cu yd and 80,100 gal based on permitted capacity, or 580 cu yd and 71,900 gal based on practical capacity (i.e., current available space). For more details, see Appendix B.

LLNL Site 300

LLNL Site 300 generation of mixed waste has been nearly eliminated by restricting the use of lead in high explosive tests. Lead and other materials that could produce hazardous or mixed wastes are used only when integral to a test, or when not readily substituted. The major radioactive material used is depleted uranium, though other materials may be used depending on needs. Currently, most waste is low-level radioactive waste and is handled accordingly. In 1990, LLNL Site 300 generated approximately 2000 lb of mixed waste.

SNL, Livermore

Mixed Waste Generation

SNL, Livermore liquid mixed wastes are acids contaminated with tritium and heavy metals and scintillation cocktails, organic solvents used for counting radioactivity, from the Tritium Research Laboratory (Building 968). California-regulated oils contaminated with tritium or uranium are also generated. In 1990, SNL, Livermore generated approximately 236 lb of liquid scintillation cocktails that were shipped offsite for incineration at a permitted treatment facility. SNL, Livermore solid mixed waste consists of hazardous wastes contaminated with tritium or uranium-238. SNL, Livermore generated approximately 70 lb of solid mixed wastes in 1990, mostly from the Tritium Research Laboratory (SNL, Livermore, 1990f). Currently, mixed wastes stored at SNL, Livermore (in Building 961) occupy approximately 25 sq ft of the 2400-sq-ft building. Source control is used to help minimize generation of mixed waste. All potential generators of mixed waste must have their proposed operations reviewed by the waste management staff to determine if alternatives could be used and/or quantities of mixed waste kept as low as possible.

Mixed Waste Management

SNL, Livermore mixed wastes are stored at Building 961. All liquid waste, except scintillation cocktails, must be solidified at the point of generation before it can be accepted by the waste management staff at Building 961 (SNL, Livermore, 1990c).

Scintillation cocktails are shipped to a permitted facility in Florida for incineration. Other mixed wastes are stored onsite in Building 961 until DOE-approved disposal options are available.

Additional information on mixed waste generation, treatment, storage, and disposal at LLNL and SNL, Livermore is provided in Appendix B.

Table 4.15-5 Annual Number of SNL, Livermore Offsite Hazardous and Radioactive Materials and Wastes Shipments for 1987–1990*

Hazardous, Radioactive, and Mixed Materials or Wastes	1987 Shipments	1988 Shipments	1989 Shipments	1990 Shipments
Explosives	110	120	91	44
Nonflammable gas	55	37	81	82
Flammable gas	19	49	21	34
Flammable solid	23	31	22	8
Oxidizer	0	0	1	1
Poison	10	11	8	18
Corrosive materials	7	17	51	68
Flammable liquids	7	6	9	10
Radioactive materials (No label required)	30	56	42	28
Radioactive materials (White label required)	7	7	8	11
Radioactive materials (Yellow label required)	17	23	26	13
Hazardous waste	10	12	22	39
Radioactive waste	1	0	0	1
Mixed waste	0	0	0	2
Otherwise regulated materials (ORM) A, B, D, and E	10	13	3	5
Total:	306	382	385	364

* SNL, Livermore shipment data include hazardous materials shipments picked up by vendors (e.g., compressed gas cylinders). Source: SNL, Livermore, 1991f.

4.15.2.5 Medical Wastes

Medical wastes consist of biohazardous waste and sharps (i.e., needles, blades, and glass slides) waste. Medical wastes generated at LLNL and SNL, Livermore are managed as a separate waste stream in accordance with the California Health and Safety Code, Division 20, Chapter 6.1.

LLNL

Medical wastes are generated at the LLNL Livermore site (Buildings 361, 364, 365, and 663) and at LLNL Site 300 (Building 877). Most of these wastes are autoclaved in Building 365 at the LLNL Livermore site to sterilize the materials before disposal as sanitary waste. Sharps waste (see Appendix B) is sent to a commercial incinerator following sterilization. LLNL generates approximately 200 lb of medical waste per month.

SNL, Livermore

SNL, Livermore medical wastes are generated in Building 911. Currently SNL, Livermore transports medical waste offsite for treatment and disposal. SNL, Livermore has incinerated medical waste in the past, and would resume onsite incineration after obtaining all required permits. Ash from the incinerator is managed as hazardous waste. Building 911 generates approximately 10 lb of medical waste per month. In 1990, SNL, Livermore generated approximately 120 lb of medical waste.

4.16 OCCUPATIONAL PROTECTION

This section describes existing LLNL and SNL, Livermore programs responsible for assuring that their respective activities are executed in a manner protective of health, safety, and the environment.

Environment, Safety, and Health

It is the policy of DOE to operate LLNL and SNL, Livermore in an environmentally safe and sound manner. These facilities are required to comply with applicable federal, state, and local laws, regulations, and rules; and with directives promulgated by DOE regarding occupational safety and health.

LLNL

The Environment, Safety, and Health Council, composed of Associate Directors, assists the Laboratory Director in discharging his environment, safety, and health responsibilities. The Council (1) reviews, formulates, and recommends environment, safety, and health policies; (2) develops and recommends environment, safety, and health guidelines; (3) reviews operating procedures and recommends changes; and (4) ensures that the Laboratory's environment, safety, and health policies are implemented. The Council is chaired by the Deputy Director and is assisted by an Environment, Safety, and Health Working Group.

The Environmental Protection Department assists LLNL managers to assure that LLNL operations comply with applicable laws and regulations and that environmental impacts from LLNL operations are mitigated to the maximum extent possible. The department is organized into four divisions, each with specific responsibilities (for more details, see Figure C-1 in Appendix C):

- Environmental Monitoring and Analysis Division
- Hazardous Waste Management Division (see Appendix B)
- Environmental Restoration Division
- Operations and Regulatory Affairs Division

The Environmental Surveillance Division conducts the environmental monitoring program, and assesses health and environmental risks from releases to the environment of radioactive and nonradioactive materials from LLNL operations. The Hazardous Waste Management Division operates LLNL's hazardous, radioactive, and mixed waste management systems. The Environmental Restoration Division is responsible for investigation and remediation of sites contaminated from prior operations. The Operations and Regulatory Affairs Division oversees environmental permitting, advises on complying with environmental laws and regulations, and provides emergency response and reporting.

The Hazards Control Department is responsible for providing expertise, guidance, and services needed by LLNL management in all phases of health and safety. Hazards Control's primary responsibilities include monitoring operations to provide management with the information needed to maintain a minimal-risk work environment, providing guidance in formulating the Laboratory's health and safety policies, directives, and standards, and specifying any protective equipment that might be required by employees to perform their work assignments safely.

The Health Services Department provides emergency treatment, limited medical care, and general health education and training, and performs routine and emergency examinations. Medical attention is provided to all LLNL employees whenever an employee is concerned with, or develops signs or symptoms associated with, exposure to hazardous chemicals from spills, leaks, and releases (LLNL, 1990f). The Health Services Department also implements prevention programs for occupational illnesses and injuries, such as monitoring worker exposure data and Valley Fever prevention at LLNL Site 300. The organizations mentioned above are discussed in more detail in Appendix C.

SNL, Livermore

At SNL, Livermore, workers and line managers share responsibility for conducting work activities in a manner that produces high quality results, preserves environmental quality, and protects the health and safety of workers and members of the public. SNL, Livermore's Center for Environment, Safety, and Health and Facilities Management, assisting the line managers in fulfilling these responsibilities, oversees the following three departments: the Health Protection Department, the Environmental Protection Department, and the Safety Programs Department. A more detailed description of the organization and function of these departments is provided in Appendix C.

Before the Tiger Team Assessment conducted by DOE at SNL, Livermore in May 1990, SNL, Livermore had reorganized its Environment, Safety, and Health Department to enhance oversight of its environmental safety and health activities. In 1991, SNL, Livermore established an environmental safety and health council chaired by the Vice President and Manager of SNL, Livermore. The members of this council include the director of each line directorate, the manager of the Center for Environment, Safety and Health and Facilities Management, and the five directorate Environment, Safety and Health coordinators. These coordinators are staff members appointed to assist the directors in management of environment, safety, and health. The function of this council is to provide management oversight of SNL, Livermore environment, safety, and health programs and to recommend programs to maintain SNL, Livermore in compliance.

The SNL, Livermore Safety, Health, and Environmental Assessment Committee is responsible for ensuring that the line organizations are carrying out their environment, safety, and health responsibilities. This committee, chaired by a Director, reviews operations and operating procedures, recommends and assists in the development of environment, safety, and health guidelines, and ensures that SNL, Livermore environment, safety, and health policies are implemented.

4.16.1 Occupational Protection

4.16.1.1 Regulatory Setting

Applicable federal and state regulatory requirements and the regulatory agencies responsible for enforcement are listed in Table C-I in Appendix C.

Although the federal Occupational Safety and Health Act (OSHA) and the California Occupational Safety and Health Act do not directly apply to LLNL and SNL, Livermore, equivalent DOE standards and requirements are enforced by DOE pursuant to a memorandum of agreement between DOE and the U.S. Department of Labor.

4.16.1.2 LLNL Occupational Protection

Each Associate Director and worker is responsible for working in a manner that produces high quality results, preserves environmental quality, and protects the health and safety of workers and members of the public. Organizations to help meet these responsibilities include the Hazards Control Department and Health Services Department. These organizations are described briefly above and discussed in more detail in Appendix C. Organization charts are also provided in Appendix C.

Special Illness Prevention Programs

LLNL Site 300 workers or visitors may be exposed to Coccidioidomycosis, a respiratory disease commonly known as Valley Fever, caused by a fungus. The disease is common in warm dry alkaline areas including the entire San Joaquin Valley. Each employee or prospective employee is tested for Valley Fever immunity before assignment to LLNL Site 300. Based on the test results and physical factors (e.g., greater susceptibility or being pregnant), employees are counseled regarding increased risk, and the Health Services Department recommends whether working at LLNL Site

300 is appropriate. An employee can work at LLNL Site 300 despite a contrary recommendation if an informed consent form is signed. The forms are included in the employee's medical record (LLNL, 1990f).

In the late 1970s, LLNL's medical director observed an unusually large number of LLNL employees with malignant melanoma. Since that time, the Laboratory and other research groups around the country have investigated potential occupational and environmental factors associated with this increase in disease. Researchers have noted that the observed incidence of malignant melanoma at LLNL is greater than the observed incidence in the local community. In addition, they have postulated relationships between increased malignant melanoma in Laboratory workers and various occupational factors. These include exposure to radioactive and hazardous materials, work at LLNL Site 300, and the presence of workers at the Pacific Test Site during a nuclear test explosion. To date, however, studies have not definitively correlated the increase in malignant melanoma among LLNL workers with any specific occupational or environmental factors. For further details on these studies, see Appendix C, section C.3.1.3.

Other Exposures and Potential Hazards

Radiation Exposures and Risk

Radionuclides emit several types of radiation with various energies and penetrating powers. The types of radiation of interest at LLNL include x rays, alpha particles, beta particles, neutrons, and gamma rays. Various types of radiation interact differently with biological tissue. Weighting factors are used to convert the organ doses to effective dose, that is, to the dose that would produce the same level of risk if delivered to the whole body.

Safety Procedures. To protect workers against radiation exposures, facilities and operations are rigorously analyzed and must meet LLNL Health and Safety Manual requirements before use or start-up (LLNL, 1990f). Safety procedures, Operational Safety Procedures or Standard Operating Procedures, are developed by program personnel with assistance from the Hazards Control Department before nonroutine operations or procedures can begin. Additionally, workers are trained in proper work procedures and provided with, and trained in use of, appropriate protective equipment. Workplaces are regularly monitored and inspected to assure safe working conditions. This monitoring shows that, despite the safeguards, some activities may expose workers to radiation above background.

Radiation Exposure Characterization. Internal radiation exposure occurs when radionuclides, such as tritium, enter the body by inhalation, ingestion, or absorption through open wounds or intact skin. Internal radiation dose is determined primarily through routine urinalyses as part of LLNL's bioassay program (LLNL, 1989c).

Tritium, a naturally occurring radioisotope of hydrogen, is one of the radioisotopes used at LLNL. The tritium used at LLNL is made in tritium-producing reactors at other DOE facilities. Its main forms are tritiated water and tritiated hydrogen gas, although it also substitutes for hydrogen in organic materials and in metal hydrides.

At LLNL there is a greater incidence of internal exposures of workers handling tritium than those handling other radionuclides. When inhaled or ingested, tritiated water is rapidly assimilated and within hours is uniformly mixed in body fluids and soft tissue. The assimilation of tritiated hydrogen gas is much lower, typically resulting in radiation doses much lower than for an equivalent intake of tritiated water. Once in body fluids, the rate of elimination of tritium from the body is fairly fast, with one half of the original intake typically being eliminated in about 10 days. To further reduce the duration of exposure to tritium, this elimination rate can be increased by increasing fluid intake, resulting in more rapid turnover of body fluids and faster excretion of the radioactive material.

Most LLNL tritium handling operations occur in the Hydrogen Research Facility, Building 331. Special precautions minimize exposures to those handling and using tritium. For example, it is received and shipped as metal hydrides, the most insoluble and least mobile form of tritium. Onsite operations are conducted in gloveboxes and hoods, standard laboratory equipment that prevents direct worker contact and minimizes the chance of inhalation or inadvertent ingestion. In work areas, continuous room air monitoring and frequent contamination checks of accessible surfaces assist in ensuring safe working conditions.

All workers in the Hydrogen Research Facility, Building 331, have weekly urinalyses to monitor tritium intake from routine workplace operations. During 1990, the most recent year for which complete information is available, the maximum internal radiation effective dose equivalent for any Building 331 worker was 0.16 rem, or 3.2 percent of DOE 5-rem annual dose limit (Mansfield, 1991; DOE, 1988e). In 1990, the sum of internal radiation doses received by all Building 331 workers, their collective dose, was 0.5 person-rem (Mansfield, 1991). Six individuals accounted for most of this collective dose. Figure 4.16-1 shows the maximum individual and collective effective dose equivalents from tritium exposures at Building 331 from 1986 through 1990.

A routine bioassay program is conducted for workers who have a potential for intake of radioactive material. This program is conducted for workers in the Heavy Element Facility (Building 251), the Plutonium Facility (Building 332), the Waste Treatment and Storage (Building 612) area, and other selected areas. Whole-body counting is also performed annually for personnel who have the potential for intake of radionuclides based on work activities. Additionally, room air monitors, routine worker monitoring, and periodic radiation surveys assess the work environment. Should these monitoring programs indicate a potential exposure, additional bioassays are performed.

Plutonium and other transuranic elements are also handled in gloveboxes and hoods to minimize inhalation and inadvertent ingestion. Inhaled plutonium is deposited in the respiratory tract. From the respiratory tract, the plutonium can be transferred to the lymph nodes, the bones or the liver, or eliminated via the gastrointestinal tract or in urine. A small fraction of ingested plutonium, about 0.001 to 0.01 percent, may be absorbed by the gastrointestinal tract into the bloodstream and deposited in the bone, where about half of the original deposition is eliminated in approximately 50 years.

External radiation exposure occurs when radiation from sources outside the body pass through the skin. These exposures occur from sources such as radioactive materials, accelerators, or x-ray machines. External exposures are measured using personal thermoluminescent dosimeters, devices that all LLNL personnel wear attached to their security badges. The dosimeter measures the amount of external exposure received by workers while onsite.

Weapons-grade plutonium, used in some LLNL research projects, is a mixture of radioisotopes of plutonium and other transuranic elements (radionuclides with atomic numbers greater than uranium). Some of these radioisotopes and their decay products emit gamma rays which can cause external radiation exposures. During the past 5 years, the major source of external radiation exposure to LLNL workers has been the Plutonium Facility (Building 332). A significant component of the personnel radiation doses in the Plutonium Facility results from handling radioactive materials in that facility's storage vault. Figure 4.16-2 shows the maximum individual dose and the collective annual dose from external radiation at the Plutonium Facility from 1986 through 1990.

Total Radiation Dose from LLNL Operations. Total LLNL worker radiation dose includes the internal plus the external radiation exposure received while at LLNL. 1990 LLNL worker exposure records indicate most measurable radiation doses received were from external sources. During 1990, individual LLNL workers received radiation doses ranging from background levels to a high of 1.47 rem; the 1.47 rem dose, due entirely to external radiation, represents 29 percent of the annual occupational dose limit of 5 rem established by DOE (LLNL, 1991k; DOE, 1988e).

The average radiation dose above background for all LLNL workers in 1990 was 0.003 rem, or about 0.06 percent of the annual dose limit. Ninety-seven percent of LLNL workers received only background levels of radiation (LLNL, 1991k). In 1990 the sum of all external radiation doses to LLNL workers was 28.0 person-rem, and the sum of all internal radiation doses was 0.5 person-rem from the intake of tritium. Figure 4.16-3 shows the distribution of total doses from external exposures for 1988, 1989, and 1990. Figure 4.16-4 shows total annual doses to all workers in person-rem due to external exposures and internal exposures at LLNL from 1971 to 1990 (LLNL, 1991k).

LLNL is concerned about total lifetime radiation exposure. Accordingly, LLNL exposure records include internal doses that continue to be received from internal deposition of radionuclides from previous exposures at other DOE facilities as well as doses from current operations.

Inadvertent Exposures. In addition to low-level exposures from routine LLNL operations, inadvertent releases of radioactive materials may also cause LLNL worker exposures. Since 1983, two inadvertent events resulted in 5 persons receiving doses from less than 0.02 to 1.1 rem effective dose equivalent. These events are discussed in detail in Appendix C. In May 1988, a worker disassembling a contaminated microscope received a committed effective dose equivalent of 0.1 rem. Most recently, on April 2, 1991, Hydrogen Research Facility (Building 331) workers inhaled tritiated water vapor while preparing a tritium reservoir for pressure and content analysis. Failure of the reservoir's valve resulted in a leak of approximately 144 curies of tritium into the work area. The highest individual dose received was an effective dose equivalent of 1.1 rem to one worker. Three other workers received doses of less than 0.02 rem.

In addition to these two events, since 1980, four other LLNL workers have had bioassays showing recordable intakes of radionuclides other than tritium, and these intakes also resulted from nonroutine events. The calculated 50-year committed effective dose equivalents to these four workers range from 0.17 to 2.03 rem (Mansfield, 1991). These doses may be compared to the DOE dose limit (for design and operation) of 5 rem (DOE, 1998e). The 50-year committed effective dose equivalent is the dose received over a 50-year period from the date of intake.

Radiation Risk Characterization. The major adverse effects from ionizing radiation are carcinogenicity (ability to cause cancer), mutagenicity (ability to cause genetic or heritable defects), and teratogenicity (ability to cause nonheritable birth defects) (EPA, 1989b). For low-level but longer duration exposures, the primary risk is developing some cancers. Very large exposures are required to induce acute effects. Mutagenic effects can occur only during the reproductive period of approximately 30 years. Teratogenic effects can occur only during gestation.

When large groups are exposed to ionizing radiation, the fatal cancers that may result from such exposures are estimated by considering the radiation doses received, and the group's size and age distribution. Various organizations including the EPA and the International Commission of Radiological Protection (ICRP) publish cancer risk estimators and standard methodologies for calculating population (i.e., large group) risks (51 Fed. Reg. 1092-1216, 1986; ICRP, 1990). Using the standard risk assessment techniques from EPA and ICRP along with 1990 radiation doses to LLNL workers, which ranged from background to a maximum of 1.47 rem effective dose equivalent, the probability that the highest-exposed individual would develop a fatal cancer is about 1 in 1400 and the chance of a deleterious health effect is about 1 in 1000 (see Appendix C for the basis for these calculations). The collective effective dose equivalent to LLNL workers during 1990 was 28.5 person-rem. Using the above risk estimators, the lifetime chance of a single fatal cancer and total health detriment among all workers from one year of operation is estimated to be 1 in 70 and 1 in 50, respectively.

The National Academy of Sciences Committee on the Effects of Ionizing Radiation cautions that risk estimators yield uncertain results at very low doses; the actual risk may be zero (BEIR-V, 1990). For comparison, the annual background radiation dose to 12,000 people, the approximate LLNL and SNL, Livermore employee population, is approximately 3600 person-rem. This yields lifetime estimates of fatal cancers and of total health detriments of 1.8 and 2.6, respectively.

Table 4.16-1 presents the internal and external radiation doses received by LLNL workers during 1990 and probabilities of fatal cancer and total health detriment based on such doses.

Exposures to Hazardous Materials

LLNL operations may expose some workers to hazardous materials (such as solvents, metals, and carcinogens). LLNL is a research and development facility. Typically, Laboratory workers are exposed to low levels of a wide variety of chemicals throughout the duration of their research. The current radioactive material and chemical inventories to which workers may be exposed are listed in Appendix A. Radioactive and hazardous wastes are discussed in Appendix B. In order to protect workers against illness and injury, LLNL has several programs and procedures in place to provide direction for monitoring, handling, storage, and use of these materials. These programs and procedures include the Hazard Communication Program, Chemical Hygiene Program, Respiratory Protection Program, and procedures for handling and use of carcinogens and biohazard materials. The Hazards Control Department keeps records of measured concentrations of hazardous materials. During special work activities, concentrations are measured by personal breathing zone and area air monitors (LLNL, 1991b). The 1990 records were reviewed to identify buildings or operations where exposures may be occurring (see Appendix C). These records demonstrate that in the areas monitored, few chemical concentrations were found to exceed the time-weighted average (15/1250). This indicates that the general airborne concentrations of chemicals at LLNL are not elevated in the areas that were sampled (LLNL, 1991b). Additional information regarding worker exposure to toxic materials is found in Appendix C.

Biohazards

Specific biological materials used or handled at LLNL are potentially hazardous. These materials are generated as a result of clinical/emergency and research activities. Individuals can be exposed to biohazards as a result of patient care procedures, and the collection, handling, processing, and disposal of various human body substances (e.g., blood, tissues) that may harbor pathogens. The potential exposure of workers at LLNL to biohazards is limited through standard work techniques and practices documented in the health and safety manual. In addition, whenever possible, all contaminated laboratory equipment and tools are sterilized prior to discarding or washing (LLNL, 1990d).

Carcinogens

At LLNL, chemical carcinogens are used by Laboratory employees only when required by a specific research project. When the use of the chemical carcinogens is unavoidable, every effort is made to minimize employee exposure to levels as low as reasonably achievable. Any work involving the use of chemical carcinogens must follow specific procedures for: purchasing and receiving, posting and labeling, packaging and storage, inventory, and decontamination and disposal. Proper employee education, training, and medical surveillance are also a part of the general requirements for usage of chemical carcinogens.

The use, synthesis, and storage of carcinogens must be evaluated by an industrial hygienist. Depending on the nature of the chemical use, the quantity of material involved, and the control measures engaged, an Operational Safety Procedure may or may not be required. For certain highly potent carcinogens, the area industrial hygienist may request the user to maintain a log of the chemical and the quantity used.

The purchasing and receiving of chemical carcinogens is controlled by several factors. Laboratory guidelines restrict the purchase of these chemicals to only the amount of material necessary for the specific project. Some carcinogenic solvents, such as benzene and chloroform, are available from internal LLNL Stores upon authorization from Materials Management. Authorization to use such chemicals requires the user to show an appropriate Operation Safety Procedure or to obtain approval from the area industrial hygienist. Unless approved by an area industrial hygienist, carcinogens shall not be ordered through open purchase orders.

Handling and internal transfer of carcinogens must be conducted with extreme care to avoid any accidental release or personnel exposure. In addition, certain potential carcinogens may require additional handling requirements, similar to those for chemical carcinogens, including: initial delivery of the material to Materials Management, actual inspection and opening of the package by a Health and Safety Technician in a controlled environment, and storage of the material in double containers in a locked cabinet.

All employees who work with carcinogens shall receive sufficient information and training so that they may work safely and understand the relative significance of the potential hazard they may encounter.

Physical Hazards

LLNL employees could also be exposed to physical hazards such as magnetic fields, noise, electric shock, tripping hazards, and lasers. LLNL has guidelines for mitigating these types of hazards, and occurrences of such hazards are monitored by the Hazards Control Department. No recorded occupational injuries or illnesses from exposure to nonionizing radiation or noise occurred from 1987 through 1991 (LLNL, 1991l). There were 14 accidents at LLNL between 1987 and 1991 requiring notification of DOE. All 14 were minor incidents and workers were released after treatment on the same day. (These incidents are discussed in section C.3.1.2 of Appendix C.)

LLNL records occupational injuries pursuant to DOE orders that utilize OSHA criteria. There were 169 recordable injuries (i.e., injuries that require medical attention beyond first aid and are reported to DOE) at LLNL in 1990, resulting in 4081 lost or restricted activity workdays. Of these injuries, 49 percent were from overexertion (e.g., muscle strains, back strains), 29 percent were wounds, 15 percent were cumulative trauma (e.g., carpal tunnel syndrome), 3 percent were skeletal injuries, and 4 percent were categorized as "other" (LLNL, 1991l).

Table 4.16-1 Radiation Doses and Health Effects from Occupational Exposures in 1990

Site	Collective Dose (person-rem)	Chance of Fatal Cancer[a]	Chance of Total Detriment[a]
LLNL Livermore Site			
Internal exposures at Building 331	0.5	0.00025	0.00036
External exposures at Building 332	19.6	0.010	0.014
Other external exposures	8.4	0.0042	0.0061
Total Collective Radiation Dose:	28.5	0.014	0.021
SNL, Livermore			
Internal exposures at Building 968	1.1	0.00055	0.00080
External exposures	2.4	0.0012	0.0018
Total Collective Radiation Dose:	3.5	0.0018	0.0026
Combined Total: (LLNL Livermore site plus SNL, Livermore)	32.0	0.016	0.023
Background Radiation[b]	3600	1.8	2.6

[a] Numbers less than one represent the chance of a fatal cancer or the chance of total detriment; numbers greater than one represent the estimated number of occurrences in the affected population of 12,000 persons.

[b] Based on an annual background radiation dose of 0.3 rem per person to a population of 12,000.

4.16.1.3 SNL, Livermore Occupational Protection

Exposures and Hazards

Radiation Exposures and Risk

Radiation Exposure Characterization. The only source of routine low-level occupational internal radiation exposure at SNL, Livermore is the Tritium Research Laboratory (Building 968). Building 968 work areas are monitored continuously for tritium, and all workers in the building have routine bioassays to monitor internal tritium exposures. Additional bioassays are performed for workers when room air monitors or routine work area contamination surveys indicate a potential exposure.

In 1990, the maximum effective dose equivalent from internal tritium exposure to any worker at Building 968 was 0.20 rem, or 4 percent of the annual DOE dose limit of 5 rem (SNL, Livermore, 1991k; DOE, 1988e). The collective dose, the sum of the internal radiation doses, received by all workers at Building 968, was 1.1 person-rem in 1990 (SNL, Livermore, 1991k). Figure 4.16-5 shows the maximum individual and collective occupational doses from tritium exposures for 1986 through 1990 at Building 968.

From 1986 through 1990, there were two inadvertent events resulting in two workers at SNL, Livermore having positive bioassays for depleted uranium. In both cases, uranium concentrations in the urine were less than 10 micrograms per liter, which is below the threshold of 15 micrograms per liter requiring further action, and less than one-tenth the level that causes measurable effects on the kidneys. In one instance exposure resulted from cleanup following a high component test in Building 961. The other exposure occurred during normal operations.

In addition to routine, low-level exposures in Building 968, inadvertent releases of tritium have exposed SNL, Livermore workers to radiation. Since 1983, two inadvertent events resulted in occupational radiation doses of 0.015 rem to 1.65 rem to eight workers. Six of these workers received an effective dose equivalent of less than 0.05 rem and one worker received an effective dose equivalent of 0.015 rem. The largest radiation dose equivalent (1.65 rem) to a worker occurred in 1987, when approximately 2.5 curies of tritiated water vapor leaked into a room from a damaged certified high pressure gas container.

Thermoluminescent dosimeters are used at SNL, Livermore to monitor external radiation exposure. These dosimeters are issued to employees working in areas where they may receive a radiation dose of more than 0.1 rem per year and to employees who are recommended for personnel monitoring by their supervisor. During 1990, the highest individual radiation dose from external exposure was 0.24 rem, representing 4.8 percent of DOE's 5-rem annual occupational dose limit (DOE, 1988e). Most SNL, Livermore employees do not receive any measurable external radiation exposures above background levels (SNL, Livermore, 1990b). The sum of all radiation doses from external exposures, the collective dose, was 2.4 person-rem during 1990. Figure 4.16-6 shows the average distribution of collective doses from external exposure at SNL, Livermore for 1988, 1989, and 1990 (SNL, Livermore, 1990b).

Radiation Risk Characterization. A general discussion of the principal adverse effects from ionizing radiation is found in section 4.16.1.2. During 1990, the radiation doses to SNL, Livermore workers ranged from background to a maximum of 0.20 rem effective dose equivalent. Using the risk estimators for fatal cancer and total health detriment discussed in section 4.16.1.2, the chance that the highest exposed individual would develop a fatal cancer from this radiation dose is 1 in 10,000 and the chance of any detrimental health effect is 1 in 7000.

The internal and external radiation doses received by workers at SNL, Livermore during 1990 are in section 4.16.1.2 (see Table 4.16-1). Table 4.16-1 also shows the chance of fatal cancer and total health detriment to the workers from these radiation doses. The collective effective dose equivalent to SNL, Livermore workers during 1990 was 3.5 person-rem. Using the cancer risk and total health detriment estimators discussed above, the chance of a single cancer among all workers from one year of operation of the facilities is about 1 in 600 for fatal cancers and 1 in 400 for total health detriment.

Exposures to Hazardous Materials

The wide range of research conducted at SNL, Livermore requires a variety of chemical and physical agents, including numerous hazardous materials. SNL, Livermore is a research and development facility; therefore, exposures to chemical and physical agents are generally low level in nature.

The major portion of the chemicals used at SNL, Livermore are distributed among six buildings. Small quantities of chemicals (e.g., liquids and gaseous fuel), are used in the Combustion Research Facility, Building 906, and two laboratories, Buildings 913 and 916. In the shop, Building 913, and plant maintenance, Building 963, small quantities of chemicals, oils, greases, and solvents are used.

Those employees whose work routinely exposes them to low levels of toxic or carcinogenic materials are placed on a special medical monitoring program. The Industrial Hygiene Organization also monitors the workplace to ensure that appropriate protective measures are in place and exposures are kept as low as reasonable achievable.

Physical Hazards

Potential occupational hazards result from noise or ergonomic factors (e.g., repetitive motion). SNL, Livermore also has various radio frequency and microwave-generating sources.

Exposure monitoring is initiated for any hazard when it is believed that exposure levels may exceed regulatory action levels (e.g., OSHA-permissible exposure levels). For example, employees exposed to excess levels of noise are placed in a hearing conservation program to routinely test their hearing to monitor whether the engineering controls are effective (SNL, Livermore, 1991b, 1991c, 1991h).

Occupational safety at SNL, Livermore was evaluated by reviewing the OSHA logs containing summary information on the number and types of accidents occurring each calendar year (SNL, Livermore, 1991n). For the 5-year period from 1986 through 1990 there were 133 accidents recorded. The following occupational injuries were identified as being the most common types of accidents (SNL, Livermore, 1991n; SNL, Livermore, 1992a).

- The most commonly reported injuries during this period were 36 cases involving lacerations (27 percent) and 28 cases of back pain or strains (21 percent).

According to records, three events at SNL, Livermore between 1987 and 1991 required workers to receive medical treatment. These events involved two minor burns and inhalation of floor cleaning solution. These incidents are described in Appendix C.

4.17 SITE CONTAMINATION AND REMEDIATION

This section presents a general overview of historic operations that contributed to contamination (4.17.2.1, 4.17.3.1, 4.17.4.1), describes and summarizes soil contaminant areas (4.17.2.2, 4.17.3.2, 4.17.4.2) for the LLNL Livermore site, LLNL Site 300, and SNL, Livermore, respectively, and describes ground water contamination at the LLNL Livermore site (4.17.2.3) and LLNL Site 300 (4.17.3.2). The LLNL Livermore site and LLNL Site 300 have been identified as Superfund sites under CERCLA/SARA and were placed on the National Priorities List (NPL) in 1987 and 1990, respectively. This section is complemented by section 4.13, which provides detailed information about hazardous and radioactive materials used onsite, and section 4.14 and Appendix C, which present detailed information regarding health risks associated with materials present at the Laboratories. Section 4.19 presents a discussion of the environmental effects on the existing environment assuming no remediation of areas contaminated by past activities.

4.17.1 Regulatory Oversight

Regulatory oversight of environmental restoration activities is provided by numerous entities including federal, state, and county agencies. A listing of applicable laws and regulations and the implementing agencies is included in Table 4.17-1.

LLNL Livermore Site

Pursuant to CERCLA Section 120, a Federal Facility Agreement (FFA) was signed by DOE, the EPA, the Regional Water Quality Control Board, and the Department of Health Services (now part of the California Environmental Protection Agency, Department of Toxic Substances Control [DTSC]), covering cleanup activities at the LLNL Livermore site. The Federal Facility Agreement coordinated efforts among these agencies to standardize requirements and to ensure compliance with applicable or relevant and appropriate requirements, orders, and permits (DOE, 1989a). The Federal Facility Agreement also specifies a schedule and details of project operation and management. An Environmental Assessment (EA) on the remediation activities subject to the Federal Facility Agreement was written as a chapter within the Feasibility Study documents prepared pursuant to NEPA and CERCLA (LLNL, 1991f).

The LLNL Ground Water Project of the Environmental Restoration Division has primary responsibility for investigation and remediation efforts under the Federal Facility Agreement. The project's name reflects the emphasis of the investigation at the LLNL Livermore site. As closely related media for contamination, ground water and soil receive primary emphasis from investigation and remediation efforts. The Ground Water Project holds public meetings, publishes a newsletter, and has formed a Community Work Group to keep the public informed and to provide a pathway for public input to the remedial action process (LLNL, 1991f).

Before the LLNL Livermore site Federal Facility Agreement was executed in 1989, the Ground Water Project activities were conducted under regulatory orders and permits and the primary oversight by the San Francisco Bay Regional Water Quality Control Board. Beginning in 1984, LLNL discharges to land and water were regulated by a series of orders issued by the Regional Water Quality Control Board or by the Department of Health Services (now the Department of Toxic Substances Control) (Table 4.17-2). Two orders specifying waste discharge requirements are currently in effect (Table 4.17-2). The remaining orders have been rescinded, or their provisions have been incorporated into the Federal Facility Agreement. Air emissions from treatment of ground water associated with the Ground Water Project are regulated by the Bay Area Air Quality Management District.

LLNL Site 300

LLNL Site 300 was placed on the National Priorities List in 1990 because volatile organic compounds were discovered in the regional aquifer underlying the site and because of the proximity of the contamination to private drinking water supplies. A Federal Facility Agreement covering cleanup activities at LLNL Site 300 was executed on June 29, 1992.

SNL, Livermore

The Regional Water Quality Control Board, San Francisco Bay Region, has identified Environmental Restoration Program activities at SNL, Livermore to be performed under a Revised Site Cleanup Order (No. 89-184), which modified Order No. 88-142, and the rescission of Order No. 85-106, dated September 21, 1988. Order No. 88-142 was issued to "consolidate all site work accomplished by Sandia Corporation and within DOE Environmental Restoration Program, and to set forth provisions and specifications for development and implementation of site cleanup alternatives for identified areas of soil and ground water pollution."

Table 4.17-1 Representative Listing of Federal, State, and Local Regulatory Requirements Affecting Environmental Restoration

Laws, Regulations and Requirements	Responsible Agencies
Air Toxics "Hot Spots" Information and Assessments Act (Health and Safety Code sections 44300 et seq.)	California Air Resources Board
California Clean Air Act (Health and Safety Code sections 39000 et seq.)	California Air Resources Board
California Safe Drinking Water and Toxic Enforcement Act (Health and Safety Code sections 25249.5 et seq.)*	California Environmental Protection Agency
California Porter-Cologne Water Quality Act (Water Code sections 13000 – 13999.16)	California Water Resources Control Board and Regional Water Quality Control Board
California Hazardous Waste Control Act (Health and Safety Code sections 25100 et seq.)	California Environmental Protection Agency
City of Livermore Sewage Discharge Regulations	City of Livermore, CA
Clean Air Act (42 U.S.C. sections 7401 et seq.)	U.S. Environmental Protection Agency
Clean Water Act (33 U.S.C. sections 1251 et seq.)	U.S. Environmental Protection Agency
Comprehensive Environmental Response Compensation and Liability Act/Superfund Amendments and Reauthorization (42 U.S.C. sections 9601 et seq.)	U.S. Environmental Protection Agency
National Environmental Policy Act of 1969 (42 U.S.C. sections 4321 et seq.)	Council on Environmental Quality
Noise Control Act of 1972 (42 U.S.C. sections 4901 et sq.)	U.S. Environmental Protection Agency
Occupational Safety and Health Act of 1970 (29 U.S.C. sections 651 et seq.)	U.S. Department of Labor
Resource Conservation and Recovery Act	U.S. Environmental Protection Agency

(42 U.S.C. sections 6901 et seq.)	
Safe Drinking Water Act (42 U.S.C. sections 300 et seq.)	U.S. Environmental Protection Agency
Toxic Substance Control Act (15 U.S.C. sections 2601 et seq.)	U.S. Environmental Protection Agency
DOE Order 5000.3A "Occurrence Reporting and Processing Operating Information"	U.S. Department of Energy
DOE Order 5400.1 "General Environmental Protection Program"	U.S. Department of Energy
DOE Order 5400.2A "Environmental Compliance Issue Coordination"	U.S. Department of Energy
DOE Order 5400.5 "Radiation Protection of the Public and the Environment"	U.S. Department of Energy
DOE Order 5400.6C "Quality Assurance" (draft)	U.S. Department of Energy
DOE Order 5480.1B "Environment, Safety, and Health Program for Department of Energy Operations"	U.S. Department of Energy
DOE Order 5480.4 "Environmental Protection, Safety, and Health Protection Standards"	U.S. Department of Energy
DOE Order 5480.8 "Contractor Occupational Medicine Program"	U.S. Department of Energy
DOE Order 5480.10 "Contractor Industrial Hygiene Program"	U.S. Department of Energy
DOE Order 5480.11 "Radiation Protection for Occupational Workers"	U.S. Department of Energy
DOE Order 5480.19 "Conduct of Operations Requirements for DOE Facilities"	U.S. Department of Energy
DOE Order 5482.1B "Environment, Safety, and Health Appraisal Program"	U.S. Department of Energy
DOE Order 5484.1 "Environment, Safety, and Health Protection Information Reporting Requirements"	U.S. Department of Energy
DOE Order 5484.1A "Occupational Safety and Health Program for Government-Owned, Contractor-Operated Facilities"	U.S. Department of Energy

* Applies to SNL, Livermore, but not to LLNL.

4.17.2 Site Contamination—LLNL Livermore Site

4.17.2.1 Contamination History

To simplify compliance with CERCLA/SARA, LLNL combined the entire LLNL Livermore site and offsite leased properties into one remedial investigation/feasibility study unit (Thorpe et al., 1990). The following section describes the historic use of hazardous and radioactive material within this unit. Sections 4.17.2.2 and 4.17.2.3 describe each of 17 potential contaminant release areas investigated by March 1991 at the LLNL Livermore site. The locations of the 17 areas are shown in Figure 4.17-1. The results from sitewide ground water investigations are summarized in section 4.17.2.3. Table 4.17-3 lists activities at each area that may have contributed to contamination.

The earliest use of the LLNL Livermore site by the federal government began in 1942 with the Livermore Naval Air Station. Subsequently, other federal entities assumed ownership or occupation. In 1952, the University of California Radiation Laboratory assumed care, custody, and control of the government-owned land to conduct research on nuclear weapons and magnetically confined nuclear fusion (LLNL, 1989a).

The earliest use of hazardous materials at the LLNL Livermore site was by the U.S. Navy. A site map of the Naval Air Station is shown in Figure 4.17-2. Based on information obtained from records at the Navy Historical Center at the Washington Navy Yard and the Military Records Branch of the National Archives in Washington, D.C., it was determined that trichloroethylene (TCE), perchloroethylene (PCE), 1,1-dichloroethylene (1,1-DCE), 1,2-dichloroethylene (1,2-DCE), and carbon tetrachloride (CCl4) were used routinely by the U.S. Navy at the Livermore Naval Air Station during World War II (LLNL, 1989a).

During the Navy's occupation of the area, much of the engine assembly, repair, and overhaul operations involving these compounds was performed in Building 511 and Building 514, located in the southeastern part of the site. Additionally, aircraft were reassembled and wiped down on parking aprons adjacent to the main runways. Paint stripping compounds included dichloroethylene, ethyl acetate, ethylene dichloride, carbon tetrachloride, methanol, and acetone (Graham, 1987). Organic solvents were also used in the unpaved and undeveloped areas flanking the paved runway and aprons (Webster-Scholten et al., 1987). These unpaved zones overlap areas where concentrations of volatile organic compounds (VOCs) are currently above action levels (Webster-Scholten et al., 1987; Graham, 1987). There is evidence that residues from "empty" barrels and drums were drained in the unpaved area above the northwest corner of the old salvage yard and along the east side of the Taxi Strip (Dreicer, 1985). An aerial photograph taken some time between 1942 and 1944 shows a disposal and burn pit located between the middle and southern blocks of the eastern unpaved areas. This pit was graded and covered when the U.S. Navy left the site (Graham, 1987).

From 1950 to 1952, in the area currently occupied by Building 431, the California Research and Development Corporation constructed the Materials Test Accelerator to demonstrate the feasibility of using high-energy neutrons to produce nuclear materials, such as tritium and plutonium, although these materials were never processed there. Cells were built just south of Building 412 to house large hardware for chemical engineering work. It is likely that oils, grease, and solvents were used in this building. Radioactive and hazardous materials were used in the California Research and Development Corporation facilities at Building 514, and the building housed a decontamination laundry. In 1953 and 1954, Pratt and Whitney leased Building 412 and converted the previously established cells into hot cells for metallurgical research using uranium (Dreicer, 1985).

During the 1950s and 1960s, new plastics, composite materials, and coatings required the use of small quantities of diverse types of hazardous and radioactive materials. Operation and maintenance of buildings, utilities, and specialized equipment generated the same types of hazardous wastes as those produced by any large vehicle and facility maintenance operation, including waste fuels, oils, hydraulic fluids, coolants, pesticides, biocides, acids, bases, paints, and varnishes.

Table 4.17-2 California Regulatory Orders for the LLNL Ground Water Investigation Governing the Discharge of Treated Ground Water to Land or Waterways

Order Number	Date	Purpose	Issuing Agency	Currently in Effect
91-106	6/18/91	Waste Discharge Requirements (NPDES No. CA 0029289) Allows discharge of treated ground water. This NPDES permit rescinds order No. 90-106.	RWQCB[a]	Yes
90-106 88-103	6/15/88	Site Cleanup Order. Allows discharge of ground water (with specified quality limits), and specifies time frame for investigation and cleanup activities. This order rescinds 87-108.	RWQCB	No[b]
88-075	5/18/88	Waste Discharge Requirements and Self Monitoring Program. Allows discharge of treated water associated with pilot treatment facility A (with specified quality limits) to the ground.	RWQCB	Yes
88-065	4/20/88	Waste Discharge Requirements (NPDES No. CA 0029289). Allows discharge of ground water (with specified quality limits) to the ground, to storm sewers, or to existing arroyos.	RWQCB	No
87-108	8/19/87	Site Cleanup Order. Allows discharge of ground water (with specified quality limits) and specified time frame for investigation and cleanup activities. This order rescinds 86-95 and 85-134.	RWQCB	No
86-95	12/17/86	Waste Discharge Requirements for Short-Term Well Tests. Allows discharge of ground water (with specified quality limits) to land during short-term hydraulic tests.	RWQCB	No
85-134	11/20/85	Waste Discharge Requirements. Allows discharge of ground water (with specified quality limits) to land during early investigations to determine (1) the extent that the ground water has been affected by hazardous constituents, and (2) the hydrogeologic conditions.	RWQCB	No
---	9/11/84	Order for Compliance. Requires investigation of ground water quality at LLNL and orders bottled water to be provided to area residents whose domestic wells have been affected by hazardous constituents.	DHS[c]	No[b]

[a] Regional Water Quality Control Board.

[b] Provisions of this order were incorporated into the Federal Facility Agreement.

[c] Department of Health Services.

Table 4.17-3 Activities at LLNL That May Have Contributed to Environmental Contamination

Areas Investigated	Period of Operation	Comments
Arroyo Seco Storm Sewer Discharge	1940s to present	Storm drain discharge to natural surface water drainage for LLNL and SNL during Navy Operations.

Area (1)		
Building 212 Area (2)	1940s to present	Built in 1940s; accelerator research 1950s to present.
Building 321 Area (3)	1954 to present	Machine, plating, and small shops.
Building 141 Area (4)	1953 to present	Built over and added to since 1953; old taxiway and unpaved areas, materials staging area and circuit board shop.
West Traffic Circle (5)	1940s to 1975	Former landing mat; traffic circle built in 1975.
East Traffic Circle (6)	1942 to 1946	Former unpaved parking apron for planes 1942–1946; used for paint stripping, degreasing and cleaning. Landfill established in late 1940s; excavated 1984.
Taxi Strip (7)	1942 to 1983	Constructed circa 1942; planes were cleaned; glass carboy storage 1953–1959; radioactive evaporation tray 1963–1976 known to have leaked; area excavated 1982–1983.
Eastern Landing Mat Storage Area (8)	1942 to 1970s	Constructed circa 1942; used for salvage and storage.
Old Salvage Yard (9)	1958 to 1979	Salvage and scrap operations.
Building 612 Area (10)	1966 to present	Constructed in 1966; solid waste holding and shipment facility for radioactive and hazardous materials.
Building 514 Area (11)	1942 to present	Engine cleaning area. Radionuclide and mixed waste storage and treatment, 1960s to present; possible plutonium release 1967.
Building 518 Area (12)	1959 to present	Gas cylinder, solvent, and oil storage.
Building 298 Area (13)	1970s	Circa 1970s; used kerosene, gasoline, and jet fuel.
Building 361 Area (14)	1950s to 1960s	Used kerosene, gasoline, and jet fuel at Fire Training Area.
Gasoline Spill Area (15)	1952 to 1979	Between 1952 and 1979, about 17,500 gal of leaded gasoline may have been lost.
Building 292 Area (16)	1977 to 1987	A rotating target neutron source (RTNS) was used for research between 1977 and 1987. In 1989 a leak test identified leaks in a 1000-gal underground tank that had contained tritiated rinsewater. On December 23, 1990, a cold water pipe froze and broke in Building 292 releasing 4000 gal of tritiated water to floor drains connected to the tank. A portion of the water was recovered; an unknown quantity of tritiated water leaked into

		soils near the tank.
Building 331 Area (17)	1956 to present	Hydrogen Research Facility. Tritium contaminated solvents and water. Tritium contaminated solid handling materials, oils, solvents, and chlorinated solvents. Tritium gas.

4.17.2.2 Soil Contamination Areas

Unsaturated or vadose zone soil and sediment contaminants and their distribution were identified during investigations of potential source areas (Figure 4.17-3) through surface sediment sampling, unsaturated zone soil vapor surveys, and boring programs. Potential contaminants identified include volatile organic compounds, fuel hydrocarbons, pesticides, polychlorinated biphenyls, metals, and tritium. Many potential source areas have been investigated at the LLNL Livermore site (Thorpe et al., 1990), and other source investigations are ongoing (Devany et al., 1990).

Tables 4.17-4 and 4.17-5 summarize contaminants detected in potential source areas investigated at the LLNL Livermore site. The areas investigated are shown in Figure 4.17-1. This document uses the common nomenclature of parts per million (ppm) and parts per billion (ppb) to identify concentrations of contaminants in soils and ground water. For reference, mg/kg (or mg/L) is equivalent to ppm and mg/kg (or mg/L) is equivalent to ppb. Sediment samples from potential source areas generally contained total concentrations of volatile organic compounds ranging from less than 5 ppb to 500 ppb, with most containing less than 100 ppb. The estimated volume of volatile organic compounds in unsaturated sediments beneath the LLNL Livermore site is about 54 gals (see Table 4.17-6). Figure 4.17-4 shows the approximate areas where total concentrations exceed 10 ppb in the unsaturated zone at the LLNL Livermore site.

Only one surficial sediment sample contained detectable levels of pesticides (88 ppb Lindane). Polychlorinated biphenyls (Aroclor-1254) were found at nine storm drain and surficial sediment sample locations at concentrations up to 1300 ppb (Thorpe et al., 1990). No metals have been detected in soils or in the vadose zone in concentrations exceeding Soluble Threshold Limit Concentrations except for lead which was detected at one location at 18 mg/kg (Soluble Threshold Limit Concentration=5 mg/kg).

Tritium activities from unsaturated sediments are reported in picocuries per liter of soil moisture (pCi/Lsm). Areas with soil tritium activities significantly above the LLNL Livermore site background level (500 pCi/Lsm) include Building 514, Building 292, Eastern Landing Mat, Building 331, and Taxi Strip areas (Isherwood et al., 1990; Dresen et al., 1991; Stone et al., 1982). Maximum concentrations reported for these areas range from 9.4×10^{4} pCi/Lsm (Eastern Landing Mat) to 2.2×10^{8} pCi/Lsm (Building 292).

Continuing investigation of sites to determine the existence and extent of contamination is a key element in the Environmental Program at LLNL (LLNL, 1991i). Currently, over 17 additional sites are being investigated.

The following sections describe individual areas, including for each the site history, nature and extent of soil contamination, existing situation, and any planned remediation activities for sites that have been identified and fully characterized. Table 4.17-7 presents the key references to additional technical information for each area. Table 4.17-5 presents an overview of the potential soil contamination from identified industrial activity or the discharge of hazardous materials, and the contaminants identified by laboratory analyses of the soil samples.

Arroyo Seco Storm Sewer Discharge Area

The Arroyo Seco channel historically has been the natural drainage for surface waters in the southern portion of LLNL and SNL, Livermore. The Arroyo Seco originates in the hills southeast of LLNL and flows northwest across SNL, Livermore before entering the southwest corner of LLNL as shown in Figure 4.11-1. A 300-ft section of the channel was diverted in 1966 so that Building 113 could be constructed. Beyond this diversion, the channel returns to its original course.

Release of hazardous materials such as solvents, fuels, and oils to the subsurface is thought to be principally from storm drain discharge during the U.S. Navy's use of the site (Dresen and Hoffman, 1986). Solvent spills, potassium dichromate from Building 113, fuel and oil from an auto repair shop, and polychlorinated biphenyls from a ruptured transformer are other potential sources of contamination.

Contaminants identified in the soil and vadose zone are presented in Table 4.17-5. Perchloroethylene was the most widespread volatile organic compound, although minor quantities of fuels and aromatic hydrocarbons were also found. There was no evidence of any release of metals or radioactive material in this area.

Building 212 Complex

Building 212, in the southwest area of the LLNL Livermore site (see Figures 4.17-1 and 4.17-2), was constructed by the U.S. Navy in the early 1940s and used as a drill hall and gymnasium. From the early 1950s to the present, LLNL has used the building for accelerator research. The building also housed machining, plating, electronic fabrication shops, and a mercury reclaimer, which generated small amounts of nonradioactive hazardous waste. Although possible releases of hazardous materials by the mercury reclaimer have not been evaluated, mercury has not been detected above the maximum contaminant level in LLNL ground water (Thorpe et al., 1990).

Volatile organic compounds listed in Table 4.17-5 have been found in trace to low concentrations in sediments. Although there is no surficial or other recorded evidence of previous release of aromatic hydrocarbons in this area, saturated and unsaturated sediments from one borehole showed from trace to very low concentrations of benzene, toluene, ethylbenzene, and xylene. There is no evidence of any release of metals or polychlorinated biphenyls in this area.

Building 321 Complex

Construction of the Building 321 complex began in 1954, with additions made in 1959, 1962, 1967, and 1985. The complex (shown in Figure 4.17-1) overlies portions of the "warm-up" concrete apron used by naval aircraft when the site was the Livermore Naval Air Station (see Figure 4.17-2). At that time, a fuel line was buried a few feet beneath the surface of the concrete apron near Building 321.

The LLNL facilities in Building 321 were designed for the operation of various machine, plating, and small project support shops (e.g., a paint shop near the north end of the west wing of the building). The Materials Fabrication Division of the Mechanical Engineering Department has occupied this building complex since the Laboratory began operations.

Sources of hazardous and radioactive material releases include a barrel storage rack area, a sump that received solvent degreaser waste, storm drains that received spilled oil, a holding area for beryllium and low-level radioactive solids and liquids, a vapor degreaser, a wastewater tank, a collection reservoir, a concrete sump, overflows from the ion exchange plant, historic plating shop trenches, sump vacuum units, and the arc welding shop.

Tests for contamination in soils show that of the several organics present, perchloroethylene is the predominant contaminant (Table 4.17-5). There is no evidence of any release of metals or polychlorinated biphenyls in this area.

Building 141 Area

The original structure in the Building 141 Complex was built in 1953. Figure 4.17-1 shows its location in the southwest area of the site. This building complex overlies portions of the taxiway and unpaved areas of the former Livermore Naval Air Station (see Figure 4.17-2). LLNL used this complex primarily as a staging area for materials destined for the Nevada Test Site and as a security badge fabrication area. Additions were made to the structure in 1954 and 1966. LLNL's original salvage yard was located just to the north of Building 141 (Thorpe et al., 1990). The LLNL Electronics Engineering Department has been the principal occupant since 1960. In 1980, the printed circuit fabrication facility, as part of the Electronics Engineering Department, moved into the facility.

Historical site records for the Building 141 Area show that sources of potential contamination include a plating shop sump (Dreicer, 1985), an unlined drainage ditch adjacent to Building 141, a wastewater retention tank and an adjacent sump and tank, portable tanks, a solvent degreaser, waste accumulation areas, and a hood and ventilation area (Thorpe et al., 1990). Additionally, oils that may have been dumped just east of Building 141, an underground gasoline tank, a second possible underground tank, a drum rack, and an open storm sewer line may have contributed to the contamination.

Trichloroethylene was the dominant volatile organic compound detected in the unsaturated sediment; other constituents were reported in trace to low concentrations (Table 4.17-5). Trace to very low concentrations of fuels and aromatic hydrocarbons were detected at various depths. There is no evidence of any release of metals or polychlorinated biphenyls in this area.

West Traffic Circle Area

The West Traffic Circle Area was constructed in 1975. It is located on the former Livermore Naval Air Station landing mat, northwest of the former air strip (see Figures 4.17-1 and 4.17-2). Currently, the West Traffic Circle Area is bordered by the Laser Program, Biomedical and Environmental Program, and Technical Services facilities. Historical and site records indicate that a fire training area and a "swamp" were located in the West Traffic Circle Area. Evidence suggests some hazardous materials releases there (Dreicer, 1985). Additionally, the biomedical facility and the open storm sewer drainage are reported as potential sources of contamination (Thorpe et al., 1990).

Chemical analyses of the unsaturated soil samples collected from boreholes, however, found only trace and low concentrations of trichloroethylene, chloroform, chloroethylene, Freon-113, 1,1-dichloroethylene, toluene, and benzene. There is no evidence of any release of metals or polychlorinated biphenyls in this area.

East Traffic Circle Landfill Area

The East Traffic Circle Landfill Area (Figure 4.17-1) was formerly one of the unpaved parking aprons flanking the runways of the Livermore Naval Air Station (see Figure 4.17-2), and was used from 1942 to 1946 for cleaning, repairing, and stripping paint from airplanes. The Navy also operated a disposal and burn pit between the middle and southern blocks of the eastern unpaved areas. This facility was graded over and covered when the U.S. Navy stopped operations at the site (Graham, 1987).

LLNL used the East Traffic Circle Landfill Area from about 1956 to 1970, when it was returned to grade. Aerial photographs from this period show the landfill to be a large depression. Materials in the landfill included metal debris, capacitors containing polychlorinated biphenyls, various drums possibly containing chemical wastes and plating solutions, sandblasting sand, miscellaneous paper, and gardening debris (Thorpe et al, 1990). During the late 1970s, gasoline was stored above ground immediately south of the East Traffic Circle Area.

During 1984 and 1985, the landfill was excavated and the contents disposed of offsite (McConachie, et al., 1986). Seven distinct areas of waste disposal containing a variety of hazardous and nonhazardous waste were uncovered. Soil samples from these areas were analyzed for organic compounds, polychlorinated biphenyls, radioactivity, and metals. The analyses showed some areas with above background levels of polychlorinated biphenyls, metals, radioactivity, oil, and volatile organic compounds.

All sediment containing metals and polychlorinated biphenyls above the soluble threshold limit concentrations was excavated and removed (McConachie et al., 1986). Metals analyses of samples from boreholes in this area after remediation showed metals below regulatory soluble threshold limit concentrations.

Post-excavation soil samples collected from the same boreholes in this area were analyzed for polychlorinated biphenyls. Except for one borehole, polychlorinated biphenyls were not found in concentrations above the detection limit of 300 ppb in any samples. The one exception contained 690 ppb of Aroclor-1254 and 370 ppb of Aroclor-1260. This level would not require remediation under existing regulatory requirements.

In the East Traffic Circle area, total volatile organic compounds in the unsaturated zone have been reported in concentrations up to 800 ppb (Thorpe et al., 1990). Vadose zone sediment tests show that trichloroethylene and perchloroethylene are the volatile organic compounds with the highest concentrations. Trace and low concentrations of other volatile organic compounds were also found (see Table 4.17-5). When selected samples were analyzed for fuels and aromatic hydrocarbons, only trace to very low concentrations were found.

Taxi Strip Area

The Taxi Strip Area (see Figures 4.17-1 and 4.17-2) was a concrete paved taxiway constructed and used by the U.S. Navy. The Navy cleaned and repaired airplanes using chlorinated solvents, principally trichloroethylene, on either side of this taxiway.

From 1953 to approximately 1976, LLNL used a strip of this taxiway, along with about 55 ft of unpaved land along its eastern edge, to store solid and liquid radioactive wastes and processed radioactive liquid wastes in evaporation ponds. These wastes were initially stored in evaporation ponds consisting of depressions, of unknown dimensions, in the ground lined with plastic. Later, the ponds were replaced by 10-ft-wide by 20-ft-long and 1-ft-deep ponds lined with epoxy-painted concrete.

Selected borehole samples were analyzed for fuels and aromatic hydrocarbons and only trace concentrations of benzene, toluene, and xylene were detected in any of the samples (Table 4.17-5). There is no evidence of any release of metals or polychlorinated biphenyls in this area. Gross alpha, gross beta, and tritium analyses were conducted on borehole samples. Most samples had no detectable tritium activity, and only background levels of gross alpha and gross beta. Tritium was detected at 3000 pCi/Lsm in one location and at slightly above estimated background (3500 pCi/Lsm) at two other locations. Results for vadose zone soils show trichloroethylene to be the most prevalent volatile organic compound. Other soil contaminants include 1,1,1-trichloroethane and perchloroethylene (Table 4.17-5).

In 1982, the upper 6 ft of the entire unpaved portion of the area, about 50 ft wide by 750 ft long, was stripped to remove radioactive and contaminated soils. Several small disposal pits were discovered during the excavation, and soil in some of the pit areas contained volatile organic compounds in concentrations exceeding 900 ppm. One old disposal pit (25 ft by 50 ft) was excavated to 34 ft below grade (Buerer, 1983). Surface and subsurface soils containing radionuclides including uranium-235, cesium-137, cobalt-60, europium-152, thorium-232, americium-241, and other transuranics were excavated and disposed of at the Nevada Test Site (Buerer, 1983; Thorpe et al., 1990). Since the excavation, many new boreholes have been drilled that indicate that there are still areas with elevated concentrations of volatile organic compounds and tritium. Other than in one sample which contained plutonium at levels slightly above background ((.072 pCi per gram or 0.5 percent of the EPA regulatory limit for unrestricted use of surface soil (Dresen et al., 1991)), no radionuclides other than tritium have been reported. This area is under further investigation.

Eastern Landing Mat Storage Area

The Eastern Landing Mat Storage Area was a strip of land parallel to the East Taxi Strip at the former Livermore Naval Air Station, but separated by an unpaved parking area (see Figures 4.17-1 and 4.17-2). LLNL used the landing mat for salvage and storage of reclaimable material. Available data indicate that only nonradioactive chemicals and oils were processed at this location.

Records for the Eastern Landing Mat Area indicate four potential sources of oil and chemical spills: a transformer dismantling area, an area where transformers were kept, an area with stained soils where hazardous materials may have been spilled (Dreicer, 1985), and an underground tank that may have been present (Thorpe et al., 1990). Recent soil and vadose zone sampling show that sediments contain a variety of volatile organic compounds, predominantly trichloroethylene and perchloroethylene.

There is no evidence of any release of fuels and aromatic hydrocarbons, metals, or polychlorinated biphenyls. No tritium above the detection limit of 1000 pCi/L was found in the sample collected from a soil borehole drilled in 1989 to evaluate this area. More recent investigations (Dresen et al., 1991), however, have identified tritium activities as high as 9.4×10^4 pCi/Lsm in soil.

Old Salvage Yard Area

The Old Salvage Yard Area was located at the southern end of the U.S. Navy's eastern unpaved parking aprons (see Figure 4.17-1). Salvage operations began in the area between 1954 and 1958 when reclaimable materials (e.g., chemicals, solvents, oils, mercury, scrap metal) were stored and prepared for resale or disposal. Although most transferring activities reportedly took place in the East Taxi Strip Area, these materials may have leaked into the salvage yard storage area. The unpaved area north of the northwest corner of the salvage yard was reportedly used to drain residue from empty barrels and drums (Dreicer, 1985). The salvage yard was moved to its present location in the southeastern corner of the LLNL Livermore site in approximately 1979. The old salvage yard is now primarily a parking lot.

The entire Old Salvage Yard Area is considered a potential source of contamination. Soil and vadose zone sampling show trace levels of trichloroethylene, perchloroethylene, chloroform, and Freon-113 (Table 4.17-5). There is no evidence of any release of fuels and aromatic hydrocarbons, metals, or polychlorinated biphenyls.

Building 612 Area

Building 612 and a portion of the surrounding yard (Figure 4.17-1) were constructed by LLNL in 1966. This area serves as a hazardous, radioactive, and mixed waste storage facility. Before its construction, the Building 612 Area was apparently little used, except for U.S. Navy–built ammunition bunkers in the northern portion of the current storage yard. No surface storage or disposal areas are known to have been associated with the bunkers during the Navy era. In 1978, the facility was expanded to the north to include the area formerly occupied by the Navy bunkers.

The Building 612 Area has been identified as a possible area of release of hazardous materials. Potential sources of contamination include a waste evaporation area (Dreicer, 1985), shipping and receiving areas, a waste processing area, a yard storage area, polychlorinated biphenyls and transuranic material storage, hazardous waste drum storage, mixed waste storage, an incinerator and incinerator waste storage areas, a historical spill area, and an area that handled miscellaneous transport equipment (Thorpe et al., 1990).

Vadose zone sediments near Building 612 are characterized by three areas of soil vapor volatile organic compound concentrations between 10 and 100 ppm located in the northern, central, and southern portions of the study area. The dominant constituents are perchloroethylene and trichloroethylene (Table 4.17-5), with the highest value occurring 11 ft below the surface and generally low concentrations in the upper 25 ft. Traces of Freon-113 were also found. No evidence exists suggesting a release of fuels and aromatic hydrocarbons, metals, or polychlorinated biphenyls. This area will undergo more extensive sampling as part of RCRA activities to close the incinerator.

Building 514 Area

Building 514 (see Figure 4.17-1) was constructed in 1943 by the U.S. Navy as a facility to test and repair aircraft engines. In 1954, LLNL converted the building to a waste disposal and decontamination facility for both radioactive and hazardous wastes. These waste disposal and decontamination operations, as described in Appendix B, have continued since LLNL acquired the operation in 1954.

Due to the nature of its past operations, Building 514 is suspected to have been a potential source of contamination at LLNL. Large quantities of solvents were used by the Navy to clean aircraft engines. Surface drainage during that time flowed through storm sewers and into Arroyo Seco.

Locations of potential contamination in the Building 514 Area have been identified and investigated as possible release areas of hazardous materials. These locations include an evaporation pit, solvent and oil spills, pipe shop, dip tank, drum storage site, wastewater treatment system (including aboveground tanks, vacuum filter press, sumps, and retention tanks), hood and ventilation system, and a steam cleaning site.

Soil and vadose zone samples show a variety of volatile organic compounds that suggests multiple releases. Fifty soil borings and monitor wells found 15 different compounds in the unsaturated zone (see Table 4.17-5). Soil samples show trichloroethylene, perchloroethylene, 1,2-dichloroethane, Freon-11, and Freon-113 as the major volatile organic compounds, with up to moderate concentrations of less than 600 ppb. Perchloroethylene was detected in one shallow soil sample (2 ft) at 2.8 ppm, although subsequent boreholes in close proximity could not confirm that value and had much lower concentrations. Perchloroethylene and trichloroethylene are the most common constituents, varying with both depth and location.

Aromatic hydrocarbons were not detected in the eight boreholes drilled in this area (Carpenter et al., 1984). Selected samples collected from a borehole north of the Building 514 Area were analyzed for fuels and aromatic hydrocarbons. Trace concentrations of benzene, toluene, ethylbenzene, and xylene were reported only in saturated sediments. The depth at which these compounds were detected, however, indicates that either they have been transported into the Building 514 Area from a minor distant source or the analyses are erroneous. Samples from the recent soil boreholes in the area revealed no aromatic hydrocarbons above 100 ppb. Trace concentrations of benzene have also been reported in unsaturated sediments from several boreholes but appear to be minor and of limited extent.

No metals above Soluble Threshold Limit Concentrations were detected, and there is no evidence of any release of polychlorinated biphenyls in this area. Tritium above the estimated background level of 3500 pCi/Lsm was detected in three of the five soil boreholes drilled in this area in 1989. Concentrations in this area ranged up to 49,000 pCi/Lsm at 6 ft. Boreholes subsequent to 1989 have detected tritium as high as 2.68×10^6 pCi/Lsm in shallow sediments, but tritium appears not to have reached the water table based on nearby monitor well data. Gross alpha, gross beta, and gamma spectrum results were all within background levels. Plutonium was detected at a concentration of 0.266 pCi/g in a sample at 5 ft from one shallow borehole, but this value is far below the EPA action threshold. Suggested sources include drum racks, the evaporation pit south of Building 514, and solvent spills near Building 513 (Thorpe et al., 1990). No sources remain that have the potential to contribute volatile organic compounds to the ground water.

Building 518 Area

Building 518 was constructed in 1959 for use as a storage dock area for gas cylinders and solvent and oil drums. The facility continues to serve as a storage area and is shown in Figure 4.17-1. Until the 1970s, the area east of Building 518 was unpaved. Anecdotal information indicates that leaking drums were taken to the southeast corner of the facility and allowed to drain onto unpaved ground. The Building 518 site is currently paved and bermed.

Other potential sources include drum rack spills (Dreicer, 1985), a steam cleaning facility, an old oil tank, solvent spills on the asphalt, and a solvent storage area (LLNL, 1989a).

Eighteen soil boreholes were drilled to develop a model of the subsurface distribution of volatile organic compounds in the known area of hazardous material release, and to evaluate the significance of soil vapor survey anomalies detected in the area. Fifteen of these were drilled in and around a major soil vapor survey anomaly in the southern portion of LLNL to also calibrate the soil vapor survey data against soil analyses. Tables 4.17-4 and 4.17-5 show the hazardous constituents identified in this investigation. The maximum volatile organic compound concentration measured here was 6000 ppb at a depth of 20 ft. These results show the site of significant release of trichloroethylene to the vadose zone which probably reached the ground water. These results also show perchloroethylene concentrations diminishing with depth, suggesting that this area is either near or at the perchloroethylene release point, but that the releases were of insufficient volume to reach the water table.

A soil vapor survey anomaly in the eastern portion of the area shows moderate levels of perchloroethylene of relatively small magnitude, which decrease in concentration with depth. Only small amounts of perchloroethylene may have reached the ground water in this area.

Trichloroethylene was the major constituent found in the northern anomaly, and results indicate that the source may be the old drum rack at Building 514. The concentrations generally decreased with depth, suggesting that the volume of trichloroethylene in the area was not sufficient to reach the water table.

There is no evidence of releases of fuels and aromatic hydrocarbons, metals, polychlorinated biphenyls, or tritium above the detection limit in this area.

Building 298—1970s Fire Training Area

Chemicals such as kerosene, gasoline, and jet fuel were used at the 1970s Fire Training Area near Building 298. The likelihood that significant quantities of hazardous materials were released to the subsurface by this activity is relatively low because (1) the operational procedure at this unit was to keep flammable liquids contained in pans, and (2) the combustible material was allowed to burn off before it was wetted down.

The entire 1970s Fire Training Area is considered to be a potential source. Soil and vadose contamination tests revealed trace to low concentrations of trichloroethylene throughout the vadose zone and trace concentrations of other volatile organic compounds (Table 4.17-5). Available data indicate that the presence of halogenated hydrocarbons is unrelated to the activities at the 1970s Fire Training Area.

Selected unsaturated sediments were analyzed for total fuel hydrocarbons; none were detected above the detection limit of 10 ppb (Thorpe et al., 1990). There is no evidence of any release of metals, polychlorinated biphenyls, or radioactive materials in this area. Trace concentrations of benzene were detected. All of these results indicate that no major releases have occurred in this area.

Building 361—Former Fire Training Area

The Building 361 former Fire Training Area has the same characteristics as those described for the northwest Firing Area. This area has been evaluated as part of the West Traffic Circle Area investigation.

Gasoline Spill Area

Between 1952 and 1979, about 17,500 gal of leaded gasoline may have leaked from the southernmost of four 10,000-gal underground fuel tanks near the since-demolished Building 403, located in the south-central part of LLNL (Thorpe et al., 1990). A records inspection indicated an inventory discrepancy of about 17,500 gal from 1952 to 1979, including unrecorded removal of gasoline at the self-serve pump for government vehicles and a leak (or leaks) in the southernmost tank. All four tanks were taken out of service and filled with sand in 1980.

Twenty monitor wells and 17 boreholes were installed to define the vertical and horizontal extent of hydrocarbons in soil and ground water in the Gasoline Spill Area. The vertical and horizontal distribution of fuel hydrocarbons in the vadose and saturated zones of the Gasoline Spill Area is discussed in detail in Dresen et al. (1986), Nichols et al. (1988), and Thorpe et al. (1990). Total fuel hydrocarbons were detected at concentrations up to 1.1 percent (weight/weight), and total aromatic hydrocarbons up to 4.8 percent (weight/weight) were detected in the vadose zone prior to the initiation of remediation efforts (see Tables 4.17-4 and 4.17-5).

Aromatic hydrocarbons in the vadose zone do not appear to have migrated appreciably in any particular direction from the leak point. Therefore, the distribution of benzene, toluene, ethylbenzene, and xylene and other fuel hydrocarbons in the vadose zone resembles a cylinder centered on the spill point, with benzene, toluene, ethylbenzene, and xylene concentrations above 1 ppm limited to an area of less than about 30 to 35 ft from the leak point. The maximum total benzene, toluene, ethylbenzene, and xylene concentration reported in the unsaturated zone was 4800 ppm at a depth of 31 ft (Dresen et al., 1991). Most of the benzene, toluene, ethylbenzene, and xylene concentrations are between 10 ppm and 100 ppm, with a relatively small proportion exceeding 1000 ppm. These are limited to an area about 35 ft from the source (Isherwood et al., 1990). Concentrations decrease to 0.1 ppm within about 40 to 45 ft of the leak point.

An EPA-approved pilot study using vacuum-induced venting is being conducted at LLNL in the Gasoline Spill Area. Over 2200 gal of condensed fuel hydrocarbon vapors have been removed from the vadose zone of the Gasoline Spill Area. Experiments suggest that hot air or steam injection may improve recovery of the fuel. Fuel hydrocarbon vapors have been destroyed by a thermal oxidizer with better than 99.8 percent efficiency.

Building 292 Area

Building 292 (Figure 4.17-1) is used for energy research, and from 1977 to 1987 a rotating target neutron source was used to study the effects of high energy neutrons on various materials. A 1000-gal underground tank (292-R1U1) received rinsewater and washwater from the experiment room floor drains in Building 292.

This underground tank, installed in 1974, was constructed of precast concrete and includes a tank inlet pipe approximately 9 ft underground (Dresen et al., 1991). A precision leak test of the tank and piping was completed in July 1989. When the tank was filled with water during this test, water was discovered leaking at an approximate rate of 180 gals per hour. Once the test water was removed from the tank, an interior inspection showed several possible leak sites. The total amount of tritiated water leakage has never been quantified. On December 23, 1990, a water line inside Building 292 froze and broke, releasing approximately 4000 gal of water. Tritiated water within the tank was removed that evening, and sampling showed 3.7×10^{6} pCi/L tritium in this water (Dresen et al., 1991). An unknown quantity of tritiated water was released to soils surrounding the tank. From January to February 1991, the piping system associated with tank 292-R1U1 was tested for leaks. This testing revealed a potential leak in the piping outside the northeast corner of Building 292.

After the leak was discovered in 1989, unsaturated sediment samples were collected from five boreholes near the tank to a maximum depth of 18 ft. The highest tritium concentration (31,000 pCi/Lsm) was observed on the northern side of the tank, where the effluent pipe joins the tank (Dresen et al., 1991). As of April 15, 1991, 15 boreholes have been drilled and sampled in the Building 292 Area. Three of these boreholes have been converted to piezometers in the uppermost portion of the saturated zone. Depth to ground water in this area is about 47 ft. Table 4.17-4 lists detected soil contaminants at this site. Tritium activities for borehole sediments ranged from not detected to 2.2×10^{8} pCi/Lsm. The highest concentrations are within 10–20 feet of the tank vertically and horizontally (Dresen et al., 1991).

Building 331 Area

Building 331, the Hydrogen Research Facility, is located in the southwest quadrant of the LLNL Livermore site. Building operations began in approximately 1960, continue today and may continue in the future. Research laboratories in this building conduct experiments with hydrogen isotopes, including tritium gases and hydrides. Facility operations include the handling and storage of up to 5 g of tritium, usually in the form of pressurized tritiated hydrogen gas (HT). The Building 331 ventilation system circulates large volumes of air through laboratories and exhausts it through two 100-ft high stacks. Liquid effluent released from Building 331 drains into the sanitary sewer system, where it mixes with other LLNL wastewater.

Two soil profiles from boreholes installed at opposite ends of Building 331, presented by Stone et al. (1982), exhibit similar soil characteristics. Tables 4.17-4 and 4.17-5 list detected soil contaminants in the Building 331 area. The highest tritium concentrations identified in these borehole samples were 24,320 pCi/Lsm and 91,200 pCi/Lsm, at depths of 2 to 3.5 ft and 10 to 12.5 ft, respectively. Relative concentrations decreased with depth, and no soil moisture sample contained tritium greater than the drinking water standard (20,000 pCi/L) at the approximate depth to ground water (80 ft). These soil profiles indicate that tritium has moved from the ground surface to the saturated zone. However, tritium has not been detected in nearby monitor wells (Dresen et al., 1991).

The LLNL Environmental Restoration Division is evaluating the Building 331 Area for additional information about past and current operations. Further investigation of the area, including the historical record searches and possible additional boreholes and soil sampling, will proceed. Continued ground water monitoring will further evaluate the potential for tritium ground water contamination.

Table 4.17-4 Summary of Potential and Detected Soil Contaminants at the LLNL Livermore Site

Areas Investigated[b]	Potential Soil Contaminant[a]					Soil Contaminants Reported at Concentrations Above Detection Limit[c]
	VOC	FHC	Metals	PCB	Rad	
Arroyo Seco Storm Sewer Discharge	Y	Y	Y	Y	N	**VOC:** chloroform, 1,1-DCA, 1-DCE, PCE, TCE, 1,1,1-TCA, **FHC:** B, T, E, X, oil

Area (1)						**Metals:** lead **PCB:** Aroclor-1260
Building 212 Area (2)	Y	Y	Y	Y	N	**VOC:** chloroform, 1,1-DCA, 1,2-DCE, 1,1-DCE, 1,2-DCE, Freon-113, PCE, TCE, 1,1,1-TCA, CCl4, Freon-11, acetone
Building 321 Area (3)	Y	Y	Y	N	N	**VOC:** chloroform, 1,1-DCA, 1,2-DCA, 1,1-DCE, CCl4, Freon-11, 1,1-TCA, PCE, TCE, acetone **FHC:** B, T, E, X
Building 141 Area (4)	Y	Y	Y	N	N	**VOC:** CCl4, chloroform, Freon-113, PCE, TCE, 1,2-DCE, Freon-11, chloroethane, dibromochloromethane **FHC:** B, T, X
West Traffic Circle Area (5)	Y	Y	Y	N	Y	**VOC:** chloroform, 1,1-DCE, Freon-113, TCE, chloroethylene **FHC:** B, T
East Traffic Circle Landfill Area (6)	Y	Y	Y	Y	N	**VOC:** CCl4, chloroform, 1,1-DCA, 1,2-DCA, 1,1-DCE, 1,2-DCE, Freon-11, Freon-113, PCE, 1,1,1-TCA, TCE, acetone, 1,2-dichloropropane **FHC:** B, T, X **PCB:** Aroclor-1260 Aroclor-1254
Taxi Strip (7)	Y	Y	Y	N	Y	**VOC:** Freon-11, Freon-113, PCE, TCE, 1,1-DCE, CCl4, 1,1,1-TCA, chloroform, bromoform, 1,1-DCA, 1,2-DCA **FHC:** B, T, X **Rad:** tritium, plutonium
Eastern Landing Mat Storage Area (8)	Y	Y	Y	Y	N	**VOC:** chloroform, TCE, PCE, 1,1-DCE, 1,1,1-TCA, acetone, Freon-113
Old Salvage Yard (9)	Y	Y	Y	N	N	**VOC:** CCl4, Freon-113, PCE, TCE, chloroform
Building 612 Area (10)	Y	N	Y	N	N	**VOC:** Freon-113, PCE, TCE, 1,1,1-TCA, PCE
Building 514 Area (11)	Y	Y	Y	N	Y	**VOC:** CCl4, chloroform, 1,1-DCA, 1,2-DCA, 1,1-DCE, 1,2-DCE, Freon-113, Freon-11, PCE, 1,1,1-TCA, TCE, fluorobenzene, acetone, methylethyl ketone, dibromochloromethane **FHC:** B, T, E, X **Rad:** tritium, plutonium
Building 518 Area (12)	Y	Y	N	N	N	**VOC:** 1,1-DCE, 1,2-DCE, 1,1-DCA, 1,2-DCA, CCl4, chloroform, Freon-113, Freon-11, acetone, PCE, 1,1,1-TCA, TCE
Building 298 Area (13)	Y	Y	N	N	N	**VOC:** chloroform, 1,1-DCE, Freon-113, 1,1,1-TCA, TCE, 1,2-DCE, dichloromethane **FHC:** B

Building 361 Area (14)	Y	Y	N	N	N	**VOC:** chloroform, 1,1-DCE, Freon-113, 1,1,1-TCA, TCE, Freon-11 **FHC:** B, T, E, X
Gasoline Spill Area (15)	Y	Y	Y	N	N	**VOC:** 1,2-DCE, 1,2-DCA, TCE, ethylene dibromide, CCl4, chloroform **FHC:** B, T, E, X **Metals:** lead
Building 292 Area (16)	N	N	N	N	Y	**Rad:** tritium
Building 331 Area (17)	N	N	N	N	Y	**Rad:** tritium

Y = Potential soil contaminant
N = Not a potential soil contaminant
VOC = Volatile organic compound
FHC = Fuel hydrocarbon constituent
PCB = Polychlorinated biphenyls
Rad = Radiological constituent
CCl_4= Carbon tetrachloride
1,1-DCA = 1,1-Dichloroethane
1,2-DCA = 1,2-Dichloroethane
1,1-DCE = 1,1-Dichloroethene
1,2-DCE = 1,2-Dichloroethene
1,1,1-TCA= 1,1,1-Trichloroethene
PCE = Tetrachloroethene (perchloroethylene)
TCE = Trichloroethene (trichloroethylene)
B = Benzene
T = Toluene
E = Ethylbenzene
X = Xylene

[a] Based upon known or suspected releases, hazardous materials use, storage, or disposal practices strongly suggestive of potential release(s).

[b] See Figure 4.17-1 for area numbers.

[c] For ranges of concentrations for key contaminants and tritium activities detected at each area investigated, see Table 4.17-5.

Table 4.17-5 Summary of the Potential Source Investigations at the LLNL Livermore Site

Areas Investigated	Range[a] of Total VOCs (ppb)	Range of Total Aromatic Hydrocarbons (ppb)	Range of Total PCBs (ppb)	Range of Tritium (pCi/Lsm)[b]	Metals
Arroyo Seco Storm Sewer Discharge Area (1)	Trace–Low	Trace–Low	ND[c]	NA[d]	NA
Building 212 Area (2)	Trace–Very Low	NA	ND	<1000[e]–3800	NA
Building 321 Area (3)	Trace–Low	Trace–Low	NA	<1–3940	<STLC[f]
Building 141 Area (4)	Trace–Very Low	Trace–Very Low	NA	<1000–1400	NA
West Traffic Circle	Trace	Trace–Very Low	NA	<1000–3300	NA

Area (5)					
East Traffic Circle Landfill Area (6)	Trace–Low	Trace–Very Low	Moderate (1 sample)	<1000–3000	<STLC
Taxi Strip Area (7)	Trace–Low	Trace	NA	<1000–3500	NA
East Landing Mat Storage Area (8)	Trace	NA	NA	$<1000–9.4\times10^{4}$	NA
Old Salvage Yard Area (9)	Trace–Very Low	NA	NA	<1000	NA
Building 612 Area (10)	Trace–Low	NA	NA	<1000	NA
Building 514 Area (11)	Trace–Moderate	ND	NA	$<1000–2.68\times10^{6}$	<STLC
Building 518 Area (12)	Trace–High	ND	NA	<1000	NA
Building 298 Area (13)	Trace–Low	Trace	NA	NA	NA
Building 361 Area (14)	Included in West Traffic Circle Area Investigation				
Gasoline Spill Area (15)	Trace–Moderate	Trace–High	NA	NA	>STLC
Building 292 Area (16)	NA	NA	NA	$<200–2.2x10^{8}$	NA
Building 331 Area (17)	NA	NA	NA	$830–4.2x10^{6}$	NA

[a]Trace = <5 ppb.
Very Low = 5–49 ppb.
Low = 50–449 ppb.
Moderate = 500–5000 ppb.
High = > 5000 ppb.

[b]pCi/LSm = picocuries per liter soil moisture.
[c] ND = None detected.
[d]NA = None analyzed.
[e] <1000 = < detection limit.
[f] STLC = Soluble Threshold Limit Concentration.

Note: Concentration ranges and qualifiers (e.g. low, medium, high, etc.) not based on regulatory action levels. See text for discussion of those areas which have been determined, based on site specific risk assessment criteria, to require remediation.
Source: Thorpe et al., 1990; Dresen et al., 1991 (Building 292); Stone et al., 1982 (Building 331).

Table 4.17-6 Estimated Volume and Mass of Volatile Organic Compounds (VOCs) in Unsaturated Sediment

Concentration Range (ppb)	Estimated Sediment Volume[a] (cu yd)	Estimated Total VOC Mass[b] (kg)	Estimated Total VOC Volume (gal)
10–100	2,330,000	92.0	17.3
100–1000	605,000	164	30.9

1000–10,000	8,780	32.6	6.14
>10,000	0	0	0
Totals:[c]	2,940,000	289	54.3

[a] Calculated using interactive volume modeling by Dynamic Graphics Incorporated, Berkeley, California.
[b] Calculated assuming a dry bulk density of 120 lb/ft^3 and 15 percent moisture by weight.
[c] Rounded to three significant figures.

Source: Isherwood et al., 1990.

Table 4.17-7 Key References for LLNL Areas Investigated

Area*	**Key References**
Arroyo Seco Storm Sewer Discharge Area (1)	Dreicer, 1985 Dresen and Hoffman, 1986 Ragaini, 1988 Thorpe et al., 1990 Isherwood et al., 1990
Building 212 Area (2)	Carpenter et al., 1984 Dreicer, 1985 Lindeken, 1987 Yukic et al., 1988 Thorpe et al., 1990
Building 321 Area (3)	EG&G, 1985 Dreicer, 1985 Henry et al., 1987 Yukic et al., 1988 Thorpe et al., 1990
Building 141 Area (4)	Dreicer, 1985 Lindeken, 1987 Graham, 1987; Webster-Scholten et al., 1987 Thorpe et al., 1990
West Traffic Circle Area (5)	Dreicer, 1985 Thorpe et al., 1990
East Traffic Circle Area (6)	Carpenter et al., 1984 McConachie et al., 1986 Graham, 1987 Thorpe et al., 1990
Taxi Strip Area (7)	Stone et al., 1982 Buerer, 1983 Burklund and Raber, 1983 Carpenter et al., 1984 Thorpe et al., 1990

Eastern Landing Mat Storage Area (8)	Dreicer, 1985 Thorpe et al., 1990
Old Salvage Yard Area (9)	Dreicer, 1985 Thorpe et al., 1990
Building 612 Area (10)	Carpenter et al., 1984 Dreicer, 1985 Thorpe et al., 1990
Building 514 Area (11)	Carpenter et al., 1984 Dreicer, 1985 Thorpe et al., 1990
Building 518 Area (12)	Carpenter et al., 1984 Dreicer, 1985 Dresen et al., 1989 Thorpe et al., 1990
Building 298—1970s Fire Training Area (13)	Thorpe et al., 1990
Building 361—Former Fire Training Area (14)	Thorpe et al., 1990
Gasoline Spill Area (15)	Carpenter et al., 1984 O.H. Materials Co., 1985a, 1985b, 1985c Weiss Associates, 1985a, 1985b Dresen et al., 1986 Nichols et al., 1988 Thorpe et al., 1990 Isherwood et al., 1990
Building 292 Area (16)	Thorpe et al., 1990 Dresen et al., 1991
Building 331 Area (17)	Stone et al., 1982

* See Figure 4.17-1 for area numbers.

4.17.2.3 Ground Water Contamination—LLNL Livermore Site

This section summarizes the vertical and horizontal extent of volatile organic compounds, trace elements, and radionuclides in the LLNL Livermore site area ground water (Isherwood et al., 1990; Dresen et al., 1991). Contaminants from the 17 soil and sediment contamination areas investigated at the LLNL Livermore site that contribute to the ground water contamination are shown in Table 4.17-8. Maximum contaminant levels (MCLs) and state discharge limits for compounds of concern in ground water at the LLNL Livermore site are shown on Table 4.17-9.

Volatile Organic Compounds in Ground Water

The following sections summarize the horizontal and vertical distribution of volatile organic compounds in the LLNL Livermore site and vicinity ground water. A summary of the potential human health risks associated with this contamination can be found in sections 4.16 and 4.19 and Appendix C.

Ground water beneath and near the LLNL Livermore site is currently monitored on a quarterly basis through a network of over 325 monitoring wells and piezometers located both on- and offsite. Ground water monitoring and remedial assessments are currently conducted under DOE Environmental Restoration and LLNL Environmental Protection Division programs.

Horizontal Distribution of Total Volatile Organic Compounds

The distribution of total volatile organic compounds detected in ground water at concentrations above drinking water standards (Thorpe et al., 1990) in the LLNL Livermore area is shown in Figure 4.17-5. Total volatile organic compounds are defined by LLNL as the sum of perchloroethylene, trichloroethylene, 1,2-dichloroethylene, 1,1-dichloroethylene, 1,1,1-trichloroethane, 1,2-dichloroethane, 1,1-dichloroethylene, carbon tetrachloride, and chloroform.

Volatile organic compounds occur in ground water beneath about 85 percent of the 1.4-square-mile LLNL Livermore site. Several overlapping smaller plumes, each with separate origins, make up the large composite plume. The largest of these is a plume about 4000 ft long and 2500 ft wide, the leading edge of which has migrated about 2500 ft west of Vasco Road from a release point in the southwest area.

The highest concentration of total volatile organic compounds detected in ground water samples collected in February 1991 was 5808 ppb, in the southeastern part of the LLNL Livermore site. Total volatile organic compound concentrations exceed 1000 ppb in three other areas: west of the East Traffic Circle Area, the Eastern Landing Mat Area Taxi Strip Area, and northwest of the LLNL Livermore site (north of the Patterson Pass–Vasco Road intersection), where 2700 ppb of trichloroethylene was reported in March 1991 (Iovenitti et al., 1991). Existing data suggests the source of the volatile organic compound contamination in the northwest corner of the LLNL Livermore site is located offsite (Dresen et al., 1991). Total volatile organic compounds exceed 1000 ppb in only 8 out of 324 LLNL-sampled monitor wells (Dresen et al., 1991).

Other than in the immediate vicinities of the 1000-ppb "hot spots" (see Figure 4.17-5), total volatile organic compound concentrations in excess of 100 ppb occur in the western part of the LLNL Livermore site, in the southwest corner, in the West Traffic Circle Area, and in the southeast corner near Building 518.

Horizontal Distribution of Individual Volatile Organic Compounds

Volatile organic compounds occur in ground water beneath about 85 percent of the 1.4-sq-mi LLNL Livermore site in diffuse plumes. However, the calculated volume of volatile organic compounds in the ground water is less than 200 gal (Isherwood et al., 1990).

Trichloroethylene, the most common volatile organic compound at the LLNL Livermore site, is present in 158 of 259 monitor wells, and is found in concentrations up to 4800 ppb (Thorpe et al., 1990). This concentration is the highest recently detected for any single volatile organic compound (excluding fuel hydrocarbons) at the LLNL Livermore site. Trichloroethylene is migrating west of the LLNL Livermore site from the southwest corner and west-central areas.

Perchloroethylene plumes occur in the eastern part of the LLNL Livermore site and in the southwest corner and offsite area. In addition, several other small, low-concentration perchloroethylene plumes occur in the study area (Thorpe et al., 1990).

There are at least two overlapping perchloroethylene plumes in the eastern part of the LLNL Livermore site. The highest concentration of perchloroethylene in ground water occurs in the Landing Mat Storage Area and in the southwest corner of the LLNL Livermore site. The persistence of perchloroethylene near the suspected release site may result from the relatively high sorptive capacity of fine-grained sediments. Perchloroethylene has migrated about 4000 ft west-northwest from the southwest corner of the LLNL Livermore site, generally following Arroyo Seco. Plumes with concentrations exceeding 100 ppb extend about 3300 ft northwest and show a strong alignment with Arroyo Seco, reflecting the prevalent ground water flow direction. Former discharges from storm sewers into Arroyo Seco were probably the major source of perchloroethylene, which is found in concentrations as high as 97 ppb in unsaturated soil at the Arroyo Seco storm sewer discharge area (Thorpe et al., 1990).

Vertical Distribution of Volatile Organic Compounds

In the saturated zone, downward vertical gradients exist over much of the site; however, the lithologic conditions prevent significant downward migration of volatile organic compounds (Isherwood et al., 1990).

Soil borings were drilled in areas of high (typically greater than 100 ppm) soil vapor total volatile organic compound concentrations. Sediment samples were collected at 10-ft increments down to the saturated zone (Thorpe et al., 1990). Total volatile organic compound concentrations exceeding 1 ppm in unsaturated sediment occur only near Building 518, in the southeast corner of the LLNL Livermore site, where a total volatile organic compound concentration of 6 ppm was measured at a depth of about 20 ft (Isherwood et al., 1990). Unsaturated zone total volatile organic compound concentrations from other potential source areas ranged from below 5 ppb to below 500 ppb. However, total volatile organic compound concentrations up to 800 ppb were reported for the unsaturated zone beneath the East Traffic Circle Area (Isherwood et al., 1990).

Of the 325 LLNL monitor wells and piezometers, only 10 are completed below a depth of 200 ft although many were drilled deeper for sampling purposes and then grouted back to shallower depths. Of these 10, only 3 wells contain volatile organic compounds: one in the Southeast Corner Area and two on DOE property southeast of the Vasco Road–East Avenue intersection. In these three wells, only the monitor well located near the Vasco Road–East Avenue intersection (MW-462) contained perchloroethylene in excess of the maximum contaminant level, with a concentration of 13 ppb. Here, perchloroethylene and 1,1-dichloroethylene were detected above the maximum contaminant levels at depths between 331 and 336.5 ft.

At greater distances from the sources, volatile organic compounds are limited to the more permeable deposits, which generally contain higher concentrations, and to some of the fine-grained sediments next to the coarse sediments. The plumes are about 30 ft to 100 ft thick, and volatile organic compounds are seldom found below a depth of 200 ft (Thorpe et al., 1990). Existing data indicate that beginning several hundred feet downgradient from the contaminant plume source area, volatile organic compounds do not extend into the fine-grained sediments more than about 5 ft from the coarser, more permeable layers. This is consistent with transport dominated by advection (volatile organic compound migration by the bulk flow of ground water) in the higher permeability sediments. Diffusion appears to play a secondary role in volatile organic compound transport at LLNL. Specifically, these preliminary data suggest that diffusion is responsible for vertical migration on the order of tens of feet in the offsite perchloroethylene plume. In the same plume, constituents are dispersed horizontally for hundreds of feet.

Fuel Hydrocarbon Compounds (FHCs) in Ground Water

Ground water samples from over 300 monitor wells, piezometers, and private wells have been analyzed for fuel hydrocarbon compounds including gasoline, diesel, some fuel oils, and aromatic hydrocarbons (benzene, toluene, ethylbenzene, and xylene). These analyses show that fuel hydrocarbon compounds are generally restricted to the Gasoline Spill Area in the south central area of the LLNL Livermore site.

Ground water from three monitor wells outside the Gasoline Spill Area was reported to contain benzene at concentrations up to 4.0 ppb, which is greater than the 1.0 ppb maximum contaminant level. Subsequent sampling in two of these monitor wells revealed no detectable benzene concentrations. Similarly, no benzene has been reported for the remaining monitor wells outside the Gasoline Spill Area. Toluene, total xylenes, and ethylbenzene, above their action levels of 100 ppb, 1750 ppb, and 680 ppb, respectively, were not detected in ground water outside the Gasoline Spill Area.

In the Gasoline Spill Area, total fuel hydrocarbons occur at concentrations of 1.0 ppb to approximately 300 ft from Building 403 (Figure 4.17-6). Total fuel hydrocarbon concentrations exceeding 10 ppm are restricted to the immediate vicinity of the gasoline leak point (see Figure 4.17-6) just southeast of Building 403 (Thorpe et al., 1990). Ground water concentrations of benzene, toluene, ethylbenzene, and xylene in the Gasoline Spill Area between 10 and 100 ppm are restricted to a small area near the probable gasoline leak point. Total benzene, toluene, ethylbenzene, and xylene ground water concentrations between 1.0 ppm and 10 ppm extend up to 300 ft away from the leak point. The vertical extent of fuel hydrocarbons and benzene, toluene, ethylbenzene, and xylene in ground water was investigated by sampling three deeper monitor wells in the Gasoline Spill Area at intervals greater than 155 ft. Ground water samples from these monitor wells identified fuel hydrocarbons and benzene, toluene, ethylbenzene, and xylene compounds below maximum contaminant or action levels (Thorpe et al., 1990).

Trace Elements in Ground Water

Total chromium was detected above maximum contaminant levels (see Tables 4.17-8 and 4.17-9). Total chromium concentrations exceed the maximum contaminant level (50 ppb) in 16 wells (Dresen et al., 1991), as shown in Figure 4.17-7. Evidence suggests that some chromium occurs naturally in the LLNL area; however, additional chromium (in the hexavalent state) may have entered the ground water from discharges of corrosion inhibitors and biocides used in the early 1970s in cooling-tower piping. Of the onsite monitor wells containing chromium above the California drinking water standard, four are near a north-flowing drainage channel east of the West Traffic Circle (see Figure 4.17-1). One additional well is located in the southeast corner of the LLNL Livermore site, close to a storm sewer around the perimeter of Building 511 that may have received blowdown water from the cooling tower at that facility.

Although data are limited, four other trace elements—barium, cadmium, selenium, and silver— possibly exceed maximum contaminant levels. Of these, cadmium and selenium have occurred above the maximum contaminant level only once. The four metals, to a very limited extent, exist in LLNL Livermore site area ground water (see Table 4.11-2) and are probably not the result of present or past LLNL activities. Two additional trace metals (iron and manganese) occur at levels above EPA secondary drinking water standards. These metals, natural constituents of most ground water, do not appear to be related to present or past LLNL activities. Lead concentrations exceeded the maximum contaminant level in two monitor wells, both in the Gasoline Spill Area where leaded gasoline leaked. Recent analyses show lead below the maximum contaminant level.

Radionuclides in Ground Water

Since 1984, ground water from 187 wells has been analyzed for radionuclides. Gamma emission measurements for ground water samples from 38 wells from 1984 to 1988 indicated no gamma-emitting radionuclides above background levels. Tritium is the only radionuclide present in ground water in concentrations that exceed regulatory limits (LLNL, 1990c).

Tritium contamination greater than the maximum contaminant level of 20,000 pCi/L for tritium has been detected in only two monitor wells, both located in the southeast quadrant of the LLNL Livermore site. Boreholes in that area have measured tritium activities as high as 105,000 pCi/L. Currently, tritium activities in water samples from only one of these wells (MW-206) located in the East Taxi Strip Area exceed the tritium maximum contaminant level (see Figure 4.17-7) (Dresen et al., 1991). The source of this tritium was apparently leakage from one of the former evaporation ponds in the East Taxi Strip waste storage area (Buerer, 1983).

Tritium has been detected at activities as high as 7700 pCi/L in ground water near an underground tank leak near Building 292. To date, all ground water samples collected near Building 292 have tritium activities below 20,000 pCi/L (Dresen et al., 1991).

Polychlorinated Biphenyls and Pesticides in Ground Water

No polychlorinated biphenyls or pesticides have been detected in ground water at LLNL, Livermore. From 1984 to 1989, ground water from 153 monitoring and private wells were analyzed for polychlorinated biphenyls and pesticides using EPA methods with detection limits ranging from 0.05 to 1.0 ppb. Although transformers containing polychlorinated biphenyls were buried in the former East Traffic Circle Landfill, these were removed during the excavation and cleanup of that area, and no polychlorinated biphenyls have been detected in LLNL ground water.

Table 4.17-8 Summary of Potential and Detected Ground Water Contaminants at the LLNL Livermore Site

	Potential Ground Water	

Areas Investigated[b]	Contaminant[a]					Water Contaminants Detected at Concentrations or Activities Above Maximum Contaminant Level
	VOC	FHC	Metals	PCB	Rad	
Arroyo Seco Storm Sewer Discharge Area (1)	Y	Y	Y	Y	Y	**VOC:** CCl4, 1,1-DCA, 1,1-DCE, 1,2-DCE, PCE, TCE **Metal:** chromium
Building 212 Area (2)	Y	Y	Y	Y	Y	**VOC:** CCl_4, 1,1-DCA, 1,1-DCE, PCE, TCE, 1,2-DCA
Building 321 Area (3)	Y	Y	Y	N	Y	**VOC:** TCE, PCE, 1,1-DCE, CCl4
Building 141 Area (4)	Y	Y	Y	N	Y	**VOC:** CCl_4, PCE, TCE
West Traffic Circle Area (5)	Y	N	Y	N	Y	**VOC:** chloroform, 1,1-DCE, TCE, 1,2-DCE, **Metal:** chromium
East Traffic Circle Area (6)	Y	Y	Y	Y	Y	**VOC:** CCl_4, chloroform, 1,1-DCA, 1,2-DCA, 1,1-DCE, 1,2-DCE, TCE, PCE
Taxi Strip (7)	Y	Y	Y	N	Y	**VOC:** CCl_4, chloroform, 1,1-DCA, 1,2-DCA, 1,1-DCE, PCE, TCE **Rad:** tritium
Eastern Landing Mat Storage Area (8)	Y	Y	Y	Y	Y	**VOC:** 1,1-DCA, 1,1-DCE, 1,2-DCE, PCE, 1,1,1-TCA, TCE
Old Salvage Yard (9)	Y	Y	Y	N	N	**VOC:** CCl_4, 1,2-DCA, 1,1-DCE, 1,2-DCE, PCE, TCE
Building 612 Area (10)	Y	N	Y	N	Y	**VOC:** CCl_4, 1,1-DCE, TCE
Building 514 Area (11)	Y	Y	Y	N	Y	**VOC:** CCl_4, 1,1-DCA, 1,2-DCA, 1,1-DCE, 1,2-DCE, PCE, TCE
Building 518 Area (12)	Y	Y	N	N	N	**VOC:** CCl_4, 1,1-DCE, 1,2-DCE, PCE, TCE
Building 298 Area (13)	Y	Y	N	N	N	**VOC:** 1,1-DCE, TCE
Building 361 Area (14)	Y	Y	N	N	N	**VOC:** 1,1-DCE, TCE
Gasoline Spill Area (15)	Y	Y	Y	N	N	**VOC:** 1,2-DCE, 1,2-DCA, ethylene dibromide, CCl_4 **Metal:** cadmium **FHC:** B, T, E, X
Building 292 Area (16)	N	N	N	N	Y	None identified
Building 331 Area (17)	N	N	N	N	Y	**Rad:** tritium

Y = Potential soil contaminant
N = Not a potential soil contaminant
VOC = Volatile organic compound
FHC = Fuel hydrocarbon constituent
PCB = Polychlorinated biphenyls

1,1-DCE = 1,1-Dichloroethene
1,2-DCE = 1,2-Dichloroethene
1,1,1-TCA= 1,1,1-Trichloroethene
PCE = Tetrachloroethene (perchloroethylene)
TCE = Trichloroethene (trichloroethylene)

Rad = Radiological constituent
CCl_4= Carbon tetrachloride
1,1-DCA = 1,1-Dichloroethane
1,2-DCA = 1,2-Dichloroethane

B = Benzene
T = Toluene
E = Ethylbenzene
X = Xylene

[a] Based upon known or suspected releases or hazardous materials use, storage, or disposal practices strongly suggestive of potential release(s).

[b] See Figure 4.17-1 for area numbers.

Table 4.17-9 MCLs and State Discharge Limits for Compounds of Concern in Ground Water at the LLNL Livermore Site

Concentration Limit for Drinking Water[a]					
Constituent	**Non-zero Federal MCLG (ppb)**	**Federal MCL (ppb)**	**CA MCL (ppb)**	**Concentration range at LLNL March 1990—1991 (ppb)**	**Discharge Limit for Treated Water**
PCE	---	5[c]	5	<0.1–1,050	4
TCE	---	5	5	<0.1–4,800	5
1,1-DCE	7	7	6	<0.5–370	5
cis-1,2-DCE	70[c]	70[c]	6	<0.5–24	5 (total 1,2-DCE)
trans-1,2-DCE	100[c]	100[c]	10	<0.5–1	5 (total 1,2-DCE)
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 THMd	---	100[d]	100[d]	<0.5–270	5
Benzene	---	5	1.0[e]	<0.1–4,600	0.7
Ethyl benzene	---	700	680	<0.2–610	5
Toluene	2,000[c]	1,000[c]	100[c,f]	<0.5–4,200	5
Xylenes (total)	10,000[c]	10,000[c]	1,750[g]	<0.5–3,700	5
Ethylene dibromide	---	0.05[c]	0.02	<0.1–51	5
Total VOCs	---	---	---	up to 5,808	5

Chromium^{+3}[h]	100[c] (total)	50[h] (total)	50 (total)	<5–150 (total)	50 (total Cr)
Chromium^{+6}[h]	100[c] (total)	50[h] (total)	50 (total)	<10–140	11
Lead	---	15[i]	50	<2–10	5.6
Tritium[j]	---	20,000 pCi/L	20,000 pCi/L	<200–33,100 pCi/L	---[k]

[a] Human receptor. The limits on this table were established through negotiations with regulatory agencies and will be in full effect for 5 years. After 5 years LLNL will comply with the most stringent MCL requirements.

[b] From NPDES Permit No. CA0029289 (revised 8/1/90) and RWQCB Order No. 90-106. VOC-specific state discharge limits exist in RWQCB Order No. 90-106 only for PCE (4 ppb) and benzene (0.7 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.

[c] These are proposed values, which means they are not enforceable by law.

[d] Total trihalomethanes; includes chloroform, bromoform, chlorodibromomethane, and bromodichloromethane.

[e] The DTSC AAL for benzene is 0.2 ppb.

[f] California Department of Health Services Action Level.

[g] MCL is for either a single isomer or the sum of the ortho, meta, and para isomers.

[h] National Interim Primary Drinking Water Regulation for total chromium is 50 ppb.

[i] National Primary Drinking Water Regulation Enforceable Action Level (Federal Register, volume 56, number 110, June 7, 1991.

[j] Thorpe et al., 1990, show that ground water in the one well that currently exceeds the tritium MCL will be naturally remediated long before it migrates offsite.

[k] There is currently no NPDES discharge limit for tritium. LLNL will use the MCL for tritium as the discharge limit.

Note: Because non-zero Federal MCLGs (Maximum Contaminant Level Goals) are equal to Federal MCLs in all cases above, these are referred to simply as MCLs throughout this document.
Source: Dresen et al., 1991

4.17.2.4 Site Characterization and Remediation Efforts

Geologic, seismologic, and hydrologic investigations were initiated as early as 1979 at the LLNL Livermore site and nearby areas. Since that time, numerous reports have documented the results of ongoing investigations. Based upon these investigations, remediation activities have been implemented. Examples of such investigations are as follows:

- In 1979, a fuel leak was discovered in the area of Building 403, the Gasoline Spill Area, in the southern part of the LLNL Livermore site. In 1985, this was the subject of several reports. These reports discussed investigations into the fuel leak and possible remedial actions. Additionally, wells west of the site were evaluated to determine whether any interaquifer cross-connection existed (Dresen and McConachie, 1986). To evaluate the integrity of underground tanks onsite, the tanks were tested, and findings were reported (Henry et al., 1986).
- In 1982, a hydrogeologic investigation to determine the likelihood of contaminant movement to the saturated zone from near the ground surface at the LLNL Livermore site was completed (Stone et al., 1982). The investigation included a survey of potential contaminant sources and identified several potential sources. The study concluded that the migration of contaminants from the vadose zone to the saturated zone beneath the site was likely.

- In 1983, documentation of the assessment and cleanup in the Taxi Strip waste storage area (see Figure 4.17-1) was prepared (Buerer, 1983). The earlier work of Stone et al. (1982) was extended by further evaluation of the potential for ground water contamination (Stone and Ruggieri, 1983).
- In 1987, reports evaluated possible releases of volatile organic compounds to ground water from the following areas: the Taxi Strip and Old Salvage Yard areas, the Southwest Corner and the Arroyo Seco area, and the remainder of the site (Webster-Scholten et al., 1987).
- Twenty-three wells historically affected by or potentially affected by the contaminant plume(s) were taken out of service. Some of the properties containing the wells were acquired by DOE in 1987. In other cases, affected residences were connected to the municipal water system by LLNL. The wells were permanently sealed between 1984 and 1989 to eliminate the potential for the wells to act as conduits for the migration of contaminants (Thorpe et al., 1990).
- In 1988, a proposal was prepared to conduct pilot ground water and soil vapor extraction and treatment in the Gasoline Spill Area (Nichols et al., 1988). This proposal evaluated potential remediation strategies for cleanup of the gasoline leak. Qualheim (1988) provided a compilation of all hydrogeologic well logs prepared through 1987 for the Ground Water Project.

Soil and ground water monitoring continue to the present, and two pilot studies are being conducted in the southwestern corner of the LLNL Livermore site and gasoline spill areas (Isherwood et al., 1990).

The Remedial Investigation (Thorpe et al., 1990) performed at the LLNL Livermore site characterized the contamination at each potential source area and throughout the ground water underlying LLNL (DOE, 1989c). For the Remedial Investigation, source characterization included the onsite and offsite areas identified in the Federal Facility Agreement, but ground water investigations were performed sitewide. LLNL prepared a feasibility study to evaluate and select alternative technologies for remediation of hazardous materials in the LLNL Livermore site subsurface (Isherwood et al., 1990). The Feasibility Study (Isherwood et al., 1990), and more recently the Proposed Remedial Action Plan (Dresen et al., 1991), summarize the recommended alternatives to the LLNL Livermore site sediment and ground water remediation.

Table 4.17-10 identifies the schedule of tasks and compliance dates associated with the LLNL Livermore site remediation. The schedule has been periodically renegotiated based on changing needs and requirements. As of June 1991, the following environmental restoration activities had taken place (LLNL, 1991f; Dresen et al., 1991):

- Taxi Strip Impoundments—Removed soil and cleaned up area.
- East Traffic Circle Landfill—Removed waste and cleaned up area.
- Polychlorinated biphenyls–Containing Units—Remedied affected areas, removing 11 transformers, 12 capacitors, and miscellaneous switch gear.
- Leaking Tanks—Removed 17 tanks and cleaned up affected areas.
- Community Relations Plan—Submitted final plan to regulatory agencies.
- Community Relations Group—Established work group with regularly scheduled meetings and a quarterly publication to keep members informed.
- Quality Assurance Project Plan—Submitted final plan to regulatory agencies.
- Work Plan for Remedial Investigation/Feasibility Study—Submitted final plan to regulatory agencies.
- Baseline Public Health Assessment—Submitted report to regulatory agencies.
- Southwest/Offsite Areas and Gasoline Spill Area—Began Pilot Studies.
- Potential Conduit Wells—Destroyed and sealed 19 wells to prevent vertical migration of contaminants.
- Remedial Investigation Report—Submitted final report to regulatory agencies.
- Installed Monitor Wells—More than 300 wells drilled, sampled, and flow-tested.
- Feasibility Study Report—Submitted draft of final report to regulatory agencies.
- Pilot Studies—Two treatment facilities have been installed to remove volatile organic compounds from the ground water using an ultraviolet-light/hydrogen-peroxide system to oxidize halogenated hydrocarbons. Gas venting system installed to remove hydrocarbons from the unsaturated zone at the Gasoline Spill Area.
- Draft Proposed Remedial Action Plan—Submitted to regulatory agencies.

Additionally, quarterly ground water quality assessments have been performed since 1983. As a result, all tasks identified in the Federal Facility Agreement have been performed, or documentation has been submitted in draft form on schedule. Full remedial actions are pending following public and regulatory reviews, and are expected to be phased in over 2 to 3 years.

Table 4.17-10 Schedule of Tasks, Compliance Dates, and Reports Documenting Environmental Compliance at the LLNL Livermore Site

Document	Deadlines/Target Dates
RI/FS Work Plan[a]	Draft submitted 10/28/88 Final submitted 5/8/89
Quality Assurance Project Plan[a]	Draft submitted 5/25/88 Final submitted 1/11/89
Community Relations Plan[a]	Draft submitted 10/26/88 Final submitted 5/12/89
Remedial Investigation Report[a]	Draft submitted 12/1/89 Final submitted 3/14/90
Feasibility Study Report[a]	Draft submitted 8/1/90 Final submitted 12/17/90
Proposed Remedial Action Plan[a]	Draft Final submitted 6/24/91
Record of Decision[a]	3/1/92
Remedial Action Implementation Plan[a]	10/1/92
Remedial Design[a]	6/1/92
Baseline Public Health Risk Assessment[b]	Draft submitted 6/15/89 Final submitted in Remedial Investigation Report 3/14/90
Monthly Reports	Monthly, within 30 days of the end of the reporting period
Annual Reports	Annually, by January 31 of the following year

[a] Source document.

[b] Secondary document.

Source: Isherwood et al., 1990; updated 8/2/91.

4.17.2.5 Proposed Remedial Actions and Potential Impacts of Remediation

Several approaches to cleaning up ground water and unsaturated sediment contamination were evaluated in the Feasibility Study (Isherwood et al., 1990) and in the Proposed Remedial Action Plan (Dresen et al., 1991). The reports present viable cleanup options for the types of contamination in different parts of the site. The Remedial Investigation (Thorpe et al., 1990), Feasibility Study (Isherwood, 1990), and Proposed Remedial Action Plan (Dresen et al., 1991) are being submitted as an Environmental Assessment (EA) under NEPA in accordance with DOE's NEPA/CERCLA integration procedures.

Proposed Remedial Actions

LLNL and DOE believe that the following alternatives best meet the criteria established by the EPA:

- Ground water extraction at 18 locations throughout the contaminated area, including source areas, to stop further contaminant migration and achieve the shortest cleanup schedule. Ground water would be treated at seven treatment facilities, four of which would use ultraviolet light and oxidation as the primary treatment process. The remainder would use air stripping as the primary treatment process. Treated water would be returned to the subsurface or used at the LLNL Livermore site. After approximately 50 years, residual ground water contaminants would be reduced to levels below maximum contaminant levels. The present-worth cost of this alternative is estimated to be $103 million.[(3)]
- Vacuum-induced vapor withdrawal from the unsaturated zone with surface treatment of vapors by thermal or catalytic oxidation (Building 518 Area, Gasoline Spill Area). Cleanup of unsaturated sediment would be complete in about 10 years. The present-worth cost of this alternative is $1.84 million.

All extraction wells and treatment facilities, except one proposed extraction location in the Rhonewood subdivision area west of the LLNL Livermore site, would be located on LLNL property and would result in little or no impact to the neighboring community. This extraction alternative would involve pumping and treating at a combined rate of about 360 gals per minute. Extracted ground water would be piped in double-walled pipe to one of the treatment facilities, and then to one or more of the following:

- Existing recharge basin at SNL, Livermore
- Drainage retention basin at the LLNL Livermore site
- Recharge well network
- Storm drainage ditches
- Cooling towers

LLNL is currently conducting two EPA-approved pilot studies within the context of the CERCLA processes (Isherwood et al., 1990). The Offsite Pilot Study located in the Southwest corner of the LLNL Livermore site is evaluating the effectiveness of a test extraction well design, an ultraviolet light/hydrogen peroxide (UV/H2O2) water treatment system, and a basin to recharge treated ground water. The Gasoline Spill Pilot Study, in the southern part of the LLNL Livermore site, is currently evaluating the feasibility of venting and treating fuel hydrocarbon compounds (i.e., gasoline) from the unsaturated zone, and from a portion of the saturated zone after it is dewatered. The pilot studies have played an integral role in assessing the effectiveness of the various remedial strategies and have accelerated the timetable for beginning remedial action. Over 32 million gal of ground water have been extracted and treated to date, resulting in significant declines in volatile organic compound concentrations in source areas.

Environmental Impacts of Remediation

Ground water

As a result of the recommended pump and treat method, the volatile organic compound plume will be intercepted and cleaned up to applicable or relevant and appropriate requirements, eventually allowing ground water already affected to be remediated and preventing loss of ground water beneficial uses elsewhere. The recommended alternative expedites ground water remediation by situating extraction wells in all areas of high volatile organic compound concentration, as well as at plume margins, thereby minimizing the time necessary to complete remediation.

For areas in which both volatile organic compounds and tritium occur above maximum contaminant levels in ground water (such as in the East Taxi Strip Area), volatile organic compounds would be reduced below discharge limits through the proposed extraction treatment alternative. LLNL plans to design the extraction systems to prevent tritium concentrations above the maximum contaminant level from exiting the treatment system.

In order to mitigate potential releases of tritium to the environment from a ground water treatment plant, LLNL will shut down any treatment system if discharges to the environment exceed the maximum contaminant levels for tritium.

Similarly, LLNL Livermore will shut down any treatment system that emits tritium to the atmosphere at a rate predicted to cause exposure of greater than 10 millirem (mrem) per year according to the Federal Standard in the Clean Air Act (Dresen et al., 1991). Water vapor containing tritium extracted from affected unsaturated soils would be separated by condensation, and if the condensate were to exceed the maximum contaminant levels for tritium, it would be disposed of appropriately (Dresen et al., 1991).

Proposed methods of disposal of treated water would beneficially use most of the treated ground water through recharge basins, wells, surface water, channels, or landscape irrigation. In 1988, LLNL constructed a recharge basin south of East Avenue on DOE property to investigate the feasibility of conserving the local ground water resource by surface recharge. The recharge basin has performed very effectively, with an estimated 92 to 98 percent of the treated water recharged. Over 12.5 million gal of treated water have been discharged to the recharge basin (Isherwood et al., 1990). The potential effects of water level decline during the long-term pumping (e.g., from 18 extraction wells and from local agricultural and domestic wells) are currently being evaluated using the ground water computer code CFEST. Results of these modeling efforts are pending.

Proposed surface discharge points at the LLNL Livermore site include a ditch running northward along Vasco Road, which drains to Arroyo Las Positas, and the Drainage Retention Basin located in the center of the LLNL Livermore site. Although increased flow would occur from the LLNL Livermore site into Arroyo Las Positas, most of the water is expected to infiltrate the floor of the Arroyo within 1000 ft of the discharge point (Dresen et al., 1991). Water discharged to the surface during the rainy season may increase flows in local drainage channels. Such increased flows would likely be minor, but they could result in increased intermittent flow to Arroyo Seco and Arroyo Las Positas. Minor adverse impacts could occur to the ground water resource and to wetland habitats and associated biota as a result of either surface water quality degradation or flooding.

Water will be tested before release to surface water as prescribed for the LLNL Livermore site by NPDES permits and Regional Water Quality Control Board waste discharge requirements. Use of treated ground water for irrigation, and perhaps for release to downstream habitats, may require some dilution of salts. In order to mitigate this potential secondary impact, some mixing of treated ground water with runoff water could be required (i.e., Hetch Hetchy water) (Isherwood et al., 1990).

Monitoring of all surface water bodies at LLNL Livermore site and vicinity, including seeps, springs, lakes, retention ponds, streams, and ditches, will continue under the environmental restoration and environmental protection monitoring programs. The surface water samples are currently analyzed for gross alpha and beta radiation, tritium, and nonradioactive pollutants including various solvents, metals, and pesticides (see section 4.11).

In order to assure that no adverse impacts would occur due to recharge activities, proposed recharge locations have been selected away from known unsaturated zone contamination. They are in areas remote from septic tanks, leachfields, basements, and agricultural operations and at strategic locations with respect to proposed extraction well fields. Water levels will continue to be monitored in recharge areas to assist in determining allowable pumping and recharge volumes.

In addition to the ongoing water level monitoring programs at the LLNL Livermore site and in the vicinity, the Alameda County Flood Control and Conservation District Zone 7 currently monitors both water quality and levels in wells upgradient and downgradient of the LLNL Livermore site, thereby providing an additional means for evaluating any local adverse impacts to the eastern Livermore ground water basin.

Extraction of ground water will cause local aquifer drawdown in the areas surrounding the extraction wells (Isherwood et al., 1990). The magnitude of the impact to local and regional water level conditions is currently not known; however, based on the total estimated flow for proposed ground water extraction programs (Isherwood et al., 1990) and estimates of ground water use in the LLNL Livermore site area, it is unlikely that municipal water supply wells would be impacted (see section 4.19). Local existing water supply wells that are screened above 200 ft could be significantly impacted in the southwest portions of the LLNL Livermore site. Furthermore, individual wells could be affected locally by one or more extraction wells because of interfering cones of influence. Additionally, the effect of remedial pumping on water quality in local water supply wells as a result of long-term pumping is not fully known.

Recently, modeling efforts by LLNL indicate that drawdown in local wells may be as much as 10 ft; additional modeling of potential drawdown effects is currently in progress (Dresen et al., 1991).

Water levels in the vicinity of the LLNL site continue to decline as a result of drought conditions. Cumulative impacts could result from the combined additive effect of water level declines due to drought conditions, from remedial ground water extraction and from local domestic or agricultural pumping. Lower water levels could further limit the effectiveness of remedial pumping by extending the time required for cleanup, particularly if further development of irrigation water sources occurs, such as south of East Avenue.

Excessive ground water pumping that causes lowered ground water levels could potentially result in the consolidation of dewatered sediments and consequent land subsidence. Unlike the subsidence problems noted in the San Joaquin and Santa Clara valleys, where over 10 ft of subsidence has been observed, subsidence from ground water withdrawal has not been noted to be a problem in the Livermore-Amador Valley area (WESCO, 1988). Therefore, land subsidence due to pumping is unlikely.

Soils

Vacuum-induced soil venting coupled with air monitoring and continued ground water monitoring is the preferred remedial action alternative at the Building 518 and Gasoline Spill Area. Soil gas extraction would greatly reduce the levels of volatile organic compounds in the soil, thereby reducing the potential for future ground water contamination. This alternative involves installing a soil gas extraction system in the soil contaminated area to remove volatile organic compounds and fuel hydrocarbon compounds. Extracted volatile organic compounds in the gaseous phase will be monitored to ensure compliance with air emission requirements. Fuel hydrocarbons in the gaseous phase would be catalytically oxidized.

No impacts to human health are anticipated from the gaseous release of volatile compounds to health-based or environmental regulatory standards. The potential health hazard due to accidental emissions is minimal. Onsite air monitoring will ensure that no health risks occur during the remediation. Granular activated carbon would be generated during the soil gas removal program that would be required to be removed to an offsite treatment storage and disposal facility.

Installation of soil vapor extraction wells would result in a minor disruption and replacement of soil, which is not considered significant. Automatic shut-off mechanisms would be installed on the system if an accidental release were to occur. Vacuum pumps that would be used for vapor extraction might generate noise levels to approximately 70 dBA. However, these pumps would be housed in buildings that would muffle this noise to below 50 dBA. Noise is not considered a significant impact.

Each impact would have a minor cumulative effect that would be added to this already industrialized site. All air permitting requirements would be followed to ensure that no significant impact to the environment would occur. Additionally, all other contributions to impacts are considered not significant.

4.17.3 Site Contamination—LLNL Site 300

4.17.3.1 Contamination History

Historic Use of Hazardous Materials

LLNL Site 300 consists of a General Services Area and a variety of facilities used for high explosives formulating, manufacturing, and testing. Hazardous materials have been used in the formulation and processing of explosives; hazardous and nonfissile radioactive materials (radioactive materials that will not undergo fission when bombarded with slow neutrons) have been included in explosive components that are tested. Solid wastes from detonation of test assemblies are the principal source of radioactive or hazardous wastes. Until November 1988, the bulk of this waste was classified as mixed radioactive waste (see section 4.15). Some of the test assemblies have contained materials such as depleted uranium, thorium, and tritium; and toxic materials such as lead, beryllium, barium, copper, and vanadium.

In the past, liquid waste including high explosive fines, solvents, and metals was discharged into unlined evaporation ponds in the High Explosives Process Area. This practice was terminated in 1985. Trichloroethylene was used as a heat transfer fluid at active test facilities such as the Building 834 Complex. Both trichloroethylene and perchloroethylene were used at a number of General Services Area facilities. Trichloroethylene was used at the Advanced Test Accelerator Facility as a cleaning solvent and as a component of insulating oil. Freon-113 was used as a degreaser. A chemical-waste retention system is provided for chemical operation areas of the High Explosive Process Area. All chemical laboratories are connected to two central, above ground waste retention tanks. All drain lines between the buildings and these tanks are above ground. The tanks are surrounded by a berm capable of containing the volume of both tanks (Santos and Landau, 1987).

4.17.3.2 Contamination Sites, Remediation Efforts, and Potential Impacts of Remediation

Since 1981, a number of site-specific environmental assessment studies focusing on soil and ground water contamination and investigation of potential source areas have been conducted at LLNL Site 300 (see Figure 4.17-8). Soil contaminants and their distribution were identified based upon potential source area investigations. Soil contaminants identified include volatile organic compounds, fuels, aromatic hydrocarbons, metals, radionuclides, and high-explosive compounds (see Table 4.17-11). Reported soil contaminant concentrations are summarized in Table 4.17-12.

Since 1956, 20 water supply wells have been drilled at LLNL Site 300. By 1990, eight of the wells were removed from service in response to either the presence of contaminated ground water or concerns about cross contamination. Currently, six water supply wells (three onsite and three offsite) are being monitored for potential contamination (Lamarre, 1990) (see Figure 4.11-9).

Ground water has been impacted to varying degrees at over six areas at LLNL Site 300 (see Figure 4.17-9) that are currently under various stages of investigation and/or remediation. Contaminants include volatile organic compounds (trichloroethylene, perchloroethylene, 1,2-DCE, Freon-113, and chloroform), high explosives RDX (cyclo-1,3,5-trimethylene-2, 4, 6-trinitrimine) and HMX (cyclotetramethylenetetranitramine), and tritium. The most significant ground water impacts at LLNL Site 300 are from chlorinated solvents, particularly trichloroethylene. Investigations of trichloroethylene contamination have focused on the General Services Area, the Building 834 Complex, and Building 815. In addition, trichloroethylene contamination has been identified in ground water near the Pit 7 Complex, and at Pit 6 and Pit 8 (Lamarre, 1989).

At present there are seven remedial investigation/feasibility study actions being conducted at LLNL Site 300, including the Building 833 Area, the Pit 6 Landfill Area, the High Explosive Process Area, the General Services Area, the Pit 7 Complex, the Building 834 Complex, and the Building 850/East Firing Area. For purposes of this EIR/EIS the Building 834 Complex and Building 833 Area are referred to as the Environmental Test Area. Additionally, a Site-Wide Remedial Investigation Report and Baseline Risk Assessment are currently being prepared for LLNL Site 300. Therefore, remedial action alternatives, risk assessments, and impact evaluations (including individual Environmental Assessments conducted for each site above) are preliminary pending completion of these sitewide evaluations.

Ground water from three LLNL Site 300 locations (the High Explosive Process Area, the General Services Area, and the Building 834 Area) will be treated at their respective extraction/treatment facilities; pilot programs are either planned or underway.[(4)]

The following sections describe site areas, including for each the existing situation at the site, key facilities, area history, previous area investigations (Figure 4.17-8), nature and extent of contamination (Figures 4.17-8 and 4.17-9), and planned activities at the site. Further details regarding site-specific areas of investigation are given in references listed in Table 4.17-13.

Environmental Test Area

The Environmental Test Area (Figure 4.17-8) consists of buildings and facilities used for the nondestructive diagnostic evaluation of parts and devices that are exposed to various environmental stresses. This area includes the Building 830 Area, the Building 834 Complex, and the Building 833 Area. For purposes of this EIS/EIR, the Building 854 Complex (see Figure 4.17-9) is included in the discussion because similar test activities and wastes are generated at this complex. The Building 834 Complex is a test facility located in the southeastern part of LLNL Site 300 (Figure 4.17-9). Trichlorethylene was, and is, used here as a heat transfer fluid (Carpenter et al., 1983, 1986).

In December 1982, trichloroethylene was detected in water from Spring 3, and in 1983, it was detected in soil and rock samples from the area (Carpenter et al., 1983). After 1983, the size of Spring 3 diminished because of less than average rainfall, and by June 1987, Spring 3 had ceased to flow. In 1985, trichloroethylene was detected at a concentration of 200 ppb in water from Spring 3. In 1985, three monitor wells were drilled in this area (Carpenter et al., 1986). One ground water sample from a monitor well in the Spring 3 Area contained 1.6 ppb trichloroethylene. Low concentrations of trichloroethylene have been periodically detected in these wells; however, trichloroethylene concentrations have not exceeded the maximum contaminant level since August 1986.

In the Building 834 Complex area, most soil samples contained trichloroethylene concentrations ranging from below the detection limit to 100 milligrams per kilogram (mg/kg), or ppm; however, a concentration as high as 12,000 ppm was detected in one sample. Soil and unsaturated rock trichloroethylene concentrations beneath the Building 830 and Building 854 areas varied from the detection limit to 10 ppm. Trichloroethylene concentrations up to 100 ppm were once detected in samples from the Building 854 Area; however, this soil was removed during 1983 (Carpenter et al., 1986).

Additional investigations reported that soil trichloroethylene concentrations in the Building 833 Area range from the detection limit to 1.5 ppm. In the 1991 Remedial Investigation for the Building 833 Area, trichloroethylene was identified in the sediments at depths less than 50 ft (Webster-Scholten et al., 1991). The maximum concentrations were detected around Building 833, probably resulting from trichloroethylene spillage at the building prior to its deactivation in 1982. A Feasibility Study for the LLNL Site 300 Building 833 Area will be prepared in 1993. Therefore, a remedial action technology for this area has not been selected, and the impacts of this action cannot be completely evaluated. The potential impact to human health and the environment, however, has been evaluated (Webster-Scholten et al., 1991). The results of this risk assessment concluded that no significant exposure points are currently associated with the trichloroethylene in the soil at the Building 833 area, and negligible risk to the regional aquifer could result from the trichloroethylene-contaminated soil (see section 4.19).

The volatile organic compound (predominantly trichloroethylene) plume at the Building 834 Complex is within the perched waterbearing zone and contains concentrations of trichloroethylene that are above the maximum contaminant levels. The highest concentration observed was 330 ppm. The 100 ppm volatile organic compound contour within the plume now extends approximately 400 ft southwest of the Building 834 Complex.

As described in the Remedial Investigation/Feasibility Study (Bryn et al., 1990), pilot vapor phase trichloroethylene remediation is underway at the Building 834 Complex. Full implementation of remedial activities will occur after the Site-Wide Remedial Investigation Report and a new Feasibility Study report are written and approved.

The proposed remedial action alternative is to pump and treat the shallow ground water plume area of the Building 834 Complex. Additional soil vapor extraction wells would be installed where needed. Innovative monitoring, extraction, and treatment technologies are proposed for the area and would begin with an evaluation of technologies.

No impacts to human health are anticipated during remedial action activities. Conditions specified in the National Pollution Discharge Elimination System permits for any releases into surface water bodies will be followed during remediation. Innovative treatment of ground water may include ultraviolet photolysis technology. Acids and bases may be used to optimize the treatability. Protocols for the safe handling and storage of these chemicals are already in place at LLNL Site 300. No impacts to human health, biota, air quality, water quality, and socioeconomics are foreseen from remediation of the Building 834 Complex other than the beneficial impact to ground water.

General Services Area

The General Services Area is located along the southeastern border of LLNL Site 300 (Figure 4.17-8) and includes equipment stores, machine shops, and other support facilities. Several plumes of volatile organic compounds have been identified in shallow alluvial and deeper bedrock aquifers in this and adjacent offsite areas. The volatile organic compounds most commonly detected in soil and ground water samples collected in the western, central, and eastern portions of the General Services Area are trichloroethylene and perchloroethylene (Ferry et al., 1990). Chemicals identified in the soil and ground water are presented in Table 4.17-11 and Table 4.17-14, respectively.

Significant ground water impacts have occurred at the General Services Area near the southeast portions of LLNL Site 300. Three trichloroethylene plumes have been identified at the General Services Area (McIlvride et al., 1990). Two of the trichloroethylene plumes originate onsite at the General Services Area and move offsite beneath private rangeland located south of Corral Hollow Road. The larger of the two plumes, the eastern General Services Area plume, extends about 1 mile down Corral Hollow from the southeastern corner of LLNL Site 300 onto adjacent public and private property. Three private water supply wells (one inactive well, one active well used by the California Department of Forestry, and one by the Connolly Ranch) are located near the plume area (see Figure 4.11-9) and could be adversely impacted by the volatile organic compounds plumes in the future. Four onsite water supply wells (Figure 4.11.9) screened in the shallow aquifer or deeper wells located within the plume boundaries (wells 4, 6, 7 and 19) have been taken out of service at the General Services Area due to either trichloroethylene contamination or the potential threat of cross-contamination between aquifers (Ferry et al., 1990). Supply Well 6 was sealed in March 1989. Wells 4, 7, and 19 were also sealed (Figure 4.11.7).[(5)]

The Remedial Investigation identified trichloroethylene and perchloroethylene in the General Services Area ground water at concentrations exceeding federal or state drinking water standards. At least six plumes of volatile organic compounds have been identified in shallow alluvial and deeper bedrock aquifers in the General Services Area and offsite areas. In the western General Services Area, a trichloroethylene plume of relatively low concentrations has been identified. Several small, but more concentrated, shallow plumes of trichloroethylene have been identified; a separate, deeper trichloroethylene plume has also been detected in the Well 7 area. In the eastern General Services Area, a relatively dilute trichloroethylene plume originates near an onsite debris pile and extends offsite along Corral Hollow Creek. The downgradient extent of this eastern plume has not been identified due to the restrictions on drilling in close proximity to wetlands that contain certain species of special concern according to the State of California and Federal Candidate species (see Appendix F) including the red- legged frog and the California tiger salamander and their habitats.

Mass calculations show that total volume of volatile organic compounds in all six ground water plumes is about 0.2 gal, 70 percent of which exists in the eastern General Services Area and offsite plume. The total volume of contaminated ground water in the General Services Area is estimated at 37 million gal. Based on site information from the Remedial Investigation, general response actions were identified. General response actions are conceptual measures for a particular environmental medium that can be implemented to achieve remediation objectives.

The general purpose of remedial action is to prevent risks or impacts to public health and the environment. The specific remediation goals for the General Services Area are to:

- Prevent risks to human health and the environment associated with treatment, disposal, discharge, or reuse of released chemicals.
- Prevent migration of chemicals to the Neroly Formation water-supply aquifers, thereby protecting the quality of water in LLNL Site 300 and offsite supply wells.
- Remove chemicals from the subsurface, where required, in soil, soil vapor, bedrock, and ground water, thereby restoring the subsurface to the best condition practical.

The remediation objective of the recommended alternative (which includes ground water extraction in Corral Hollow, ground water treatment, and discharge of treated ground water) is to clean up contamination in ground water to concentrations below state and federal maximum contamination levels. LLNL proposes that the total volatile organic compounds concentration in ground water treatment facility discharge not exceed 5 ppb, and that no individual contaminants exceed the applicable maximum contamination level (Ferry et al., 1990).

A draft Feasibility Study was prepared for the General Services Area to comply with Regional Water Quality Control Board requirements (Ferry et al., 1990). Together with the previously conducted Remedial Investigation (McIlvride et al., 1990), which characterizes the site, the Feasibility Study forms the basis for evaluating and selecting methods for remediation of hazardous materials beneath the General Services Area and adjacent offsite areas.

LLNL will present design specifications for remedial actions in the Remedial Action Plan, following regulatory approval of the Site-Wide Remedial Investigation report currently being prepared and a new Feasibility Study report for the area (Ferry et al., 1990). A CERCLA Removal Action consisting of ground water extraction is currently in place and operating in the Eastern General Services Area. Another system is planned for the Central General Services Area. A separate Environmental Assessment was completed for these activities and is included in the Draft Feasibility Study.

The purpose of the remedial action at the General Services Area is to reduce potential risks and impacts to human health and the environment from the spread of volatile organic compounds and to restore subsurface conditions to the best practical condition. This remedial action has been separated into actions taken in the eastern and central portions of the General Services Area. The remedial action will include additional site investigation, ground water monitoring, and soil vapor extraction and treatment.

There are no risks to human health from released chemicals associated with site investigation, monitoring, and remediation because onsite monitoring will indicate acceptable working conditions during drilling, and the vapor produced during any treatment process would be captured and treated. The treatment system would be designed to meet regulatory requirements for all emissions. Impacts from ground water treatment of the contaminated ground water would improve ground water quality and mitigate existing and potential contamination.

The proposed preferred remedial action alternative in the western General Services Area is for additional subsurface investigation and ground water monitoring. The additional investigations will be performed to determine the full nature and extent of contamination at this area. It is anticipated that implementation of this alternative would not impact physiography, geology, seismicity, climate, cultural and historic resources, surface water, aesthetics, human health, noise, or traffic. During drilling operations insignificant temporary impacts would occur to ground water, air quality, soils, wildlife and vegetation, floodplains and wetlands and to the socioeconomics of the area.

The proposed preferred remedial action alternative at the central General Services Area is additional investigation, ground water and soil vapor extraction and treatment, and monitoring. The impacts associated with additional investigation and monitoring are the same as the impacts discussed for the western General Services Area above. Soil-vapor extraction and treatment would be conducted to achieve maximum capture of the contaminant plume at this site. Vacuum enhancement could be used to increase the yields of the ground water extraction wells. The impacts to the ground water conditions are anticipated to be beneficial. Extraction and treatment of the contaminated ground water would improve water quality and mitigate existing and potential contamination.

Effluent water from proposed ground water treatment systems at the General Services Area may be discharged into Corral Hollow Creek, an intermittent stream. Preliminary infiltration studies (Ferry et al., 1990) indicate that discharges from proposed ground water treatment systems would infiltrate rapidly into the coarse-grained streambed sediments within 100 ft of the discharge point and that no negative impacts to the downstream Corral Hollow Ecological Reserve would be experienced, nor would perennial flow be established. Water discharge from a ground water treatment facility would cause an expected 100-ft length of flow of surface water during the dry season. This flow would cause an increase of growth of existing riparian trees and shrubs and the establishment of additional vegetation. Habitat could be created for the California tiger salamander, foothill yellow-legged frog, and red-legged frog. Some vegetation would be expected to die following termination of the ground water extraction program.

Drilling- and construction-related disruption of the soil would occur during site investigation and remediation activities. This is expected to have minimal impact on the area, but if any areas were extensively disturbed, they would be revegetated with native grasses and/or shrubs to restore the area to its original condition. Minor disturbances of wildlife could occur from drilling and monitoring activities.

Ground water remediation in the General Services Area would have beneficial effects on land use and socioeconomics. The treatment operations would restore the ground water as a resource, thereby alleviating any restrictions on the range of feasible uses of the land. The remedial action would not require more than 10 additional workers. However, the number of workers at the site and the duration of their stay would not be constant or continuous. This increase in workers would not represent a substantial change, and represents the variability expected during normal operations.

Implementation of proposed remedial actions at LLNL Site 300 would have an overall beneficial impact on the ground water resources and land use limitations. The volume of ground water that would be removed from the bedrock aquifers is generally not expected to affect the capability of the aquifers to provide water for current or future development activities (Ferry et al., 1990) although careful monitoring of drawdowns, particularly during drought periods, will be required.

High Explosives Process Area

The High Explosives Process Area is a major facility located in the south-central portion of LLNL Site 300 (Figure 4.17-8). High explosive compounds are mixed, pressed, and machined for experimental purposes at various facilities within the process area. Rinsewater discharges from buildings within the High Explosives Process Area historically were disposed of by a combination of infiltration and evaporation in nine small unlined lagoons adjacent to processing Buildings 806/807, 807A, 807B, 817, 825, 826, 827 C/D, 827E, and 828. Initial investigations of these lagoons were conducted in 1982 (Raber, 1983) and use of these lagoons was terminated in 1985. Beginning in March 1986, LLNL conducted the hydrogeologic investigations required for permanent closure of the nine decommissioned lagoons. In October 1989, the lagoons were closed by covering them with impermeable clay caps.

In 1985, low concentrations of the high explosive compound RDX (maximum value of 350 mg/L) were detected in ground water near Building 815 in the High Explosives Process Area (Crow and Lamarre, 1990). Additional investigations have determined RDX to be present locally in two aquifers beneath Buildings 815 and 817.

Sixty-nine monitor wells (some constructed as early as 1984) and several soil borings were used to characterize the areal and vertical extent of contamination. Chemical constituents identified in the soil and ground water include RDX and HMX and trichloroethylene. Traces of fuel hydrocarbons and metals have also been found in the soil.

Concentration of high explosive compounds in the shallow perched and Neroly upper sandstone aquifers have remained essentially unchanged since 1986 and are consistent with historical trends. Trichloroethylene concentrations vary considerably over this period, but do not show any consistent increasing or decreasing trend. The trichloroethylene plume extends from Building 835 to the western General Services Area in the south.

To date, the EPA has not established a water-quality criterion for RDX and HMX, nor are they regulated under the Safe Drinking Water Act. In the absence of guidance for water quality goals, LLNL evaluated all known RDX and HMX toxicological data and reported a RDX drinking water criterion of 105 mg/L for the Site 300 ground water (Etnier, 1989). The evaluation of the HMX toxicological data could not be used to calculate a HMX drinking water criterion (Crow and Lamarre, 1990). However, HMX is considered to be much less toxic than RDX because of its lower solubility. Only trace to low concentrations of HMX have been detected in monitoring wells at the High Explosives Process Area, with a maximum reported concentration of 41 ppb (Crow and Lamarre, 1990).

The concentrations of RDX in perched aquifer ground water are somewhat higher than the 105 mg/L criterion. RDX levels in concentrations in the Neroly aquifer range from not detectable to 270 mg/L, or slightly above the suggested criterion. The average concentration of RDX in the ground water is less than the drinking water criterion.

The Draft Feasibility Study being prepared for this site will review available remedial technologies and associated costs for remediating trichloroethylene and high explosive compounds in ground water, soil, and rock. Three additional monitor wells were installed during the first quarter of 1991 as part of the ongoing trichloroethylene plume investigation. To locate the northern extent of the trichloroethylene plume, one well was installed west of Building

814. Monitor wells installed near Building 815 have assisted in defining the vertical extent of trichloroethylene and high explosive compounds in soil, rock, and ground water. One monitoring well was installed upgradient (north) of Building 827 to provide hydrostratigraphic information on the upper Neroly blue sandstone aquifer.

High explosive compounds beneath the closed rinsewater lagoons are present in low concentrations and confined to the unsaturated zone. Traces of volatile organic compounds are present beneath the 827C/D and 828 lagoons. At their present locations, these compounds pose no threat to human health, safety, or the environment. The force distributing these compounds in the unsaturated zone was the hydraulic head generated by rinsewater in the lagoons. With no further accumulation of liquids in the lagoons, the compounds should remain immobile.

To ensure this immobility, LLNL filled and capped the decommissioned lagoons with compacted backfill and clay soil. The compacted clay caps are a minimum of 2 ft thick and extend beyond the edges of the lagoons. The clay cap materials were selected, tested, and emplaced according to a closure plan approved by the California Regional Water Quality Control Board. To reduce the potential for degradation of the compacted clay cap by bioturbation, the caps were covered with 18 inches of uncompacted topsoil seeded with local grasses. The exception is the 825 Lagoon, which was covered instead with a concrete slab and holding tank for continued operations at Building 825. The lagoons at the High Explosives Process Area have been formally closed in accordance with a closure plan approved by the California Regional Water Quality Control Board.

Ongoing investigations of trichloroethylene and high explosive compounds in ground water will be reported in the new Feasibility Study and in the Site-Wide Remedial Investigation currently being prepared.

Landfill Pit 6

Landfill Pit 6 is in the southwestern portion of LLNL Site 300, approximately 200 ft from the southern boundary (Figure 4.17-8). Records show that Pit 6 received a variety of waste materials from the LLNL Livermore site and from the Lawrence Berkeley Laboratory. Following closure in 1973, Pit 6 was covered with locally obtained clay soil. The site has since been developed as a rifle range for use by the LLNL Protective Services Department, the California Highway Patrol, and other public safety officers.

Low concentrations of trichloroethylene and related volatile organic compounds were detected in ground water immediately downgradient of the landfill (Figure 4.17-9). The plume's configuration and results from an extensive soil gas survey suggest that low levels of trichloroethylene were released from the southeastern portion of the landfill. Ground water trichloroethylene concentrations generally are declining. The long axis of the plume is approximately parallel to the direction of ground water flow.

A draft Remedial Investigation report for the Pit 6 site (Taffet, 1990) was completed in December 1990, and a draft Feasibility Study of alternative remedial actions (Taffet et al., 1991) was completed March 31, 1991. The proposed remedial action alternative for Landfill Pit 6 includes modification of the landfill area and installation of a run-on/run-off diversion system to prevent water from infiltrating into the landfill. Monitoring and additional site investigation would also be performed. Other alternatives being considered include soil vapor and ground water extraction. Work planned for the Pit 6 area includes continued sampling of ground water monitor wells, monthly water-level measurement to further define local hydrogeology, and preparation of the Site-Wide Remedial Investigation report.

The risk to human health from potential long-term exposure to the volatile organic compound– contaminated ground water has been determined to be minimal (Taffet, 1990). Much of the trichloroethylene ground water plume is naturally volatilizing along a seepage face southeast of the landfill. Maximum concentrations in the plume are presently about 20 times the maximum concentration level for trichloroethylene (100 ppb), but concentrations are declining with time. The proposed remedial action alternative would not have an impact on ground water, air quality, soils, vegetation and wildlife, or noise and traffic.

Landfill Pit 8

Pit 8 is located several hundred feet northeast of Building 801 (Figure 4.17-8), within a narrow ravine. Low concentrations of trichloroethylene in ground water from two Pit 8 monitor wells are likely from release immediately upgradient (from the west) of the landfill and not from landfill contents. Other volatile organic compounds detected at Pit 8 included chloroform and Freon-113 at very low concentrations.

The extent of contamination in the immediate area of Pit 8 is unknown. The Pit 8 investigation is ongoing.

Landfill Closure Area

Debris from high explosives tests was disposed of in Landfill Pits 1 and 7 at the northern end of LLNL Site 300 (Figure 4.17-8). Landfill Pits 1 and 7 are unlined disposal units constructed prior to the establishment of liner requirements (Corey, 1988). Pit 1 was opened in 1961 and Pit 7 was opened in 1979. These pits were operated as single cells, and cover material was applied about four times a year (Corey, 1988). A mixture of low-level radioactive wastes and RCRA hazardous wastes generated from the firing of test assemblies was disposed of in Pits 1 and 7 (Corey, 1988).

In 1988 approximately 12,347 cu yd of gravel from all LLNL Site 300 firing tables were disposed of in landfill Pit 7. Also, the soils underlying firing table 851 were removed and placed in landfill Pit 7. The gravels were removed because activities of tritium and uranium exceeded background levels for some samples. Soils from firing table 851 were removed because beryllium and lead concentrations in one sample exceeded Soluble Threshold Limit Concentrations. Soils from other firing tables were not removed, because only a few of the samples contained either lead or beryllium at concentrations above the soluble threshold limit concentration or maximum concentration level. Furthermore, each soil sample was bounded by other samples above and below it with concentrations lower than the standards (Lamarre and Taffet, 1989).

Pits 1 and 7 were operated until November 8, 1988, under RCRA interim status. In March 1988, LLNL decided not to pursue its RCRA Part B permit for these landfills, and submitted a closure and postclosure plan to the regulatory agencies. In 1992 LLNL will complete closure of LLNL Site 300 Pits 1 and 7 as specified in the closure plan.

Monitor wells have been installed at all of the landfills, and periodic ground water analysis is conducted.

Freon-113 was also detected at Pit 1 but at levels far below the maximum contaminant level. Trichloroethylene, 1,1-dichloroethylene, and tritium concentrations in the Pit 7 Area wells did not change significantly between 1988 and 1989 (Lamarre, 1990). During the second quarter of 1989, slightly elevated levels of gross alpha activity were detected. This is likely from naturally occurring uranium in the ground water (Raber and Carpenter, 1983). In the fourth quarter of 1989, one monitor well exhibited a gross alpha activity slightly above the state maximum contaminant level of 15 pCi/L. Isotopic uranium analysis showed that this alpha activity was likely from naturally occurring uranium.

The landfills will be closed in accordance with guidelines prepared by the EPA, the California Regional Water Quality Control Board–Central Valley Region, and the California Department of Toxic Substances Control and in compliance with federal, state, and local regulations. Given the low mobility of waste contaminants in Pits 1 and 7 (lead, uranium, beryllium, and barium), their low concentrations, the high evapotranspiration rate at LLNL Site 300, and the absence of free liquids in the pits, the risk of constituent migration due to leaching is minimal (McIlvride et al., 1988).

Closed Pits 1 and 7 will receive postclosure monitoring in accordance with RCRA. Postclosure use of the areas at landfill Pits 1 and 7 will not disturb the final cover or any of the components of the monitoring system unless approved by the regulatory authorities.

Tritium Project

The Tritium Project Area (see Figure 4.17-9) includes the Pit 7 Complex, the Building 850/East Firing Area, and the Building 851 Area. Historically, debris from high explosive tests has been disposed of in landfills at the northern end of LLNL Site 300 (Lamarre, 1989). In 1981, a Hazardous Waste Assessment study of the hydrology, geology, and ground water chemistry associated with LLNL Site 300 landfills was initiated. As part of this project, monitor wells were installed at the landfills and a program of periodic ground water monitoring started.

In 1984, tritium levels in ground water samples from four of the wells were above the California drinking water standard of 20,000 pCi/L. An investigation delineated three distinct plumes of tritium in ground water, including the Pit 7 complex (which includes Pits 3 and 5), the Building 850 area in the West Firing Area, and near Pit 2 in the East Firing Area (Figure 4.17-8). In the Pit 7 complex area soil moisture above the water table was sampled for tritium. At the 1.3 ft to 2.5 ft interval, only one sample showed a tritium activity in excess of the drinking water standard (20,000 pCi/L) (Taffet et al., 1989). At approximately 15 ft above the current water table, the soil moisture tritium maxima occur. Tritium activities of 200,000 pCi/Lsm have been detected in this interval of the vadose zone. Tritium activities are an order of magnitude lower in the underlying ground water (Taffet and et al., 1989).

Tritium has been detected in the Neroly Formation, both in the shallow perched aquifer and in the regional aquifer immediately east of the southwestern branch of the Elk Ravine fault. Tritium plumes continue to migrate from 46 to 610 ft/year. The Pit 3 and Pit 5 plumes are migrating east-northeast. The Building 850 plume is migrating northeast and southeast. The only production well affected by tritium is well 1, located in the East Firing Area near the downgradient edge of the Building 850/Doall Ravine/East Firing Area plume. Well 1 is currently inactive and is used as a backup fire water supply well.

Tritium-contaminated ground water in the Pit 7 complex area is thought to originate from flooding by elevated water tables into Pits 3 and 5 during periods of high rainfall (Buddemeier et al., 1987c). Two separate tritium plumes originate from the Pit 7 complex area, one from Pit 3 and one from Pit 5 (Taffet et al., 1989). Contaminant fate and transport modeling predicts that because of tritium's radioactive decay, when the plumes reach the site boundary, they will contain tritium levels below the California drinking water standard (Buddemeier et al., 1987c).

The investigation of tritium in ground water at the Landfill Pit 7 complex was completed and a remedial investigation/feasibility study was submitted to EPA, the Regional Water Quality Control Board, RWQCB, and DHTS (Taffet, Oberdorfer, and McIlvride, 1989). The conclusion of the report stated that ground water is moving at a maximum of 15 meters per year towards the northern site boundary. Given that the radioactive decay half-life for tritium is 12.3 years, by the time this ground water reaches the site boundary along a most-direct flow path, tritium activities will be at or below background activities (200 pCi/L). Therefore, LLNL proposed the no action, continued monitoring alternative. No impact to human health or the environment is anticipated (see section 4.19).

The Remedial Investigation of the Building 850/East Firing Area identified tritium as the only contaminant released to ground water from the Building 850 firing table area. Tritium detected in ground water at a maximum present activity of 300,000 pCi/L exceeds the maximum contaminant level of 20,000 pCi/L. The tritium plume is migrating to the northeast down the Do-all Ravine in alluvium and weathered bedrock. A smaller portion of the tritium plume is migrating to the northeast from Building 850 in fractured bedrock (Buddemeier et al., 1987c). The plume, which averages 1000 to 1500 ft in width, has traveled almost 6000 ft from the Building 850 source (Taffet and Oberdorfer, 1991). Near Pit 2 in the East Firing Area, this plume enters the regional ground water flow system and migrates to the southeast. A Feasibility Study was prepared to address remedial action for compounds that may have been released in soil, rock, or ground water from the immediate vicinity of the Building 850 firing table at LLNL Site 300 (see Figure 4.17-8) (Taffet and Oberdorfer, 1991). The Feasibility Study, along with the previously conducted Remedial Investigation (Taffet et al., 1990) that characterizes the site, formed the basis for evaluating and selecting remediation methods to prevent further release of waste constituents from this area in the subsurface.

Ground water contaminant fate and transport modeling shows that when the Building 850 tritium plume reaches the nearest possible human exposure points (offsite water supply wells in Corral Hollow), it will contain tritium levels below the background activity in rainfall at the site and below the state MCL (Taffet and Oberdorfer, 1991). The preferred remedial action alternative includes combined technologies for the monitoring of ground water and tritium source isolation.

Source isolation can be achieved by the installation of a permanent plastic cover over the tritium source areas in the soil. This would reduce migration of tritium into the ground water from the vadose zone beneath the Building 850 Area. LLNL will present specific design specifications for remedial action in the Remedial Action Plan, following regulatory approval of the Feasibility Study and the Site-Wide Remedial Investigation Report and Baseline Risk Assessment that are currently underway.

Future work in the Tritium Project Area includes:

- Quarterly ground water sampling and analysis for tritium and periodic ground water level measurements.

A worst-case calculation of the dose received from using tritium-bearing ground water from the site boundary or the current exposure point was identified to be insignificant (Taffet and Oberdorfer, 1991). The general purpose of the remedial action that would be performed at this location is to prevent risks or impacts to public health and the environment. This would be achieved by preventing ground water containing more than 1000 pCi/L of tritium from reaching any receptor well, protecting drinking water supplies from potential contaminants released from the site, and preventing further release of tritium or any other compound from the Building 850 area.

It is possible that human exposure to tritium through the ground water pathway could occur if the contaminated aquifer were to be used as a drinking water source (Taffet and Oberdorfer, 1991). This would be unlikely because San Joaquin County does require a permit to be approved by the Department of Health Services and ascertains the location of any proposed wells. Well permits would likely be denied if the wells were near the contaminated ground water areas or might impact ground water remediation efforts. Additionally, LLNL Site 300 management does not plan to use the aquifer underlying the Building 850 area.

There would be no significant risk from utilizing the ground water at the site boundary (Taffet and Oberdorfer, 1991) as discussed above. Although no ground water treatment has been proposed as a component of the preferred alternative (see Taffet and Oberdorfer, 1991), treated water could be discharged to the atmosphere in the form of water vapor. Such action would require approval by regulatory agencies including EPA and San Joaquin County Air Pollution Control District. Tritium remediation and associated potential impacts will be addressed in the Site-Wide Remedial Investigation Report and the Site-Wide Baseline Public Health Risk Assessment.

Building 865

Building 865 was the test facility for the Advanced Test Accelerator experimental project (Figure 4.17-9). From 1982 to 1989, the Advanced Test Accelerator used a linear electron accelerator for charged particle-beam research (Cabayan and Eccles, 1986). The facility consisted of a control and support building, a power supply building, diagnostic equipment, two modular office buildings, a tunnel building that contained the pulse-forming unit, an electron injector, and a series of accelerator modules (Energy and Technology Review Reprints, 1984). The facility did not use radioactive or high explosive materials (UC, 1986).

Floor washdown water drained from Building 865 to three aboveground tanks located southwest of the building. This water contained insulating oil and Freon-113. Insulating oil was used for transferring heat in the electrical transmission lines and the accelerator modules. Freon-113 was used as a solvent for cleaning the accelerator modules and other experiment apparatus. Before installation of the aboveground tanks in late 1985, rinsewater was stored in a lined 7000-gal surface impoundment and an underground tank. When the tanks or impoundment were filled, the rinsewater was transferred to tanker trucks for disposal offsite.

As part of a routine upgrade project for the Building 865 rinsewater retention system, 16 soil and bedrock samples were collected at the site of three aboveground tanks. Oil and grease were found in both the soil and bedrock samples and even in a presumed background sample. Some soil and bedrock samples were also analyzed for purgeable aromatics and volatile organic compounds. No detectable concentrations have been reported for these analytes.

It is believed that the lined surface impoundment leaked or that rinsewater was spilled during transferring operations. Preliminary findings support this conclusion, and additional site characterization will be conducted (Lamarre, 1990).

Table 4.17-11 Summary of Potential and Detected Soil Contaminants at LLNL Site 300

	Potential Soil Contaminant[a]	Soil Contaminants Reported at

Area	VOC	FHC	Metals	PCB	Rad	HE	Concentrations Above Detection Limit[b]
Environmental Test Area (Building 834 Complex)	Y	N	N	N	N	N	**VOC:** TCE
General Services Area	Y	N	N	N	N	N	**VOC:** PCE, TCE, 1,2-DCE
High Explosives Process Area	Y	N	N	N	N	Y	**VOC:** TCE **HE:** RDX, HMX
Landfill Pit 6	Y	N	Y	Y	N	N	TCE (soil vapor survey)
Landfill Pit 8	Y	N	Y	N	Y	N	None identified
Landfill Closure Area: Landfill Pit 1	Y	N	Y	N	Y	N	None identified
Landfill Pit 7	N	N	Y	N	Y	N	**Rad:** tritium
Tritium Project	Y	N	N	N	Y	N	**Rad:** tritium
UST location near Building 850	N	Y	N	N	Y	N	**FHC:** diesel **Rad:** tritium
UST location at Building 874 (874-11D)	N	Y	N	N	N	N	**FHC:** diesel
Building 865 with associated tanks	Y	Y	N	N	N	N	**FHC:** oil and grease

Y = Potential soil contaminant
N = Not a potential soil contaminant
VOC = Volatile organic compound
FHC= Fuel hydrocarbon constituent
UST= Underground storage tank
PCB = Polychlorinated biphenyl
Rad = Radiological constituent
HE = High explosives (includes RDX, HMX)
TCE = Trichloroethylene
RDX = Cyclo-1, 3, 5 – trimethylene -2, 4, 6 – trinitramine
HMX = cyclotetramethylenetetranitramine
1,2-DCE = 1,2-Dichloroethene
PCE = Perchloroethylene

[a] Based upon known or suspected contaminant releases or hazardous materials use, storage, or disposal practices strongly suggestive of (a) potential release(s).
[b] For ranges of concentrations for key contaminants and tritium activities detected at each area investigated, see Table 4.17-11.

Table 4.17-12 Summary of Soil Concentrations for Potential Source Investigations at LLNL Site 300

Area Investigated	Range[a] of Total VOCs (ppb)	Range of Total Aromatic Hydrocarbons (ppb)	Range of Total PCBs (ppb)	Range of HE compounds (ppb)	Range of Tritium Activities (pCi/LSM)[b]	Metals
Environmental Test Area 834 Complex (1)	Trace–High	Trace	N/A[c]	Very Low	<200[d]–440	<STLC[e]
General Services Area (2)	Trace–Very Low	Trace–Very Low	N/A	N/D[f]	N/A	<STLC
High Explosives Process Area (3)	Trace–Low	Trace–Moderate	N/A	Trace–High	N/A	>STLC
Landfill Pit 6 (4)	Trace–Low	N/A	N/D	N/A	N/A	N/A
Landfill Pit 8 (5)	Trace	Trace	N/A	N/A	N/A	<STLC
Landfill Closure Area (6) Landfill Pit 1 Landfill Pit 7	 N/D N/D	 N/D N/D	 N/A N/D	 N/D N/A	 N/D N/D	 N/D N/D
Tritium Project (7)	N/A	N/A	N/A	N/A	<192–11,000,000	>STLC
UST[g] near Building 850 (8)	N/D	N/D	N/A	N/A	9,600–71,900	<STLC
UST at Building 874 (874-11D) (9)	N/D	N/D	N/A	N/A	N/A	N/A
Building 865 with associated tanks (10)	N/D	N/D	N/A	N/A	N/A	N/A

[a]Trace = <5 ppb.
Very Low= 5–49 ppb.
Low = 50–449 ppb.
Moderate= 500—5000 ppb.
High = >5000 ppb.

Note: Concentration ranges and qualifiers (e.g. low, medium, high, etc.) not based on regulatory action levels. See text for discussion of those areas which have been determined, based on site specific risk assessment criteria, to require remediation.

[b] pCi/LSM = picocuries per liter soil moisture.
[c] N/A = None analyzed.
[d] <200 = less than detection limit.
[e] STLC = Soluble threshold limit concentration.
[f] N/D = None detected.
[g]UST = Underground storage tank.

Source: (1) Bryn et al., 1990; Webster-Scholten et al., 1991; (2) McIlvride et al. 1990; (3) Crow and Lamarre, 1990; Webster-Scholten and Crow, 1989; (4) Taffet, 1990; Taffet and Lamarre, 1986; CH2M Hill, 1985; Raber and Carpenter, 1983; (5) Taffet, 1989; (6) Taffet et al., 1989; Buddemeier et al., 1987c; Raber and Carpenter, 1983; Carlsen et al., 1987; (7) Taffet et al., 1990; Taffet and Oberdorfer, 1991; (8) Carlsen, 1991; (9) Copland and Lamarre, 1990; (10) Lamarre, 1990.

Table 4.17-13 Key Area Investigation References for LLNL Site 300

Area	Key References
Environmental Test Area	Ruggieri et al. 1987 Carpenter et al., 1983, 1986 Buddemeier et al., 1987a, 1987c Lamarre, 1989, 1990 Bryn et al., 1990
General Services Area	Buddemeier et al., 1987b Weiss Associates, 1987 Lamarre, 1989, 1990 Crow and Lamarre, 1990 McIlvride et al., 1990
High Explosives Process Area	Raber, 1983 Ruggieri et al., 1987 Buddemeier et al., 1987b Brown and Caldwell, Inc., 1987a, 1987b Carpenter et al., 1988 Webster-Scholten and Crow, 1989 Crow et al., 1986
Landfill Pit 6	Raber and Carpenter, 1983 CH2M Hill, 1985 Brown and Caldwell, 1987a Taffet et al., 1990 Taffet and Lamarre, 1986
Landfill Pit 8	LLNL, 1989a Taffet, 1989
Landfill Closures	Buddemeier et al., 1987a, 1987b Carlsen et al., 1987 Raber and Carpenter, 1983 LLNL, 1990d
Tritium Project	Lamarre, 1989 Buddemeier et al., 1985, 1987a, 1987b, 1987c LLNL, 1989a, 1990d Taffet et al., 1990
Underground Tanks	LLNL, 1989a Carlsen, 1991

Building 865	Cabayan and Eccles, 1986 Energy and Technology Review Reprints, 1984 Copland and Lamarre, 1990
Enhanced Soil Bioremediation Pilot	Lamarre, 1990
Well Sealing	Lamarre, 1989

Table 4.17-14 Summary of Potential and Detected Ground Water Contaminants at LLNL Site 300

Area	Potential Water Contaminant*						Water Contaminants Detected at Concentrations Above Maximum Concentration Level
	VOC	FHC	Metals	PCB	Rad	HE	
Environmental Test Area (Building 834 Complex)	Y	N	N	N	N	N	**VOC:** TCE
General Services Area	Y	Y	N	N	N	N	**VOC:** PCE, TCE, 1,2-DCE
High Explosives Process Area	Y	N	N	N	N	Y	**VOC:** TCE **HE:** HMX RDX **OTHER:** T
Landfill Pit 6	Y	N	N	N	N	N	**VOC:** TCE
Landfill Pit 8	Y	N	N	N	N	N	**VOC:** TCE, 1,2-DCA
Landfill Closure Area: Landfill Pit 1	N	N	N	N	N	N	
Landfill Pit 7	Y	N	N	N	Y	Y	**VOC:** TCE, 1,1-DCE **HE:** HMX RDX **Rad:** tritium
Tritium Project	Y	N	N	N	Y	N	**Rad:** tritium
UST near Building 850	N	Y	N	N	N	N	None identified
UST at Building 874 (874-11D)	N	Y	N	N	N	N	None identified
Building 865 with associated tanks	Y	Y	Y	N	N	N	None identified

Y = Potential water contaminant
N = Not a potential water contaminant
VOC = Volatile organic compound
FHC = Fuel hydrocarbon constituent
PCB = Polychlorinated biphenyl
Rad = Radiological constituent
HE = High explosives

TCE = Trichloroethylene
1,1-DCE= 1,1-Dichloroethene
1,2-DCA= 1,2-Dichloroethane
1,2-DCE= 1,2-Dichloroethene
PCE = Perchloroethylene
T = Toluene
RDX = Cyclo-1, 3, 5 – trimethylene -2, 4, 6 – trinitrimine
HMX = Cyclotetramethylenetetranitramine

* Based upon known or suspected contaminant releases or hazardous materials use, storage, or disposal practices strongly suggestive of a potential release.

4.17.4 Site Contamination—SNL, Livermore

4.17.4.1 SNL, Livermore Historic Use of Hazardous Materials

From 1942 until 1947, the U.S. Navy disposed of trash and construction debris at the southern end of the Navy property, the location of the present SNL, Livermore Navy Landfill. The site consists of debris fill placed in and around a natural ravine that extends approximately 200 ft by 400 ft. No historical records are available regarding the nature and quantity of materials disposed of in the Navy Landfill.

LLNL began operations in 1952 and disposed of construction debris and empty containers in the landfill until 1960 (Rowe, 1960). Wastes were trucked to the ravine and deposited over the sides. Some fill material was dumped on top of the waste to provide a firm surface for roads. Debris was visible in historic site photographs; materials included large pieces of concrete, machine turnings, wire, glass, and plastic. Visible debris is now greatly reduced at the site. No mixed or radioactive wastes are known to be present; however, low concentrations of acetone, dichloromethylene, trichloracetic acid, Freon-113, and copper and lead were found at the site (DOE, 1990f). SNL, Livermore took over this land in 1956 but never used the Navy Landfill site for disposal of any materials. Lithium, potassium, and sodium scrap metal were treated at a high explosives burn pit located east of the Navy Landfill incinerator.

Diesel oil used as heating oil for buildings and the nonhazardous waste incinerator has been stored in a 179,900-gal tank since 1972. Small quantities of waste solvents or gasoline were utilized in a fire extinguisher training area near Building 961 between 1959 and 1978.

The Trudell Auto Repair Shop, formerly a gasoline station/repair shop, was built in the early 1950s (DOE, 1986c). Fuels, oils, solvents, waste oils and solvents, and other materials associated with automotive repair and maintenance were used and stored at this site. This site was acquired by DOE in 1987 as part of its security enhancement program.

4.17.4.2 Contamination Sites, Remediation Efforts, and Potential Impacts of Remediation

The following sections describe site facilities, including for each the site history, previous site investigations, nature and extent of soil and ground water contamination, the existing situation, and planned activities at the site. Figure 4.17-10 and Figure 4.17-11 show the locations of areas with potential soil and ground water contamination at SNL, Livermore. The sites and their potential contaminants are inventoried in Table 4.17-15. Reported soil contaminant concentrations are summarized in Table 4.17-16. There have been three contaminated sites which have been investigated at SNL, Livermore (Navy Landfill, Fuel Oil Spill, Trudell Auto Repair Shop); also six sites have been classified as Miscellaneous Sites. Other sites will not undergo further investigation because they have been remediated or are in the process of remediation under different environmental programs (Table 4.17-17). More in-depth information pertaining to these site-specific areas of investigation can be obtained from references listed in Table 4.17-18. Tables 4.17-15, 4.17-16, and 4.17-19 summarize potential contaminants and contaminants identified in soils and ground water at each of the SNL, Livermore sites.

Navy Landfill

Thirteen soil boreholes sampled before 1989 showed very low concentrations of acetone, dichloromethylene, trichloroacetic acid, Freon-113, copper, and lead in soil. Both lead and copper concentrations exceeded soluble threshold limit concentrations (Ahlquist et al., 1985). No constituents were found in ground water that exceeded California regulatory drinking water standards, although Freon-113 was found in very low concentrations (Ahlquist et al., 1985). Freon is a common laboratory reagent and often a source of laboratory contamination.

A Solid Waste Water Quality Assessment Test field program was performed at the Navy Landfill in 1989 (DOE, 1990f). Three new monitor wells were installed, soil samples were collected from two lysimeter boreholes, one piezometer was installed north of the Las Positas fault, one soil borehole was drilled onsite, and four test pits were dug by backhoe (DOE, 1990f).

As a result of the Navy Landfill investigation no pesticides, polychlorinated biphenyls, or explosives were detected in any soil sample collected at the Navy Landfill site during the 1989 remedial investigation (DOE, 1990f). However, low concentrations of combined oil and grease were identified in three soil samples from the onsite lysimeter and in two samples from the onsite borehole. Because the oil and grease analysis is nonspecific, it may reflect naturally occurring organic compounds in the soil, including humic acids. None of the metals detected in soil samples approached the total threshold limit concentration of the California Assessment Manual (California Regional Water Quality Control Board, 1986), and all were generally within the typical concentration ranges in natural soils in the western United States.

No contamination of vadose zone soil-pore water was found. No pesticides, polychlorinated biphenyls, or explosives were identified in any water sample collected from the Navy Landfill site (DOE, 1990c). Total organic carbon and total organic halogens were detected in several samples at low concentrations during the first quarter sampling, but were not identified in subsequent quarterly samplings. This indicates possible cross-contamination from equipment in the first quarter samples. Total organic carbon and total organic halogens are, therefore, not considered to be contaminants at the Navy Landfill site.

There does not appear to be contamination of the soil or ground water at the Navy Landfill site, and no contaminants have been found in the area ground water. SNL, Livermore has, therefore, requested release from further remedial action at this site from the Regional Water Quality Control Board. Regulatory acceptance of the Solid Waste Water Quality Assessment Test Report and approval of the SNL, Livermore request to release this site from further investigation is pending. A response to SNL, Livermore's request is expected in the first quarter of Fiscal Year 1992 from the Regional Water Quality Control Board. SNL, Livermore plans to regrade and landscape the surface of the Navy Landfill to provide a safe working environment, prevent erosion, and prevent slope failure of the site.

Fuel Oil Spill

In February 1975, 59,500 gal of No. 2 diesel fuel oil spilled when a transfer line buried 4 ft underground was accidently punctured (DOE, 1986c). The spill occurred 75 ft north of the aboveground fuel storage tank. Some of the diesel fuel infiltrated the soil underlying the spill site, and the remainder migrated laterally in a light-pole trench adjacent to the spill and then migrated vertically beneath the trench into the underlying soil.

Since 1984, SNL, Livermore, its subcontractors, and LLNL have drilled and sampled 37 boreholes and 16 monitor wells at the Fuel Oil Spill site (Figure 4.17-11). Soil samples were analyzed for chemical contaminants and geotechnical parameters. Ground water samples were analyzed for chemical contaminants. Ground water levels were evaluated for flow system characteristics of the upper aquifer. The data were used to develop a conceptual site model of contaminant migration and provide lateral extent and depth profiles for contaminants at the Fuel Oil Spill site.

The interval of highest total petroleum hydrocarbon soil contamination is from 10 to 30 ft below ground surface. The highest total petroleum hydrocarbon concentrations (1000–10,000 ppm) are limited to the area closest to the source. The greatest areal extent of soil contamination is at the 100 ft depth. At this depth, the total fuel hydrocarbon concentrations ranging from 1000 to 10,000 ppm extend to approximately 120 ft downgradient to the northwest and approximately 100 ft cross-gradient to the southwest of the spill release point. No contamination was detected below 101 ft during the 1988 Fuel Oil Spill site investigation (DOE, 1990b). The total volume of soil contaminated with total fuel hydrocarbons was estimated to be 45,400 cu yd (DOE, 1990b).

Benzene, toluene, ethylbenzene, and xylene were found in the soil. Contaminants appear to be within the more permeable gravel-sand-silt units beneath the Fuel Oil Spill site with the highest contaminant concentrations near the end of the light-pole trench and not closest to the spill point. Analysis for metals showed background metal concentrations in the soil. Four of the boreholes showed no soil contamination at all.

Benzene contamination was found at concentrations of up to 3 ppb in ground water samples in three wells until May 1986. In all subsequent ground water sampling investigations at the fuel oil spill site since May 1986, benzene has not been detected in any well. No other fuel hydrocarbons have been detected in any ground water sampling investigation. Two of the wells where benzene was detected in ground water samples have since gone dry. No volatile organic compounds (as differentiated from fuel hydrocarbons, as shown in Table 4.17-19) were detected in any of the ground water samples from the wells. Bis(2-ethylhexyl)phthalate was detected in one downgradient well, but this compound is a common laboratory contaminant and a component of polyvinyl chloride, not of diesel fuel. Ground water analyses show that manganese concentrations in three downgradient wells and iron concentrations in one downgradient well were above secondary drinking water standards and above background concentrations.

A qualitative risk assessment evaluated the potential threat to human health and the environment from the Fuel Oil Spill site. Air and surface water exposure pathways were considered insignificant. The only important exposure pathway would be from ingestion of ground water from a hypothetical well drilled into the uppermost aquifer at the Fuel Oil Spill Site. Only the active treatment or disposal options and alternatives provided would guarantee protection of human health and the environment. However, if the contamination does not migrate significantly, or ground water does not continue to rise, other treatments or no action provide equal protection. An in situ pilot study system is being designed to evaluate the feasibility of bioremediation at this location as one of the active treatment options.

The pilot study would determine whether bioremediation at the Fuel Oil Spill site is appropriate and would provide information for treatment facilities design. The Regional Water Quality Control Board has agreed with SNL, Livermore to proceed with a pilot study that would assess the effectiveness of in situ bioremediation. A Remedial Action Plan that would identify the implementation of this pilot study is planned to be submitted to the Regional Water Quality Control Board in the first quarter of 1992. The SNL, Livermore is planning to implement the pilot study in the fourth quarter of 1992.

Trudell Auto Repair Shop

The Trudell Auto Repair Shop site (Figure 4.17-10) was formerly occupied by a gasoline service station in the 1950s (DOE, 1986c). The service station dispensed gasoline and performed minor auto repair work. Although the gas pumps were removed in 1965 and the facility was operated as an auto repair shop, the underground gasoline tanks remained in place. During the fuel shortage of the early 1970s, the underground tanks were used by the repair shop for temporary fuel storage. SNL, Livermore purchased the property in 1987 as a security buffer zone between the surrounding properties and the site. Five areas were identified as potential sources: the septic tank leach field, the south waste oil area, the east waste oil area, the underground storage tank area, and nonpoint sources.

Two remedial investigations were conducted at the Trudell Auto Repair Shop site. The first included soil gas sampling, ground-penetrating radar, and surface soil sampling. The data showed no sources of volatile organic compounds. However, low concentrations of volatile organic compounds were detected in soils to a depth of 72.5 ft during the installation of a ground water monitor well at the Trudell property as part of the LLNL ground water investigation program. Volatile organic compounds were also detected in saturated soil samples collected from this monitor well from the first through fifth waterbearing zones. However, these concentrations may have reflected cross-contamination from installation of the monitor well. Therefore, the Regional Water Quality Control Board requested borehole sampling to verify the findings.

In the second remedial investigation a total of 36 grab soil samples and 5 surface soil samples were collected in the septic system leach field area. A total of 12 boreholes were also drilled as part of the second remedial investigation; four 20-ft boreholes in the southern waste oil area, four 30-ft boreholes in the east waste oil area, one 20-ft borehole near the underground storage tank, and three 30-ft boreholes at non–point source locations. Although elevated concentrations of various organic compounds and metals were detected at many of these locations (see Tables 4.17-15 and 4.17-16), the contaminants were generally limited to the upper 5 ft.

The Trudell Auto Repair Shop site remediation objective was to ensure that human health and the environment were protected. An interim remedial measure by excavation was implemented in June 1990. Soil contamination consisting of fuel hydrocarbon compounds (benzene, toluene, ethylbenzene, and xylene) and metals (see Table 4.17-15 and Table

4.17-16) was remediated through removal of soils to a maximum depth of 8 ft and offsite disposal. All contaminated soil was removed to a licensed disposal facility. In addition, a previously unidentified hydrocarbon underground storage tank was also removed. Sampling during the excavation verified that the source areas were removed.

The Trudell Auto Repair Shop site is within the boundaries of an existing contaminant plume in the alluvial aquifer system (DOE, 1990f). The results of the interim remedial action removed all contaminated soils at this site. Soil contamination was not present below a depth of 20 ft at this site, and ground water is at a depth of approximately 80 ft. Therefore, ground water contamination below and in the vicinity of the site cannot be attributed to the sources of soil contamination at the Trudell Auto Repair Shop site. Closure was approved by the California Regional Water Quality Control Board on November 16, 1990.

On November 16, 1990, the Regional Water Quality Control Board completed its review of the Trudell Auto Repair Shop Feasibility Study Report (DOE, 1990f) and status reports documenting the cleanup, and issued a finding that the reports addressed the Board's concerns. Accordingly, the Board noted that provisions C.2.a and C.2.b of the SNL, Livermore cleanup order 89-184 were satisfied. Further activities, therefore, are unnecessary at the Trudell Auto Repair Shop site.

Miscellaneous Sites

A preliminary assessment/site inspection was performed by DOE at SNL, Livermore in 1986. The results of this inspection concluded that, because of the nature of previous activities performed, no site posed an immediate threat to human health and the environment. However, various sites had a potential for low levels of soil contamination because of the historical activities performed at these locations (DOE, 1991b). These sites are identified as the SNL, Livermore Miscellaneous Sites, including Arroyo Seco, a former trash dump area, a fire extinguisher training area, two waste material storage areas, and a high explosives burn pit. These sites were also investigated during DOE Environmental Survey Audit with associated sampling that was performed at SNL, Livermore in 1988 (DOE, 1991b). The data collected during the Environmental Study Audit supported the conclusions of the preliminary assessment/site inspection (DOE, 1989d). However, upon review of the data that were reported in the Survey Data Report, analytical values were found to be questionable and could not be used to verify that a site did or did not contain contaminated soils. Therefore, a second soil sampling program was performed in 1991 (DOE, 1991b).

SNL, Livermore was required by the Regional Water Quality Control Board to identify the location of all potential sources of hazardous materials disposed, or discharged, at its facility and to determine if a discharge to soil or ground water had occurred. Although no compliance deadline was identified, SNL, Livermore performed a Reconnaissance Investigation in June 1991. Investigation findings concluded that no organic or inorganic contaminants above RCRA action levels were present. Tests also indicated no leaching potential for gasoline and diesel. No organic or inorganic constituents appear to be migrating from any of the miscellaneous sites (DOE, 1991b). The results of this investigation were submitted to the Regional Water Quality Control Board in the fourth quarter of 1991. The acceptance of closure of these sites by the Regional Water Quality Control Board is pending, and no further action at these locations by SNL, Livermore is expected.

Information available for each of the SNL, Livermore miscellaneous sites is summarized below.

<u>Arroyo Seco</u>

Storm water from SNL, Livermore is periodically discharged as runoff into Arroyo Seco. Soil samples were collected in the arroyo during DOE Environmental Survey Audit (DOE, 1989d).

DOE Environmental Survey Audit (DOE, 1989d) identified Arroyo Seco as the receptor of non-point source water discharged as runoff from SNL, Livermore. There was no indication of contamination in arroyo sediments collected during this survey (DOE, 1989c). However, because of uncertainties in the data, additional sampling was recommended to verify the absence of contamination (DOE, 1991b).

The Arroyo Seco Area is an active ephemeral drainage. Only drainage from the storm water sewer discharges currently enter the Arroyo Seco drainage. New sources are not expected, although undocumented historical releases may contribute to any contamination.

The maximum concentrations of organic constituents of di-n-butyl phthalate (0.7 mg/kg), phenol (26.0 mg/kg), and beta BHG (0.038 mg/kg) were below proposed Resource Conservation and Recovery Act (RCRA) action levels of 8000, 50,000, and 4 mg/kg, respectively (40 C.F.R. 264). The maximum levels of total petroleum hydrocarbons (11 mg/kg) and toluene (0.006 mg/kg) were below the State of California maximum allowable levels of 100 and 20,000 mg/kg, respectively, using Table 2-1, Leaching Potential Analysis for Gasoline and Diesel, from the Leaking Underground Fuel Tank Manual (SWRCB, 1989). Organic and inorganic constituents identified in Arroyo Seco are not contaminants of concern.

Sediments in Arroyo Seco were also analyzed for selected radionuclides, gross alpha, and gross beta. Cesium-137, potassium-40, gross alpha, and gross beta concentrations detected in Arroyo Seco sediments were considered to be naturally occurring background concentrations. Further downstream, the tritium concentrations drop, and there is no significant difference between upstream and downstream concentrations of tritium. Concentrations of tritium in Arroyo Seco sediments were low, and soil-pore water is not considered to be a drinking water source; therefore, tritium does not pose a risk to human health or the environment, and radionuclides are not considered to be contaminants of concern at the SNL, Livermore Arroyo Seco site.

Former Trash Dump Adjacent to Arroyo Seco

Near-surface samples were collected at 15 locations at Arroyo Seco. Near-surface samples were collected from approximately 1-ft to 3-ft depths.

Previous owners of the SNL, Livermore property used a portion of Arroyo Seco as a trash dump. The trash was removed to the Livermore city dump (DOE, 1986c), and in 1970 Arroyo Seco was rechanneled. Soil and concrete were dumped into the former trash dump to prevent erosion. Records show that no hazardous constituents were present in the trash in this fill material. Sampling was not performed at this location, although it was recommended to verify the absence of contaminated soils (DOE, 1991b).

Several extractable organic compounds and volatile organic compounds were detected at very low concentrations during DOE Environmental Survey Audit (DOE, 1989d). Radiochemical and metals analyses were performed, but contamination was not detected. In 1991, near-surface and subsurface soil samples were collected at three borehole locations near the Former Trash Dump. No organic and inorganic constituents of concern were identified in the Former Trash Dump Area.

Fire Extinguisher Training Area

The Fire Extinguisher Training Area was located east of Building 961. During training exercises, waste solvents or gasoline were poured on the ground, ignited, and then extinguished by trainees. Approximately 10 training sessions were held each year from 1959 to 1978.

DOE Environmental Survey Audit (DOE, 1989d) identified the Fire Extinguisher Training Area as potentially contaminated, but data for this location shows no contaminated soils (DOE, 1989d). Concentrations of metals in samples from the fire extinguisher training area were below regulatory limits (DOE, 1989d). Several extractable organic compounds and volatile organic compounds were detected at concentrations below the contract-required detection limit. Radiochemistry identified gross alpha, gross beta, potassium-40, and cesium-137 in concentrations similar to those in Arroyo Seco.

Based upon the uncertainty in the Environmental Survey Audit data, additional sampling was performed. Nine near-surface samples and two boreholes were completed in the Old Fire Extinguisher Training Area. No contaminants of concern were identified at the SNL Old Fire Extinguisher Training Area site (DOE, 1991b).

Building 918 and Building 961 Storage Areas

Both the decontamination and waste storage area associated with Building 961 and a storage area surrounding

Building 918 (Figure 4.17-10) were identified as requiring investigation during the preliminary site inspection (DOE, 1986c). Raw stocks of metals, oils, solvents, acids, and compressed gases were stored in the surrounding area. There are no sumps or drains leading into the sewer line from this building. Waste oil drums were stored on the west side of Building 918, and occasionally, when rainwater collected in them, these drums overflowed. SNL, Livermore has installed berms at the Building 918 and 961 areas to prevent spills from migrating into Arroyo Seco. Open drums are no longer stored onsite.

No surface or subsurface samples had been collected at these locations, and no additional information was known about the possible presence of contaminants. DOE, therefore, recommended surface and subsurface soil sampling (DOE, 1991b). The Building 918 and Building 961 storage areas are active storage areas, and currently comply with all applicable state and federal regulations for storage of hazardous materials.

Five near-surface samples and two boreholes were completed at the Building 918 storage area. Laboratory analyses did not detect elevated concentrations of organic compounds in the borehole samples. Metals were not detected above the background concentrations found at SNL, Livermore in any of the near-surface soil samples. Therefore, organic and inorganic constituents in the SNL Building 918 storage area are not considered to be contaminants of concern.

Five near-surface samples and two boreholes were completed in the Building 961 storage area. Metals were not detected above the background concentrations found at SNL, Livermore in any of the near-surface soil or borehole samples. There were no organic or inorganic contaminants of concern were detected at the SNL, Livermore Building 961 storage area site.

Navy Landfill Burn Pit

A high explosives burn pit (approximately 30 by 30 ft and about 10 to 20 ft deep) was located east of the Navy Landfill incinerator (DOE, 1991b). Lithium, potassium, and sodium scrap were treated here by burning or spraying with water. The reactive nature of the metals treated in the pit is not known (DOE, 1991b). The burn pit became inactive in the 1950s and has since been filled and paved over.

No surface or subsurface samples had been collected at these locations, and no additional information was known regarding the possible presence of contaminants. DOE, therefore, recommended surface and subsurface soil sampling (DOE, 1991b).

Metals were found in concentrations slightly higher than background levels during DOE Environmental Survey Audit (DOE, 1986c). Extractable and volatile organic compounds were identified, but were below the contract-required detection limit. Radiochemistry identified gross alpha, gross beta, potassium-40, and cesium-137 in concentrations similar to those found in Arroyo Seco. However, based upon the uncertainty in the Environmental Survey Audit data, additional sampling was performed.

One borehole was sampled in the Former Burn Pit. No organic contaminants were detected in analytical laboratory assays of borehole samples. Low levels of nickel, cobalt, and barium above the background concentrations for metals at SNL, Livermore were detected in borehole samples. However, the concentrations of these constituents were below background concentration ranges found in natural soils in the western United States and below the proposed RCRA action levels for nickel and barium in soil. No proposed RCRA action level exists for cobalt in soil. Cobalt is not considered to be a threat to human health and the environment at SNL. The burn pit is also covered by asphalt, and there would be no migration. Therefore, there were no organic or inorganic contaminants of concern detected at the SNL, Livermore former burn pit site (DOE, 1991b).

Table 4.17-15 Summary of Potential and Detected Soil Contaminants[a] at SNL, Livermore

	Potential Soil Contaminant							Soil Contaminants Detected at

Area	VOC	FHC	Metals	PCB	Rad	HE	Other	Concentrations Above Detection Limit
Navy Landfill Area	Y	N	Y	N	N	Y	1,2	None identified
Fuel Oil Spill Area	N	Y	N	N	N	N		**FHC:** B, T, X, E, diesel
Trudell Auto Repair Shop (remediated)	Y	Y	Y	N	N	N	2	**VOC:** PCE, TCE, methylene chloride, acetone **FHC:** B, T, X, E, fluoranthene, heavy and light hydrocarbons, 2-methylnaphthalene, naphthalene, oil and grease, bis(2-ethylhexyl)phthalate,* di-n-octylphthalate **Metals:** As, Cd, Cr, Pb, Zn, Ba, Co, Cu, Ni, Ag, Ti **Other:** Assorted pesticides, 2-butanone
Arroyo Seco	Y	Y	N	Y	Y	N	2	None identified
Former Trash Dump Area	N	N	N	N	N	N		None identified
Fire Extinguisher Training Area	N	Y	N	N	N	N		None identified
Building 918/961 Decon Storage Area	N	Y	Y	Y	N	N		None identified
Burn Pit at Navy Landfill	N	N	Y	N	N	Y		**Metals:** Pb, Ni, Zn
Building 962 Storage Area	N	N	N	N	N	N	2	None identified

* = Possible laboratory contaminant
FHC = Fuel Hydrocarbon Compound
TCE= Trichloroethylene
Co= Cobalt
1 = Trichloroacetic acid, acetone
HE = High explosives (includes RDX, HMX)
As = Arsenic
Cu = Copper
2 = Pesticides
B = Benzene
Cd = Cadmium
Ni = Nickel Y =
Potential soil contaminant
T = Toluene
Cr = Chromium
Ag = Silver
N = Not a potential soil contaminant
X = Xylene
Pb = Lead
Ti = Titanium
VOC = Volatile organic compound
E = Ethylbenzene

Zn = Zinc
Rad = Radiological constituent
PCE = Perchloroethylene
Ba = Barium

[a] Based upon known or suspected contaminant releases or hazardous materials use, storage, or disposal practices suggestive of a potential release.
Source: DOE, 1986c, 1989c, 1990f, 1991b.

Table 4.17-16 Summary of Soil Concentrations for Potential Source Investigations at SNL, Livermore

Areas Investigated	Range of Total VOCs[a](ppb)	Range of Total Aromatic Hydrocarbons	Range of Total PCBs (ppb)	Range of Tritium Activities (pCi/kg)[b]	Metals
Navy Landfill Area	Trace to low	N/D	N/D[c]	N/A[d]	>STLC[e]
Fuel Oil Spill Area	N/D	High	N/D	N/D	>STLC
Trudell Auto Repair Shop[f]	Very low	Moderatef	N/D	N/D	<STLC
Arroyo Seco	N/D	Trace	N/D	11,000–31,000 pCi/kg	>STLC
Former Trash Dump Area	N/D	N/D	N/D	N/A	
Fire Extinguisher Training Area	Trace	N/D	N/D	N/A	
Building 918/961 Decon Storage Area	Trace	Very low	Very low	N/A	
Burn Pit at Navy Landfill	N/D	N/D	N/D	N/A	

[a]Trace = <5 ppb.
Very low=5–49 ppb.
Low = 50–449 ppb.
Moderate?= 500–5000 ppb.
High = >5,000 ppb.
[b] pCi/kg = picocuries per kilogram.
[c] N/D = Not detected.
[d] N/A = Not analyzed.
[e] STLC = Soluble Threshold Limit Concentration.
[f] Site remediated. Soils removed and disposed of in an appropriate landfill.

Note: Concentration ranges and qualifiers (e.g. low, medium, high, etc.) not based on regulatory action levels. See text for discussion of those areas which have been determined, based on site specific risk assessment criteria, to require remediation.

Source: DOE, 1986c, 1989c, 1989d, 1990b, 1990c, 1990f, 1991b.

Table 4.17-17 SNL, Livermore Environmental Restoration Activities Summary

Area	Period of Operation	Comments
Navy Landfill	1942 to 1960	Remedial investigation completed, contamination was not confirmed. Submittal of SWAT Report June 1990[a] complete. Awaiting final decision by RWQCB.[b] Regrading and erosion control planned.
Fuel Oil Spill	1975 to present	Remedial investigation completed, risk assessment indicates minimal risk and feasibility study completed. Bench/pilot study for in situ bioremediation design/implementation and remediation planned.
Trudell Auto Repair Shop	Early 1950s to 1965; fuel storage in 1970s	Remedial investigation completed, feasibility study completed, and site was remediated. The site is considered closed by the RWQCB. No activities planned.
Miscellaneous Sites		
Arroyo Seco	1943 to present	No contaminants of concern were identified at any SNL Miscellaneous Site (DOE, 1991b).
Former Trash Dump	Removed 1970	No contaminants of concern were identified at any SNL Miscellaneous Site (DOE, 1991b).
Fire Extinguisher Training	1959 to 1978	No contaminants of concern were identified at any SNL Miscellaneous Site (DOE, 1991b).
Building 918/961 Decon/Storage Area	? to present	No contaminants of concern were identified at any SNL Miscellaneous Site (DOE, 1991b).
Burn Pit	To mid-1970s	No contaminants of concern were identified at any SNL Miscellaneous Site (DOE, 1991b).

[a] (DOE, 1990c).
[b]RWQCB = Regional Water Quality Control Board.

Table 4.17-18 Key Area Investigation References for SNL, Livermore

Area	Key References
Navy Landfill	Rowe, 1960 Alhquist et al., 1985 DOE, 1989d

	DOE, 1990c CRWQCB, 1986
Fuel Oil Spill	DOE, 1986c DOE, 1990b
Trudell Auto Repair Shop	DOE, 1986c DOE, 1989c DOE, 1990f
Miscellaneous Sites	DOE, 1991b DOE, 1986c

Table 4.17-19 Summary of Potential and Detected Ground Water Contaminantsa at SNL, Livermore

Area	Soil Contaminant							Water Contaminants Detected
	VOC	FHC	Metals	PCB	Rad	HE	Other	
Navy Landfill Area	Y	N	N	N	N	N	1,2	**VOC:** oil and grease
Fuel Oil Spill Area	N	Y	N	N	N	N		**FHC:** B **Metals:** Mn, Fe
Trudell Auto Repair Shop (remediated)	Y	Y	Y	N	N	N	2	N/A*[b]
Arroyo Seco	Y	Y	N	Y	Y	N	2	N/A[c]
Former Trash Dump Area	N	Y	N	N	N	N		N/A[c]
Fire Extinguisher Training Area	N	Y	N	N	N	N		N/A[c]
Building 918/961 Decon Storage Area	N	Y	Y	Y	N	N		N/A[c]
Burn Pit at Navy Landfill	N	N	Y	N	N	Y		N/A[c]
Building 962 Storage Area	N	N	N	N	N	N	2	

1 = Trichloroacetic acid, acetone
2 = Pesticides
Y = Potential soil contaminant
N = Not a potential soil contaminant
VOC = Volatile organic compound
Rad = Radiological constituent
HE = High explosives (includes RDX, HMX)

B = Benzene
FHC = Fuel Hydrocarbon Compound
PCE = Perchloroethylene
TCE = Trichloroethylene
Mn = Manganese
Fe = Iron

[a] Based upon known or suspected contaminant releases or hazardous materials use, storage, or disposal practices strongly suggestive of a potential release.

[b] Trudell site cleanup and remedial action has been performed; ground water contamination underlying site is currently being investigated by LLNL, Livermore.

[c] No soil contaminants identified during site remedial investigation (DOE, 1991b). N/A = Not applicable.

4.17.4.3 Site Contamination—Site-Wide Summary

Site investigations at SNL, Livermore have focused on three major areas—the Navy Landfill, Fuel Oil Spill, and Trudell Auto Repair Shop—and six Miscellaneous Sites located throughout the SNL, Livermore facility. Soil and ground water investigations were first initiated at the Navy Landfill in 1985. No mixed or radioactive wastes were detected. Initial sampling results for shallow soils revealed low concentrations of acetone, dichloromethylene, trichloroacetic acid, Freon-113, copper, and lead. No constituents were detected in ground water. Upon additional investigation these soil contaminants were verified to be below regulatory action levels, and SNL, Livermore has requested to the Regional Water Quality Control Board that no further action be performed at this location. SNL, Livermore is planning to landscape the area and provide surface water runoff control measures. This activity is planned to ensure slope stabilization of the Navy Landfill site. Ground water monitoring of the existing monitoring wells will continue to be performed as part of the SNL, Livermore environmental monitoring program.

A fuel oil spill resulted from the accidental puncture of a pipe transfer line leading from an above ground diesel fuel storage tank. This site has been extensively characterized for soil contamination present at this location. Due to an increase in the depth to first ground water, ground water has not been affected at this site. Bench scale study tests have identified the feasibility of in situ biomediation as an implementable and cost-effective remedial action technology to cleanup the contaminated soils at this location. Presently, a pilot study is being designed to implement this technology at the fuel oil spill site. Based upon the results of the pilot study full scale remediation activities will be performed.

The Trudell Auto Repair Shop was obtained by SNL, Livermore in 1987 as part of their security enhancement program. Soils contaminated during the operations of the auto repair shop were present at the site when DOE obtained this property. DOE investigated the nature and extent of contaminated soils at this location. Site remediation activities occurred in 1990, and the Regional Water Quality Control Board has been satisfied that site cleanup responsibilities have been completed and no further action is warranted at this location.

Several miscellaneous sites were identified during a preliminary assessment/site inspection at the SNL, Livermore facility. Potentially contaminated soils at these locations were investigated in 1991 and no soil contaminants were identified. The results of this investigation were submitted to the Regional Water Quality Control Board in the fourth quarter of 1991. Regulatory review of these results and of the SNL, Livermore request for no further action at these locations is anticipated.

4.18 ENVIRONMENTAL COMPLIANCE AND INADVERTENT RELEASES

LLNL and SNL, Livermore must comply with all applicable federal, state, and local environmental regulations implemented by a variety of regulatory agencies including the Environmental Protection Agency, California Department of Toxic Substances Control (previously the California Department of Health Services), California Department of Fish and Game, regional water quality control districts, local air pollution control districts, county health departments, and the City of Livermore Water Reclamation Plant.

In 1989 the Secretary of Energy, James D. Watkins, established teams (Tiger Teams) to assess the ES&H programs and their management commitment to ES&H for all DOE facilities, and to determine if changes were needed to improve the protection of the environment, safety, and health. These Tiger Team Assessments of LLNL and SNL, Livermore, conducted from February to May 1990, identified a number of key findings in the area of quality assurance and quality control of environment, safety, and health programs. Both LLNL and SNL, Livermore have addressed and are continuing to take steps to address the deficiencies that were noted. (A more complete discussion of the Tiger Team Assessments can be found in Appendix C.)

The Environmental Protection Department of LLNL and the Environment, Safety and Health Department of SNL, Livermore conduct programs to assess compliance with applicable environmental regulations, and to estimate the impacts of operations on the environment, including the effectiveness of effluent control measures. The results of these internal monitoring programs are reported annually to DOE and to other appropriate federal, state, and local regulatory agencies. The results are published and available to the general public in the Laboratories' annual environmental reports.

Environmental analysts from the Laboratories assist in the day-to-day activities such as waste management, waste minimization, and pollution abatement control. Compliance status is maintained and verified by a staff who keep informed of all existing and planned activities, review construction documents, inspect facilities, and audit waste management procedures.

LLNL and SNL, Livermore conduct facility inspections to scrutinize proper handling and management of hazardous and radioactive wastes, as well as other critical aspects of waste generation and handling, in an effort to minimize environmental impacts. Trained personnel investigate, sample, and evaluate all potentially hazardous spills and leaks to the environment. After cleanup operations are conducted, the affected areas are sampled to verify that the cleanup has been successful. All spills, leaks, and releases that are required to be reported are reported to the appropriate regulatory agencies.

Tables 4.18-1 and 4.18-2, respectively, list the permits held by LLNL during 1990 and those held by SNL, Livermore during 1990.

Tables 4.18-3 and 4.18-4 summarize the regulatory agency inspections and audits conducted at the LLNL Livermore site and LLNL Site 300, respectively (LLNL, 1991f, 1992a). Table 4.18-5 summarizes the regulatory inspections and audits pertaining to SNL, Livermore during 1990 and 1991 (SNL, Livermore, 1991i, 1992b). Findings resulting from these activities are summarized below and are representative of the type of regulatory oversight that may be expected to continue into the future.

The more recent inspections have not identified new compliance concerns at either LLNL or SNL, Livermore.

LLNL Livermore Site—Regulatory Inspections and Audits

Air Inspections

The Bay Area Air Quality Management District conducted 20 days of inspections at the LLNL Livermore site during 1990. Inspections were conducted to review start-up of new equipment and operation of existing equipment with permits. As a result of these inspections, the Laboratory received three Notices of Violation. They were issued for operating a silk-screening unit without proper controls (the district interpreted this unit as regulated by rules pertaining to cold cleaners, rather than by the surface preparation rules LLNL thought applicable); operating two paint spray booths without permits; and using an improper mix of thinner in paint, resulting in too much volatile organic content. In response to these Notices of Violation the Laboratory took the following actions: the silk-screening unit was shut down until the rule applicability could be sorted out and compliance measures taken; the paint spray booths received permits to operate; and the paint shop corrected its mixing proportions of thinner to paint.

Hazardous Waste Inspections

The Department of Health Services inspected LLNL hazardous waste management units and generator operations on February 26 and 28, 1990. An inspection report was received in May. It cited the following: containers were improperly labeled (three containers were observed that either lacked labels or had labels that were only partially completed); one container located at a satellite work station was open; a fire extinguisher at one waste accumulation area (WAA) lacked a tag documenting maintenance activities; and one WAA lacked a readily accessible eyewash/safety shower. The Laboratory corrected the observed violations and responded to DHS with documentation of corrections in a letter dated June 26, 1990. DHS issued a Return to Compliance letter on September 3, 1990.

On September 21, 1990, the EPA visited the Livermore site as part of a nationwide information gathering effort to review training programs for incinerator operators. Although the LLNL incinerator has not operated since 1988, the inspector reviewed the historical training records on file. Staff who had operated the incinerator in the past also were interviewed. No report was sent to the Laboratory regarding the findings of this survey.

Tank Inspections

In January 1990, an inspector from the Alameda County Health Department inspected the floor of the Building 322 plating shop for approval of coating material and sampling procedures. Approvals were granted. The inspector returned on November 20 to inspect tank 298-R1U1 and analytical records for several other tanks.

Sewer Discharge Inspections

The Livermore Water Reclamation Plant spent 10 days onsite during Calendar Year (CY) 1990 inspecting and sampling discharges. Each of these inspections is summarized briefly below.

The Livermore Water Reclamation Plant inspector spent 2 separate days in February and March reviewing the Building 322 plating shop. This area was inspected first in February; during the March inspection, samples of the Building 322 plating shop wastewater discharge were collected. No formal reports were issued by the Livermore Water Reclamation Plant.

On April 30, specific areas of Buildings 196 (Sewer Monitoring Station), 197 (semiconductor and metal finishing process), 514 (Liquid Waste Treatment), 612 (Waste Storage), 131 (Microfab Processing Laboratory), and 253 (Hazards Control Bright-Dip Operation) were inspected by the Livermore Water Reclamation Plant. No violations were noted; however, the inspector arranged to return to participate in the quarterly pretreatment program. Split samples were collected on May 8, 9, and 18. The inspector observed a pH excursion. Corrective action was taken while sampling at Building 131.

On May 31, the inspector toured a construction site checking for potential sewer discharge concerns. None were noted.

Pretreatment processes were inspected and sampled at Buildings 131 and 253 on August 15. The inspector requested modifications at the Building 131 sampling location. These modifications subsequently were completed and reported to the Livermore Water Reclamation Plant.

On November 5, the Livermore Water Reclamation Plant inspected and sampled the Building 321 water jet, inspected various processes at Buildings 406 and 691, and toured the sewer diversion facility. No issues were noted by the inspector.

On December 10, samples were collected at Building 141, and the Building 251 facility was inspected. The Livermore Water Reclamation Plant inspector requested modifications to aid sample collection at Building 141 as well as construction of a berm around the Building 251 tank system. The modifications at Building 141 were completed and the design and construction of the berm were initiated as part of the retention tank upgrade project.

LLNL Site 300—Regulatory Inspections and Audits

Air Inspections

On June 12, 1990, the San Joaquin County Air Pollution Control District conducted an inspection of the vapor recovery system; no discrepancies were found.

Hazardous Waste Inspections

The EPA conducted an inspection of hazardous waste management activities on March 21, 1990 which resulted in a Warning Letter being issued to LLNL on June 28, 1990. This letter included the inspection report, which identified conditions at the facility at the time of the inspection, areas of noncompliance with RCRA regulations, and potential RCRA violations. Specific observations identified in the inspection report included the following:

- Hazardous wastewater was stored for more than 90 days in a portable tank, and records of weekly inspections for leaks or deterioration were not available;
- Accumulation start dates were not identified on labels for two waste containers held at a waste accumulation area;
- The emergency coordinator was not clearly defined in contingency plans;
- Training records lacked a description of the hazardous waste training requirements;
- Employees working alone did not have immediate access to external emergency assistance at one waste accumulation area;
- Three plans used at LLNL Site 300 to respond to various contingencies were incomplete and inconsistent;
- A written report of a leak from a retention tank containing oily wastewater was not filed with the EPA;
- An exception report was not filed for one manifest; the waste minimization plan was not submitted to regulatory agencies by December 27, 1989;
- Signs were needed to designate storage areas within the permitted storage area;
- A container of lead shot (D008) was observed in the permitted storage unit, although that waste stream is not identified in the permit;
- Land disposal restriction (LDR) notifications were not provided with three manifests;
- The appropriate treatment standard was not marked on one manifest;
- The proper EPA waste code was not shown on one waste container filled with Freon.

In response to these observations, LLNL made the necessary corrections and provided the EPA with documentation to support the corrections. The EPA sent LLNL a letter dated August 22, 1990, which stated that LLNL had addressed the violations and documented the facility's return to compliance with the regulations cited in the inspection report.

On August 8, DHS toured the two landfills being considered for closure pursuant to the Closure/Postclosure Plans originally submitted in 1988. This tour was an opportunity for DHS staff and management to become more familiar with the project and the proposed closure activities.

Staff from the EPA viewed the Environmental Restoration Division ground water investigation activities in the eastern General Services Area on November 14 as part of their general oversight of the CERCLA investigations.

Tank Inspections

On three occasions in 1990, San Joaquin County Public Health Services Staff visited LLNL Site 300 to witness soil sampling that was part of closure activities for three underground tank systems. On May 30, 1990, soil sampling was performed to complete closure of the already-removed underground diesel fuel tank system at Building 873. On June

27 soil sampling was performed coincident with the removal of the diesel fuel tank at Building 874, and on November 11 soil sampling was performed in conjunction with the removal of a small underground tank that received drainage from a drum storage area (since removed) at Building 875.

SNL, Livermore—Regulatory Inspections and Audits

Air Inspections

The Bay Area Air Quality Management District (BAAQMD) inspected SNL, Livermore air emissions sources on April 12, May 31, and August 31, 1990. A Notice of Violation (NOV) was issued to Sandia for three violations. These violations were administrative in nature (none involved exceeding allowable emissions) and included: failure to notify the Bay Area Air Quality Management District of an inactive landfill and onsite cooling towers, and operation of unpermitted sources. In response to the NOV, SNL, Livermore promptly notified the Bay Area Air Quality Management District of the inactive landfill and provided detailed information.

Since 1987 the landfill has been part of the California Solid Waste Water Quality Assessment Test (SWAT) Program. Because the site is being remediated through a California Regional Water Quality Control Board order, it was inadvertently unreported to the Bay Area Air Quality Management District. SNL responded promptly to the Bay Area Air Quality Management District on cooling towers in use and the treatment chemicals used onsite. In response to the issue of unpermitted sources, SNL initiated a sitewide air emissions inventory. This inventory evaluates and documents all equipment and materials usage to ensure compliance with air quality regulations. Applications and permit exemptions have been submitted.

Sewer Discharge Inspections

The Livermore Water Reclamation Plant inspected SNL, Livermore on three occasions in 1990. Livermore Water Reclamation Plant inspected the onsite sewer monitoring on July 16, 1990; the noncategorical waste process stream on July 17, 1990; and the onsite categorical sources (Electroplating Facility and Printed Wiring Facility) for compliance with federal pretreatment standards on February 26, 1990.

Hazardous Waste Inspections

The California Department of Health Services (now the Department of Toxic Substances Control) inspected the site on October 17, 1990. A Report of Violation alleging twelve violations of the Health and Safety Code was issued. The violations included inadequate labeling, improper signage, a missing contingency plan, lack of a permit for Bays 6 and 7 in Building 9622, storage of excess waste, failure to store waste in designated areas, aerosol cans without caps, and waste in open containers. SNL, Livermore has submitted a formal response to Department of Toxic Substances Control. DOE and SNL, Livermore are currently negotiating with Department of Toxic Substances Control to resolve these issues.

The Environmental Protection Agency (EPA) visited the site on March 8, 1990. They reviewed the waste analysis plan and the incinerator plan. The EPA issued a warning letter requiring revision and resubmission of the waste analysis plan and incinerator plan. SNL, Livermore revised and resubmitted these plans and has written subsequent plans since 1990.

On August 8, 1991, the California Department of Toxic Substances Control performed a waste management inspection at SNL, Livermore. A Report of Violation was issued. The violations included accumulation paperwork that was incorrect; two waste containers not closed; one waste container in poor condition; and silver recording paper improperly labelled. SNL, Livermore submitted a formal response in April 1992 to resolve these issues.

LLNL and SNL, Livermore—Summary of Inadvertent Releases

Table 4.18-6 summarizes inadvertent incidents that have occurred at LLNL from 1980 to April 1991; Table 4.18-7 summarizes inadvertent incidents that have occurred at SNL, Livermore from 1980 to July 1992. These tables represent a best effort to identify all incidents that may have had the potential to adversely affect the environment. The information in these tables has been obtained from the Unusual Occurrence Reports (LLNL, 1991t, 1992c; SNL, Livermore, 1991l, 1992c) that have been reported to DOE by LLNL and SNL, Livermore.

Table 4.18-1 Permits Held by LLNL Livermore Site and LLNL Site 300 During 1990

Permits	Regulatory Agency
LLNL Livermore: 192 permits for air emissions and equipment operation	BAAQMD
Waste Discharge Requirements Order No. 88-075 for discharge of treated ground water to ponds, and Permit No. 90-106 for discharge of treated ground water to storm drains	RWQCB
Hazardous Waste (Interim Status Document CA2890012584)	EPA, DTSC
Sewer Discharge Permit No. 1205A	LWRP, RWQCB
Permits for 65 storage tanks	ACHD
Federal Facility Agreement for Livermore ground water investigation/remediation	RWQCB, EPA, DTSC
LLNL Site 300: Nine permits for air emissions and equipment operation	SJCAPCD
Waste Discharge Requirements; Order No. 80-184 for Class II-1 solid waste landfills, Order 82-105 for cooling tower discharges, Order 85-188 for sanitary and industrial wastewater discharges to ponds and septic systems	RWQCB
Hazardous Waste, Part B Permit CA2890090002 for hazardous waste storage and Interim Status for open burning of high explosives	EPA, DTSC
Permits for 15 storage tanks	San Joaquin County

ACHD = Alameda County Health Department.
BAAQMD = Bay Area Air Quality Management District.
DTSC = Department of Toxic Substances Control.
EPA = Environmental Protection Agency.
LWRP = Livermore Water Reclamation Plant.
SJCAPCD = San Joaquin County Air Pollution Control District.
RWQCB = Regional Water Quality Control Board.

Table 4.18-2 Permits Held by SNL, Livermore During 1990

Permits	Regulatory Requirements and Implementing Agency	Category
BAAQMD permit for 16 air emission sources. Permits renewed annually.	BAAQMD	Air Q uality
EPA NESHAP permit for TRL low-level tritium evaporator. Trial run completed; permit approved.	40 C.F.R. 61 (NESHAP), EPA	Air Quality
Permit for site sanitary and industrial wastewater discharge. Permit renewed annually.	City Ordinance, City of Livermore	Wastewater Discharge
1983 RCRA Part B permit expired 12/88. Renewal filed 6/88, SNL is currently operating under interim status.	40 C.F.R. 264 (RCRA), EPA 22 C.C.R. Chapter 30, DHS	Waste Management
One underground storage tank registered; two underground storage tanks removed 12/20/89.	23 C.C.R. 2611-2714 Cal. UST Reg., Alam. Co., DHS	Waste Management
Extremely Hazardous Waste Permits for transporting hazardous waste offsite. Six were issued in 1990: 1/30/90—#2-12008, 2/15/90—#2-12076, 4/24/90—#2-12303, 4/24/90—#2-12304, 5/9/90—#2-12340, 7/23/90—#2-12580	22 C.C.R. 66570(b) DHS	Waste Management
Permit for Medical Waste	Alameda County Department of Environmental Health	
Incinerator Emergency Permit	EPA; Cal. EPA	Waste Management

BAAQMD = Bay Area Air Quality Management District.
CFR = Code of Federal Regulations.
DHS = California Department of Health Services.
EPA = Environmental Protection Agency.
NESHAP = National Emission Standards for Hazardous Air Pollutants.
TRL = Tritium Research Laboratory.

Table 4.18-3 Compliance Summary for 1990 and 1991—LLNL Livermore Site

Audits/Inspections (date)	Regulatory Agency
Annual Inspection of permitted units (January 9, 11, 24, 1990)	BAAQMD
Inspection of B322* floor for approval of coating (January 1990)	ACHD
Waste Accumulation Area and Hazardous Waste Management inspection (February 26 and	DHS

28, 1990)	
Inspect B322 plating shop (February 1990)	LWRP
Sampling of B322 plating shop discharge and total effluent at B196 (March 1990)	LWRP
Inspect specific discharges at B131, 196, 197, 253, 514, and 612 (April 30, 1990)	LWRP
Quarterly Pretreatment Sampling of Wastewater discharges (May 8, 9, and 18, 1990)	LWRP
Inspect newly permitted units (May 21, 1990)	BAAQMD
B321 asbestos removal (May 25, 1990)	BAAQMD
B391 LaNSA construction site (May 31, 1990)	LWRP
B272 refurbishment project, discussion of B196 and Facility A (June 14, 1990)	BAAQMD
B141 vapor degreasers, B166, T1786,* B383, and B391 cold cleaners (June 15, 1990)	BAAQMD
Permitted sources inspection of seven boilers, three vapor degreasers and one spray cleaner (June 28, 1990)	BAAQMD
Permitted sources inspection of two boilers, three cold cleaners and one solvent cleaner (June 29, 1990)	BAAQMD
B332 fuming box scrubber and B322 solvent cleaner (August 3, 1990)	BAAQMD
Permitted source inspection B224 milling machine, B175 solvent cleaner (August 9, 1990)	BAAQMD
Inspect and sample B131 and B253 for pretreatment program (August 15, 1990)	LWRP
Permitted sources, three solvent cleaners in B321 and various lathes (August 17, 1990)	BAAQMD
Review out-of-service sources (paperwork) and B511 degreasers (September 12, 1990)	BAAQMD
B418 paint spray booths, view Facility B for Permit to Operate (September 26, 1990)	BAAQMD
Inspect permitted air sources (October 3, 1990)	BAAQMD
Incinerator training records (October 4, 1990)	EPA
Inspect permitted air sources (October 10, 1990)	BAAQMD
Inspect Sources at B169B, 381, 611, and 691 (October 23, 1990)	BAAQMD
Inspect B418 paint shop sources and collect samples (November 5, 1990)	BAAQMD
Inspect and sample B321 water jet, inspect various processes at B406 and B691, tour sewer diversion facility (November 8, 1990)	LWRP
Inspect sources at B418, 432, 438, and 490 (November 16, 1990)	BAAQMD
Review underground tank records (November 20, 1990)	ACHD

Inspect B438 to verify compliance (November 30, 1990)	BAAQMD
Inspect B141 and B251 discharges (December 10, 1990)	LWRP
Compliance Evaluation Inspection of hazardous waste management facilities, selected generator operations, and temporary storage units (January 9-15, February 5, 1991)	DTSC
Inspect and sample processes at B197 and 511 (February 6, 1991)	LWRP
Inspect process and retention tank at B131 (March 1, 1991)	LWRP
Inspect and sample process and retention tank at B131 and 141 (April 25)	LWRP
B298 retention tank inspection (July 1991)	ACHD
Inspect B193, 196, 251, 253 (July 31, 1991)	LWRP
Inspect B321L, 322, and sampled process at B151 (September 10, 1991)	LWRP
Review of processes in B322, 253, 193, 196 (September 13, 1991)	LWRP, EPA, CWRB, SFRWQCB
Inspect and sample B321C and 251 (October 30, 1991)	LWRP
Inspect and sample B253 and 343 (November 18, 1991)	LWRP
Review start-up of new equipment; inspect operation of existing permitted equipment (20 days in 1991)	BAAQMD

* B indicates building number, and T indicates trailer number.

ACHD = Alameda County Health Department.
BAAQMD = Bay Area Air Quality Management District.
CWRB = California Water Resources Board.
DHS = California Department of Health Services.
DTSC = California Department of Toxic Substances Control.
EPA = Environmental Protection Agency.
LWRP = Livermore Water Reclamation Plant.
SFRWQCB = San Francisco Regional Water Quality Control Board.

Table 4.18-4 Compliance Summary for 1990 and 1991—LLNL Site 300

Audits/Inspections (date)	Regulatory Agency
S-300 RCRA inspection (March 21, 1990)	EPA
Annual *Amsinckia grandiflora* count (April 4, 1990)	USFW & CDFG
S-300 WDR 85-188 (April 5, 1990)	RWQCB-CV

Witness soil sampling at B874 former diesel tank location (May 30, 1990)	SJCPHS
Vapor recovery system (June 12, 1990)	SJCAPCD
Inspect tank closure at B874 (June 27, 1990)	SJCPHS
Familiarization tour for landfill closure at LLNL Site 300 (Aug 8, 1990)	DHS
View Pit 6 fault (End Sept., 1990)	California Mines & Geology
Water quality (Oct. 11, 1990)	RWQCB-CV
B875 tank closure (Nov. 5, 1990)	SJCPHS
View eastern GSA cleanup (Nov. 14, 1990)	EPA
Appraisal of overall tank program (Nov. 13-30, 1990)	DOE
Underground fuel tanks inspection (March 26 and April 11, 1991)	SJCPHS
Inspection of RCRA-regulated units (May 28, 1991)	EPA
Inspections of air sources (3 days in 1991)	SJCAPCD

CDFG = California Department of Fish and Game.
DHS = California Department of Health Services.
EPA = Environmental Protection Agency.
RWQCB-CV = Regional Water Quality Control Board—Central Valley Region.
SJCAPCD = San Joaquin County Air Pollution Control District.
SJCPHS = San Joaquin County Public Health Services.
USFW = United States Fish and Wildlife Service.

Table 4.18-5 Compliance Summary for 1990 and 1991—SNL, Livermore

Audits/Inspections (date)	Regulatory Agency
Federal wastewater pretreatment inspection (February 26, 1990)	LWRP
EPA inspection (March 8, 1990)	EPA
Permitted air discharge sources (April 12 and May 31, 1990)	BAAQMD
DHS inspection (June 20 and 22, 1990)	DHS
Process wastewater discharge inspection (July 16–17, 1990)	LWRP
Permitted air discharge sources (August 31, 1990)	BAAQMD
Process wastewater inspection (December 13, 1990)	LWRP
Process wastewater discharge inspection (January 30, 1991)	LWRP

Federal pretreatment compliance inspection (May 24, 1991)	LWRP
Air discharge sources (July 18, 1991)	BAAQMD
Process wastewater discharge inspection (September 4, 1991)	LWRP

BAAQMD = Bay Area Air Quality Management District.
DHS = California Department of Health Services.
EPA = Environmental Protection Agency.
LWRP = Livermore Water Reclamation Plant.

Table 4.18-6 LLNL Inadvertent Events with the Potential for Environmental Impacts

Date	Material Released	Description of Event	Consequences and/or Actions Taken*
4/8/80	Plutonium	Glovebox burst contaminating the laboratory and releasing 2.6×10^{-7} Ci of plutonium to the environment.	No worker exposures, no offsite consequences.
4/16/80	Plutonium	Fire-generated pressure caused leaky glovebox. Plutonium escaped into a room in Building 332.	No worker exposures, no offsite consequences.
Before 1982	Actinium-227 and curium-244	Actinium-227 and curium-244 leaked or were spilled onto asphalt.	The contaminated asphalt was removed and disposed of as radioactive waste.
Before 1982	Tritium and organic solvents	Sampling in an area of a Taxi Strip Area, which was used between 1955 and 1976 as a disposal site, revealed soils contaminated with tritium, trichlorethylene, tetrachloroethylene, and chloroform.	The affected soils were removed in 1984 and disposed of as radioactive waste.
1983	Curium-244	0.002 Ci of curium-244 was accidentally spilled onto the soil.	The spill did not impact the environment. The material was completely recovered and was properly disposed of.
6/8/84	Tritium	Human error resulted in the release of 5000 Ci of tritium to the environment.	No offsite consequences, no action required.
Before 7/19/84	Metals, PCBs, and radioactive materials	An abandoned landfill was discovered near the east LLNL Livermore site boundary. Soil sample analysis revealed contamination from lead, zinc, copper, cadmium, PCBs, and low-level radioactive contamination including cesium-137, radium-226, uranium-238, thorium-232, and americium-241.	The contaminated soils were excavated and disposed of at approved waste disposal sites.
1985	Petroleum products	During testing of 60 tank systems, leaks were discovered in the piping systems of 9 tanks.	The piping systems were either repaired and retested, or decommissioned. Contaminated material was removed and properly disposed of.

1/25/85	Tritium	Human error resulted in the release of 1000 Ci of tritium from Building 331.	No worker exposures, no offsite consequences.
9/86	Chromium and nickel	50 lb of chromium and nickel were accidentally released to the sewer.	The wastewater was diverted into a Livermore Water Reclamation Plant holding pond which prevented it from contaminating the sewage treatment process.
4/15/87	Unknown milky-white substance	Inadvertent release into the storm drain lines.	Approximately 2000 gal of the material, which is believed to be paint residues from paint cleaning equipment, were collected and disposed of as hazardous waste.
8/18/87	Tritium	Human error during tritium unloading operation resulted in the release of 110 Ci of tritium into the laboratory and exhausted to the environment.	The worker received a radiation dose equivalent of 0.015 rem. A person at the site boundary would have received a radiation dose equivalent of 1×10^{-7} rem.
10/7/87	Mixed waste	A mixed waste spill occurred as a result of human error.	Approximately 100 gal of waste (pH 1.1), containing 250 ppm of depleted uranium and 1600 ppm of volatile halogenated solvents, spilled as a result of a partially open valve. The spill was remediated and the contaminated materials were shipped to a licensed disposal facility.
10/19/87	Hazardous waste	Less than 5 gal of hazardous wastewater containing chromium and other constituents were released to the storage drain when a tank overflowed during a steam-cleaning operation.	No sewer discharge limits were exceeded.
4/25/88	Acidic uranium solution	Approximately 500 mL of liquid (pH 2.0) containing 3.9×10^{-4} Ci/mL of uranium and nine other materials were spilled due to human error.	The spill was remediated.
4/26/88	Mixed acids	Roughly 0.5 gal of mixed acids were released due to an eruptive reaction that occurred during a Bulking Operation.	The spill was neutralized and recovered for proper disposal. Five workers were treated for minor injuries caused by exposure to the vapor plume.
4/26/88	Mixed acids	Roughly 1 to 3 gal of mixed acids were released due to an eruptive reaction that occurred during a bulking operation.	The spill was neutralized and recovered for proper disposal. As a result of exposure to the vapor plume, 41 workers received medical attention.
5/10/88	Plutonium	During a microscope disassembly operation a worker inhaled approximately 5×10^{-10} Ci of plutonium. The worker did not know that the microscope was contaminated.	The worker received an effective dose equivalent of 0.1 rem. The minor surface contamination resulting from the incident was cleaned up.
6/13/88	Waste oil mixture	Leaking 55-gal drum.	The spill was cleaned up and the recovered materials properly disposed of as hazardous waste. The spill did not

			impact the environment.
7/1/88	Dielectric fluids	Equipment failure resulted in a fire involving less than 2 gal of dielectric fluid (less than 1 ppm PCB), and approximately 105 gal of dielectric fluid.	The fire was extinguished and the area was properly cleaned up. The incident did not impact the environment.
7/25/88	Convoil-20	Less than 5 gal of 100 percent Convoil-20 (petroleum distillate pump oil) leaked from a 55-gal drum.	The spill was cleaned up and the recovered materials properly disposed of as hazardous waste.
8/24/88	Reagent=grade phenol	Approximately 1.5 gal of 98 percent reagent-grade phenol leaked from a 55-gal drum as a result of human error.	The spill was cleaned up and the recovered materials properly disposed of as hazardous waste. Air monitoring indicated that air concentrations did not exceed the TLV level.
8/26/88	Methyl alcohol and tritium	Approximately 1 gal of 20 percent methyl alcohol and 8×10^{-9} Ci of tritium escaped from a leaking 55-gal drum.	All spilled materials were recovered. Swipe testing indicated that the area had been properly decontaminated. No soil or water was impacted.
8/29/88	Mixed waste	From 5 to 10 gal of liquid waste containing low levels of metals (Cr[III] 9.0 ppm, Be 45 ppm), and radioactivity (alpha 3.8×10^{-10} Ci/mL, beta 3.9×10^{-10} Ci/mL, tritium 1.3×10^{-7} Ci/mL) spilled from a leaking tank during a pipe transfer operation.	The material was cleaned up and disposed of as mixed waste. No soil or water was impacted.
9/20/88	Low-level radioactive waste	Approximately 30 gal of low-level, liquid radioactive waste escaped through a defective seal during a pipe transfer operation.	Approximately 10 gal of the spilled material was recovered; the remainder was lost through evaporation. Swipe testing indicated no residual traces of radioactive contamination.
9/22/88	Chemical carcinogen	Roughly 1 gal of 1 percent PCC-1 list waste (chemical carcinogens) in a saline solution leaked from a defective 55-gal drum.	The spill was cleaned up and the area decontaminated. The spill did not impact the environment.
9/28/88	Chromium and sodium dichromate	Approximately 20 gal of 50 percent Kodak sodium dichromate bleach solution containing 1.75 lb of chromium were spilled during a tank transfer operation.	The material was recovered. All contaminated soil was recovered, and removed, and the affected surfaces were decontaminated.
10/15/88	Metals and volatile halogenated solvents	As a result of human error, 1 gallon of a retention tank wastewater solution containing copper (72 ppm), chromium (600 ppm), nickel (160 ppm), zinc (12.4 ppm), beryllium (0.4 ppm), and 450 ppm of volatile halogenated solvents was spilled.	The material was recovered and disposed of as hazardous waste.
10/21/88	Chromium and sodium dichromate	Less than 1 pint of waste Kodak sodium dichromate bleach solution containing 8749 mg/L of chromium leaked from a drain seal.	The material, except for a small portion of the liquid that was lost by evaporation, was recovered and disposed of as hazardous material. The spill did not impact the environment.

11/11/88	Uranium	An unspecified amount of uranium oxide was released into a laboratory as a result of human error.	The material was trapped in filters and no radioactivity was released to the environment. Contaminated personnel were decontaminated and examined by the Medical Department.
12/5/88	Methanol	Less than 10 gal of methanol leaked from a defective 55-gal drum.	Most of the material was lost to the environment due to evaporation. The remainder was cleaned up and disposed of as hazardous waste. The spill did not impact the environment.
2/23/89	Machining coolant	10 gal of wastewater containing a small fraction of machining coolant evaporated into the environment as a result of an exothermic reaction in a waste drum.	The drum was removed to a covered area to allow the reaction to go to completion.
4/13/89	Photographic waste material	Less than 1 pint of photographic waste material was spilled as a result of human error.	The contaminated cleanup materials, rocks, and soils were removed and treated as hazardous waste. Sampling was conducted to confirm that the cleanup was complete. Surface water and ground water were not impacted.
4/18/89	Diesel fuel	From 20 to 30 gal of diesel fuel were spilled as a result of human error.	All of the material was recovered. The contaminated cleanup materials and soil were disposed of as hazardous waste. The incident did not impact surface water or ground water.
7/17/89	Insulating oil and Freon 113	Roughly 2000 gal of wastewater contaminated with insulating oil (2500 ppm) and Freon 113 were released to the surrounding gravel as a result of human error.	The incident was reported to the Regional Water Quality Control Board.
7/28/89	Sulfamic acid and potassium dichromate	Approximately 16 gal of microfilm bleach solution (a mixture of sulfamic acid and potassium dichromate in an aqueous solution) spilled onto a laboratory floor as a result of a pump failure.	The spilled material was recovered and placed in storage drums. No material was released to the environment.
8/9/89	Gasoline	Approximately 5 gal of gasoline spilled from a ruptured automobile gasoline tank.	Three gal of the material were recovered. Materials used in the cleanup were disposed of as hazardous waste. The spill did not contaminate the soil or ground water.
8/25/89	Tritium	Due to human error, 297 Ci of tritium was released to the environment. Based on stack monitoring information, this release consisted of 7 Ci of tritiated water vapor and 290 Ci of tritium gas.	The estimated radiation dose equivalent at the fenceline was conservatively estimated to be 0.0007 mrem.
9/8/89	Chromium and lead	As a result of human error, 75 to 100 gal of paint booth wastewater containing lead (40 ppm) and chromium (8 ppm) were spilled	Five gal of the material were lost to the sewer, 10 to 20 gal were recovered, and the balance evaporated into the

		onto the floor.	environment. The contaminated soil was removed and disposed of as hazardous waste. Samples were taken to determine if further remedial action was required.
11/15/89	Chlorinated fluorocarbons	Approximately 3 gal of chlorinated fluorocarbons spilled from a leaky 55-gal drum.	The affected areas were cleaned up and the wastes from the cleaning operation were appropriately handled. A survey of the area indicated that no radioactive materials were involved in the spill.
1/17/90	Trimethylamine	Approximately 0.375 lb was spilled from a leaking cylinder.	No material was recovered. The cylinder was moved from its original location to a fume hood.
1/18/90	Methyl ethyl ketone	Approximately 50 lb were spilled due to a drum puncture at Building 612.	Approximately 1 gal of the estimated 6 gal was recovered by absorption into clay absorbents applied to the spill. Material not absorbed evaporated to the atmosphere.
2/9/90	High explosives and photo process rinsewater	Leak in liner of LLNL Site 300 surface impoundment pond.	100 percent of the material that leaked through the primary liner was intercepted by the leachate collection system and returned to the overflow pond.
3/2/90	Various paint-related products and other containers	Suspect midnight dump or abandonment comprising of 55 containers.	All containers were intact and there was no evidence of leakage. There was no release to the environment (i.e., air, water, or land).
8/23/90	Battery acid (sulfuric acid)	0.57 gal were spilled when two batteries were knocked off the top of a pallet onto the asphalt.	100 percent of the material was recovered by using a baking soda and water mixture to neutralize the acid and an absorbent to collect the liquid.
12/12/90	Battery electrolyte solution containing lead	3.9 gal were spilled onto other batteries, shelf, and floor of building due a puncture of one battery.	100 percent of the material was recovered by using a neutralizing agent/absorbent onto the spilled electrolyte solution.
12/26/90	Washdown water containing oil (DTE) and Freon 113	Approximately 25 gal were spilled when a copper pipe slipped out of a rubber gasket.	Visibly contaminated soil was excavated and soil samples will be taken to confirm cleanup.
2/5/91	High explosives process water	Approximately 500 gal were released due to a crack in the pump.	No materials were recovered. A valve was installed between the tank and the pump so that the tank can be isolated from the pump in the future.
4/2/91	Tritium	An estimated 144 Ci of tritium were released into the laboratory when a valve failed.	The worker received an effective dose equivalent of 1.1 rem. The potential radiation dose at the fenceline was estimated to be less than 1×10^{-5} rem.

* Information excerpted from previous reports; no new analyses were prepared for this EIS/EIR.

Table 4.18-7 SNL, Livermore Inadvertent Events with the Potential for Environmental Impacts

Date[a]	Material Released	Description of Event	Consequences and/or Actions Taken
7/20/84	Tritium	Certified, high-pressure gas, stainless-steel nipple failed as a result of a crack during a disassembly operation. This resulted in the release of 2.5 Ci of tritiated water into the laboratory.	One worker received a radiation dose equivalent to 1.65 rem, another received 0.145 rem, and five others received less than 0.045 rem. No offsite consequences. Facilities and procedures for an array of experiments were reviewed and upgraded.
9/4/84 and 9/28/84	Nickel sulfamate	Tank overflow resulted in the release of nickel sulfamate into the site sanitary sewer system.	The affected sewer was diverted into a holding pond, thus preventing upset of the sewage treatment plant.
1/10/86	Tritium	40 ml of contaminated water containing 200 Ci of tritium were inadvertently released from a leak in a storage container caused by corrosion.	No worker exposure. No offsite consequences. Enclosure of regeneration water recovery operation in glovebox was performed.
2/13/87	Tritium	3000-Ci glovebox release.	No worker exposure. No offsite consequences. Reviewed experimental design and changed procedure for packing disks for future experiments. No corrective action required. The tritium was removed by the gas purification system already in operation.
8/18/87	Tritium	1110 Ci of tritium were inadvertently released as result of human error, during disassembly of a charging vessel.	The tritium was released to the environment. The worker received an effective dose equivalent to 0.015 rem. The potential effective dose equivalent at the site boundary was calculated to be 0.001 rem. Training and safety procedures were reviewed with staff.
10/6/88	Tritium	124 Ci of tritium were inadvertently released to the environment due to an error in the drier regenerations program.	No worker exposure. No offsite consequences. Drier regeneration procedures and time between regeneration.
2/6/89	Tritium	Several hundred gal of wastewater, containing 18 Ci of tritium, were released as a result of an equipment failure.	The released wastewater was collected in a wastewater holding tank. No environmental release occurred. Equipment design was reevaluated to consider extreme weather conditions.
3/6/89	Tritium	11.5 Ci of tritium were inadvertently released during maintenance activities.	No offsite consequences. Maintenance personnel are being trained on procedures for pump maintenance.
4/15-21/91	Cyanide	Sanitary sewer effluent exceeded allowable discharge for cyanide. Measured concentration 0.05 mg/L	LWRP[b] notified. Re-analysis of sample by contract laboratory was requested and done. No impact to employees, the public or operations at LWRP, or the environment.
5/13-	Copper	Exceedence of wastewater discharge	LWRP notified. Re-analysis requested and done. All

19/91	and zinc	limit for copper and zinc: 4.5 mg/l (limit is 3.0 mg/l). Normal reading is <1.0 mg/l.	sources of zinc checked. Bulletin to employees re-iterating wastewater discharge limits and policy.
5/28/92	Tritium	4 Ci released by gasket leak in Tritium Research Laboratory.	Investigation being conducted.
6/1/92	Tritium	36 Ci released through Tritium Research Laboratory stack failure after failure of a pressure regulator.	Investigation being conducted.

[a] There were no inadvertent events reported in 1982, 1983, 1985, and 1990

[b] LWRP = Livermore Water Reclamation Plant

4.19 ENVIRONMENTAL IMPACTS OF CONTAMINATION

The extent of ground water and soil contamination at the LLNL Livermore site, LLNL Site 300, and SNL, Livermore is presented in section 4.17. Cleanup and remediation are required by law and the Laboratories are fully committed to these efforts; however, for purposes of a complete analysis of the existing setting, this section presents a discussion of the environmental effects on the existing environment assuming no remediation. If no remediation of ground water or soils were to occur, and ongoing characterization efforts were to cease, potential environmental impacts could result. These impacts are summarized below.

LLNL Livermore Site

As part of the evaluation of remedial alternatives for ground water and soil cleanup at the LLNL Livermore site conducted under the Federal Facilities Agreement, a no remediation alternative was evaluated (Dresen et al., 1991) to provide a baseline from which to evaluate the various remedial alternatives. Potential environmental impacts that could occur as the result of the no remediation scenario are summarized below.

- Failure to remediate ground water and soil to regulatory agency–approved levels would place DOE in a situation of noncompliance with state and federal laws.
- Volatile organic compounds, fuel hydrocarbons, and tritium within the unsaturated zone soils would continue to migrate through the soil column to the ground water. Ground water would most likely be impacted at the Building 518 Area, the East Traffic Circle/Taxi Strip Area, the Gasoline Spill Area, and the Building 292 Area.
- Concentrations of contaminants in ground water and soil would continue to exceed state and federal regulatory levels.
- Continued degradation of the Livermore area ground water would occur as the plume(s) continued to migrate. The volatile organic compound and fuel hydrocarbon plumes would continue to migrate downgradient toward local water supply wells and City of Livermore municipal wells. This could inhibit future beneficial uses of increasingly greater proportions of the aquifer system (Isherwood et al., 1990). Over time, however, reduction in chemical concentrations would occur through natural attenuation processes, including biodegradation, dispersion, and abiotic degradation (Isherwood et al., 1990).

Ten active domestic drinking water supply wells and seven industrial and/or agricultural supply wells are located within 1 mile of the LLNL Livermore site volatile organic compounds ground water plume. These wells are generally either transverse, cross- or upgradient, or are in a different ground water regime; therefore, they do not appear to be in the direct (downgradient) flow path of the plume (see Figures 4.11-6 and 4.11-8). Should lateral dispersal be significant, or should a change in ground water flow direction occur (which are both highly unlikely scenarios based on existing data), these wells could be potentially impacted by the advancing plume(s). Additionally, although further development of the ground water resource in the vicinity of the volatile organic compound plumes for domestic consumption is unlikely, development of additional water sources for irrigation is highly possible (Isherwood et al., 1990).

- Ground water models used in the remedial investigation (Thorpe et al., 1990) indicate that at an average ground water velocity of 70 ft/year, the closest municipal water supply wells would not be impacted for approximately 270 years if no remediation occurred. If contaminated ground water were to reach municipal wells, economic impacts associated with the loss of water resources to local water consumers could result. Water purveyors now supplying water pumped from municipal wells to constituents might need to treat the contaminated water sources or purchase water from other sources, resulting in increased water costs. Given the length of time predicted for such an impact to occur, and the estimated concentration after 270 years of only 1.5 ppb for total volatile organic compounds in ground water (well below volatile organic compound maximum contaminant levels) (Isherwood et al., 1990), the impact would be minimal. This "Best Estimate" case assumes a migration rate based on current data and on the assumption that some degradation and retardation or slowing of the chemical (50-year half-life) has occurred. Assuming that chemicals will not be retarded or degraded, the arrival time (or the estimated length of time it would take for the highest concentration of chemicals to reach the hypothetical well) is estimated to be 110 years ("Health Conservative Case").

- Assuming that no remediation occurs and contamination reaches municipal wells, and that an individual consumes 2 liters of water each day from a municipal well in downtown Livermore for a 70-year (lifetime) period, the maximum additional cancer risk from a lifetime exposure to volatile organic compounds (including trichloroethylene, perchloroethylene, chloroform, and carbon tetrachloride) could be 7 in 10 million (Best Estimate Case) and 1 in 1000 (Health Conservative Case) (Dresen et al., 1991). This risk is much lower than the normal 1 in 4 cancer risk faced by all Americans due to both natural and artificial (i.e., medical) radiation exposures.
- Assuming that an individual consumes 2 liters of water each day from a potential drinking water well located 250 ft west of the LLNL Livermore site boundary for a 70-year (lifetime) period, the maximum additional cancer risk from exposure to these same constituents would be 2 in 1000 (Dresen et al., 1991). This Health Conservative Case scenario assumes an arrival time of 35 years. A 50-year half-life for contaminants is also assumed. However, administrative controls discouraging the use of this water for drinking and the availability of municipal water would continue under agency programs and greatly reduce, if not eliminate, the possibility of such a Health Conservative Case.
- Tritium would continue to migrate through soils to ground water and in ground water in the East Traffic Circle/Taxi Strip Area and Building 292 Area. By the time the tritium reached the LLNL Livermore site boundary, however, the tritium would have naturally decayed to levels below the drinking water standard.
- Chromium in ground water would continue to migrate downgradient and offsite. However, the levels of chromium are so low that combined with further dilution and natural attenuation, chromium would not likely represent an offsite health threat.
- Potential contaminant source areas that have not been investigated and remediated could continue to contribute to the soil and ground water contamination problem. Investigations have not yet been completed on over 17 potential source areas.

LLNL Site 300

At present seven individual investigations are being conducted to mitigate contamination at LLNL Site 300. These include the Building 833 Area, the Pit 6 Landfill Area, the High Explosive Process Area, the General Services Area, the Pit 7 Complex, the Building 834 Complex, and the Building 850/East Firing Area. Details of the extent of contamination and proposed remedial action strategies are presented in section 4.17.

Additionally, a Site Wide Remedial Investigation Report and Baseline Risk Assessment are currently being prepared for LLNL Site 300. The remedial action alternatives, risk assessments, and impacts evaluations presented below are preliminary pending completion of these sitewide evaluations.

<u>Building 833</u>

- Failure to remediate soils to regulatory agency–approved levels would place DOE in a situation of noncompliance with state and federal laws.
- Assuming no remediation is performed, the volatile organic compounds (including trichloroethylene, perchloroethylene, and 1,2-dichloroethene) in the vicinity of Building 833 would continue to migrate downward through the unsaturated zone and through areas with ephemeral perched ground water.
- Concentrations of volatile organic compounds in ground water and soils would continue to exceed state and federal regulatory limits.
- Due to the great depth of the regional (Neroly lower blue sandstone) aquifer (270 ft) and intervening aquitard units, it is unlikely that the chemicals in the shallow unsaturated zone would reach this regional ground water aquifer.
- Assuming that a drinking water well was installed in the regional aquifer near Building 833 (counter to current administrative controls) and that trichloroethylene migrated to this aquifer with a resultant concentration of 1.5 mg/L, the worst-case estimate of incremental cancer risk is 1 in 1 million. This risk is based in part on a Designated Level Methodology attenuation factor of 1000 (Webster-Scholten et al., 1991).
- Because the nearest water supply wells are located over 2000 ft southeast of the Building 833 Area in the

General Services Area, it is unlikely that the volatile organic compounds listed above would ever reach these wells in detectable concentrations (Webster-Scholten et al., 1991).

Pit 6 Landfill Area

- Failure to remediate ground water and soil to regulatory agency–approved levels would place DOE in a situation of noncompliance with state and federal laws.
- Assuming no remediation, the low-concentration trichloroethylene plume would continue to migrate downward through the unsaturated zone and downgradient in the general direction of the Ranger well, a private water supply well located offsite approximately 850 ft from the leading edge of the plume. The plume, however, would not likely migrate offsite, based on analysis of hydrogeologic conditions (Taffet et al., 1991), and no trichloroethylene has ever been detected in the Ranger well.
- Concentrations of volatile organic compounds (trichloroethylene) in ground water would continue to exceed state and federal regulatory limits although concentrations are declining.
- The plume undergoes self-remediation through evaporation and photodegradation as a large portion of the waterbearing zone is evaporating at a point where the waterbearing strata crop out immediately north of the Corral Hollow Creek floodplain.
- Assuming that no remediation occurs, contamination reaches the Ranger well and that the well water is consumed for 70 years, 6 to 1000 people could be exposed to ground water from the Ranger water supply well containing trichloroethylene at 15 mg/L and perchloroethene at 2.5 mg/L (Taffet et al., 1991). The aggregate incremental cancer risk associated with this worst-case, long-term exposure was calculated at about 6.1 in 1 million to 1.4 in 10,000; therefore, risk to human health from long-term exposure to the volatile organic compound–contaminated ground water has been determined to be minimal (Taffet et al., 1991).
- The beneficial use of the shallow aquifer would continue to be impacted in the plume area; however, this impact would be minimal as there are currently no water supply wells in the plume area and administrative controls limit the use of the affected ground water. Furthermore, the affected aquifer has poor water supply potential with estimated maximum yields of several gallons per minute (Taffet et al., 1991).

High Explosive Process Area

- Assuming no remediation is performed, the high explosive compounds RDX and HMX, as well as trichlorethylene, would continue to migrate downward through the unsaturated zone into the perched aquifers and deeper Neroly upper blue sandstone aquifer.
- The high explosive compounds and trichloroethylene would continue to migrate downgradient towards the water supply wells located in the General Services Area. (Well 20 is located within about 500 ft of the inferred edge of the trichloroethylene plume (see Carlsen, 1991).)
- The risks to public health and the environment associated with the soil and ground water contamination and the need for site remediation at the High Explosive Process Area are currently being evaluated in the Site Wide Remedial Investigation Report and Baseline Risk Assessment for LLNL Site 300.

General Services Area

- The three volatile organic compound plumes, if not remediated, would continue to migrate downward through the unsaturated zone and downgradient by natural processes thus affecting a larger portion of the shallow alluvial aquifer, and potentially migrating to deeper aquifers currently used in the area for water supply.
- Trichloroethylene would remain at levels above the drinking water standard if ground water and soil were not remediated to regulatory agency–approved levels. This would place DOE in a situation of noncompliance with state and federal laws.
- Two of the plumes, if not remediated, would continue to move toward potential receptor wells, CDF-1 and CON-1, located about 800 ft downgradient on private ranch land. No volatile organic compounds have been detected in these wells to date. Based on modeling, the exposure point concentrations at these potential receptor points are conservatively estimated to be 15 mg/L for trichloroethylene and 2.5 mg/L for perchloroethylene (McIlvride et al., 1990).

Assuming no remediation occurs, contamination reaches the wells and the water is consumed, the incremental cancer risks for this hypothetical migration scenario range from 5.4 in 1 million to 1.0 in 10,000 for trichloroethylene, and 6.9 in 10 million to 3.7 in 1 million for perchloroethylene using conservative assumptions (McIlvride et al., 1990).

Pit 7 Complex

- Failure to remediate ground water and soil to regulatory agency–approved levels would place DOE in a situation of noncompliance with state and federal laws.
- The tritium plumes at the Pit 7 Complex would continue to migrate downgradient, thus affecting a larger portion of the shallow aquifer system.
- Natural radioactive decay and dispersion would prevent offsite migration of ground water with greater than 1000 pCi/L of tritium, one-tenth the drinking water standard (Taffet et al., 1989).
- The ground water beneficial use would be impacted for at least several times the 12.3 year half-life of tritium within the plume boundaries. Institutional controls to restrict access to tritiated ground water would continue, however, and no ground water–producing wells are located within or near the plume boundary. Without remediation, tritium activities in ground water would continue to exceed the drinking water standards for at least several half-lives.

Building 834 Complex[(6)]

- Failure to remediate ground water and soil to regulatory agency–approved levels would place DOE in a situation of noncompliance with state and federal laws.
- Without remediation the volatile organic compound ground water plume which includes trichloroethylene, perchloroethylene, 1,2-dichloroethene, 1,1-dichloroethene, and methylene chloride would continue to migrate through the unsaturated zone. It is highly unlikely that contamination would migrate through the perched zone into the Neroly upper sandstone aquifer, and potentially into the regional lower Neroly sandstone aquifer, found at a depth of 280 ft beneath the Building 834 Complex.
- Concentrations of volatile organic compounds would continue to exceed state and federal regulatory limits.
- Preliminary estimated cancer risks for the key indicator chemicals trichloroethylene and perchloroethylene are 4.3 in 1000 and 8.9 in 1000 using maximum ground water concentrations of 120,000 ppb and 5300 ppb respectively (see Bryn et al., 1990).
- Preliminary risk assessments (Bryn et al., 1990) have determined that the potential exposure pathways for dermal contact, ingestion, or inhalation of volatile organic compounds in shallow soils beneath the Building 834 Complex are currently incomplete, because most affected soils are covered and no construction is planned in this area, and an upper-bound cancer risk of 1.8 in 10 million for inhalation of volatilized trichloroethylene is estimated.
- Should soil disturbance occur in the affected area, the estimated cancer risks for exposure to trichloroethylene and perchloroethylene due to inhalation are 4.29 in 100 and 8.86 in 100, respectively. Administrative controls would prevent such soil disturbances.

Building 850/East Firing Area

- Failure to remediate ground water and soil to regulatory agency–approved levels would place DOE in a situation of noncompliance with state and federal laws.
- Without remediation, tritium would continue to migrate from the unsaturated zone beneath the firing table soils to the perched waterbearing zone in the shallow alluvium, to underlying decomposed bedrock and, in certain areas, to the regional water-bearing zone. Tritium could also potentially be discharged in springs during periods of very high rainfall.
- Affected ground water would potentially discharge to the surface via the Well 8 Spring and Spring 6 located in Do-all Ravine. While not human receptor points, the springs are potentially exposure points for animals (Taffet and Oberdorfer, 1991).
- Preliminary worst-case calculations of the dose received from human consumption of tritium-bearing ground water from exposure points at the LLNL Site 300 boundary indicated a dose of 4.6 mrem/year (assuming an exposure point activity of 26,600 pCi/L and a predicted arrival time of 47 years). The estimated site boundary

excess cancer risk for this worst-case scenario is 1.3 in 1 million. Dose calculations for the nearest exposure point (LLNL Site 300 supply wells) yielded 0.7 mrem/year using a predicted arrival time of 80 years for water containing 4100 pCi/L. The incremental cancer risk for this scenario is 1.3 in 1 million.

- Dose calculations (Taffet and Oberdorfer, 1991) analogous to those above indicate that approximately 0.8 mrem/year would be received by using water from the offsite wells CDF-1 and CON-1 for an unlikely Health Conservative Case (assuming an exposure point concentration of 1000 pCi/L and an arrival time of 78 years). The incremental cancer risk associated with this scenario is negligible.
- Various tritium migration scenarios to LLNL Site 300 water supply wells and to the nearest offsite wells (the nearest offsite well lies 2.8 km to the north/northeast and is not in a downgradient direction) show that no significant increase in cancer risk would occur from utilization of ground water at the site boundary.
- Natural radioactive decay (12.3 year half-life) and dispersion would provide for self-remediation of the tritium plume. Tritium concentrations in ground water would continue to exceed the drinking water standard for a number of half-lives assuming no remediation is performed.
- The shallow ground water resource within the plume boundary would be affected for a number of half-lives. No drinking water supply wells, however, currently tap water in or near the plume area (Taffet and Oberdorfer, 1991), and administrative controls over the use of water from Well 1 and the installation of additional supply wells remain in effect.

SNL, Livermore

Presently, remediation is planned for only one site at SNL, Livermore, the fuel oil spill. Under the no remediation scenario, no additional measures would be taken to remediate the diesel fuel–contaminated soil at the site. The extent of diesel contamination in soils is summarized in section 4.17. Potential environmental impacts as a result of this no remediation scenario are presented below.

- The diesel contamination would continue to slowly migrate downwards to the water table. Although contaminants do not migrate appreciably under present conditions, a rise in the ground water level could result in contamination of the ground water by benzene.
- Soil contaminant concentrations (benzene) would continue to exceed state and federal regulatory limits.
- Failure to remediate soils (and potentially ground water) to regulatory agency–approved levels would place DOE in a situation of noncompliance with state and federal laws.
- Ground water beneath SNL, Livermore is not used as a drinking water source. Furthermore, the potentially affected aquifer has poor supply potential. Assuming that this water source is used as a routine source of drinking water with 3.5 mg/L of benzene (the maximum concentration detected in ground water) a total lifetime cancer risk of 5.7 in 1 million is calculated (DOE, 1990b).
- The lifetime cancer risk for benzene from drinking water (leachate) from the fuel oil spill has been estimated at 4.6 in 10,000. The cancer risk from ingesting leachate containing polycyclic aromatic hydrocarbons is 4.6 in 100 million (DOE, 1991b).
- Should benzene levels exceed 0.7 mg/L (California maximum contaminant levels), the beneficial use of the shallow aquifer beneath the fuel oil spill within the resultant plume boundary would be impacted, and downgradient water production wells could be impacted. Dispersion and natural attenuation would likely reduce contaminant concentrations to concentrations below maximum contaminant levels prior to reaching these receptors.

SECTION 4 REFERENCES

15 U.S.C. 2601, Toxic Substances Control Act, as amended, 15 U.S.C. sections 2601 et seq.

16 U.S.C. 470 et seq., 1966, National Historic Preservation Act, as amended.

33 U.S.C. 1251, The Federal Water Pollution Control Act, as amended, 33 U.S.C. sections 1251 et seq.

40 C.F.R. Part 61, National Emission Standards for Hazardous Air Pollutants.

42 U.S.C. 300, The Safe Water Drinking Act, as amended, 42 U.S.C. sections 300 et seq.

42 U.S.C. 6901, The Resource Conservation and Recovery Act of 1976, as amended, Title 42, U.S.C. 6901 et seq.

42 U.S.C. 7401, The Clean Air Act, as amended, 42 U.S.C. sections 7401 et seq.

42 U.S.C. sections 4321, The National Environmental Policy Act of 1969, as amended, 42 U.S.C. section 4321 et seq.

42 U.S.C. sections 4901 et seq., Noise Control Act of 1972, as amended, October 1972.

48 Fed. Reg. 44716–44742, 1983, *National Park Service Sets Forth Guidelines for Archaeology and Historic Preservation Activities and Methods*, September 29, 1983.

51 Fed. Reg. 1092–1216, 1986, *NRC Extends to May 12, 1986 Comment Deadline on NPRN (December 20, 1985 Fed. Reg. 51992) to Provide Requirements for Protection of Individuals Exposed to Ionizing Radiation from Routine Activities at NRC Licensed Plants*, January 9, 1986.

56 Fed. Reg. 40,446–40,480, 1990, *Floodplain and Wetland Notification for Remedial Action at Site 300*.

56 Fed. Reg. 58,804-58,836, 1991, *Endangered and Threatened Wildlife and Plants; Animal Candidate Review for Listing as Endangered or Threatened Species, Proposed Rule*.

Ahlquist, A. J., T. K. Devlin, and R. W. Ferenbaugh, 1985, *Status Report on Use, Storage, and Disposal of Hazardous Materials at Sandia National Laboratories, Livermore*, status report to California Regional Water Quality Control Board, Sandia National Laboratories, Livermore, Livermore, CA, March 30, 1985.

Association of Bay Area Governments, 1989, *Projections 90*, Oakland, CA.

Association of Bay Area Governments, 1990, *Economic Information Directory for the San Francisco Bay Area*, Oakland, CA.

Atwater, T., 1970, "Implications of Plate Tectonics for the Cenozoic Tectonic Evolution of Western North America," *Geologic Society of America Bulletin*, 81:3513–3536.

BAAQMD, 1991, *Bay Area Quality Management District Summary of Emissions By Major Source Categories, Annual Average Inventory*, Bay Area Air Quality Management District, San Francisco, CA.

BEIR-V, 1990, *Health Effects of Exposures to Low Levels of Ionizing Radiation*, Committee on the Biological Effects of Ionizing Radiations, Board on Radiation Effects Research, Commission on Life Science, National Research Council, National Academy Press, 1990.

Bell, Allen, 1991, City of Tracy, personal communication, May 13, 1991.

Bio-Tech, 1983, *A Study of the Biotic Resources of the Carnegie New Town Project, San Joaquin County, California*, prepared for the County of San Joaquin, CA.

Bolt, B. A., T. V. McEvilly, and R.A. Uhrhammer, 1981, "The Livermore Valley, California, Sequence of January 1980," *Bulletin of the Seismological Society of America* v. 71, pp. 451–463.

Brady, N. C., 1974, *The Nature and Properties of Soils*, 8th Ed, MacMillan, New York.

Brekke, D. D., 1990, *Site Environmental Report for 1989, Sandia National Laboratory, Livermore*, SAND90-8016, UC-600, Sandia National Laboratories, Livermore, Livermore, CA.

Brekke, D. D., 1991, *Sandia National Laboratory, Livermore Semiannual Categorical Process Report for the Period of June–November 1990*, Sandia National Laboratories, Livermore, Livermore, CA, June 1991.

Brown and Caldwell, Inc., 1987a, *Hydrogeologic Investigation, Lawrence Livermore National Laboratory, Site 300, Pit 6*, UCRL-15915, Lawrence Livermore National Laboratory, Livermore, CA.

Brown and Caldwell, Inc., 1987b, *Summary, June 1987 Quarterly Monitoring Activities at Lawrence Livermore National Laboratory, Site 300*, Letter report to Lawrence Livermore National Laboratory, Livermore, CA.

Bryn, S. M., R. K. Landgraf, and S. E. Booth, 1990, *Draft Remedial Investigation and Feasibility Study For the Lawrence Livermore National Laboratory Site 300 Building 834 Complex*, UCRL-ID-103960, Vol. 1, Lawrence Livermore National Laboratory, Livermore, CA.

Buddemeier, R. W., M. R. Ruggieri, D.W., Carpenter, and D. T. Young, 1985, *Investigation of Tritium in Ground Water at Site 300, UCID-20600*, Lawrence Livermore National Laboratory, Livermore, CA.

Buddemeier, R. W., D. W. Carpenter, and M. R. Ruggieri, 1987a, *LLNL Site 300 Environmental Investigations Quarterly*, UCAR-10194-87-1, Lawrence Livermore National Laboratory, Livermore, CA.

Buddemeier, R. W., D. W. Carpenter, and M. R. Ruggieri, 1987b, *LLNL Site 300 Environmental Investigations Quarterly*, UCAR-10194-87-2, Lawrence Livermore National Laboratory, Livermore, CA.

Buddemeier, R. W., M. R. Ruggieri, and J. A. Oberdorfer, 1987c, *Tritium in Ground Water at Site 300*, UCID-21031, Lawrence Livermore National Laboratory, Livermore, CA, April 1987.

Buerer, A. L., 1983, *Assessment and Clean-up of the Taxi Strip Waste Storage Area at the Lawrence Livermore National Laboratory*, UCID-20869, Lawrence Livermore National Laboratory, Livermore, CA.

Burkland, P. W,. and E. Raber, 1983, *Method to Avoid Ground Water Mixing Between Two Aquifers During Drilling and Well Completion Procedures*, UCRL-89440, Lawrence Livermore National Laboratory, Livermore, CA.

Busby, C. I., D. M. Garaventa, and L. S. Kobori, 1981, *A Cultural Resource Inventory of Lawrence Livermore National Laboratory's Site 300, Alameda and San Joaquin Counties, California*, report on file, Northwest Information Center, Sonoma State University (S-2675), and Central California Information Center, California State University, Stanislaus.

Busby, C. I., D. M. Garaventa, and R. M. Harmon, 1990, *A Cultural Resources Assessment of Sandia National Laboratories Livermore Facility, Alameda County, California*, report by Basin Research Associates, San Leandro, CA.

Busby, C. I., and D. M. Garaventa, 1990, *A Cultural Resources Overview and Historic Preservation Regulatory Analysis of Sandia National Laboratories Livermore Facility, Alameda County, California*, report by Basin Research Associates, San Leandro, CA.

Cabayan, H. S., and S. F. Eccles, 1986, "The Free-Electron Laser Program," *E&TR-Energy and Technology Review*, UCRL-5200-86-12, Lawrence Livermore National Laboratory, Livermore, CA

California Department of Finance, 1985a, "Alameda County Population and Housing Estimates," (computer printout report E-5).

California Department of Finance, 1985b, "San Joaquin County Population and Housing Estimates," (computer printout report E-5).

California Department of Finance, 1990a, "Alameda County Population and Housing Estimates," (computer printout report E-5).

California Department of Finance, 1990b, "San Joaquin County Population and Housing Estimates," (computer printout report E-5).

California Department of Fish and Game, 1983, *Los Vaqueros Project—Fish and Wildlife Impacts, a Status Report*, Sacramento, CA.

California Department of Water Resources, 1974, *Evaluation of Ground Water Resources, Livermore and Sunol Valleys*, California Department of Water Resources Bulletin, 118-2.

California Division of Mines, 1950, "Mines and Mineral Resources of Alameda County, California," *California Journal of Mines and Geology*, 46(2):280–339.

California Division of Mines, 1957, *Mineral Commodities of California, Geologic Occurrence, Economic Development and Utilization of the State's Mineral Resources*, Bulletin 176.

California Division of Mines and Geology, 1964, *Franciscan and Related Rocks and Their Significance in the Geology of Western California*, Bulletin 183.

California Division of Mines and Geology, 1987, *Mineral Land Classification: Aggregate Materials in the San Francisco–Monterey Bay Area*, Special Report 146, Part II.

California Division of Mines and Geology, 1988, *Mineral Land Classification of Portland Cement Concrete Aggregate in the Stockton-Lodi Production-Consumption Region,* Special Report 160.

California Division of Oil and Gas, 1982, *California Oil and Gas Fields*, Vol. 3, 4th Ed.

California Division of Oil and Gas, 1986, *72nd Annual Report of the State Oil and Gas Supervisor*.

California Employment Development Department, 1990a, *Annual Planning Information for Alameda County*, Sacramento, CA.

California Employment Development Department, 1990b, *Annual Planning Information for Stockton MSA (San Joaquin County)*, Sacramento, CA.

California Office of Noise Control, 1976, *Guidelines for the Preparation and Content of Noise Elements of the General Plan,* February 1976.

CAPCOA, 1991, *Air Toxics "Hot Spots" Program Risk Assessment Guidelines,* AB2588 Risk Assessment Committee of the California Air Pollution Control Officers Association, January 1991.

CARB, 1985–1990, *California Air Quality Data Annual Summary*, California Air Resources Board, Sacramento, CA.

Carlsen, T. M., 1991, *LLNL Site 300 Environmental Investigations Quarterly, January-March 1991,* UCAR-10194-91-1, Lawrence Livermore National Laboratory, Livermore, CA.

Carlsen, T. M., G. Brown, and D. H. Armstrong, 1987, *LLNL Site 300 Ground Water Monitoring Program, Quarterly Report,* UCAR-10191-87-4, Lawrence Livermore National Laboratory, Livermore, CA.

Carpenter, D. W., 1984, *Assessment of Contamination in Soils and Ground Water at Lawrence Livermore National Laboratory, Sandia National Laboratories, Livermore, and Adjacent Properties*, UCAR-10180, Lawrence Livermore National Laboratory, Livermore, CA

Carpenter, D. W., R. Elwood, and L. G. Gnoss, 1983, *Assessment of the Extent of Trichloroethylene Contamination of Soil and Water at Lawrence Livermore National Laboratory Site 300,* UCID-19945, Lawrence Livermore National Laboratory, Livermore, CA.

Carpenter, D. W., J. J. Sweeney, P. W. Kasameyer, N. R. Burkhard, K. G. Knauss, and R. J. Shlemon, 1984, *Geology* *of the Lawrence Livermore National Laboratory Site and Adjacent Areas*, UCRL-53316, Lawrence Livermore National Laboratory, Livermore, CA.

Carpenter, D. W., R. Elwood, and L. G. Gnoss, 1986, *Assessment of the Extent of Trichloroethylene Contamination of Soil and Water at Lawrence Livermore National Laboratory Site 300*, UCID-20774, Lawrence Livermore National Laboratory, Livermore, CA.

Carpenter, D. W., A. L. Lamarre, N. B. Crow, and P. M. Swearengen, 1988, *Closure Plan for the Decommissioned High Explosives Rinse-Water Lagoons at Lawrence Livermore National Laboratory Site 300*, UCAR-21369, Lawrence Livermore National Laboratory, Livermore, CA.

Carpenter, D. W., J. R. Copland, A. L. Lamarre, R. S. Mateik, M. J. Taffet, and W. M. Wade, 1991, *Investigation of Holocene Faulting Near Closed Landfill Pit 6, Lawrence Livermore National Laboratory Site 300*, Lawrence Livermore National Laboratory, Livermore, CA.

CH2M-Hill California, Inc., 1985, *Hazardous Waste Site Assessment, Inactive Landfill Site 300, Lawrence Livermore National Laboratory*, UCRL-15850, CH2M-Hill California, Inc., Emeryville, CA.

City of Dublin, 1990, *Housing Element of the General Plan*, Dublin, CA.

City of Livermore, 1975, *Airport Master Plan Report*, August W. Compton & Associates, Livermore, CA, December 1975.

City of Livermore, 1976a, *Livermore Community General Plan 1976–2000*, Livermore, CA.

City of Livermore, 1976b, *Livermore Community General Plan 1976–2000 Map*, (blueline map), Livermore, CA.

City of Livermore, 1977a, *Noise Element of the City of Livermore General Plan*, Livermore, CA, October 1977.

City of Livermore, 1977b, *Scenic Route Element of the City of Livermore General Plan 1976–2000*, Livermore, CA.

City of Livermore, 1985, *Housing Element of the City of Livermore General Plan*, Livermore, CA.

City of Livermore, 1987, *Noise Ordinance*, Livermore, CA, October 1987.

City of Livermore, 1988a, *Livermore Community General Plan 1976–2000 Map*, (blueline map), Livermore, CA.

City of Livermore, 1988b, *North Livermore Area "A" General Plan Amendment*, Livermore, CA.

City of Livermore, 1990, *Zoning District Maps*, Livermore, CA.

City of Livermore, 1991a, City Council Resolution No. 90-11, Livermore, CA, March 25, 1991.

City of Livermore, 1991b, *Zoning Ordinance, City of Livermore, California*, Livermore, CA.

City of Pleasanton, 1990, *Growth Management Plan*, Pleasanton, CA.

City of Tracy, 1975, *Airport Master Plan Report*, Tracy, CA, April 1975.

City of Tracy, 1982, *Noise Element of the City of Tracy General Plan*, Tracy, CA, March 1982.

City of Tracy, 1990, *City of Tracy General Plan Map*, (blueline map), Tracy, CA.

Coates, 1991, *Determination of Effective Acceleration for Use in Design at the LLNL Site*, UCRL-JC-107649, Lawrence Livermore National Laboratory, Livermore, CA, August 17, 1991.

Conant, Bob, 1991, City of Tracy Planning Department, personal communication, March 20, 1991.

Copland, J. R. and A. L. Lamarre, 1990, *Investigation of the 850-D1U1 Underground Storage Tank, Lawrence Livermore National Laboratory Site 300*, UCRL-AR-105701, Lawrence Livermore National Laboratory, Livermore, CA.

Corey, R., 1988, *Closure and Post-Closure Plans Landfill Pits 1 and 7 Lawrence Livermore National Laboratory Site 300*, UCRL-AR-1 06919 V I, Lawrence Livermore National Laboratory, Livermore, CA.

County of Alameda, 1966, *Scenic Route Element of the General Plan*, Hayward, CA, May 1966.

County of Alameda, 1973, *Open Space Element of the General Plan*, Hayward, CA, May 30, 1973.

County of Alameda, 1977, *Livermore-Amador Valley Planning Unit General Plan*, Hayward, CA, November 1977.

County of Alameda, 1988, *Alameda County Ordinance Code*, Hayward, CA.

County of Alameda, 1991, *South Livermore Valley General Plan Amendment*, Hayward, CA.

County of San Joaquin, 1973, *Open Space/Conservation Element of the San Joaquin County General Plan*, Stockton, CA.

County of San Joaquin, 1976, *San Joaquin County General Plan*, Stockton, CA.

County of San Joaquin, 1978a, *Noise Element of the San Joaquin County General Plan*, Stockton, CA, November 1978.

County of San Joaquin, 1978b, *Scenic Highways Element of the San Joaquin County General Plan*, Stockton, CA.

County of San Joaquin, 1987, *Housing Element of the San Joaquin County General Plan*, Stockton, CA.

County of San Joaquin, 1988, *San Joaquin County Ordinance Code Planning Title, Zoning and Subdivision Regulations*, Stockton, CA, December 1988.

Crow, N. B., R. Elwood, and P. Webster-Scholten, 1986, *Distribution of High Explosives Compounds in Soil and Water at the 806/807 Lagoons, HE Process Area, LLNL Site 300*, UCAR-10169, Lawrence Livermore National Laboratory, Livermore, CA.

Crow, N. B. and A. L. Lamarre, 1990, *Remedial Investigation of the High Explosives (HE) Process Area*, UCID-21920, Lawrence Livermore National Laboratory, Livermore, CA.

CRWQCB, 1986, *The Designated Level Methodology for Waste Classification and Cleanup Level Determination (Tentative)*, California Regional Water Quality Control Board.

Devany, R. O., M. D. Dresen, J. P. Ziagos, W. F. Isherwood, 1990, *LLNL Ground Water Project 1990 Annual Report*, UCAR-10160-90-12, Lawrence Livermore National Laboratory, Livermore, CA.

Devany, R. O., M. D. Dresen, R. W. Bainer, J. P. Ziagos, 1991, *LLNL Ground Water Project Monthly Progress Report*, UCAR-10160-91-7, Lawrence Livermore National Laboratory, Livermore, CA, July 1991.

Dibblee, T. W., Jr., 1980a, A Preliminary Map of the Altamont Quadrangle, Alameda County, California, U.S. Geological Survey, Open-File Report 80-538.

Dibblee, T. W., Jr., 1980b, A Preliminary Map of the Cedar Mountain Quadrangle, Alameda and San Joaquin Counties, California, U.S. Geological Survey, Open-File Report 80-850.

Dibblee, T. W., Jr., 1980c, A Preliminary Map of the LaCosta Valley Quadrangle, Alameda County, California, U.S. Geological Survey, Open-File Report 80-533a.

Dibblee, T. W., Jr., 1980d, A Preliminary Map of the Midway Quadrangle, Alameda and San Joaquin Counties, California, U.S. Geological Survey, Open-File Report 80-535.

Dibblee, T. W., Jr., 1981a, A Preliminary Map of the Mendenhall Springs Quadrangle, Alameda County, California, U.S. Geological Survey, Open-File Report 81-235.

Dibblee, T. W., Jr., 1981b, A Preliminary Map of the Tracy Quadrangle, San Joaquin County, California, U.S. Geological Survey, Open-File Report 81-464.

DOE, 1981, Environmental Protection, Safety, and Health Protection Information Reporting Requirements, Order 5484.1, U.S. Department of Energy, Washington, D.C., February 24, 1981.

DOE, 1983, Occupational Safety and Health Program For Government-Owned, Contractor-Operated Facilities, Order 5483.1A, U.S. Department of Energy, Washington, D.C., June 22, 1983.

DOE, 1984, Environmental Protection, Safety, and Health Protection Standards, Order 5480.4, U.S. Department of Energy, Washington, D.C., May 15, 1984.

DOE, 1985, Contractor Industrial Hygiene Program, Order 5480.10, U.S. Department of Energy, Washington, D.C., June 26, 1985.

DOE, 1986a, Environment, Safety, and Health Program for Department of Energy Operations, Order 5480.1B, U.S. Department of Energy, Washington D.C., September 23, 1986.

DOE, 1986b, Environmental and Health Appraisal Program, Order 5482.1B, U.S. Department of Energy, Washington, D.C., September 23, 1986.

DOE, 1986c, *Phase I: Installation Assessment Sandia National Laboratories, Livermore*, Draft Report, U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, NM.

DOE, 1987a, Contractor Occupational Medicine Program, Order 5480.8, U.S. Department of Energy, Washington, D.C., November 16, 1987.

DOE, 1988b, General Environmental Protection Program, Order 5400.1, U.S. Department of Energy, Washington, D.C., November 9, 1988.

DOE, 1988c, *Nevada Test Site Defense Waste Acceptance Criteria, Certification, and Transfer Requirements*, U.S. Department of Energy, Nevada Operations Office, and Reynolds Electrical and Engineering Co., October 1988.

DOE, 1988d, Radioactive Waste Management, DOE Order 5820.2A, U.S. Department of Energy, Washington, D.C., October 1988.

DOE, 1988e, Radiation Protection for Occupational Workers, Order 5480.11, U.S. Department of Energy, Washington, D.C., December 21, 1988.

DOE, 1989a, Environmental Compliance Issue Coordination, Order 5400.2A, U.S. Department of Energy, Washington, D.C., January 31, 1989.

DOE, 1989b, *Federal Facility Agreement under CERCLA Section 120*, U.S. Environmental Protection Agency, California Department of Health Services, and California Regional Water Quality Control Board.

DOE, 1989c, *Remedial Investigation Report*, *Navy Landfill Site, Sandia National Laboratories, Livermore,* U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, NM.

DOE, 1989d, *Sampling and Analysis Data Document for Lawrence Livermore National Laboratory; Sandia National Laboratories-Livermore*, Draft Report, U.S. Department of Energy, Washington, D.C.

DOE, 1989e, *Toxics Hot Spot Emission Inventory Plan, Sandia National Laboratories Livermore, California,* U.S. Department of Energy, Albuquerque, NM, August 1989.

DOE, 1990a, Conduct of Operations Requirements for DOE Facilities, Order 5480.19, U.S. Department of Energy, Washington, D.C., July 9, 1990.

DOE, 1990b, *Fuel Oil Spill, Feasibility Study, Sandia National Laboratories, Livermore,* U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, NM.

DOE, 1990c, *Navy Landfill Solid Waste Water Quality Assessment Test Report, Sandia National Laboratories, Livermore,* U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, NM.

DOE, 1990d, Occurrence Reporting and Processing of Operations Information, Order 5000.3A, U.S. Department of Energy, Washington, D.C., June 31, 1990.

DOE, 1990e, Radiation Protection of the Public and the Environment, Order 5400.5, U.S. Department of Energy, Washington, D.C., February 8, 1990.

DOE, 1990f, *Trudell Auto Repair Shop, Feasibility Study, Sandia National Laboratories, Livermore*, U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, NM.

DOE, 1991a, *Environmental Assessment for the Demonstration of Uranium-Atomic Vapor Laser Isotope Separation (U-AVLIS) at Lawrence Livermore National Laboratory, Livermore*, U.S. Department of Energy, Washington, D.C., May 1991.

DOE, 1991b, *Miscellaneous Sites Reconnaissance Sampling Plan, Sandia National Laboratories, Livermore,* U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, NM.

DOE, 1991c, Quality Assurance, Order 5700.6C, U.S. Department of Energy, Washington, D.C., August 21, 1991.

DOE, 1992, *Notice of Intent for General Permit to Discharge Storm Water Associated With Industrial Activity (WQ Order No. 91-130-DWQ)*, Department of Energy, Albuquerque Field Office, Albuquerque, New Mexico, March 1992.

Dreicer, M., 1985, *Preliminary Report of the Past and Present Uses, Storage and Disposal of Hazardous Materials and Wastes at the Lawrence Livermore National Laboratory,* UCRL-20442, Lawrence Livermore National Laboratory, Livermore, CA.

Dresen, M. D., and F. Hoffman, 1986, *Volatile Organic Compounds in Ground Water West of LLNL,* UCRL-53740, Lawrence Livermore National Laboratory, Livermore, CA, July 1986.

Dresen, M. D., and W. A. McConachie, 1986, *Evaluation of Wells West of LLNL for Inter-Aquifer Cross-Connection*, UCAR-10167, Lawrence Livermore National Laboratory, Livermore, CA.

Dresen, M.D., W. A. McConachie, and D. S. Thompson, 1986, *LLNL Ground Water Project Monthly Progress Report July 15-August 15, 1986,* Lawrence Livermore National Laboratory, Livermore, CA.

Dresen, M. D., F. Yukic, R. O. Devany, D. Homan, D. Rice, G. Howard, and W. Isherwood, 1988, *LLNL Ground water Project Monthly Progress Report, February 15– March 15, 1988,* UCAR-10160-88-4, Lawrence Livermore National Laboratory, Livermore, CA.

Dresen, M. D., R. S. Lawson, J. L. Iovenitti, R. O. Devany, P. D. Weiler, D. W. Rice, P. Cederwall, A. J. Boegel, and W. F. Isherwood, 1989, *LLNL Ground Water Project Monthly Progress Report May 1989*, Lawrence Livermore

National Laboratory, Livermore, CA.

Dresen, M. D., W. F. Isherwood, and J. P. Ziagos, 1991, *Proposed Remedial Action Plan for the LLNL Livermore Site, Livermore, CA,* UCRL-AR-105577, Lawrence Livermore National Laboratory, Livermore, CA.

Dugan, W., R. S. Mateik, and D. W. Carpenter, 1991, Geologic Map of LLNL Site 300, in press.

EG&G, 1985, *An Aerial Radiological Survey of the Lawrence Livermore National Laboratory and Surrounding Area*, Las Vegas, NV.

E&TR, 1984, "Beam Research Program, Lawrence Livermore National Laboratory, Livermore, California," *Energy and Technology Review Reprints*, Lawrence Livermore National Laboratory, Livermore, CA, April 1984.

Ellsworth, W. L., J. A. Olson, L. N. Shijo, and S. M. Marks, 1982, *Seismicity and Active Faults in the Eastern San Francisco Bay Region*, in Hart, E. W., Hirschfeld, S. E., and Schulz, S. S., editors, Proceedings of Conference on Earthquake Hazards in the Eastern San Francisco Bay Area, California Division of Mines and Geology Special Publication 62.

Environmental Science Associates, Inc., 1990, *Sandia National Laboratories Livermore Environmental Field Investigations*, Sandia National Laboratories, Livermore, Livermore, CA, August 15, 1990.

EPA, 1989a, *Exposure Factors Handbook*, Office of Health and Environmental Assessment, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1989b, *Region IX Risk Assessment Guidance for Superfund Human Health Risk Assessment: U.S. EPA Region IX Recommendations,* Interim Final, U.S. Environmental Protection Agency, San Francisco, CA, December 1989.

Ernst, W. G., 1970, "Tectonic Contact Between the Franciscan Melange and the Great Valley Sequence—Crustal Expression of a Late Mesozoic Benioff Zone," *Journal of Geophysical Research*, 75:886–901.

Etnier, L., 1989, "Water Quality Criteria for Hexahydro-1,3,5-Trinitro-1,3,5-Triazine (RDX)," *Regulatory Toxicology and Pharmacology 9,* pp. 147–157.

FAA, 1977, *Impact of Noise on People*, Office of Environmental Quality, Federal Aviation Administration, May 1977.

Federal Highway Administration, 1978, *Highway Noise Prediction Model*, FHWA-RD-77-108.

Federal Highway Administration, 1981, *Sound Procedure for Measuring Highway Noise: Final Report*, FHWA #DP-45-1R, U.S. Department of Transportation, August 1981.

Federal Interagency Committee for Wetland Delineation, 1989, *Federal Manual for Identifying and Delineating Jurisdictional Wetlands*, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and U.S. Department of Agriculture Soil Conservation Service, Washington, D.C.

FEMA, 1981, *Flood Insurance Rate Map (FIRM), Alameda County, California (unincorporated areas)*, National Flood Insurance Program, Panel 230 of 325, Community - Panel Number 060001 0230A, Federal Emergency Management Agency, April 15, 1981.

FEMA, 1986, *Flood Insurance Rate Map (FIRM), Alameda County, California (unincorporated areas)*, National Flood Insurance Program, Panel 210 of 325, Community - Panel number 060001 0210B, Federal Emergency Management Agency, February 19, 1986.

Ferry, R. A., A. L. Lamarre, R. K. Landgraf, 1990, *Draft Feasibility Study of the General Services Area (GSA), Lawrence Livermore National Laboratory Site 300,* UCRL-AR-104510, Lawrence Livermore National Laboratory, Livermore, CA.

Freeland, E. E., 1984, *Earthquake Safety Program*, UCAR-10129, Lawrence Livermore National Laboratory, Livermore, CA, August 21, 1984.

Followill, F. E., and J. M. Mills, Jr., 1982, "Locations and Focal Mechanisms of Recent Microearthquakes and Tectonics of Livermore Valley, California," *Bulletin of the Seismological Society of America*, v. 72, pp. 821–841.

Geomatrix Consultants, 1985, *Lawrence Livermore National Laboratory Seismic Exposure Comparison Report and Spectra Report*, Lawrence Livermore National Laboratory, Livermore, CA.

Geomatrix Consultants, 1990, *Equal-Hazard Response Spectra for Lawrence Livermore National Laboratory*, UCRL-CR-107281, Lawrence Livermore National Laboratory, Livermore, CA, November 30, 1990.

Garrigan, Howard T., 1991, Undersheriff, Alameda County Sheriff's Department, correspondence, April 19, 1991.

Geomatrix Consultants, 1991, *Evaluation of Effective Acceleration and Selection of Seismic Analyses Accelerograms for Lawrence Livermore National Laboratory*, Lawrence Livermore National Laboratory, Livermore, CA.

Giuliani, Otto, 1991, Captain, City of Livermore Police Department, personal communication, April 17, 1991.

Graham, K. F., 1987, *Claim on Department of Defense Environmental Restoration Account*, Lawrence Livermore National Laboratory, Livermore, CA.

Grandfield, C. H., 1989, *Guidelines For Discharges to the Sanitary Sewer System*, Lawrence Livermore National Laboratory, Livermore, CA, August 1989.

Hale, Kathy, 1991, Lawrence Livermore National Laboratory, interoffice memorandum, March 1991.

Hamilton, W., 1969, *Mesozoic California and the Underflows of the Pacific Mantle*, Geologic Society of America, Bulletin 80:2409–2430.

Hansen, B., 1991, University of California Museum of Paleontology, personal communication, University of California, Berkeley, CA, June 1991.

Henry, R., R. Sites, and M. Sledge, 1986, *Testing Underground Tanks for Leak Tightness at LLNL*, UCID-20775, Lawrence Livermore National Laboratory, Livermore, CA.

Henry, R., W. Schwartz, and D. Castro, 1987, *Testing and Correction of Underground Storage Tanks at Lawrence Livermore National Laboratory, Workplan and Schedule*, UCRL-50027-87, Lawrence Livermore National Laboratory, Livermore, CA.

Holland, R., and S. Jain, 1977, "Vernal Pools," in *Terrestrial Vegetation of California*, M.G. Barbour and J. Major, editors, Wiley, New York.

Holmes & Narver, Inc., 1985, *Buffer Zone Drainage Modifications*, Volume 1 Concept Development, Lawrence Livermore National Laboratory, Livermore, CA.

Hsu, K. J., 1971, "Franciscan Melanges as a Model for Eugeoscynclinal Sedimentation and Underthrusting Tectonics," *Journal of Geophysical Research* 76:1162–1170.

Huey, A. S., 1948, *Geology of the Tesla Quadrangle, California*, California Division of Mines Bulletin 140:52.

ICRP, 1990, *Recommendations of the ICRP*, Publication 60, International Commission on Radiological Protection, Pergamon Press, New York, 1991.

Ingersoll, R. V., 1981, *Initiation and Evolution of the Great Valley Forearc Basin of Northern and Central California, USA*, Geological Society of London Special Publication, London, England.

Iovenitti, J. K. MacDonald, M. D. Dresen, W. F. Isherwood, and J. P. Ziagos, 1991, *Possible Sources of VOCs in the Vasco Road–Patterson Pass Road Area*, UCRL-AR-106898, Lawrence Livermore National Laboratory, Livermore, CA.

Isherwood, W. F., C. H. Hall, and M. D. Dresen, 1990, *CERCLA Feasibility Study for the LLNL Livermore Site*, UCRL-AR-104040, Lawrence Livermore National Laboratory, Livermore, CA, December 1990.

Islas, Lorre, 1992, County of San Joaquin, personal communication, January 2, 1992.

Kang, Sang-Wook, and John Kleiber Jr., 1991, *Atmospheric Propagation of Highway Explosive Blast Waves*, Lawrence Livermore National Laboratory, Livermore, CA, April 2, 1991.

Karam, Gabriel, 1991a, Solid Waste Engineer, County of San Joaquin Public Works Department, correspondence, May 8, 1991.

Karam, Gabriel, 1991b, Solid Waste Engineer, County of San Joaquin Public Works Department, personal communication, June 19, 1991.

Karam, Gabriel, 1991c, Solid Waste Engineer, County of San Joaquin Public Works Department, personal communication, September 11, 1991.

Karam, Gabriel, 1992, Solid Waste Engineer, County of San Joaquin Public Works Department, personal communication.

Kennedy, R. P., S. A. Short, J. R. McDonald, M. W. McCann, Jr., R. C. Murray, J. R. Hill, 1990, *Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards*, U.S. Department of Energy, Washington, D.C.

Kleiber, John, 1991a, Interoffice Memorandum to Kent Lamson, Lawrence Livermore National Laboratory, Livermore, CA, April 1991.

Kleiber, John, 1991b, Interoffice Memorandum to S.W. Kang, Lawrence Livermore National Laboratory, Livermore, CA, May 22, 1991.

Kleiber, John, 1991c, Interoffice Memorandum to Beverly Bruesch, Lawrence Livermore National Laboratory, Livermore, CA, July 18, 1991.

Lamarre, A. L., 1989, *LLNL Site 300 Environmental Investigation Quarterly January– March, 1989*, UCAR-10194-89-1, Lawrence Livermore National Laboratory, Livermore, CA.

Lamarre, A. L., 1990, *LLNL Site 300 Ground Water Monitoring Program Quarterly Report, July-September 1990*, UCAR-10191-90-3, Lawrence Livermore National Laboratory, Livermore, CA.

Lamarre, A. L. and M. J. Taffet, 1989, *Firing Table Gravel Cleanup at Lawrence Livermore National Laboratory Site 300*, UCAR-10282, Lawrence Livermore National Laboratory, Livermore, CA.

Lindeken, C. L., 1987, *U.S. Department of Energy Comprehensive Environmental Response, Compensation, and Liability Act Program, DOE Order No. 5480.14, Lawrence Livermore National Laboratory, Phase II: Confirmation, Part II: Livermore Site*, UCAR-10190, Part II, Lawrence Livermore National Laboratory, Livermore, CA.

Linsley, Jr., Ray K., Max A. Kohler, and Joseph L. H. Paulhus, 1982, *Hydrology for Engineers*, Third edition, McGraw-Hill, New York.

Livermore Valley Joint Unified School District, 1991a, *Monthly Enrollment Analysis* (computer printout), April 19, 1991.

Livermore Valley Joint Unified School District, 1991b, *Short-Term School Facilities Status Report*, February 1991.

LLNL, 1986–1990, *Environmental Monitoring Report* (Years 1986,1987, 1988, 1989, 1990), Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1987, *LLNL TRU Waste Certification Program: TRU Waste Certification Plan*, M-078, Rev. 1, Supplement 2, Lawrence Livermore National Laboratory, Livermore, CA, February 1987.

LLNL, 1988, *Parking Master Plan*, Lawrence Livermore National Laboratory, Livermore, CA, May 1988.

LLNL, 1989a, *Environmental Restoration Division People and Projects*, UCAR-10274, Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1989b, *Hazardous Waste Management Plan,* Lawrence Livermore National Laboratory, Livermore, CA, September 1989.

LLNL, 1989c, *Internal Dosimetry Program Manual*, Health and Safety Manual, Supplement 33.10, Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1989d, *NMC&A Program Manual—Statement of Policy,* Rev. 0, Lawrence Livermore National Laboratory, Livermore, CA, January 30, 1989.

LLNL, 1989e, *Permit Application Section VI,* Lawrence Livermore National Laboratory, Livermore, CA, December 1989.

LLNL, 1989f, *San Joaquin County Hazardous Materials Management Plan*, Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1989g, *Site Development and Facilities Utilization Plan*, Lawrence Livermore National Laboratory, Livermore, CA, December 1989.

LLNL, 1990a, *AB2588 Air Toxic Inventory Report for LLNL Site 300*, Lawrence Livermore National Laboratory, Livermore, CA, June 20, 1990.

LLNL, 1990b, *Action Description Memorandum for Revitalizing Site 300*, Lawrence Livermore National Laboratory, Livermore, CA, April 1990.

LLNL, 1990c, *Action Plan in Response to the April 1990 Tiger Team Assessment of the Lawrence Livermore National Laboratory*, Lawrence Livermore National Laboratory, Livermore, CA, September 1990.

LLNL, 1990d, *Environmental Report for 1989,* UCRL-50027-89, Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1990e, *Hazardous Material Business Plan for Alameda County*, Lawrence Livermore National Laboratory, Livermore, CA, February 1990.

LLNL, 1990f, *Health and Safety Manual, Medical Program,* Lawrence Livermore National Laboratory, Livermore, CA, July 1990.

LLNL, 1990g, *LLNL Emergency Preparedness Plan*, Revision 3, Lawrence Livermore National Laboratory, Livermore, CA, February 1990.

LLNL, 1990h, *LLNL Waste Minimization Program Plan*, Lawrence Livermore National Laboratory, Livermore, CA, May 1990.

LLNL, 1990i, *LLNL Wastewater Discharge Permit Application 1990–1991*, Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1991a, *AB2588 Air Toxics Risk Screening Document for Lawrence Livermore National Laboratory, Plant No. 255,* Lawrence Livermore National Laboratory, Livermore, CA, February 1991.

LLNL, 1991b, Analytical Laboratory Sampling Records-1990, Data Base printout, Lawrence Livermore National Laboratory, Livermore, CA, April 1991.

LLNL, 1991c, *Commercial/Industrial Waste Generation Survey Response*, Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1991d, *Emergency Response Plan (2/27/90); Release of Tritium to the Environment (1981–1990)*, Lawrence Livermore National Laboratory, Livermore, CA, February 2, 1990.

LLNL, 1991e, *Employee Residence Analysis*, (computer printout), Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1991f, *Environmental Report for 1990,* UCRL-50027-90, Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1991g, *FY 1990 Annual Report In-House Energy Management Program*, Lawrence Livermore National Laboratory, Livermore, CA, January 1991.

LLNL, 1991h, Hazardous Waste Received by HWM January 1, 1990–December 31, 1990, 4 Data Base Files (By Quarter), Lawrence Livermore National Laboratory, Livermore, CA, April 23, 1991.

LLNL, 1991i, *Institutional Plan, FY 1991–1996*, UCAR-10076-9, Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1991j, *Lawrence Livermore National Laboratory Site Development Plan*, UCLR-AR-106743, Lawrence Livermore National Laboratory, Livermore, CA, April 1991.

LLNL, 1991k, *LLNL External Dosimetry Data*, Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1991l, *LLNL Safety Experience 1990*, Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1991m, Low-level Waste Received by HWM January 1, 1990–December 31, 1990, Data Base File, Lawrence Livermore National Laboratory, Livermore, CA, April 16, 1991.

LLNL, 1991n, Mixed Waste Received by HWM January 1, 1990–December 31, 1990, Data Base File, Lawrence Livermore National Laboratory, Livermore, CA, April 16, 1991.

LLNL, 1991o, *Nuclear Design Waste Minimization 1990 Progress Report*, Lawrence Livermore National Laboratory, Livermore, CA, April 1991.

LLNL, 1991p, *Onsite Hazardous Materials Packaging and Transportation Safety Manual*, (Draft, Rev. 5), Lawrence Livermore National Laboratory, Livermore, CA, August 1991.

LLNL, 1991q, *Shipment Mobility/Accountability Collection—All Outbound Hazardous Materials Shipments Reported to SMAC*, Lawrence Livermore National Laboratory, Livermore, CA, April 3, 1991.

LLNL, 1991r, *Site Development Plan Site 300*, UCAR-106744, Lawrence Livermore National Laboratory, Livermore, CA, April 1991.

LLNL, 1991s, TRU Waste Received by HWM 1989–1990, 2 Data Base Files, Lawrence Livermore National

Laboratory, Livermore, CA, April 4, 1991.

LLNL, 1991t, *Unusual Occurrence Reports, 1986–1990*, Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1992a, *Environmental Report for 1991*, Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1992b, *Resource Conservation and Recovery Act Part B Permit Application, Hazardous Waste Treatment and Storage Facilities*, #2890012584, Lawrence Livermore National Laboratory, Livermore, CA, January 1992.

LLNL, 1992c, *Unusual Occurrence Reports 1991*, Lawrence Livermore National Laboratory, Livermore, CA.

Lydick, John, 1991a, Vasco Road Landfill, correspondence, May 10, 1991.

Lydick, John, 1991b, Vasco Road Landfill, personal communication, September 24, 1991.

MacRae, Terry, 1991, California Department of Finance, personal communication, June 4, 1991.

Madigan, Lisa, County of Alameda Planning Department, personal communication, November 20, 1991.

Maestas, Gene, 1991, Manager, Livermore Municipal Airport, personal communication, Livermore, CA, April 4, 1991.

Mansfield, G., 1991, *Internal Dosimetry Program and Data,* Lawrence Livermore National Laboratory, Livermore, CA.

Martin, Mike, 1991, Battalion Chief, State of California Department of Forestry, correspondence, May 23, 1991.

McConachie, W. A., J. P. Como, D. W. Carpenter, and R. C. Ragaini, 1986, *East Traffic Circle Landfill Closure Report*, UCID-20662, Lawrence Livermore National Laboratory, Livermore, CA.

McDonald, J. K., M. D. Dresen, J. P. Ziagos, and W. F. Isherwood, 1991, *LLNL Ground Water Project, Monthly Progress Report, January 1991*, UCAR-10160-91-1, Lawrence Livermore National Laboratory, Livermore, CA.

McIlvride, W. A., M. J. Taffet, N. B. Crow, J. A. Oberdorfer, and A. L. Lamarre, 1988, *LLNL Site 300 Environmental Investigations Quarterly, April-June 1988*, UCAR-10194-88-2, Lawrence Livermore National Laboratory, Livermore, CA.

Mcllvride, W. A., R. A. Ferry, S. P. Vonder Haar, W. M. Wade, and L. L. Glick, 1990, *Remedial Investigation of the General Services Area (GSA), Lawrence Livermore National Laboratory Site 300*, UCRL-AR-103161, Lawrence Livermore National Laboratory, Livermore, CA.

Miller, Gordon, 1989, Memorandum to D. Weingart, *Estimate of Noise Levels Towards Residential Area West of Building 191 Created by Shots in Building 191*, Lawrence Livermore National Laboratory, Livermore, CA, October 17, 1989.

Nason, R., 1982, *Damage in Alameda and Contra Costa Counties, California, in the Earthquake of 18 April 1906*, U.S. Geological Survey Open-File Report 82-63.

NCRP, 1979, *Tritium In The Environment*, Report No. 62, National Council on Radiation Protection and Measurements, Bethesda, MD, March 9, 1979.

NCRP, 1988, *Exposure of Populations in the United States and Canada from Natural Background Radiation*, Report No. 94, National Council on Radiation Protection and Measurements, Bethesda, MD.

NCRP, 1991, *Effects of Ionizing Radiation on Aquatic Organisms*, Report No. 109, National Council on Radiation Protection and Measurements, Bethesda, MD, August 30, 1991.

Nichols, E. M., M. D. Dresen, and J. Field, 1988, *Proposal for Pilot Study LLNL Building 403 Gasoline Station Area*, UCRL-10248, Lawrence Livermore National Laboratory, Livermore, CA.

Nilsen, T. H., 1972, *Preliminary Photointerpretation Map of Landslides and Other Surficial Deposits of Parts of the Altamont and Carbona 15-Minute Quadrangles, Alameda County, California*, San Francisco Bay Region Environment and Resources Planning Study, Miscellaneous Field Studies Map MF-321.

Nilsen, T. H., 1977, *Late Mesozoic and Cenozoic Sedimentation and Tectonics in California*, San Joaquin Geological Society, Bakersfield, CA.

NOAA, 1980–1990, *Climatological Data Annual Summary, California*, National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC.

O. H. Materials Company, 1985a, *Site Investigation, Hydrocarbon Leak Near Building 403,* UCRL-15857, Lawrence Livermore National Laboratory, Livermore, CA.

O. H. Materials Company, 1985b, *Preliminary Report, Evaluation of Remedial Action Alternatives, Hydrocarbon Leak Near Building 403*, Lawrence Livermore National Laboratory, Livermore, CA.

O. H. Materials Company, 1985c, *Remedial Action Plan for Gasoline Leak Near Building 403*, UCRL-15856, Lawrence Livermore National Laboratory, Livermore, CA.

Office of Technology Assessment, 1986, *Transportation of Hazardous Materials, OTA-SET-304*, Washington, D.C., July 1986.

Oppenheimer, D. H., and N. G. MacGregor-Scott, 1991, *Seismic Potential of the East San Francisco Bay Region of California*, Geological Society of America Abstracts with Programs, v. 23, no. 2, p. 85.

Orloff, S., 1986, *Wildlife Studies of Site 300 Emphasizing Rare and Endangered Species, Lawrence Livermore National Laboratory San Joaquin County, California*, prepared for Lawrence Livermore National Laboratory by BioSystems Analysis, Inc., Sausalito, CA.

Page, B. M., 1966, "Geology of the Coast Ranges of California," in *Geology of Northern California*, California Division of Mines and Geology Bulletin 190.

Page, B. M., 1981, "The Southern Coast Ranges," in *The Geotectonic Development of California*, edited by W. G. Ernst, Prentice-Hall, Englewood Cliffs, NJ.

Pavlik, B., 1990, *Reintroduction of* Amsinckia grandiflora *to Stewartville*, prepared for the Endangered Plant Program, California Department of Fish and Wildlife, Sacramento, CA.

Pavlik, B., 1991, *Continuing Reintroduction and Recovery Efforts Related to* Amsinckia grandiflora, Mills College, Oakland, CA, February 20, 1991.

Pellegrino, Joseph, 1991a, City of Tracy Transportation Coordinator, personal communication, April 24, 1991.

Pellegrino, Joseph, 1991b, City of Tracy Transportation Coordinator, personal communication, May 9, 1991.

Pellegrino, Joseph, 1992, City of Tracy Transportation Coordinator, personal communication, January 24, 1992.

Qualheim, B. J., 1988, *Well Log Report for the Livermore Site Ground Water Project, 1982-1984,* UCID-21342, Lawrence Livermore National Laboratory, Livermore, CA.

Raber, S., and D. W. Carpenter, 1983, *An Evaluation of the Hydrogeology and Ground Water Chemistry Associated with Landfills at LLNL's Site 300*, UCRL-53416, Lawrence Livermore National Laboratory, Livermore, CA.

Raber, S., ed., 1983, *Chemical Characterization and Hydrogeological Considerations Concerning Wastewater Discharge into Surface Impoundments at LLNL Site 300*, *Lawrence Livermore National Laboratory*, UCID-19753, Lawrence Livermore National Laboratory, Livermore, CA.

Radian Corporation, 1990, *Lawrence Livermore National Laboratory RCRA Part B Health Risk Assessment Phase II—Hazardous Waste Management Units*, UCRL 21223, Livermore, CA, February 1990.

Ragaini, R. C., 1988, *Environmental Incident Report,* Letter to the California Department of Health Services, October 3, 1988.

Raymond, L. A., 1969, *The Stratigraphy and Structural Geology of the Northern Lone Tree Creek and Southern Tracy Quadrangles, California*, M.S. Thesis, San Jose State University, San Jose, CA.

Reid, R., 1991, California Division of Oil and Gas, personal communication, Woodland, CA.

Rhoads, W. A., T. P. O'Farrell, and M. L. Sauls, 1981, *Occurrence and Status of Endangered Species, San Joaquin Kit Fox* (Vulpes Macrotis Mutica) *and Large-flowered Fiddleneck* (Amsinckia grandiflora) *on Lawrence Livermore National Laboratory, Site 300, CA,* U.S. Department of Energy, Nevada Operations Office.

Rogers, L. L., 1982, *Water Table Configuration Below the LLNL Site and Surrounding Sections*, UCID-19340, Lawrence Livermore National Laboratory, Livermore, CA.

Rowe, J. L., 1960, Manager, Plant Service Department, Sandia Corporation, Livermore Laboratory, Letter to J. E. Armstrong, Director, Engineering Division, U. S. Department of Energy, San Francisco Operations Office, March 4, 1960.

Ruggieri, M. R., D. W. Carpenter, A. L. Lamarre, M. J. Taffet, N. B. Crow, and J. A. Oberdorfer, 1987, *LLNL Site 300, Environmental Investigations Quarterly at Site 300,* UCAR-10194-87-4, Lawrence Livermore National Laboratory, Livermore, CA, December 31, 1987.

Rumney, George, 1968, *Climatology and the World's Climate*, MacMillan, New York.

Santos, L. E., and N. K. Landau, 1987, *Environmental Assessment, Construction and Operation of the High Explosives Applications Facility,* UCAR-10206, Lawrence Livermore National Laboratory, Livermore, CA, August 1987.

Scheimer, J. F., 1985, *Lawrence Livermore National Laboratory Site & Seismic Safety Program–Summary of Findings*, Lawrence Livermore National Laboratory, Livermore, CA, July 1985.

Scheimer, J. F., S. R. Taylor, and M. Sharp, 1982, *Seismicity in the Livermore Valley Region, 1969–1981*, in Hart, E. W., Hirschfeld, S. E., and Schulz, S. S., editors, Proceedings Conference on Earthquake Hazards in the Eastern San Francisco Bay Area, California Division of Mines and Geology Special Publication 62, pp. 155–166.

SNL, Livermore, 1987, *SNL, Livermore Firing Range Sound Level Survey*, Sandia National Laboratories, Livermore, Livermore, CA, February 26, 1987.

SNL, Livermore, 1990a, *Emergency Preparedness Manual*, Revision 3, Sandia National Laboratories, Livermore, Livermore, CA, August 1990.

SNL, Livermore, 1990b, *External Dosimetry Report for 1989,* Sandia National Laboratories, Livermore, Livermore, CA, March 1990.

SNL, Livermore, 1990c, *Hazardous Waste Operation Plan,* Sandia National Laboratories, Livermore, Livermore, CA, December 1990.

SNL, Livermore, 1990e, *News Release*, Sandia National Laboratories, Livermore, Livermore, CA.

SNL, Livermore, 1990f, *Waste Management Site Plan FY 90*, Sandia National Laboratories, Livermore, Livermore, CA, November 1990.

SNL, Livermore, 1991a, *Airborne and Liquid Radioactive Effluents Released by Sandia National Laboratory (1986–1990)*, Sandia National Laboratories, Livermore, Livermore, CA.

SNL, Livermore, 1991b, *Environmental Safety and Health Manual, Industrial Hygiene*, Chapter 6, Sandia National Laboratories, Livermore, Livermore, CA, February 1991.

SNL, Livermore, 1991c, *Environmental Safety and Health Manual, Primer of ES&H Information for Supervisors*, Chapter 2, Sandia National Laboratories, Livermore, Livermore, CA, February 1991.

SNL, Livermore, 1991d, *Guidelines for Hazardous Waste Generators*, Sandia National Laboratories, Livermore, Livermore, CA, May 1991.

SNL, Livermore, 1991e, *Ground Water Investigations Quarterly Report, January-March, 1991*, Sandia National Laboratories, Livermore, Livermore, CA.

SNL, Livermore, 1991f, *Hazardous Materials Shipping Data—1987–1990*, Sandia National Laboratories, Livermore, Livermore, CA, April 1991.

SNL, Livermore, 1991g, *On-Roll Counts by City*, (computer printout), Sandia National Laboratories, Livermore, Livermore, CA.

SNL, Livermore, 1991h, *Operating Safety Procedure for Radiofrequency/Microwave Safety Program*, Sandia National Laboratories, Livermore, Livermore, CA.

SNL, Livermore, 1991i, *Site Environmental Report for 1990, Sandia National Laboratories, Livermore*, Sandia National Laboratories, Livermore, Livermore, CA.

SNL, Livermore, 1991j, *Transportation Safety Manual (Draft)*, Sandia National Laboratories, Livermore, Livermore, CA, May 1991.

SNL, Livermore, 1991k, *Tritium Research Lab Health Physics Report*, Sandia National Laboratories, Livermore, Livermore, CA, January 1991.

SNL, Livermore, 1991l, *Unusual Occurrence and Inadvertent Releases*, Sandia National Laboratories, Livermore, Livermore, CA, October 3, 1991.

SNL, Livermore, 1991m, *Waste Reduction Report FY90, Rough Draft*, Sandia National Laboratories, Livermore, Livermore, CA, March 1991.

SNL, Livermore, 1991n, *Log of Occupational Injuries and Illnesses, 1986, 1987, 1988, 1989*, Sandia National Laboratories, Livermore, Livermore, CA.

SNL, Livermore, 1992a, *Log of Occupational Injuries and Illnesses, 1991*, Sandia National Laboratories, Livermore, Livermore, CA.

SNL, Livermore, 1992b, *Site Environmental Report for 1991*, Sandia National Laboratories, Livermore, Livermore, CA.

SNL, Livermore, 1992c, *Unusual Occurrence Reports*, Sandia National Laboratories, Livermore, Livermore, CA, May 1992.

Sorenson, S. K., P. V. Cascos, and R. L. Glass, 1984, *Water Quality Conditions and an Evaluation of Ground and Surface-Water Sampling Programs in the Livermore-Amador Valley, California*, U.S. Geological Survey, Water

Resources Investigations Report S84-4352.

State Historic Preservation Office, 1990, *Cultural Resources Inventory*, Letter to R. H. Johnsen at Sandia National Laboratories, Livermore, October 24, 1990.

State of California, 1982, *Economic Practices Manual*, Sacramento, CA.

Stein, Deborah, 1992, County of Alameda Planning Department, personal communication.

Stone, R., and M. R. Ruggieri, 1983, *Ground Water Quality and Movement at Lawrence Livermore National Laboratory*, UCRL-53474, Lawrence Livermore National Laboratory, Livermore, CA.

Stone, R., M. R. Ruggieri, L. L. Rogers, D. O. Emerson, and R. W. Buddemeier, 1982, *Potential for Saturated Ground Water System Contamination at the Lawrence Livermore National Laboratory*, UCRL-53426, Lawrence Livermore National Laboratory, Livermore, CA.

SWRCB, 1989, *Leaking Underground Fuel Tank Field Manual*, State of California Water Resources Control Board, October 1989.

Taffet, M. J., 1989, *Remedial Investigation of Landfill Pit 8, Lawrence Livermore National Laboratory Site 300*, UCID-21764, Lawrence Livermore National Laboratory, Livermore, CA.

Taffet, M. J., 1990, *Draft Remedial Investigation of Landfill Pit 6, Lawrence Livermore National Laboratory Site 300*, UCAR-10194-89-1, Lawrence Livermore National Laboratory, Livermore, CA.

Taffet, M. J., and A. L. Lamarre, 1986, *Solid Waste Assessment Test (SWAT), Inactive Landfill Pit 6, Lawrence Livermore Laboratory Site 300, San Joaquin County, California*, UCAR-10242, Lawrence Livermore National Laboratory, Livermore, CA.

Taffet, M. J., and A. L. Lamarre, 1989, *Remedial Investigation of Landfill Pit 9, Lawrence Livermore National Laboratory Site 300,* UCID-21688, Lawrence Livermore National Laboratory, Livermore, CA.

Taffet, M. J., and J. A. Oberdorfer, 1991, *Draft Feasibility Study of the Building 850/East Firing Area, Lawrence Livermore National Laboratory Site 300*, UCRL-AR-107033, Lawrence Livermore National Laboratory, Livermore, CA.

Taffet, M. J., A. L. Lamarre, and W. A. Mcllvride, 1989, *LLNL Site 300 Environmental Investigations Quarterly, January-March 1989*, UCAR-1019489-1, Lawrence Livermore National Laboratory, Livermore, CA.

Taffet, M. J., J. A. Oberdorfer, and W. A. McIlvride, 1989, *Remedial Investigation and Feasibility Study for the Lawrence Livermore National Laboratory Site 300 Pit 7 Complex*, UCID-21685, Lawrence Livermore National Laboratory, Livermore, CA.

Taffet, M. J., J. A. Oberdorfer, T. N. Carlsen, W. R. Dugan, R. S. Mateik, 1990, *Draft Remedial Investigation of the Building 850/East Firing Area, Lawrence Livermore National Laboratory Site 300*, UCCL ID-104335, Lawrence Livermore National Laboratory, Livermore, CA, December 1990.

Taffet, M. J., J. R. Copland and R. A. Ferry, 1991, *Draft Feasibility Study of Landfill Pit 6, Lawrence Livermore National Laboratory Site 300,* UCRL-AR-106307, Lawrence Livermore Laboratory, Livermore, March 1991.

Taylor, D. W., and W. Davilla, 1986a, *Vegetation of Site 300 Lawrence Livermore National Laboratory San Joaquin County, California*, prepared for Lawrence Livermore National Laboratory by BioSystems Analysis, Inc., Santa Cruz, CA.

Taylor, D. W., and W. Davilla, 1986b, *A Rare Plant Survey of Site 300 Lawrence Livermore National Laboratory San Joaquin County, California*, prepared for Lawrence Livermore National Laboratory by BioSystems Analysis, Inc., Santa Cruz, CA.

TERA Corporation, 1983, *Seismic Hazard Analysis for Lawrence Livermore National Laboratory and Site 300*, Lawrence Livermore National Laboratory, Livermore, CA.

The Mark Group Engineers and Geologists, Inc., 1986, *Final Report Site Hydrogeological Investigation*, Sandia National Laboratories, Livermore, Livermore, CA, March 31, 1986.

Thorpe, R. K., W. F. Isherwood, M. D. Dresen, and C. P. Webster–Scholten, 1990, *CERCLA Remedial Investigation Report for LLNL Livermore Site*, Lawrence Livermore National Laboratory, Livermore, CA.

TJKM Transportation Consultants, 1986, *Traffic Circulation and Access Study for the Lawrence Livermore National Laboratory*, Pleasanton, CA, October 1986.

TJKM Transportation Consultants, 1992, *Traffic Study for the Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore, Environmental Impact Statement/Environmental Impact Report*, Pleasanton, CA.

Tokarz, F., G. E. Freeland, and J. R. Hill, 1991, *Major Seismic Building Upgrades at the Lawrence Livermore National Laboratory*.

Toney, K. C., 1990, *A Hydrogeological Investigation of Ground water Recharge Near the Drainage Retention Basin, Lawrence Livermore National Laboratory, Livermore, CA*, unpublished thesis, San Jose State University, San Jose, CA.

UC, 1987, *Final Environmental Impact Report for the University of California Contract with the Department of Energy for Operation and Management of Lawrence Livermore National Laboratory,* SCH-85112611, University of California, Berkeley, CA.

U.S. Army Corps of Engineers, 1981, *HEC-1 Flood Hydrograph Package User's Manual.*

U.S. Census Bureau, 1988, *County Business Patterns*.

U.S. Census Bureau, 1991, *Population and Housing Units*, March 1991.

U.S. Department of Agriculture Soil Conservation Service, 1966, *Soil Survey of the Alameda Area, California.*

U.S. Department of Agriculture Soil Conservation Service, 1990, *National Cooperative Soil Survey of the San Joaquin County, California*, in publication.

U.S. Geological Survey, 1978, Altamont Quadrangle 7.5 Minute Topographic Map, 1953, photo revised 1978.

U.S. Geological Survey, 1980, Midway Quadrangle 7.5 Minute Topographic map, 1953, photo revised 1980.

Warner, R. E., 1981, "Structural, Floristic, and Condition Inventory of Central Valley Riparian Systems," in *California Riparian Systems, Ecology, Conservation, and Productive Management*, R. E. Warner and K. M. Hendrix, editors, University of California Press, Berkeley, CA.

Webster-Scholten, C. P., and C. H. Hall, 1989, *Work Plan, Lawrence Livermore National Laboratory, Livermore Site: CERCLA Remedial Investigation/Feasibility Studies*, UCAR-10225, Lawrence Livermore National Laboratory, Livermore, CA.

Webster-Scholten, C. P., and N. B. Crow, 1989, *Remedial Investigation of the High Explosives Burn Pit Facility, Building 829 Complex*, UCID-21692, Lawrence Livermore National Laboratory, Livermore, CA.

Webster-Scholten, C. P., M. D. Dresen, R. O. Devany, R. A. Ferry, D. N. Homan, W. A. McConachie, M. C. Small, and W. F. Isherwood, 1987, *LLNL Ground Water Project Monthly Progress Report, October 15-November 15, 1987*, UCAR-10160-87-12, Lawrence Livermore National Laboratory, Livermore, CA.

Webster-Scholten, C. P., T. M. Carlsen, J. R. Copland, R. A. Ferry, S. P. Vonder Haar, and W. M. Wade, 1991, *Draft Remedial Investigation of the Building 833 Area, Lawrence Livermore National Laboratory Site 300*, UCRL-AR-1073771, Lawrence Livermore National Laboratory, Livermore, CA.

Weiss Associates, 1985a, *Annual Report for Fiscal Year 1985, Ground Water Investigations at Lawrence Livermore National Laboratory, Livermore, CA, Volume One - Text*, UCRL-15835, Lawrence Livermore National Laboratory, Livermore, CA.

Weiss Associates, 1985b, *Annual Report for Fiscal Year 1985, Ground Water Investigations at Lawrence Livermore National Laboratory, Livermore, CA, Volume Two - Appendices*. UCRL-15835, Lawrence Livermore National Laboratory, Livermore, CA.

Weiss Associates, 1987, *Well Development and Hydraulic Testing at LLNL Site 300: Building 830, 834, 840 and General Services Area Areas*, UCRL-21010, Lawrence Livermore National Laboratory, Livermore, CA.

Wentworth, C. M. and M. D. Zoback, 1989, "The Style of Late Cenozoic Deformation at the Eastern Front of the California Coast Ranges," *Tectonics*, v. 8, pp. 237–246.

WESCO, 1988, *Draft Environmental Impact Report for Zone 7 of Alameda County Flood Control and Water Conservation District Water Supply and Water Quality Improvements in the Livermore-Amador Valley*, Western Ecological Services Company, Inc., Novato, CA, March 1988.

WESTON, 1991, *Backup Calculations in Support of the 1991-92 LLNL Site-wide EIS/EIR*, Lindvall/Richter/Benuska Associates, Los Angeles, CA, September 1991.

William Self Associates, 1992, *Documentation and Assessment of the History of Lawrence Livermore National Laboratory, Livermore Facility, and Site CA-SJo-173H, the Carnegie Townsite, at Lawrence Livermore National Laboratory's Site 300*, Alameda and San Joaquin Counties, CA, August 1992.

Williams, Peter, 1991a, San Joaquin County Council of Governments, personal communication, April 11, 1991.

Williams, Peter, 1991b, San Joaquin County Council of Governments, personal communication, May 3, 1991.

Wong, I. G., R. W. Ely, and A. C. Kollmann, 1988, "Contemporary Seismicity and Tectonics of the Northern and Central Coast Ranges–Sierran Block Boundary Zone, California," *Journal of Geophysical Research*, v. 93, pp. 7813–7834.

Woodruff, M. C., 1990, *Evaluation of Two Properties at Lawrence Livermore National Laboratory: Building 310 and the Lighty Property (or, Building 051)*, letter report on file, Northwest Information Center, Sonoma State University (S-12290).

Woodward-Clyde Consultants, 1984, *Lawrence Livermore National Laboratory/Seismic Exposure Analysis*, Draft, Lawrence Livermore National Laboratory, Livermore, CA.

Yano, Gordon, 1991, "White Paper Recycling Plan Targeted to Start April 8," *Newsline*, Volume 16, No. 18, Lawrence Livermore National Laboratory, Livermore, CA, March 1991.

Yourick, P. D., E. L. Ashcraft, G. E. Chavez, P. C. Pei, R. W. Bild, 1989, *On-site Transportation of Hazardous Material and Wastes*, Sandia National Laboratories, Livermore, Livermore, CA, October 1989.

Yukic, F. A., M. D. Dresen, J. L. Iovenitti, I. Flashka, E. M. Nichols, R. O. Devany, B. Qualheim, G. Howard, P. Cederwell, and W. Isherwood, *LLNL Ground Water Project Monthly Progress Report, August 15-September 15, 1988*, UCAR–10160–88–10, Lawrence Livermore National Laboratory, Livermore, CA.

4.4 COMMUNITY SERVICES

This section describes the existing demands on fire protection and emergency services, police protection and security services, school services, and nonhazardous solid waste disposal from the operation of LLNL and SNL, Livermore. Appendix J presents a more detailed discussion of emergency preparedness planning and response, and mutual assistance agreements.

4.4.1 Fire Protection and Emergency Services

This section describes the existing fire protection and emergency services at LLNL and SNL, Livermore. At LLNL, these services are provided by the LLNL Fire Safety Division and by offsite fire protection agencies through mutual or automatic aid agreements. SNL, Livermore has its own environment, safety, and health organization, but relies on LLNL for fire department services.

LLNL Livermore Site

Onsite Facilities

The Fire Safety Division at the LLNL Livermore site occupies two facilities: a fire station at Building 323 (Fire Station No. 1) and an emergency dispatch center at Building 313. All LLNL Livermore site health and safety alarms and most of SNL, Livermore alarms are received by the emergency dispatch center through the LLNL Livermore site Sitewide Alarm System. In addition to monitoring the LLNL Livermore site alarms and dispatching personnel, the emergency dispatch center serves as the Mutual Aid Dispatch Center for both the Twin Valley Mutual Aid Plan and the Alameda County Mutual Aid Plan. Requests for mutual aid are processed and appropriate mutual aid equipment is dispatched based on a standard response schedule. The LLNL Fire Chief is the Mutual Aid Coordinator for the Twin Valley Mutual Aid Plan and the Alameda County Mutual Aid Plan.

There are about 49 fire protection and emergency services personnel at LLNL, in the following categories: fire protection engineering and fire prevention, training, emergency dispatch, and emergency operations. Personnel travel between the LLNL Livermore site fire station and the LLNL Site 300 fire station (Fire Station No. 2). The minimum staff level for the LLNL Livermore site (Fire Station No. 1) is six personnel and one chief officer on-call 24 hours a day.

Fire Apparatus Description and Replacement Schedule

LLNL Fire Station No. 1 equipment consists of four large capacity pumpers (1500 to 1000 gpm) including one ladder truck and one 4-wheel drive, one smaller capacity (325 gpm) 4-wheel drive pumper, a special services unit with hazardous material containment equipment, two ambulances, and three command vehicles.

A Fire Apparatus Replacement Schedule, which covers a 5-year period, was prepared in 1984 and is updated on a yearly basis. Each apparatus has a planned lifespan and replacement date. An additional year is added annually; therefore, the plan continues to cover a 5-year period, and changes are made to reflect changes or additions in the replacement schedule. Adequate funding for replacement apparatus is available.

Onsite Emergency Procedures

LLNL has compiled its general emergency response policies and procedures into the "Emergency Preparedness Plan" (LLNL, 1990g). The plan provides an overview of emergency response procedures for LLNL management and for major departments and programs. Detailed operational procedures of individual emergency response organizations are included in the "Emergency Preparedness Plan Implementing Procedures." Appendix J presents a more detailed discussion of the LLNL Livermore site Emergency Preparedness Plan.

Emergency Response Characteristics

The average LLNL Livermore site Fire Department response time onsite is 3.5 minutes. One vehicle and three personnel will initially respond to a call onsite. Additional equipment and personnel will respond as needed. Table 4.4-1 provides a summary of the numbers and types of onsite emergency calls to which Fire Station No. 1 responded in 1988, 1989, and 1990.

At the LLNL Livermore site, the ambulances transport patients to the LLNL Livermore site Health Services Department during normal working hours. Health Services personnel provide evaluation and treatment of patients and determine the need for further acute care. When further acute care is required, or outside of normal working hours, patients are transported to Valley Memorial Hospital in Livermore.

Offsite Agency Involvement

The LLNL Fire Safety Division participates in several automatic and mutual aid agreements with various offsite agencies. Automatic aid is dispatched without request on a first alarm. Mutual aid assistance is specifically requested after local agency resources have been depleted. LLNL participates in automatic and mutual aid agreements with the City of Livermore Fire Department and the Alameda County Fire Patrol, respectively. LLNL participates in a mutual aid network that extends throughout the state of California.

The LLNL Livermore site Fire Department responds to approximately 3.6 percent of the City of Livermore Fire Department's total annual calls. Conversely, the City of Livermore Fire Department responds to less than 1 percent of the LLNL Livermore site Fire Department's total annual calls. The LLNL Livermore site and the Alameda County Fire Patrol respond to less than 1 percent of each other's calls per year. The California Department of Forestry, which provides mutual aid to LLNL Site 300, does not respond to mutual aid requests at the LLNL Livermore site because it does not maintain structural fire equipment. The LLNL Livermore site fire station assists with approximately three wildland fires per year within the California Department of Forestry's jurisdiction. This constitutes less than 1 percent of the California Department of Forestry's total annual calls (Martin, 1991).

LLNL Offsite Facilities

The mutual and automatic aid agreements between the LLNL Fire Department and the local Fire Departments are based on the concept that the closest emergency aid responds to the call. The LLNL Fire Department would respond, along with the City of Livermore Fire Department, to a call at the Graham Court warehouse, the Research Drive offices, or the Almond Avenue school site. The LLNL Fire Department would also respond to a call at the Camp Parks facility if requested by the Camp Parks Fire Department.

The City of Livermore responds to structural fires at the Livermore Municipal Airport. However, the LLNL Fire Department provides crash fire and rescue services at the airport when an LLNL plane is taking off or landing. An LLNL Fire Department crash truck is on standby at the airport when an LLNL plane is scheduled to leave or arrive.

LLNL Site 300

Onsite Facilities

LLNL Fire Station No. 2 is located in Building 870 at LLNL Site 300. This facility is part of the overall Fire Safety Division of LLNL and is operated under the direction of the LLNL Fire Chief. The minimum staff level at Fire Station No. 2 is three personnel on duty 24 hours a day. One chief officer is on call at the LLNL Livermore site during normal business hours and from an offsite residence outside of normal business hours.

Description of Fire Apparatus

LLNL Fire Station No. 2's equipment consists of two large (1250 gpm) pumpers—one of which is 4-wheel drive, one smaller 4-wheel drive pumper (325 gpm)—and one ambulance.

Onsite Emergency Procedures

Alarms at LLNL Site 300 are monitored by the LLNL Site 300 police dispatcher, who dispatches fire personnel and equipment from Fire Station No. 2 and then notifies the Emergency Dispatch Center at the LLNL Livermore site. The Emergency Dispatch Center dispatches additional resources from the LLNL Livermore site Fire Station No. 1 if necessary. The onsite emergency procedures previously described for the LLNL Livermore site relative to the Emergency Preparedness Plan are also applicable to the LLNL Site 300 fire station, since this facility is also guided by the Emergency Preparedness Plan and its implementing procedures.

Emergency Response Characteristics

The average LLNL Site 300 fire station response time onsite is 4.5 minutes. One vehicle and three personnel respond from the LLNL Site 300 fire station. In addition, a vehicle from the LLNL Livermore site responds as a "cover" in case an additional fire breaks out. The response time to the LLNL Site 300 main gate from the LLNL Livermore site is approximately 15 minutes. Table 4.4-2 provides a summary of the type and number of onsite emergency calls to which the LLNL Site 300 Fire Department responded in 1988, 1989, and 1990.

At LLNL Site 300, the ambulance transports patients to the LLNL Site 300 Health Services Department during normal working hours. Health Services personnel evaluate and treat patients and determine the need for further acute care. If further acute care is required outside of normal working hours, patients are transported to Tracy Memorial Hospital in the City of Tracy.

Offsite Agency Involvement

The LLNL Fire Safety Division maintains mutual aid agreements with several agencies, including the City of Tracy and the California Department of Forestry, that could serve LLNL Site 300. Although there is no formal agreement, LLNL Site 300 also interacts with the Tracy Rural County Fire Protection District.

The City of Tracy Fire Department and the LLNL Site 300 fire station typically do not request aid from each other. The LLNL Site 300 fire station has not historically responded to calls within the Tracy Rural County Fire Protection District's jurisdiction. Conversely, less than 1 percent of Tracy Rural County Fire Protection District's total calls are mutual aid requests from LLNL Site 300. The State of California Department of Forestry and the LLNL Site 300 fire station respond to an average of less than 1 percent of each other's calls (Martin, 1991).

SNL, Livermore

Onsite Facilities

SNL, Livermore does not maintain an onsite fire department. Through a memorandum of understanding, the LLNL Livermore site Fire Station No. 1 provides primary emergency response to SNL, Livermore. SNL, Livermore does, however, have its own fire protection staff and other site facility support, which is described briefly below.

Onsite Emergency Procedures

General emergency response policies and procedures for SNL, Livermore have been compiled into its Emergency Preparedness Plan and Emergency Plan Implementation Procedures.

SNL, Livermore's Site Facility Support consists of four main functional areas: Plant Engineering, Security, Public Information; and Environment, Safety and Health Manager and Staff. Building Emergency Teams are assigned for all onsite areas and respond at the scene of an incident. The Emergency Preparedness Plan for the site procedures discusses the functions of the site facility support areas referred to above. Appendix J provides a detailed discussion of emergency response activities of SNL, Livermore.

Emergency Response Characteristics

The average LLNL Livermore site Fire Department response time to SNL, Livermore is 3.5 minutes. One vehicle and three personnel will initially respond to a call at SNL, Livermore. Additional equipment and personnel will respond as needed. Table 4.4-1 provides a summary of the type and number of SNL, Livermore emergency calls responded to by the LLNL Livermore site Fire Department in 1988, 1989, and 1990.

Offsite Agency Involvement

SNL, Livermore has a memorandum of understanding with LLNL for primary emergency response services. Offsite agencies are available to respond to SNL, Livermore for fire protection and emergency services through a mutual aid request from LLNL.

Table 4.4-1 LLNL Livermore Site and SNL, Livermore Onsite Emergency Response Data for LLNL Fire Station No. 1a

	Number of Incidents					
	1988		1989		1990	
Type of Incident	**LLNL**	**SNL, Livermore**	**LLNL**	**SNL, Livermore**	**LLNL**	**SNL, Livermore**
Fire	761	43	757	46	906	22
Ambulance	249	9	242	9	253	10
Hazardous Condition[b]	196	5	240	6	212	7
Standby[c]	398	0	398	0	326	0
Total:	1604	57	1637	61	1697	39

[a] These data represent all calls for assistance and include false alarms.

[b] A hazardous condition is a situation in which an event has occurred that is not in itself an emergency, but presents the potential for an emergency: for example, equipment with arcing or sparking electrical components.

[c] Standby is a situation in which no event has occurred, but the potential exists for an emergency: for example, the transfer of a highly toxic or hazardous material.

Table 4.4-2 LLNL Site 300 Onsite Emergency Response Data for Fire Station No. 2a

	Number of Incidents		
Type of Incident	**1988**	**1989**	**1990**
Fire	31	54	21
Ambulance	7	7	8
Hazardous Condition[b]	0	0	0

Standby[c]	20	11	17
Total:	58	72	46

[a] These data represent all calls for assistance and include false alarms.

[b] A hazardous condition is a situation in which an event has occurred that is not in itself an emergency, but presents the potential for an emergency: for example, equipment with arcing or sparking electrical components.

[c] Standby is a situation in which no event has occurred, but the potential exists for an emergency: for example, the transfer of a highly toxic or hazardous material.

4.4.2 Police and Security Services

This section presents an overview of onsite security services at LLNL (the LLNL Livermore site and LLNL Site 300) and SNL, Livermore. Also discussed are the existing police services provided by offsite agencies participating in emergency response agreements with LLNL and SNL, Livermore.

LLNL Livermore Site and LLNL Site 300

Onsite Activities

Police and security services at LLNL are provided by the Protective Force Division of the Safeguards and Security Department. This department has approximately 390 personnel, of which approximately 200 are assigned to the Protective Force Division. The Protective Force Division maintains 5 canine units, 3 armored personnel carriers, 11 sedans, and 10 all-wheel-drive vehicles.

It is the function of the Protective Force Division to provide protection of LLNL personnel and assets. This protection is provided through several elements, including access control, fixed access and surveillance points, random vehicle and foot patrols, response elements, and special response team elements.

Emergency Response Characteristics

The Protective Force Division provides emergency response service to the LLNL Livermore site and LLNL Site 300 and has contingency plans to cover credible emergencies, including work stoppages, bomb threats, natural disasters, sitewide evacuations, callout procedures, satellite command center activation procedures, executive protection, alarm response procedures, and civil disorders.

Offsite Agency Involvement

LLNL participates in emergency response agreements with the City of Livermore Police Department, the Alameda County Sheriff's Department, the San Joaquin County Sheriff's Department, the State of California Highway Patrol, and the Federal Bureau of Investigation. Offsite agencies generally provide first alarm response to LLNL offsite leased properties.

The City of Livermore Police Department is rarely requested to respond to calls at the LLNL Livermore site through its emergency response agreement and does not maintain records of its LLNL-related calls (Giuliani, 1991). The Alameda County Sheriff's Department responds to an average of six calls at the LLNL Livermore site per year, which is less than 1 percent of the agency's total annual calls. LLNL Site 300 is within Patrol District 8 of the San Joaquin County Sheriff's Department. Sheriff's Department records show that the department did not receive any calls for assistance at LLNL Site 300 and that the department did not request assistance from the LLNL Protective Force Division in either 1989 or 1990. The California Highway Patrol (CHP) responds to calls from the LLNL Safeguards and Security Department during large-scale demonstrations that have the potential to block Vasco Road and Greenville

Road. The California Highway Patrol responds to calls for crowd control from the LLNL Safeguards and Security Department on an average of once per year. There is occasional interaction with the FBI.

SNL, Livermore

Onsite Activities

At SNL, Livermore, the Protective Force is the organization responsible for implementing actions to secure onsite areas, for responding to security threats, for supporting Building Emergency Team activities, and for assisting in site evacuation. It is comprised of approximately 90 personnel.

Equipment maintained by the Protective Force includes radios, firearms, closed-circuit televisions, and security vehicles. The Protective Force also has access to canine units from the LLNL Livermore site through a mutual aid agreement. Based on response times, the Protective Force staffs enough personnel to provide adequate service to SNL, Livermore.

The activities of the Protective Force are coordinated by the Security Supervisor. Activities include overall site access control, provisions for expedient entry of emergency vehicles, security communications, implementation of site evacuation, and closure of the site. The Security Supervisor is the primary liaison between the SNL, Livermore Protective Force, the Alameda County Sheriff's Department, and the City of Livermore Police Department (SNL, Livermore, 1990a).

Emergency Response Characteristics

The SNL, Livermore Protective Force can respond to an emergency at any location onsite within 2 minutes. The most frequent types of calls are medical emergencies and fire alarms. The Protective Force has special staffing needs only for bomb threats, for which canine units are called in from the LLNL Livermore site as well as local police or sheriff's departments through mutual aid agreements.

Offsite Agency Involvement

The SNL, Livermore Protective Force participates in mutual aid agreements with LLNL. The Alameda County Sheriff's Department, the City of Livermore Police Department, and the State of California Highway Patrol participate in emergency response agreements with SNL, Livermore. The Alameda County Sheriff's Department responds to an average of two calls per year at SNL, Livermore (Garrigan, 1991). This represents less than 1 percent of the agency's total number of calls each year. SNL, Livermore does not typically respond to Sheriff's Department calls (Garrigan, 1991). Interaction with the City of Livermore Police Department and the California Highway Patrol is infrequent.

4.4.3 School Services

This section presents the student enrollment characteristics for families of LLNL and SNL, Livermore employees. The LLNL Livermore site and LLNL Site 300 are discussed together because employment figures for LLNL are administratively aggregated.

LLNL Livermore Site and LLNL Site 300

Description of Local Schools

As of September 1991 (the latest information available), approximately 41.0 percent of LLNL employees lived in the City of Livermore (LLNL, 1991e) (see Table 4.3-2). The balance of the employees reside throughout approximately 40 other cities (LLNL, 1991e). Because the largest concentration of LLNL employees resides in the City of Livermore the following discussion of school services focuses on the Livermore Valley Joint Unified School District, which includes the City of Livermore (including unincorporated areas around the city), and portions of Alameda and Contra Costa counties.

Enrollment Characteristics

The Livermore Valley Joint Unified School District includes nine elementary schools (grades kindergarten through 5), four middle schools (grades 6 through 8), and three high schools (grades 9 through 12). Of the 10,058 students enrolled in the Livermore Valley Joint Unified School District for the 1990 to 1991 school year, 1688 were members of families with one or more LLNL employees (Livermore Valley Joint Unified School District, 1991a). This constitutes 17 percent of the Livermore Valley Joint Unified School District's total enrollment.

The enrollment characteristics of each school in the Livermore Valley Joint Unified School District are presented in Table 4.4-3, including current enrollment and current enrollment capacity.

SNL, Livermore

Approximately 48 percent of SNL, Livermore employees reside in the City of Livermore (SNL, Livermore, 1991g). The balance of the employees reside in numerous other cities in the region. Based on the large concentration of SNL, Livermore employees in the City of Livermore, the above discussion of school services provided by the Livermore Valley Joint Unified School District is equally relevant to SNL, Livermore.

During the 1990–1991 school year, 205 students enrolled in the Livermore Valley Joint Unified School District were members of families with one or more SNL, Livermore employees (Livermore Valley Joint Unified School District, 1991a). This constitutes 2 percent of the Livermore Valley Joint Unified School District's total enrollment of 10,058 students.

4.4.4 Nonhazardous and Nonradioactive Solid Waste Disposal

This section discusses only nonhazardous and nonradioactive solid waste disposal. Disposal of hazardous and radioactive waste generated at LLNL and SNL, Livermore is discussed in section 4.15.

LLNL Livermore Site

Description of Landfill Facilities

Nonhazardous solid waste generated at the LLNL Livermore site is transported to the Vasco Road Landfill for disposal. The remaining capacity of the Vasco Road Landfill as of May 1990 is 23.6 million cu yd, with an anticipated lifespan under current conditions extending to the year 2008. The current total daily intake at the Vasco Road Landfill is 8288 cu yd (Lydick, 1991a). There are plans for expansion at the Vasco Road Landfill, which would provide an additional 12 years of operating life (Lydick, 1991b).

Plans for Expansion of Onsite Facilities

There are no plans to expand the LLNL Livermore site nonhazardous solid waste storage facilities or to modify nonhazardous waste disposal methods.

Onsite Solid Waste Characteristics

Approximately 65 cu yd of nonhazardous solid waste are collected and transported daily to the Vasco Road Landfill from the LLNL Livermore site. This waste represents a net generation of approximately 2000 cu yd a month and 24,000 cu yd a year at the LLNL Livermore site, after waste reduction and recycling (described below). Paper makes up approximately two-thirds of this total generation, and the remaining one-third consists of plastics, glass, other organics, and other wastes. This waste is stored in 258 onsite containers with average volume capacities of 4 cu yd each. Waste from 170 of the containers is collected and disposed of daily at the Vasco Road Landfill by LLNL workers. Waste from the other 88 containers is collected and disposed of twice weekly by the same method. In addition, approximately 200 cu yd of landscape clippings are disposed of at the landfill each month (LLNL, 1991c).

Waste Reduction and Recycling Programs

A portion of the nonhazardous waste generated annually is sold for recycling or reuse. Sold recyclable waste includes approximately 76,000 lbs of cardboard containers, 3 million lbs of ferrous metals, 1 million lbs of nonferrous metals, and 71,000 lbs of tires and other rubber products. Additionally, 500 cu yd of landscape clippings are chipped and reused annually as mulch, and approximately 80 percent of the total aluminum-can waste generated onsite is collected by individuals for personal recycling (LLNL, 1991c).

In April 1991, LLNL implemented a voluntary paper recycling program in which it is anticipated that 65 percent of LLNL employees would participate (Yano, 1991). Employees are provided with containers to use in their offices to collect unclassified white paper for recycling. A private recycling firm retrieves the collected paper from specified onsite dumpsters and removes it for processing. The program is expected to divert approximately 1200 tons of recyclable paper away from landfill disposal each year (Yano, 1991).

LLNL Site 300

Description of Landfill Facilities

Nonhazardous solid waste generated at LLNL Site 300 is transported to the Corral Hollow Sanitary Landfill, approximately 4 miles east of LLNL Site 300 on Corral Hollow Road.

According to the County of San Joaquin, Public Works Department, the total remaining capacity at the Corral Hollow Sanitary Landfill as of May 1991 is 1.15 million cu yd (Karam, 1991a). The landfill is scheduled for closure in January 1995 (Karam, 1991b). The current intake at the Corral Hollow Sanitary Landfill is approximately 1000 cu yd per day or 365,000 cu yd per year (Karam, 1991a). The County of San Joaquin is currently conducting a study to determine its long-term solid waste disposal plans. The study is considering several alternatives, including expansion of the existing landfill, siting a new landfill in the county, and construction of a transfer station. The study is estimated to be completed in the summer of 1992 (Karam, 1992).

Solid Waste Characteristics

Approximately 2200 cu yd of nonhazardous solid waste per year are transported from LLNL Site 300 to the Corral Hollow Sanitary Landfill. This is an average of 180 cu yd per month, which are transported in approximately 11 trips each month. The sources of this waste include office and laboratory refuse, construction debris, and landscape clippings. The office and laboratory refuse is collected daily at all LLNL Site 300 facilities, stored in a 16-cu-yd garbage truck, and emptied at approximately 1-week intervals (4 trips each month). The construction debris and landscape clippings generated at LLNL Site 300 are collected in dump trucks and taken to the landfill as needed in approximately 7 trips each month.

Waste Reduction and Recycling Programs

Scrap wood from old pallets and construction and demolition debris are stored onsite and made available to employees. Old tires are sent to the salvage yard at the LLNL Livermore site and sold on the outside market. Scrap metal is collected in several 1-cu-yd scrap bins and transferred periodically to the LLNL salvage yard by the LLNL Transportation Department. Computer paper and white ledger paper are collected on a voluntary basis at LLNL Site 300 and transferred for recycling to the LLNL Livermore site by the LLNL Transportation Department. Approximately 750 cu yd of scrap records, generated by the Records Management Department, are shipped annually from LLNL Site 300 to the hammer mill at the LLNL Livermore site.

SNL, Livermore

Description of Landfill Facilities

Nonhazardous solid waste generated at SNL, Livermore is transported to the Vasco Road Landfill for disposal. See the earlier "Description of Landfill Facilities" under the LLNL Livermore site.

Onsite Solid Waste Characteristics

In fiscal year 1990, SNL, Livermore disposed of approximately 3600 cu yd of nonhazardous solid waste at the Vasco Road Landfill, averaging approximately 300 cu yd a month. SNL, Livermore maintains contracts with two companies for refuse services. The Livermore Dublin Disposal Company is responsible for trash removal service. At this time, the scope of the contract is for "as needed removal of forty 1-cu-yd trash containers." SNL, Livermore also holds a contract with the De Paoli Equipment Company for refuse disposal privileges at the contractor's disposal site. In addition to the nonhazardous solid waste disposed of at the Vasco Road Landfill, approximately 800 lb per year of classified papers and film have been processed in an incinerator at SNL, Livermore.

Waste Reduction and Recycling Programs

SNL, Livermore implemented an informal waste minimization program in 1985 that is still in use. The underlying structure of the program is compliance with the waste management regulations set forth by DOE, the federal government, the State of California, and local governmental and planning agencies. A formal waste minimization plan was submitted and approved by DOE in the summer of 1991. The principal objective of the waste minimization program is to make use of all opportunities for elimination or minimization of waste through source reduction, recycling, and treatment in all corporate operations (SNL, Livermore, 1991m).

A program is in effect through the Plant Maintenance Department to reduce the amount of landscape clippings sent to the landfill. A wood chipper is used to mulch tree trimmings and leaves into compostable material. This end product is used onsite and documented by the Plant Maintenance Department. It is estimated that this recycling of landscape clippings would result in a 10 percent reduction in the amount of nonhazardous solid waste currently disposed of at the Vasco Road Landfill (SNL, Livermore, 1991m).

SNL, Livermore has supported a metal recycling program for several years. Assorted metals are collected and sold to an outside vendor for sorting and recycling.

Classified and sensitive paper waste that is sent to the LLNL Livermore site for processing is then shipped to a paper products manufacturer for recycling. A pilot paper recycling program for unclassified paper has recently been implemented.

Additionally, SNL, Livermore has implemented a volunteer employee program to collect aluminum cans and donate the proceeds to charity.

Table 4.4-3 Livermore Valley Joint Unified School District Enrollment Characteristics

Name of School	Address	Current Enrollment (April 1991)	Current Enrollment Capacity (February 1991)
Elementary:			
Arroyo Seco	5280 Irene Way	504	570
Christensen	5757 Haggin Oaks Avenue	705	780
Jackson	554 Jackson Avenue	609	660
Marylin	800 Marylin Avenue	570	630

Michell	1001 Elaine Avenue	429	480
Portola	3652 Portola Avenue	597	630
Rancho Las Positas	401 Las Positas Boulevard	518	540
Smith	391 Ontario Drive	461	540
Sunset	1671 Frankfurt Way	600	630
Middle:			
Christensen	5757 Haggin Oaks Avenue	88	---[a]
East Avenue	3951 East Avenue	763	717
Junction Avenue	298 Junction Avenue	654	705
Mendenhall	1701 El Padro Drive	730	826
Secondary:			
Del Valle	2253 Fifth Street	2830[b]	3387[b]
Livermore	600 Maple Street		
Granada	400 Wall Street		

[a] The Christensen school is being converted in phases from an elementary school to a middle school by September 1992. Its ultimate capacity as a middle school is not known.

[b]Current enrollment and current enrollment capacity figures are combined totals for all secondary schools.

Source: Livermore Valley Joint Unified School District, 1991a, 1991b.

4.5 PREHISTORIC AND HISTORIC CULTURAL RESOURCES

This section provides a summary evaluation of the prehistoric and historic cultural resources on the LLNL Livermore site, LLNL Site 300, and SNL, Livermore. Paleontological resources are discussed in section 4.8. Prehistoric cultural resources refer to any material remains of items utilized or modified by people prior to the establishment of Mission Dolores in San Francisco (the first San Francisco Bay Area mission) in 1776, or physical alteration of the landscape that occurred during the prehistoric time. Historic cultural resources include all material remains since the establishment of Mission Dolores, and any other physical alteration of the landscape. An overview of the prehistoric and historic resources in the project areas is presented in Appendix H.

4.5.1 Federal and State Regulations Related to Cultural Resources

NEPA requires consideration of the effects on cultural resources. Section 106 of the National Historic Preservation Act (16 U.S.C. section 470(h)-2) requires DOE to take into account the effects of its undertakings on properties included in or eligible for the National Register of Historic Places. Criteria for determining eligibility for the National Register and the steps involved in the Section 106 review process are described in Appendix H.

In the context of Section 106 of the National Historic Preservation Act, the Area of Potential Effect is the area in which planned development may directly or indirectly affect a cultural resource. Direct effects would include alteration of the surface by construction, while indirect effects would include human activity around the area. The Area of Potential Effect is determined by DOE during the EIS (in this case, EIS/EIR) process.

The California Environmental Quality Act (CEQA) requires consideration of the effects of a project on prehistoric and historic resources. Additional information regarding CEQA requirements is presented in Appendix H.

4.5.2 Prehistoric Resources

LLNL Livermore Site

Information regarding prehistoric resources on the LLNL Livermore site is from an updated archival literature review conducted at the California Archaeological Inventory at Sonoma State University; the California Archaeological Inventory at California State University Stanislaus; records in the possession of Basin Research Associates, San Leandro, California; and records on file at the LLNL Livermore site.

Three surveys of various portions of the LLNL Livermore site (primarily in areas where historic alteration of the ground was limited) were conducted from 1974 to 1990 and no cultural (prehistoric or historic) resources were discovered (see Appendix H for more detail on these surveys). A recent (1991) records search by Holman & Associates at the California Archaeological Inventory Northwest Information Center at Sonoma State University did not report any recorded cultural resources on or near the LLNL Livermore site property. Field inspections for cultural resources by Holman & Associates in the undeveloped western and northern perimeter areas at the LLNL Livermore site (including the 500-ft-wide buffer areas and additional undeveloped area along the western perimeter) were conducted in May and October 1991; no prehistoric resources were discovered.

LLNL Site 300

The general regional area in which LLNL Site 300 is located appears now to contain few natural resources that would have been attractive to either prehistoric populations or historic settlers and later to farmers, ranchers, and industrialists of the Carnegie era (see Appendix H); however, prehistorically the area probably contained more varied habitats, which would have been attractive to either prehistoric or historic populations, that have since been eliminated by modern agricultural and industrial uses. LLNL Site 300 contains at least a few potentially important prehistoric resources, the potential importance arising partially from the very scarcity of prehistoric sites in the region.

A total of 24 cultural resource sites (3 prehistoric, 20 historic, 1 with both a prehistoric and historic component) and several more areas of potential resources were recorded during a 1981 field and archival survey by Busby, Garaventa, and Kobori (1981). This survey involved an intensive visual field inspection of the site to identify surface indicators of cultural activity, but included no subsurface presence or absence testing. The prehistoric sites located and recorded during this survey included three rock shelters with associated artifacts and one surface lithics resource (stone artifact). No protective measures have been implemented at these sites. One of the prehistoric resources recorded in 1981 was not relocated during the 1991 resurvey of the sites; either the 1981 mapping was inaccurate or the site has been obscured. A more detailed description of these sites is presented in Appendix H.

SNL, Livermore

SNL, Livermore has been the subject of a recent thorough cultural resources overview and inventory (Busby and Garaventa, 1990) and cultural resources assessment (Busby, Garaventa, and Harmon, 1990). The 1990 studies were completed under the most recent guidelines and regulations regarding federal cultural resources procedures (48 Fed. Reg., 1983). Although all structures and features at SNL, Livermore were considered in the 1990 reports for potential inclusion in the National Register of Historic Places or National Historic Landmark status, no structures qualified for such status (State Historic Preservation Office, 1990). Consequently, no further investigation of prehistoric resources, or evaluation pursuant to the National Historic Preservation Act, is needed at SNL, Livermore (State Historic Preservation Office, 1990).

4.5.3 Historic Resources

LLNL Livermore Site

Neither the previous surveys nor the 1991 records search identified any historic properties which, in the opinion of the professionals involved, met the criteria for nomination to the National Register of Historic Places (as contained in 36 CFR 60.4) in the areas surveyed. In the 1991 field survey of the western perimeter area, remnants of what may be a former historic building location were seen at the northwest corner of the perimeter area. This area was not considered by the researchers to be significant (Woodruff, 1990), and was not evaluated further. Consultation with the State Historic Preservation Office will determine whether the properties meet the criteria for nomination to the National Register. Research in compliance with the historic property identification phase of Section 106 is being conducted within the LLNL Livermore site in order to identify which facilities within the site may be considered eligible for the National Register of Historic Places. The overall facility itself is also being evaluated for potential historical importance relative to its role during the Cold War years (William Self Associates, 1992). Historical information on the Laboratory is found in Section 2 of the EIS/EIR and in Appendix H. The historical overview of LLNL is important to the understanding of the historical importance of the facility relative to National Historic Preservation Act requirements. See section 5.1.4 and Appendix H for more information regarding this historical evaluation.

LLNL Site 300

Archival research prior to and during the 1981 field survey revealed that the LLNL Site 300 area has a high potential to contain important historic resources (Busby, Garaventa, and Kobori, 1981). The 1981 field survey and report located and recorded 21 historic sites, all of which were reinspected by Holman & Associates for this EIS/EIR. Only 4 of the 21 sites are within the Area of Potential Effect. During the 1991 reinspection, 7 of the historic sites, including the 4 sites within the Area of Potential Effect, were not relocated (they are either obscured or have been removed), and an eighth site was revisited but the artifact associated with the site had been collected during the 1981 survey (see Appendix H for more details).

The 1981 report recommended additional historic archival research to clarify the locations and characteristics of the Carnegie townsite–era residential, industrial, and other types of resources (described in Appendix H). Additional archival research on the historic activities along the southern border of LLNL Site 300 identified materials and locations associated with the town of Carnegie that may be potentially eligible for inclusion on the National Register (William Self Associates, 1992).

SNL Livermore

No existing historic resources at the SNL, Livermore facility are currently eligible for inclusion on the National Register based on consultation with the State Historic Preservation Office (State Historic Preservation Office, 1990). Consequently, no further review of historic cultural resources at SNL, Livermore, pursuant to the National Historic Preservation Act, is needed.

4.6 AESTHETICS AND SCENIC RESOURCES

This section discusses the visual and scenic resources of the Laboratory sites and the surrounding areas.

4.6.1 Visual Character of the Project Vicinity

LLNL Livermore Site and SNL, Livermore

While they are distinct operations managed and operated by different contractors, for purposes of this discussion the LLNL Livermore site and SNL, Livermore are addressed together because of their proximity. The Livermore Valley of eastern Alameda County, where the LLNL Livermore site and SNL, Livermore are located, is ringed by hills and mountains that define the regional viewshed and provide open space around the development on the valley floor. The terrain in the vicinity of the sites ranges from relatively flat land to gently rolling hills. The hills east and south of the LLNL Livermore site and SNL, Livermore gradually become steeper as they trend eastward to form the Altamont Hills of the Diablo Range. Wind turbines north and south of the Altamont Pass punctuate the eastern horizon and have become part of the eastern valley landscape identity. Figure 4.6-1 shows an oblique aerial view of the LLNL Livermore site and SNL, Livermore looking southeast toward the Altamont Hills.

The area surrounding the LLNL Livermore site and SNL, Livermore is generally rural and pastoral because of the surrounding hillside open space. Rural residences and grazing land are the primary visual features to the south and east of the sites. The rural character continues to the southwest, where large vineyards are the primary visual features. West of the LLNL Livermore site, existing and newly constructed residential areas of the City of Livermore provide a more suburban character. The area extending north from the LLNL Livermore site to I-580 is industrial, and provides a visual continuation of the research, business, and industrial character of the LLNL Livermore site. Primary features are one- and two-story industrial buildings, business parks, and the Union Pacific and Southern Pacific railroad lines that traverse the area.

LLNL Site 300

LLNL Site 300 is located in the Altamont Hills of the Diablo Range, where the nearby topography varies from rolling hills to steep ridges and valleys. The surrounding area is primarily undeveloped and rural in character. LLNL Site 300 is visible from Corral Hollow Road, that forms its southern boundary.

Physics International operates a testing facility adjacent to and northeast of LLNL Site 300. Although the sign at the entrance to Physics International is visible from Corral Hollow Road, because of the topography of the site, the structures are not. The SRI International testing facility, in the hills approximately 0.6 mile south of LLNL Site 300, is not visible from Corral Hollow Road.

Carnegie State Vehicular Recreation Area is south of the western portion of LLNL Site 300 and is visible from Corral Hollow Road. The hillsides of the park, used for off-road vehicle riding, are lined with dirt trails. A ranger station and picnic area near the park entrance are also visible from Corral Hollow Road.

4.6.2 Views of the Sites from Surrounding Areas

LLNL Livermore Site and SNL, Livermore

While they are distinct operations managed and operated by different contractors, for purposes of this discussion the

LLNL Livermore site and SNL, Livermore are addressed together because of their proximity. The LLNL Livermore site has a campus or business park–like setting with buildings, internal roadways, pathways, and open space. Portions of the site along the western and northern boundaries remain undeveloped and serve as security buffer areas. A row of eucalyptus and poplar trees surrounds much of the developed portion of the LLNL Livermore site, screening most ground-level views of the facility. Onsite buildings range in height from 10 to approximately 110 ft. A 9-ft-high, chain-link and barbed-wire security fence surrounds the LLNL Livermore site.

The central area of the SNL, Livermore site is developed with structures, roadways, and parking areas. An open space area, ranging in width from approximately 600 to 1200 ft, borders the developed area on the west, south, and east. Onsite buildings range in height from 10 to approximately 40 ft. A 9-ft-high, chain-link and barbed-wire security fence runs along the perimeter of SNL, Livermore.

The existing visual character of the LLNL Livermore site and SNL, Livermore is illustrated by several photographs taken of the sites from nearby sensitive viewpoints (e.g., residences and scenic roadways). Figure 4.6-2 indicates where the photographs depicted in Figures 4.6-3 through 4.6-5 were taken, and the directions of the views.

The LLNL Livermore site is relatively distant from I-580 (approximately 1.5 miles) and only the tallest onsite building is visible from this highway. Much of the site is prominently visible, however, when approaching from the north on Vasco Road.

A tract of single-family residences on the southwest corner of Patterson Pass Road and Vasco Road has a view of the northwest corner of the LLNL Livermore site. Figure 4.6-3 shows the view of the LLNL Livermore site looking southeast from these residences. The view consists of the security fencing in the foreground, the 500-ft open space buffer along Vasco Road in the midground, and the row of high-standing eucalyptus trees in the background. Few onsite structures are visible from this residential area.

The LLNL Livermore site is also prominently visible when approaching the site from the south on Vasco Road. Several scattered residences along Vasco Road south of East Avenue have a direct view. Figure 4.6-4 presents a view of the LLNL Livermore site looking northeast from a residence on Vasco Road, approximately 1800 ft south of East Avenue. Structures and landscaping in the southwestern quadrant of the LLNL Livermore site are visible from this vantage point.

When approaching from the south on Greenville Road (a City of Livermore and Alameda County scenic roadway), the LLNL Livermore site and SNL, Livermore are intermittently visible among the rolling hillsides. Figure 4.6-5 provides a view of the LLNL Livermore site and SNL, Livermore looking northwest from Greenville Road approximately 2000 ft south of East Avenue. A panoramic view of both sites is offered from this section of Greenville Road. Structures, parking lots, and onsite landscaping are visible in the background, and the open space security buffer bordering the developed portion of SNL, Livermore is visible in the foreground.

LLNL Site 300

The I-580 freeway is approximately 2 miles east of LLNL Site 300 and is designated as a scenic highway by the State of California; however, because of distance and intervening topography, LLNL Site 300 is not visible from the I-580 corridor. Corral Hollow Road, which is adjacent to and south of LLNL Site 300, is the only public roadway in the vicinity with a view of the site. The view consists of parking areas and several single-story structures in the General Services Area. The view of the LLNL Site 300 General Services Area from Corral Hollow Road is shown in Figure 4.6-6. The remainder of the view of LLNL Site 300 from Corral Hollow Road consists of rolling hillsides and a few scattered small structures on the hilltops. Other than the General Services Area, the facilities of LLNL Site 300 are not apparent in landscape views from publicly accessible viewpoints; however, a 3-ft-high wire fence surrounding LLNL Site 300 is visible from Corral Hollow Road, along the site's southern boundary.

LLNL Site 300 can be seen from the Carnegie State Vehicular Recreation Area, which lies directly south. One single-story structure (Building 899) and its surrounding light posts are visible from the park. From the picnic area near the park entrance, the view of LLNL Site 300 consists primarily of undeveloped hillsides.

4.6.3 Scenic Resources Policies

LLNL Livermore Site and SNL, Livermore

While they are distinct operations managed and operated by different contractors, for purposes of this discussion the LLNL Livermore site and SNL, Livermore are addressed together because of their proximity.

County of Alameda

Scenic Route Element of the County of Alameda General Plan. The scenic route element of the County of Alameda General Plan was adopted by the Alameda County Board of Supervisors in May 1966. This element, consisting of text and a map, is designed to serve as a guide for establishment of programs and legislation for the development of a system of scenic routes. A primary goal of the element is the preservation and enhancement of scenic qualities and natural scenic areas adjacent to and visible from scenic routes. The element contains objectives, definitions, policies, standards, and implementation measures (County of Alameda, 1966).

Scenic routes are defined as consisting of three elements: the right-of-way, the adjacent scenic corridor, and areas extending beyond the scenic corridor. Scenic corridors are either areas that extend beyond a scenic route right-of-way and are of sufficient scenic quality to be acquired by state or local jurisdictions, or areas to which development controls should be applied to preserve and enhance nearby views or maintain unobstructed distant views along a scenic route and provide a pleasant route of travel (County of Alameda, 1966).

Figure 4.2-4 in section 4.2 illustrates the scenic routes designated in the County of Alameda scenic route element. The following roadway segments in the vicinity of the LLNL Livermore site and SNL, Livermore are designated as scenic routes according to the element:

- Interstate 580 (I-580)
- Vasco Road
- Patterson Pass Road (from Vasco Road to the San Joaquin County border)
- Tesla Road (from Vasco Road to the San Joaquin County border)
- Greenville Road (from I-580 to Tesla Road)
- Altamont Pass Road (from I-580 to Route 239)
- Cross Road (from Patterson Pass Road to Tesla Road)

A summary of relevant policies excerpted from the County of Alameda scenic route element includes the following:

- Provide for Normal Uses of Land and Protect Against Unsightly Features. In both urban and rural areas, normally permitted uses of land should be allowed in scenic corridors, except that panoramic views and vistas should be preserved and enhanced by supplementing normal zoning regulations with special height, area, and sideyard regulations; and by providing architectural and site design review.
- Use Landscaping to Increase Scenic Qualities of Scenic Route Corridors. Landscaping should be designed and maintained in scenic route corridors to provide added visual interest, to frame scenic views, and to screen unsightly views.
- Underground Utility Distribution Lines When Feasible; Make Overhead Lines Inconspicuous. New, relocated, or existing utility distribution lines should be placed underground whenever feasible. When it is not feasible to place lines underground, they should be inconspicuous from the scenic route. Poles of an improved design should be used wherever possible. Combined or adjacent rights-of-way and common poles should be used wherever feasible.
- Control Tree Removal. As a means of preserving the scenic quality of the county, no mature trees should be removed without permission from the local jurisdiction.

City of Livermore

Scenic Route Element of the Livermore General Plan 1976–2000. The scenic route element of the Livermore General Plan 1976–2000, adopted by the Livermore City Council on October 11, 1977, is designed to guide the preservation and enhancement of scenic values along the streets and highways in the Livermore Valley. It also aims to preserve and enhance scenic values that are of outstanding quality or that provide access to important scenic, recreational, cultural, or historic points. Further, the scenic route element provides a comprehensive plan and expands the scenic route plans of Alameda County and CALTRANS within the Livermore Planning Area. The Livermore General Plan scenic route element incorporates the County of Alameda scenic route element, adding local routes with scenic qualities (City of Livermore, 1977b).

The following roadway segments in the vicinity of the LLNL Livermore site and SNL, Livermore are designated as scenic routes in the city's scenic route element (City of Livermore, 1977b) (see Figure 4.2-4 in section 4.2):

- Interstate 580 (I-580)
- Greenville Road
- Tesla Road
- Altamont Pass Road
- Patterson Pass Road
- Flynn Road

The policies in the scenic route element of the Livermore General Plan 1976–2000 are similar to those contained in the scenic route element of the County of Alameda General Plan (County of Alameda, 1966). These policies address the use of landscaping to increase the scenic qualities of scenic corridors and encourage the use of underground utilities and the preservation of mature trees (City of Livermore, 1977b).

LLNL Site 300

County of San Joaquin

Scenic Highways Element of the San Joaquin County General Plan. The scenic highways element of the County of San Joaquin General Plan was adopted by the San Joaquin County Board of Supervisors on October 19, 1978. The purpose of the element is to establish scenic routes in the county and to guide the preservation and enhancement of scenic qualities and natural scenic areas adjacent to and visible from scenic routes (County of San Joaquin, 1978b).

San Joaquin County recognized the value of scenic resources surrounding a 16-mile portion of I-580 and I-5 between Stanislaus and Alameda counties and, in 1974, adopted a Scenic Corridor Zone, designed to give aesthetic protection to county-designated scenic highways. Later in 1974, this 16-mile segment of I-580 and I-5 received official designation as a state scenic highway by its inclusion in the State Master Plan of Scenic Highways. No other highways or roadways within San Joaquin County have been identified as scenic. Figure 4.2-4 in section 4.2 shows the location of a segment of the I-580 state scenic highway corridor within San Joaquin County.

4.7 METEOROLOGY

This section discusses weather and other meteorological conditions at the sites.

4.7.1 Temperature

The daily maximum and minimum temperatures for each month for Livermore, California, are shown in Table 4.7-1. The mean annual temperature for the 30-year period from 1951 through 1980 was 14.5·C (58.1·F) with daily extremes ranging from –8·C (18·F) to 45·C (113·F).

4.7.2 Precipitation

Most rainfall in the Livermore Valley occurs between October and April. The average annual precipitation for the region is 379 mm (14.9 inches) (NOAA, 1980–1990). Table 4.7-2 contains the average monthly precipitation for the Livermore Valley for the years 1980 through 1990. The annual precipitation at LLNL Site 300 for the 18-year period from 1973 through 1990 was 263 mm (10.34 inches).

4.7.3 Winds

LLNL Livermore Site and SNL, Livermore

The Livermore Valley, in which both the LLNL Livermore site and SNL, Livermore are located, is bowl-shaped, measuring approximately 21 km in length and 7 to 11 km in width. The surrounding hills range from 300 to 600 m above the valley floor. The LLNL Livermore site and SNL, Livermore lie in the southeastern portion of the valley. As airflow moves east through Dublin Gap, it diverges until it encounters Mt. Diablo and the Altamont Hills to the north. These obstructions turn the flow toward the southeast. South of the Dublin Gap, the influence of the foothills of the Diablo Mountain Range and the surrounding Altamont Hills then diverts the airflow towards the northeast. Airflow exits the valley through Altamont Pass, located directly northeast of the LLNL Livermore site and SNL, Livermore. Large-scale upper-air influences either weaken or enhance this surface flow pattern.

The seasonal and annual wind roses from the 10-m meteorological tower located at the LLNL Livermore site are shown in Figure 4.7-1. The data illustrated are from the years 1986 through 1990.

The annual frequency of the winds at the LLNL Livermore site is shown in Table 4.7-3. The frequency of calm winds (0 to 1 m/sec) is divided among the 16 wind directions according to the frequency of occurrence of the first noncalm wind speed category.

During the summer months, winds are predominantly from the south or southwest as a result of the sea breeze. The sea breeze phenomenon is created when air over land is heated more rapidly by solar radiation than the air over the cooler Pacific Ocean. As the air is heated it rises and begins to develop a circulation, causing the air over the ocean to move inland. During this period of replacement (which typically occurs between 14:00 and 16:00 Pacific Standard Time), the wind velocity increases. This differential heating rarely occurs during the winter months when winds are more evenly distributed because of the passage of winter storms and because the differential temperature between the land surface and ocean water is less.

LLNL Site 300

LLNL Site 300 is located near the northern end of the Diablo Range at a distance of about 15 miles east-southeast of the LLNL Livermore site and SNL, Livermore, and approximately 8 miles southwest of the City of Tracy. The topography of the area varies from rolling hills with relatively flat benches and valleys to steep hills and rugged canyons. The climate is characterized by mild, rainy winters and warm, dry summers. Sunshine is abundant throughout the year. It is officially classified as "Mediterranean Scrub Woodland" climate (Rumney, 1968).

During winter, cyclonic storms affect the region, attended by southerly or southwesterly winds and short periods of rain. As the low pressure passes, light snow sometimes falls over the higher elevations. Following the passage of the low pressure, skies typically clear as the eastern Pacific high builds inland. Occasionally these conditions produce strong northerly surface winds with gusts in excess of 30 m/sec for a day or two.

During nonrainy periods, particularly during December and January, radiation fogs form frequently in the San Joaquin Valley and move over the site.

Summer sea breezes often develop in the afternoon when modified marine air moves through the passes to the west and is funneled through Corral Hollow, of which LLNL Site 300 is a part. A strong sea breeze can reduce maximum temperatures by 5·C or more. This breeze persists into the evening and occasionally throughout the night, resulting in cool temperatures. If the marine layer is sufficiently deep, stratus clouds are advected to within several kilometers of the western boundary. The clouds usually dissipate during the afternoon. The sea breeze ranges between 5 to 15 m/sec but may exceed 20 m/sec at LLNL Site 300.

Spring and autumn are typically transitional periods in which no exceptional meteorological phenomena occur. The seasonal and annual frequency of wind occurrence for the period 1986 through 1990 from the 10-m meteorological tower at LLNL Site 300 is shown in Figure 4.7-2. The average annual wind speed percent occurrence for each of the six wind classes during the period 1986 through 1990 is shown in Table 4.7-4.

Table 4.7-1 Daily Maximum, Minimum, and Monthly Temperature (·F)Livermore, California

Month	Daily Maximum Temperature	Daily Minimum Temperature	Monthly Average Temperature
January	57.0	34.7	45.9
February	61.3	37.8	49.6
March	64.6	38.8	51.7
April	70.1	41.4	55.8
May	76.6	45.9	61.3
June	83.6	50.5	67.1
July	90.0	52.7	71.3
August	89.2	52.6	70.9
September	86.8	51.2	69.0
October	78.7	46.4	62.6
November	66.1	39.5	52.8
December	57.7	35.2	46.5

Year Average:	73.5	43.9	58.1

Source: NOAA, 1980–1990.

Table 4.7-2 Annual Monthly Mean Precipitation (Inches) Livermore Valley, California

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	4.2	4.2	1.4	1.3	0.5	0.0	0.7	0.0	0.0	0.0	0.3	1.2	13.8
1981	4.0	1.1	2.9	0.6	0.1	0.0	0.0	0.0	0.1	2.1	3.4	2.6	16.9
1982	5.3	2.2	5.6	1.5	0.0	0.3	0.0	0.0	1.5	2.2	3.7	2.8	25.1
1983	6.3	5.6	6.1	3.5	0.2	0.0	0.0	0.5	1.0	0.3	5.4	3.4	32.4
1984	0.3	1.9	1.0	0.5	0.0	0.0	T	0.0	0.0	1.3	4.7	1.5	11.3
1985	0.5	1.3	2.6	0.3	0.1	0.2	T	0.0	0.1	0.7	2.7	2.0	10.4
1986	2.0	7.1	4.1	0.6	0.1	0.0	0.0	0.0	0.5	0.0	0.1	0.9	15.5
1987	1.8	3.5	2.3	0.2	0.1	ND	0.0	0.0	0.0	0.9	1.4	2.3	12.4
1988	1.8	0.4	0.3	1.2	0.5	0.1	0.0	0.0	0.0	0.1	1.9	2.0	8.2
1989	0.8	1.0	2.9	0.9	0.1	0.1	0.0	0.0	1.3	1.1	1.0	0.1	9.3
1990	1.5	2.5	0.9	0.4	1.8	T	0.0	T	0.1	0.1	0.4	1.5	9.0
Average	2.6	2.8	2.7	1.0	0.3	0.1	0.1	0.0	0.4	0.8	2.3	1.8	14.9

ND = Data not available.
T = Trace, less than 0.01 inch.
Source: NOAA, 1980–1990.

Table 4.7-3 Wind Frequency Distribution (Percent Occurrence) LLNL Livermore Site* 1986 Through 1990

Compass Direction	Wind Speed Classes (m/sec)					
	0–1.3	1.3–3.0	3.0–5.1	5.1–8.2	8.2–10.8	>10.8
N	1.3	0.72	0.84	0.72	0.23	0.05
NNE	1.56	1.4	1.52	0.48	0.05	0.01
NE	1.95	1.93	1.99	0.13	0	0

ENE	2.37	1.02	0.63	0.14	0.02	0
E	4.01	0.68	0.21	0.06	0.01	0
ESE	6.05	0.66	0.09	0.04	0.01	0
SE	3.38	0.34	0.06	0.03	0.01	0
SSE	2.09	0.19	0.06	0.03	0.02	0.01
S	2.52	0.95	0.16	0.04	0	0
SSW	2.65	2.08	0.94	0.40	0.10	0
SW	2.76	4.82	5.81	2.79	0.20	0
WSW	2.58	5.85	5.26	1.67	0.06	0
W	1.85	3.82	5.80	1.75	0.02	0
WNW	1.3	0.94	0.85	0.33	0	0
NW	1.24	0.57	0.21	0.04	0	0
NNW	1.25	0.58	0.43	0.18	0.02	0

* Lawrence Livermore National Laboratory, 10-meter meteorological tower.
Source: LLNL, 1991f.

Table 4.7-4 Wind Frequency Distribution (Percent Occurrence) LLNL Site 300* 1986 Through 1990

	Wind Speed Classes (m/sec)					
Compass Direction	**0–1.3**	**1.3–3.0**	**3.0–5.1**	**5.1–8.2**	**8.2–10.8**	**>10.8**
N	0.51	0.65	1.5	1.49	0.25	0.37
NNE	0.40	0.51	0.58	0.04	0	0
NE	0.52	1.11	0.70	0.01	0	0
ENE	0.6	1.09	0.23	0.01	0	0
E	0.75	0.80	0.18	0.03	0	0
ESE	0.69	0.46	0.13	0.10	0.03	0.01
SE	0.82	0.50	0.22	0.15	0.01	0.04
SSE	1.08	0.73	0.26	0.13	0.03	0.03
S	1.35	1.02	0.30	0.16	0.04	0.01
SSW	1.22	0.86	0.28	0.13	0.06	0.03
SW	0.84	0.57	0.78	0.92	1.05	1.16

WSW	0.75	0.87	2.53	11.52	11.65	5.83
W	0.86	1.13	2.53	4.82	0.89	0.13
WNW	1.06	1.05	1.42	1.38	0.21	0.04
NW	1.83	2.47	2.13	2.64	1.14	0.57
NNW	0.99	1.33	2.85	3.76	1.33	1.69

* LLNL Site 300, 10-meter meteorological tower.
Source: LLNL, 1991f.

4.7.4 Storm Events

The Livermore Valley and LLNL Site 300 rarely experience severe weather. The greatest annual rainfall during the period between 1931 and 1990 was 1041 mm (41 inches) (NOAA, 1980-1990). During the 5 years between 1986 and 1991, California experienced less than normal precipitation, which is 379 mm (14.9 inches). Annual rainfall for the Livermore region for 1986 through 1990 was only 274 mm (10.9 inches), which is 28 percent below normal. This can be compared to the 508 mm (20.0 inches) average for an earlier 5-year period (1980 through 1984), which is 34 percent above normal. Thunderstorms occur fewer than 10 days per year and are not intense; hail occurs even less frequently.

4.8 GEOLOGY

This section provides an overview of the affected physical environment, including discussions of the local and regional geologic setting, stratigraphy (rock and sediment types), soils, economic geology, structural geology, and geological hazards (including seismicity). A discussion of existing contamination in the soils at the sites is included in section 4.17.

4.8.1 General Geology

Topography and Geomorphology

The LLNL Livermore site, LLNL Site 300, and SNL, Livermore are located in the California Coast Ranges geologic province (Dibblee, 1980a, 1980b) characterized by low rugged mountains and relatively narrow intervening valleys. Figure 2-1 shows the location of the LLNL Livermore site, LLNL Site 300, and SNL, Livermore relative to the surrounding area.

LLNL Livermore Site and SNL, Livermore

The LLNL Livermore site and SNL, Livermore are located in the southeastern portion of the Livermore Valley. The valley forms an irregularly shaped lowland area about 16 miles long east-to-west and 7 miles to 10 miles wide north-to-south. The floor of the valley slopes to the west at about 20 ft per mile.

In general, the LLNL Livermore site and SNL, Livermore are located on relatively flat foothills that have low relief and slope gently northwest and north. Slopes at the LLNL Livermore site do not generally exceed a 1-degree inclination while those at SNL, Livermore vary from 1 to 3 degrees (U.S. Department of Agriculture Soil Conservation Service, 1966). The southern area of SNL, Livermore is situated on the north side of a ridge approximately 150 ft (46 m) above the surrounding land. The SNL, Livermore property ranges in elevation from 849 ft (259 m) above mean sea level (MSL) at the south end of the SNL, Livermore ridge top to 615 ft (187 m) at the northwest corner of the site. The LLNL Livermore site property ranges in elevation from 676 ft (206 m) in the southeast corner to 571 ft (174 m) in the northwest corner.

LLNL Site 300

LLNL Site 300 is located in the Altamont Hills near the western boundary of San Joaquin County. The site occupies approximately 7000 acres of steep ridges and canyons with a decrease in elevation toward the southeast. Slopes range from 8 degrees to greater than 45 degrees in the canyons. In the General Services Area located in the southeastern portion of the site, slopes can be as low as 2 or 3 degrees (U.S. Department of Agriculture Soil Conservation Service, 1990). The maximum elevations onsite are found in the northwest portions of LLNL Site 300 and range from 1476 ft (450 m) to 1722 ft (525 m) above mean sea level. The lowest elevation onsite, where Corral Hollow Creek follows the southern LLNL Site 300 southern boundary, is approximately 500 ft (152 m) above mean sea level.

Structural Geology

A generalized map of the regional structural geology and physiography of the San Francisco Bay Area is presented in Figure 4.8-1. The Diablo Range, which includes the Altamont Hills, is part of the northwest-trending Coast Ranges, and parallels three major faults in the area (Nilsen, 1977; Atwater, 1970). These include the San Andreas fault system, the Sur-Nacimiento fault, and the Coast Range thrust fault system (the Sur-Nacimiento fault and the Coast Range thrust are not exposed in the area shown in Figure 4.8-1). These faults can generally be considered to define three different lithologic blocks (Page, 1966). The westernmost block is the Salinian Block, which lies west of the San

Andreas fault shown in Figure 4.8-1. This block consists primarily of metamorphic and granitic rock. To the east of the Salinian Block is the Franciscan Assemblage, lying between the San Andreas and the Coast Range thrust fault zones. It is composed of marine sedimentary and volcanic rocks. The next block positioned above the Coast Range thrust fault zone consists of late Mesozoic through late Tertiary marine sedimentary rocks overlying complex ancient oceanic and continental crust rocks. This block lies primarily along the eastern margin of the Coast Range Province. Structural relationships along the Coast Range thrust are complex due to later reactivation of the thrust by high-angle normal and strike slip faults.

The Hayward fault, which is part of the San Andreas fault system (see Figure 4.8-1), forms the western boundary of the East Bay Hills and is located about 17 miles west of the LLNL Livermore site. Another branch of the San Andreas fault system, the Calaveras fault zone, trends northwest through the San Ramon Valley, which borders the Livermore Valley to the west. A major structural feature north of the Livermore Valley is the Mount Diablo Complex. This complex consists of folded and thrust faulted rock in the vicinity of Mount Diablo and the surrounding hills (Page, 1966). This complex is bordered on the northeastern edge by the Green Valley–Clayton fault system. The Suisun Bay is to the north and the Livermore Valley to the southeast flank of the Diablo Complex. The two regional northwest-southeast trending fault zones located closest to the Laboratories are the Greenville fault zone and the Tesla-Ortigalita fault zones, both shown in Figure 4.8-1.

A geologic map showing general geologic structures including faults mapped in the vicinity of the LLNL Livermore site and SNL, Livermore is presented in Figure 4.8-2. Geologic structures mapped at LLNL Site 300 are shown in Figure 4.8-3. It contains the most accurate depiction of bedrock geology; however, Figure 4.8-8 should be used for landslides and fault mapping. More detailed discussions of faulting in the LLNL/SNL, Livermore vicinity are presented in section 4.8.3 and in Appendix I.

Stratigraphy

Figure 4.8-4 presents a schematic stratigraphic column of rocks outcropping at the LLNL Livermore site, LLNL Site 300, and SNL, Livermore.

A geologic map showing the distribution of geologic materials mapped at the LLNL Livermore site and SNL, Livermore is presented in Figure 4.8-2. The distribution of rock types mapped at LLNL Site 300 is shown in Figure 4.8-3. The Diablo Range consists primarily of metamorphic and igneous rocks known as the Mesozoic Franciscan Assemblage (Dibblee 1980a, 1980b). These formations extend to, and in places are overlain by, oceanic crustal and marine sedimentary rocks from late Mesozoic and late Tertiary ages (California Division of Mines and Geology, 1964).

The Franciscan Assemblage generally contains metamorphic rocks known as graywacke, metagraywacke, shale or argillite, blueschist, greenstone; some limestones and cherts; and assorted igneous rocks. These assorted rock types are present throughout the Franciscan Assemblage but have been deformed and are discontinuous.

Overlying the Franciscan Assemblage are sedimentary rocks known as the Great Valley Sequence, which consists of layers that are somewhat deformed (Ingersoll, 1981). The Great Valley Sequence is thought to have formed during the late Mesozoic within a basin resting between the Sierra Nevada, which was then the location of a volcanic island–arc, and a trench to the west (Page, 1981; Atwater, 1970). Outcrops of the Great Valley Sequence are seen in the Altamont Hills east of Livermore, and especially along the eastern edge of the Coast Ranges. The Franciscan Assemblage is thought to have been formed as an accretionary wedge of trench sediments that were thrust beneath the western edge of the Great Valley Sequence deposits (Hamilton, 1969; Ernst, 1970; Hsu, 1971). The contact between the Great Valley Sequence and the Franciscan Assemblage is the Coast Range thrust and is seen along the eastern margin of the Coast Ranges.

LLNL Livermore Site and SNL, Livermore

The sediments beneath the Livermore Valley range in age from Jurassic to Quaternary (see Figure 4.8-4). A large volume of the valley sediment is composed of late Tertiary and Quaternary alluvial sediments known as the Livermore Formation (Carpenter et al., 1984; The Mark Group, 1986). The maximum thickness of the Livermore Formation is thought to be approximately 4000 ft (1219 m). This formation has been divided into Upper and Lower Members (Huey, 1948; Thorpe et al., 1990). The Upper Member of the Livermore Formation is characterized by massive gravel beds mixed with sand, silt, and clay. The Lower Member of the Livermore Formation is dominated by greenish- to bluish-grey silt and clay, with lenses of gravel and sand (Huey, 1948; Thorpe et al., 1990). For additional information on the local stratigraphic units and hydrogeology at the LLNL Livermore site and SNL, Livermore see section 4.11.2.2.

LLNL Site 300

Sedimentary rocks at LLNL Site 300 are similar to those present in the vicinity of the Livermore Valley. This hilly terrain contains sedimentary units that dip 5 to 10 degrees or more to the east and southeast. Some older formations, including the Upper Cretaceous Panoche Formation, are exposed in limited areas of the northwest and northeast corners of the site. A majority of the exposed strata onsite are of Tertiary age, including the Miocene Cierbo and Neroly Formations. The Miocene Neroly Formation is exposed over the greatest areal extent of all sedimentary units onsite. Pliocene nonmarine sedimentary rocks may have formed at the same time as the Livermore Formation in the Livermore Valley and occupy a similar position in the stratigraphic column. In addition, younger Quaternary alluvial deposits are present onsite in limited areas, but most have been removed by erosion. For additional information on the local LLNL Site 300 stratigraphy and hydrogeology, see section 4.11.2.2.

Soils

LLNL Livermore Site and SNL, Livermore

A generalized map of the soils of the Livermore area is shown in Figure 4.8-5. The soils in the Livermore Valley beneath the LLNL Livermore site and SNL, Livermore are formed primarily upon sediments deposited by local streams. Most of the deposits in the eastern part of the valley are relatively young, and thus soils are only moderately developed. These soils (generally loam) have minimal horizon or development of layers, and can be locally several meters thick. The soils are used for crop production when provided with sufficient water and nutrients or minerals (Brady, 1974; U.S. Department of Agriculture Soil Conservation Service, 1966). Four soils cover most of the LLNL Livermore site vicinity. In order of decreasing extent they are: Rincon loam, Zamora silty clay loam, Positas gravelly loam, and Rincon clay loam. These soils are primarily Alfisols, or moderately developed soils, and grade into Mollisols, which are grassland soils (Brady, 1974).

LLNL Site 300

A generalized map of LLNL Site 300 soils is provided in Figure 4.8-6. The LLNL Site 300 soils have developed on marine shales and sandstones, uplifted river terraces, and fluvial deposits. They are classified as loamy Entisols. Entisols are young soils that have little or no horizon development. Clay rich soils (Vertisols) are also present and have been mapped as the Alo-Vaquero complex. Vertisols are mineral soils characterized by a high clay content that display shrink/swell capability. The remaining soil types identified at LLNL Site 300 occur only in limited areas. These units are mixtures of the soils described and are not readily separable, including grassland Mollisols, or are poorly developed Inceptisols (U.S. Department of Agriculture Soil Conservation Service, 1966, 1990). All LLNL Site 300 soil types are potentially useful for limited agriculture but are constrained by location and steepness of the slopes. The loamy soils easily erode, and vegetation can be churned into the soil by moderate livestock or other traffic during wet periods. Vertisols exhibit low permeability and are subject to moderate erosion. Wildlife habitat and limited grazing by livestock are the best use of these soils.

Soil properties and extent are important factors in evaluating potential transport of contaminants. A discussion of the distribution of soil and sediment contamination at LLNL and SNL, Livermore is presented in section 4.17. Hazardous materials, if sorbed to surficial soil, might potentially leave the LLNL Livermore site, LLNL Site 300, and SNL, Livermore as components of airborne dust particles, or be transported by surface water flow. Soil properties, especially infiltration capacity, govern the transport of hazardous material to the saturated zone. For example, the infiltration rates in the LLNL retention basin varied from 0.01 ft/day near the center, where a silt layer had been deposited on the basin floor, to 1.9 ft/day in the banks of the basin (Toney, 1990). Based on percolation and whole-trench tests, reported surface infiltration rates in the recharge basin south of the LLNL Livermore site range from 0.24 to 10 ft/day, depending on lithology (Dresen et al., 1988). The USDA estimated the permeability for undisturbed soils covering the central and eastern areas of the LLNL Livermore site at approximately 0.4 to 1.6 ft per day. With the exception of parts of the western and northern areas, most LLNL Livermore site soil has been paved over, compacted, or reworked for landscaping, thus lowering its natural permeability.

4.8.2 Geologic Resources

The geologic resources found on or near the LLNL Livermore site, LLNL Site 300, and SNL, Livermore include aggregate deposits, mineral deposits, fossil occurrences, and petroleum. These resources are described below.

Aggregate Deposits

The present and potential stone and aggregate resources of the eastern Livermore Valley and western San Joaquin County were assessed in 1987 and 1988 (California Division of Mines and Geology, 1987, 1988). Mineral Resource Zones have been established that identify sand, gravel, and stone source areas. Within the eastern Livermore Valley several deposits have been identified as recoverable and marketable resources. Land that is currently developed for urban areas, industry, or research, including the LLNL and SNL, Livermore sites, was not included in these inventories. The estimated gravel resource for the eastern Livermore Valley, western San Joaquin County, and vicinity is 570 million tons with 242 million tons of reserves. Several gravel quarries have operated in the Livermore-Pleasanton valley west of the City of Livermore. Large reserves and resources of gravel are described for the area of western San Joaquin County south of Tracy (California Division of Mines and Geology, 1988); this area contains at least one large-scale gravel quarry. No sand or gravel resources have been assessed within the drainage basin of Corral Hollow Creek (i.e., Corral Hollow and LLNL Site 300), but there is a potential for interest in the alluvial fan deposits northeast of Interstate 580 (California Division of Mines and Geology, 1988).

Mineral Resources

Three types of mineral resources, clay, coal, and silica (California Division of Mines, 1950), have been mined or have the potential to be mined in the vicinity of the LLNL Livermore site, LLNL Site 300, and SNL, Livermore. Clays found in this region have been used for brick, sewer pipe, and roofing tile. Significant clay deposits are associated with outcrops of the Eocene Tesla Formation near the old settlement of Tesla in Corral Hollow, and some clays have been excavated from the perimeter of the Livermore Valley (California Division of Mines, 1950). The clay beds near Tesla were mined from 1897 to 1912. Extensive clay deposits still remain, but the need for and cost of subsurface mining prevents the economic exploitation of these deposits (California Division of Mines, 1957).

Lignite coal was discovered near the settlement of Tesla before 1857. This coal was often found layered with clays in the Tesla Formation and was mined between 1897 and 1902. During that time more than 70,000 tons per year of lignite coal were produced (California Division of Mines, 1950). Silica was mined in an unspecified location in the hills north and west of Corral Hollow from a high silica Tesla Formation sandstone. The extent of this resource is presently unknown. This material was mined only intermittently, for use in refraction of machine parts and for furnace linings (California Division of Mines, 1950).

Several occurrences of other potentially economically valuable mineral deposits are within a 10-mile radius of the LLNL Livermore Site and SNL, Livermore. These include deposits of manganese, chromium, clay, gemstones, pyrite, dimension stone, sand and gravel, and natural gas. Past production statistics and the current development status of these mineral resources are unknown. No commercially exploitable mineral deposits are known to exist within the boundaries of the LLNL Livermore site, LLNL Site 300, or SNL, Livermore.

Fossil Occurrences

Fossils in the eastern Livermore Valley and the hills to the east are principally found in unconsolidated and poorly consolidated Cenozoic deposits. Fossil-bearing units are depicted on the generalized stratigraphic column in Figure

4.8-4. The primary fossil-bearing units are the Miocene Neroly and Cierbo formations, and some younger units of Pleistocene age (Hansen, 1991).

LLNL Livermore Site and SNL, Livermore

The only vertebrate fossil deposits in the vicinity of the LLNL Livermore site or SNL, Livermore are in the Quaternary deposits of the surrounding low hills of the east Livermore Valley, but the fossils are few in number and quite scattered. They have been tentatively identified as Rancho La Brean and Blancan in age (Pleistocene) and consist of bone fragments of the mammoth and giant sloth (Hansen, 1991). Invertebrate shells and leaf and stem fossils have also been found. These appear to be randomly dispersed, mainly within the Neroly Formation. No invertebrate or botanical fossil deposits of significance are believed to be present in the eastern Livermore Valley (Hansen, 1991).

LLNL Site 300

Several vertebrate fossil deposits have been found in the vicinity of LLNL Site 300 and Corral Hollow. Most finds have been a result of road improvement or erosion along stream banks. Nearly all bone fragments found are considered to be Clarendonian age (Miocene) and are scattered within the Neroly Formation. An assortment of mammalian groups are represented: camelids, mastodon, assorted early horses, shrews, beavers, and squirrels. Fossil finds are generally widely scattered, and none consist of more than one or a few fragments of bone. The eroded terraces of exposed Neroly Formation on the south side of Corral Hollow Creek, adjacent to LLNL Site 300 are the only places where numerous fragments have been recovered (Hansen, 1991).

Gravels from the Franciscan Assemblage are known to contain Icthyosaurus fossils, but no fossil locales have been mapped (California Division of Mines and Geology, 1964). An occasional vertebrate bone fragment has been found within LLNL Site 300. In May 1991, numerous fossil bones and bone fragments were found on the fire trail and road improvement areas along the ridge south of Building 827. The locale was secured and is in the process of being assessed. The fossils are within the Neroly Formation and were tentatively identified as mastodon, horse, and an extinct predator. Invertebrate shells, primarily oysters, have been recovered from the Cierbo Formation. Stem and leaf fossils are found in many places within the finer-grained lower Neroly Formation. The fossils are generally scattered, and no significant invertebrate or botanical fossil locales have been identified on LLNL Site 300 or in the surrounding area (Hansen, 1991).

Petroleum Production

The Livermore oil field just east of the LLNL Livermore site was discovered in 1967 and to date is the only oil field in the Livermore–San Ramon Valley area (California Division of Oil and Gas, 1982). According to Carpenter et al. (1984), the Livermore oil field was originally operated by the Hershey Corporation and consisted of 10 producing wells. These wells are located east of the northeastern corner of the LLNL, Livermore site. Production is primarily from Miocene Cierbo Formation sandstones from depths of 900 to 2000 ft (274 to 610 m). The Livermore oil field is now operated by the American Exploration Corporation. Of the original 10 wells, 5 are still producing an average of seven barrels of oil per day; 1 well has been plugged and abandoned; 3 wells have been shut in; and 1 well is now used for saltwater injection (Reid, 1991). Reserves are thought to be only about 132,000 barrels and production is declining (California Division of Oil and Gas, 1986). No oil or gas exploration is currently being conducted or proposed for the Livermore Valley or in the hills to the east (Reid, 1991).

4.8.3 Geologic Hazards

Seismicity of the LLNL Livermore Site and SNL, Livermore

This evaluation of seismic hazards for the LLNL Livermore site and SNL, Livermore is based on a review of (1) published literature, (2) internal LLNL and SNL, Livermore geologic and seismological reports, (3) the seismicity of the region, and (4) probabilistic seismic hazard analyses of the Laboratory sites. For comparison, deterministic seismic hazard analyses were conducted for each site and response spectra were produced for the engineering evaluation of structures. Appendix I contains the results of these seismic hazard analyses and the evaluation of structures.

The LLNL Livermore site and SNL, Livermore are located near the boundary between the North American and Pacific tectonic plates, and the area is characterized by the San Andreas fault system which trends northwest (Figure 4.8-1). Three principal components of the San Andreas fault system, the San Andreas, Hayward, and Calaveras faults, have produced the majority of significant historical earthquakes in the Bay Area. These three faults also accommodate the majority of slip along the Pacific and North American plate boundary and they would likely continue to generate moderate to large earthquakes more frequently than other faults in the region. These faults, and other faults in the vicinity of the Laboratory sites, are described in more detail in Appendix I. While the 1906 Great San Francisco Earthquake (of estimated magnitude 8.3) on the San Andreas fault produced limited structural damage in the Livermore Valley, the local faults in the Livermore Valley region are still the main seismic hazard to the LLNL Livermore site and SNL, Livermore (Scheimer, 1985). The potential for local, damaging earthquakes was highlighted by the January 1980 Livermore earthquake sequence on the Greenville fault, which produced two earthquakes of magnitudes 5.5 and 5.6 (Bolt et al., 1981). The first earthquake caused discontinuous surface displacements along 6.2 km of the fault and produced a maximum peak ground acceleration of 0.26g (where 1.0g = acceleration due to gravity) at nearby Lake Del Valle. The earthquake caused structural and nonstructural damage to the LLNL Livermore site and SNL, Livermore facilities.

The eastern San Francisco Bay Area is dominated by a series of northwest-trending epicentral zones and a matrix of more randomly distributed epicenters that do not display any obvious relation to the faults (Ellsworth et al., 1982). While many faults are identified easily by concentrations of earthquakes, others such as those in the Livermore Valley are not easily located through such seismic activity (Ellsworth et al., 1982). The most pronounced pattern of seismicity in the valley is associated with the 1980 Livermore sequence earthquake along the Greenville fault. A less well defined area of activity may be associated with either the Williams or the Valle fault.

In most cases, earthquakes in the Livermore Valley region have occurred on strike-slip faults, generally indicating north-south oriented compression (Scheimer et al, 1982; Followill and Mills, 1982). Microseismicity occurs along much of the length of the Calaveras fault. The 30-km segment from Calaveras Reservoir to Dublin (the segment nearest the LLNL Livermore site and SNL, Livermore) may be capable of generating a magnitude 6 to 6.5 earthquake (Oppenheimer and MacGregor-Scott, 1991).

Additional information regarding seismic activity in the vicinity of the LLNL Livermore site and SNL, Livermore is presented in Appendix I.

Seismic Hazards

Ground Motion. Strong earthquake ground motion is responsible for producing almost all damaging effects of earthquakes, except for surface-fault rupture. Ground shaking generally causes the most widespread effects, not only because it propagates considerable distances from the earthquake source, but also because it may trigger secondary effects from ground failure and water inundation. Potential sources for future ground motion at the LLNL Livermore site and SNL, Livermore include the major regional faults, as well as the local faults including the Greenville, Las Positas, Verona, Corral Hollow–Carnegie, and Williams faults (Geomatrix Consultants, 1991).

Seismic hazard analyses have been performed for the LLNL Livermore site and SNL, Livermore to quantify the hazard. The analyses identify the probability of exceeding a given peak ground acceleration and are summarized in Table 4.8-1. A deterministic analysis was used to estimate the possible intensity of future earthquake ground shaking at both the LLNL Livermore site and SNL, Livermore. Using various mean and standard deviation relations, a magnitude 6.6 earthquake on the Greenville fault at a distance of 1.5 km from the LLNL Livermore site will produce estimated average peak ground accelerations of 0.47 to 0.76g (Table I-4 in Appendix I). A magnitude 6.0 earthquake on the Las Positas fault at a distance of 0.1 km from SNL, Livermore would generate average horizontal peak ground accelerations of 0.38 to 0.64g (Table I-5 in Appendix I). See Appendix I for more detailed information related to this deterministic analysis.

Larger earthquakes on more distant faults such as the San Andreas do not significantly affect the hazard estimation for either the LLNL Livermore site or SNL, Livermore.

Surface Faulting. Surface faulting is the displacement of ground along both sides of a "trace," the surface expression of an earthquake fault. The potential for surface faulting within the LLNL Livermore site is very low, although potential for surface faulting does exist at SNL, Livermore. The north branch of the Las Positas fault runs along the northern edge of SNL, Livermore Buildings 970, 972, 973, and 976; therefore, these structures are exposed to the greatest risk of damage from surface faulting. Because of the limited amount of subsurface information about the fault and the relatively wide fault zone (Carpenter et al., 1984), additional unrecognized faults of the Las Positas fault zone may be present beneath the SNL, Livermore facilities.

Liquefaction. Liquefaction is a type of soil failure in which a mass of saturated soil is transformed from a solid to a fluid state in response to earthquake shaking. The liquefaction potential of a soil deposit is controlled by several factors, including the depth to ground water, the type and density of the soil, and the intensity and duration of ground shaking. Depths to ground water range from about 43 to 161 ft (13 to 49 m) beneath the LLNL Livermore site and from about 89 to 125 ft (27 to 38 m) beneath SNL, Livermore (Carpenter et al., 1984). Based on the fairly deep ground water levels, the uniformly distributed, poorly sorted sediments beneath the sites, and a relatively high degree of sediment compaction, the potential for damage from liquefaction at the LLNL Livermore site and SNL, Livermore is quite low.

Seismically Induced Landslides. The LLNL Livermore site consists of a relatively smooth land surface that slopes gently to the northwest. Ground surface elevations within the laboratory range from a low of 571 ft (174 m) at the northwest corner of the site to 676 ft (206 m) at the southeast corner. There is little potential for slope instability at the LLNL Livermore site because of the very low relief.

The SNL, Livermore site consists of two different types of terrain separated by the north branch of the Las Positas fault. The area north of the fault consists of a relatively smooth land surface that gently slopes downward to the northwest. Because of the very low relief, the potential for slope instability on the northern portion of SNL, Livermore is remote. The terrain south of the Las Positas fault, however, contains greater relief and steeper slopes which increase the potential for slope instability. The potential for slope instability in the southern portion of SNL, Livermore is considered moderate.

Demand Criteria for EIS/EIR

Maximum horizontal peak ground accelerations at the LLNL Livermore site and SNL, Livermore for return periods of 500, 1000, and 5000 years are 0.5g, 0.6g, and 0.8g, respectively (Table 4.8-1). In Table 4.8-1, these values are compared with the results of previous ground motion hazard studies, as well as past and present criteria for seismic design for facilities at the LLNL Livermore site and SNL, Livermore. The technical basis for these peak ground acceleration values is provided in Appendix I.

Seismicity of LLNL Site 300

The evaluation of seismic hazards for LLNL Site 300 was based on a review of the literature and an aerial photographic analysis of the faults and landslides at LLNL Site 300 prior to field reconnaissance mapping and review of features recently identified in detailed studies of faulting and geology at the site (Carpenter et al., 1991; Dugan et al., 1991).

LLNL Site 300 is located near the eastern edge of the Coast Range Province, which is characterized by northwest trending, strike-slip faults of the San Andreas fault system. The boundary between the Coast Ranges and the San Joaquin Valley lies immediately east of LLNL Site 300 and is characterized by east-northeast compression, resulting in reverse and thrust faulting and folding (Wong et al., 1988; Wentworth and Zoback, 1989).

The principal faults in the vicinity of LLNL Site 300 are the Corral Hollow–Carnegie, Black Butte, and Midway faults (Figure 4.8-7). These faults are described in Appendix I. The active Carnegie fault of the Corral Hollow–Carnegie fault zone crosses the southern portion of the site (Carpenter et al., 1991). No significant recorded earthquakes have occurred on any of the local faults.

Seismic Hazards

Ground Motion. The region surrounding LLNL Site 300 has experienced strong ground shaking during historic earthquakes. In 1906 the Great San Francisco Earthquake (magnitude greater than 8) on the San Andreas fault produced structural damage a few kilometers west of LLNL Site 300 (Nason, 1982). Potential sources for future ground motion at LLNL Site 300 include major regional faults such as the San Andreas, Hayward, and Calaveras, as well as smaller faults including Greenville, Las Positas, Corral Hollow–Carnegie, Black Butte, and Midway.

A seismic hazard analysis of LLNL Site 300 produced hazard curves that display peak horizontal ground acceleration versus return period for two locations within LLNL Site 300 (TERA Corporation, 1983). The two locations were the Building 854 Complex near the western boundary of the site and the Building 834–836 Complex near the eastern boundary. Peak ground accelerations corresponding to return periods of 500, 1000, and 5000 years were calculated at 0.32g, 0.38g, and 0.56g for the Building 854 Complex and 0.28 g, 0.34 g, and 0.51 g for the Building 834–836 Complex (TERA Corporation, 1983).

Using another approach (described in Appendix I), the largest ground motions produced at the Building 854 Complex are from a magnitude 6.5 on the Corral Hollow–Carnegie fault zone at a distance of 1.4 km. Average peak horizontal ground accelerations from various mean and standard deviation relations range from 0.53 to 0.82g (Table I-6, in Appendix I). The ground motions at the Building 834–836 Complex, located in the eastern portion of the site, are greatest when considering a magnitude 6.6 earthquake on the Black Butte fault at a distance of 2.4 km. Average values of peak horizontal ground acceleration range from 0.59 to 0.91g (Table I-7; Appendix I).

Larger earthquakes on more distant faults such as the San Andreas do not significantly affect the hazard estimation.

Surface Faulting. There is a potential for surface faulting at LLNL Site 300. The areas adjacent to the active Carnegie fault could experience ground deformation should a major earthquake occur on the fault. A 10- to 13- ft (3- to 4-m)-wide zone of faulting is present in Holocene and late Pleistocene deposits near the Carnegie fault, attesting to the potential for surface rupture. In addition to the principal Holocene strike-slip Carnegie fault strand, two subsidiary faults could potentially produce minor amounts of surface rupture (Dugan et al., 1991). The only structures located adjacent to the Holocene strand of the Carnegie fault and, therefore, subject to the hazard of surface faulting, are Buildings 899A and 899B at the pistol range. However, these two structures contain no hazardous or radiological materials and have very low occupancies.

Liquefaction. LLNL Site 300 is underlain almost entirely by Tertiary bedrock, which is nonliquefiable. The Quaternary alluvium at the site is limited to generally unsaturated Pleistocene gravel-bearing terrace deposits above Corral Hollow and minor amounts of younger alluvium in canyon bottoms (Raber and Carpenter, 1983). Based on the presence of bedrock beneath LLNL Site 300, and the age, composition, and unsaturated condition of the terrace deposits, the potential for liquefaction at LLNL Site 300 is low.

Seismically Induced Landslides. Numerous ancient landslides are located at LLNL Site 300 with the largest landslide covering approximately 1.4 sq km (see Figure 4.8-8). The potential for seismically induced landslides at LLNL Site 300 still exists. The potential for slope instability is greater on northeast-facing slopes that have strata of the Cierbo Formation exposed. Buildings 825, M825, 826, M51, 847, 851A, 851B, 854, 855, and 856 are located on old landslides. The potential for ground deformation at these buildings, located on landslide deposits, is considered to be moderate to high.

Demand Criteria for EIS/EIR

Values for maximum ground acceleration at both LLNL Site 300 locations for return periods of 500, 1000, and 5000 years are 0.5g, 0.6g, and 0.8g, respectively. These values are listed in Table 4.8-1, where they can be compared with the results of the previous ground motion hazard study as well as the present DOE seismic design criteria for LLNL Site 300.

The demand criteria, which are the same values used as the EIS/EIR demand capacity for the LLNL Livermore site and SNL, Livermore, are more conservative than those estimated in the TERA Corporation 1983 study for LLNL Site 300. Subsequent seismic hazard studies for the LLNL Livermore site have shown that the ground motion attenuation relations and the earthquake source characterization methods used previously for both the LLNL Livermore site and LLNL Site 300 by TERA Corporation underestimate the seismic hazard. In the absence of any additional seismic hazard studies, the values of 0.5g, 0.6g, and 0.8g are considered to be appropriate as peak ground accelerations for LLNL Site 300.

Nonseismically Induced Landslides

LLNL Livermore Site and SNL, Livermore

At the LLNL Livermore site and SNL, Livermore facilities there is generally little potential for nonseismically induced landslides because the sites are situated on gently sloping to nearly flat topography. The exception to this is the extreme south end of SNL, Livermore, where a canyon in the hillside has been used as a landfill and subsequently paved over. The hillside surrounding this canyon consists of moderately to weakly consolidated sand and gravel, and colluvial and alluvial terrace deposits. The hill has been mapped as showing extensive evidence of mass movement (Nilsen, 1972). If the walls of the canyon surrounding the Navy Landfill Site have steepened, there is an increased chance of slope failure during wet years.

LLNL Site 300

At LLNL Site 300, the topography ranges from gently sloping to nearly vertical in places, and numerous landslide features have been mapped (see Figure 4.8-8). The potential for nonseismically initiated landslides is great along the canyon walls, especially where soils consist of deep loams and clay loams. During periods of extended wet weather the saturated soils can become structurally weakened and expand, with resulting slope failure. If slopes are made steeper by road cutting or building excavation, the potential for localized slope instability greatly increases. If a particular location has historic evidence of slope failure (presence of landslide deposits and colluvium), the probability of a failure in the future is greatly increased.

Table 4.8-1 Ground Motion Hazard Estimates, Design Criteria, and EIS/EIR Demand Criteria Expressed as Peak Horizontal Ground Acceleration (g)a

	Average Return Period (years)								
	LLNL Livermore Site and SNL, Livermore			LLNL Site 300 Complex 854			LLNL Site 300 Complex 834/836		
Source	**500**	**1000**	**5000**	**500**	**1000**	**5000**	**500**	**1000**	**5000**
Ground Motion Hazard Estimates									
Tera Corporation (1983)	0.41	0.48	0.68	0.32	0.38	0.56	0.28	0.34	0.51
Woodward-Clyde Consultants (1984) and Geomatrix Consultants (1985)	0.49	0.58	0.79	N/A	N/A	N/A	N/A	N/A	N/A
Geomatrix Consultants (1990)	0.57	0.68	0.98	N/A	N/A	N/A	N/A	N/A	N/A
Geomatrix Consultants (1991)	0.51	0.61	0.88	N/A	N/A	N/A	N/A	N/A	N/A
Seismic Design Criteria (1980 — 1989) Criteria									
LLNL (1980–1989) Criteria (Freeland, 1984)[b] and Tokarz (1991a)	0.25	0.25/ 0.5	0.5/ 0.8	N/A	N/A	N/A	N/A	N/A	N/A
DOE (Kennedy et al., 1990)	0.41	0.48	0.68	0.32	0.38	0.56	0.28	0.34	0.51
LLNL Proposed (Coates, 1991)	0.47	0.57	0.82	N/A	N/A	N/A	N/A	N/A	N/A

Seismic Demand Criteria for 1991 EIS/EIR									
WESTON (1991a)	0.5	0.6	0.8	0.5	0.6	0.8	0.5	0.6	0.8

[a] 1.0g = acceleration due to gravity.

[b] The values of 0.25g/0.5g, and 0.5g/0.8g were required by the referenced criteria for all new designs and/or modifications of General/Low Hazard, Moderate Hazard, and High Hazard facilities, respectively. These values were not developed specifically to reflect the 500-, 1000-, and 5000-year return periods.

N/A = Not applicable (i.e., study did not include this site).

4.9 ECOLOGY

The information in this section is a summary of a more detailed analysis of the ecological characteristics and the status of threatened and endangered species in Appendix F, and of wetlands in Appendix G. The scientific names of species mentioned in this section appear in Appendix F.

4.9.1 Vegetation

LLNL Livermore Site

The LLNL Livermore site covers 821 acres of which approximately 640 acres are developed. The vegetation at this site was initially altered in the 1800s when livestock grazing began on a large scale in the Central Valley and surrounding areas of California. The intensity of grazing that took place on lands at this site is not known; however, it is highly likely that the native perennial grasslands and riparian plant communities were adversely altered by grazing and other agricultural activities. Grazing is one of the principal reasons for the significant loss and degradation of wetland riparian plant communities in the Central Valley and surrounding areas (Warner, 1981).

The plant communities at the LLNL Livermore site were further degraded and destroyed when the U.S. Navy acquired the land in 1942 and covered the site with concrete runways, roads, and buildings. In addition, Arroyo Las Positas, which flowed through the site, was channelized and now traverses part of the eastern boundary and flows through the northern part of the site.

The developed areas at the LLNL Livermore site are planted with ornamental vegetation and lawns. There are also small areas of disturbed ground with early successional plant species. The undeveloped land in the security zone is the introduced grassland plant community dominated by non-native grasses such as slender oat and ripgut brome.

Another relatively undisturbed plant community at the LLNL Livermore site is a remnant of the native wooded riparian plant community along Arroyo Seco. This arroyo bisects SNL, Livermore and traverses the southwest corner of the LLNL Livermore site. At the LLNL Livermore site, Arroyo Seco is steep-sided, with the slopes covered with grass species such as slender oat and ripgut brome. Much of the arroyo has native tree species such as red willow and California walnut, and introduced species such as black locust and almond.

LLNL operations do not usually impact vegetation offsite. One current project that would affect vegetation offsite is the infrastructure modernization project. Part of this project is an 8000-ft-long 16-inch water supply pipeline from the Hetch Hetchy water supply Mocho Pumping Station to SNL, Livermore. The water supply pipeline is within an existing 10-ft right-of-way. Two thousand ft are below a currently paved area, while 6000 ft are in natural or landscaped areas. Construction of this pipeline would result in an estimated temporary clearing of 1.4 acres of existing plant communities (assuming a 10-ft-wide disturbance zone along the 6000-ft pipeline). The disturbed area would become vegetated with early succession grasses and forbs soon after completion of the project.

LLNL Site 300

LLNL Site 300 covers approximately 7000 acres of land in eastern Alameda County and western San Joaquin County. The northern portion is characterized by rolling hills while the southern part consists of steep, deep canyons. The site was acquired in 1953, and since then no grazing or farming has taken place. A relatively small part (approximately 5 percent) has been developed for LLNL activities; the remainder is undisturbed, except for controlled burning. Controlled burning takes place every year on approximately 2000 acres of land in the northern part of the site.

Four upland plant community types are located within LLNL Site 300: (1) introduced grassland, (2) native grassland, (3) coastal sage scrub, and (4) oak woodlands (Taylor and Davilla, 1986a). (See Figure F-3 in Appendix F, which is a plant community type map.) Introduced grasslands cover 5647 acres, and are dominated by slender oat and ripgut brome grass; native perennial grasslands cover approximately 723 acres, and are dominated by pine bluegrass. Coastal sage scrub plant community type is dominated by California sagebrush, California buckwheat, black sage, and snakeweed. This type typically occurs on southwest facing slopes in the southern portion of the site and covers 108 acres. Oak woodland, dominated by blue oak, occurs in scattered areas on steep slopes in the southern half of the site and covers approximately 150 acres. The understory is dominated by grassland species such as brome grass and slender oat (Taylor and Davilla, 1986a). Small areas of wetlands occur at the site and are discussed in section 4.9.4 below.

Ongoing practices at LLNL Site 300 that affect the site's vegetation include the exclusion of grazing and other agricultural uses; annual maintenance of fire roads and breaks; an annual controlled burn; weed control along roads, power poles, and security fences; planned minor construction in or adjacent to existing facilities; and road-widening projects. The maintenance of fire roads and breaks, and weed control measures, for example, have resulted in sparse vegetative cover dominated by early successional plant species and including introduced grass species. The area of land disturbed for fire roads, weed control, buildings, and other facilities, however, occupies less than 5 percent of LLNL Site 300 total area.

The exclusion of grazing and other agricultural activities has resulted in a greater diversity of plant community types at LLNL Site 300 than in nearby offsite lands that are grazed. In addition, steep onsite slopes show less instability and erosion than nearby grazed lands because of a more stable plant cover, including soil-building native plant species (Taylor and Davilla, 1986a).

Approximately 2000 acres are burned annually at LLNL Site 300 to control vegetation that could become an uncontrolled fire hazard. These burns have been conducted for the last 31 years. The development of stands of native grassland is strongly correlated with the burn area (see Figure F-4 in Appendix F) (Taylor and Davilla, 1986a). The exclusion of grazing and other agricultural practices in 1953 may also have contributed to the development of the over 700 acres of native perennial grasslands onsite.

Under current operations, a major funded project that will affect vegetation is the LLNL Site 300 Revitalization Project. Vegetation would be removed by various aspects of this plan including road improvements (14.5 acres), construction of a central control port (0.6 acre), and water system improvements (1.4 acres onsite and 2.0 acres offsite). A total of 16.5 acres of introduced grassland habitat would be eliminated onsite. The offsite water supply improvements include a 1.7-mile 10-inch pipeline from San Francisco's Hetch Hetchy water supply system. Construction of this pipeline would result in the temporary disturbance of an estimated 2.0 acres of land (assuming a 10-ft width disturbance zone along the 1.7-mile-long pipeline). The plant community types along this pipeline have not been characterized; these 2.0 acres of land are likely to be in the introduced grassland plant community type. The loss of vegetation from this project is long term for the road widening and control tower construction (15.1 acres) and short term (1 year) for the remaining construction activities.

SNL, Livermore

SNL, Livermore covers 413 acres, of which approximately 213 acres are developed and 200 acres are undeveloped land. As with the LLNL Livermore site, the vegetation was initially altered in the 1800s due to livestock grazing. The developed areas have been landscaped and there are also small areas of disturbed ground with early successional plant species. The undeveloped land in the security zone is grassland, dominated by non-native grasses such as slender oat and ripgut brome.

Arroyo Seco has three distinct segments at SNL, Livermore based on vegetative characteristics (Environmental Science Associates, Inc., 1990). The eastern segment of this drainage supports a remnant riparian strip of vegetation consisting of several large sycamore, valley oak, and numerous red willow. The riparian understory includes patches of mule fat, seaside heliotrope, curly dock, and tree tobacco. Ripgut brome and slender oat grow along the channel-grassland interface in most areas. Patches of cattail and rush, and a high concentration of red willow occur at the existing flood control area near the eastern border of the site.

The central segment of Arroyo Seco at SNL, Livermore measures approximately 8 ft wide and supports less diverse vegetation because of the developed adjacent areas. A few valley oak, almond, and species characteristic of disturbed sites persist. Arroyo Seco exits the developed portion of the site by way of a 75-ft cement-lined flood control channel. Vegetation along this improved portion of the channel includes a canyon live oak, annual grasses, and several early successional species.

Vegetation within or adjacent to the western segment of the channel consists of a canopy of red willow, valley oak, and several eucalyptus with a sparse understory of seaside heliotrope, ripgut brome, slender oat, and other early successional species. This segment of the channel measures roughly 12 ft wide and 15 ft deep (Environmental Science Associates, Inc., 1990).

Operations at SNL, Livermore have resulted in the construction of projects in developed areas. Because these areas contain sparse vegetation that is not sensitive, the impacts of these activities on vegetation is minimal.

Tritium Levels in Vegetation and Commodities

In 1990, tritium was measured in Livermore Valley rainwater, vegetation, milk, wines, and honey (LLNL, 1991f). The dose received from consumption of all products is analyzed by the AIRDOS-PC model discussed in section 4.10. In 1990, the tritium content of the moisture in vegetation in the Livermore Valley ranged from 2.2×10^{-7} mCi/mL to 1.4×10-6 mCi/mL depending on the sampling location. The maximum potential dose resulting from the consumption of vegetation with the highest average tritium concentration is 6.6×10^{-5} rem/yr (0.066 mrem/yr) (LLNL, 1991f). In addition, two sampling locations at LLNL Site 300, one adjacent to a landfill and one adjacent to the Building 850 Firing Table, which is the source of the tritium, have, since 1971, frequently shown elevated tritium values in the moisture in vegetation. During 1990, the highest reported value was 4.2×10^{-5} mCi/mL and the average at that location was 1.3×10^{-5} mCi/mL. This vegetation is not consumed by humans nor is it used as a source of feed; however, if a hypothetical person's total diet was only this vegetation (grasses), the resulting annual dose would be 2.3×10^{-4} rem (0.23 mrem). This dose is well within the radiation dose limit of 0.01 rem (10 mrem) per year specified in NESHAP for radiation doses resulting from airborne releases of radionuclides and far below the average background dose of 0.3 rem (300 mrem) per year. The radiation dose to animals would be about the same as to humans and is well below the exposure levels needed to ensure protection of nonhuman populations (NCRP, 1991).

Retail wines produced in the Livermore Valley, California wines from outside the Livermore Valley, and wines from European vineyards are also analyzed for tritium. The average tritium concentration of Livermore Valley wines sampled between 1986 and 1989 was 3.35×10^{-7} µCi/mL. This is greater than the average tritium concentrations of wines produced in other regions of California (1.05×10^{-7} µCi/mL) and Europe (2.43×10^{-7} µCi/mL) purchased during this same period. There are no health or environmental standards for tritium in wine; however, the observed tritium levels are well below the regulatory limit for drinking water of 2×10^{-5} mCi/mL. The potential dose from drinking Livermore Valley wines was calculated for both a high and a realistic consumption rate. High consumption assumes a person drinks one bottle (0.75 liter) per day for a year. The more realistic scenario assumes a person drinks one bottle of wine per week for a year. Using the 3.35×10^{-7} µCi/mL average tritium concentration, the resulting effective dose equivalents are 6×10^{-6} rem/yr (0.006 mrem/yr) and 8×10^{-7} rem/yr (0.0008 mrem/yr), respectively. These doses are well within the radiation dose limit of 0.01 rem (10 mrem) per year specified in NESHAP for radiation doses at the edge of nuclear facilities resulting from airborne releases of radionuclides and far below the average background dose of 0.3 rem (300 mrem) per year.

The highest tritium concentration measured in goat milk in the Livermore Valley in 1990 was reported to be 3.8×10^{-6} mCi/mL. Consumption of 310 L per year of goat milk at this concentration would result in an annual radiation dose of 4.6×10^{-6} rem (0.0046 mrem). (For an explanation of concentrations (mCi/mL) and doses (mrem) see section 4.16.) This dose is well within the radiation dose limit of 0.01 rem (10 mrem) per year specified in NESHAP for radiation doses resulting from airborne releases of radionuclides and far below the average background dose of 0.3 rem (300 mrem) per year. Tritium levels measured in Livermore area honey fluctuate significantly from year to year, and may be either higher or lower than in other California honey. Tritium is found in honey in about the same concentrations as those found in wine; in 1990, the concentration ranged from 1.3×10^{-7} to 7.9×10^{-7} mCi/mL and averaged $3.2\pm1.0\times10^{-7}$ µC/mL. There are no health or environmental standards for tritium in honey; however, the observed tritium levels are below regulatory levels for drinking water of 2×10^{-5} mCi/mL (LLNL, 1991f).

It should be noted that the calculation of radiation doses for tritium releases into the atmosphere using AIRDOS-PC, and presented in section 4.10, assume that food ingested is in equilibrium with the tritiated water vapor in the air. Thus the doses presented above are a subset of the AIRDOS-PC calculations and are not additive.

4.9.2 Fish and Wildlife

There are no perennial streams or permanent bodies of water at LLNL or SNL, Livermore, other than the sewage lagoon at LLNL Site 300. Fish are not known to inhabit the sewage lagoon, although amphibians such as the red-legged frog do.

LLNL Livermore Site

A total of 3 species of amphibians and reptiles, 31 species of birds, and 10 species of mammals were observed at the LLNL Livermore site during the 1991 biological surveys (see Tables F-6 through F-8 in Appendix F for lists of species).

Wildlife includes species that live in the undeveloped grassland and species that live in the developed areas or along the arroyo. Representative species observed in the undeveloped grassland areas include the fence lizard, the black-tailed hare, the California ground squirrel, the red fox, and the western meadowlark. Nesting birds include the American crow, American robin, house finch, mockingbird, and house sparrow. These species nest in the planted trees onsite. A raven's nest was observed among some pipes on an LLNL Livermore site building. Bird species observed along Arroyo Seco include the mourning dove, acorn woodpecker, and turkey vulture.

Current operations and funded projects result in a minimal impact to wildlife resources since most of the activities occur in developed areas that do not contain important wildlife habitat. A small amount of wildlife habitat associated with the Mocho Pumping Station water supply pipeline, as described in section 4.9.1, would be affected. This effect would be minimal due to the small amount of land cleared and the rapid revegetation of disturbed ground.

LLNL Site 300

LLNL Site 300, with large areas of undisturbed vegetation, interspersion of various plant community types, and availability of water at springs, provides habitat for a diversity of wildlife.

A total of 20 amphibian and reptile species have been observed at LLNL Site 300 (see Table F-6 in Appendix F). The scarcity of permanent water limits the potential of LLNL Site 300 to support more than a few species of amphibians. Aquatic habitat is available at the sewage lagoon and some of the drainages contain aquatic vegetation supported by underground springs and seeps. Two species of salamanders were observed: the California slender salamander and the tiger salamander. The latter species was observed during 1986 biological surveys (Orloff, 1986), but not during 1991 surveys. Frog and toad species known to occur on the site are the western toad, Pacific treefrog, and red-legged frog.

Conditions are far more favorable for reptiles than for amphibians. Grassland provides ideal habitat for racers and gopher snakes. Rock sites provide suitable habitat for such species as the western fence lizard, western skink, common kingsnake, and the western rattlesnake. Seeps and springs provide excellent habitat for the northern alligator lizard. Side-blotched lizards and California horned lizards frequent areas with more open vegetation and sandy soils.

A total of 70 bird species have been observed at LLNL Site 300 (see Table F-7 in Appendix F). These species were recorded during springtime biological surveys in both 1986 (Orloff, 1986) and 1991. Although grasslands normally support a limited resident bird population, the LLNL Site 300 interspersion of several different plant community types and an abundance of seeds and insects provide good habitat for a variety of birds. The western meadowlark, horned lark, and savannah sparrow were the most common small birds seen throughout the open grassland areas. Vegetation at springs and seeps provides nesting habitat for the red-winged blackbird. These permanent water sources attract a greater number of birds than normally found in the adjacent grasslands. For example, mourning dove, cliff and barn swallow, and California quail all require daily water. Oak woodland and a few cottonwood provide nesting habitat for western kingbird, northern oriole, loggerhead shrike, and American goldfinch. Coastal sage scrub supports scrub jay, Anna's hummingbird, rufous-crowned sparrow, and white-crowned sparrow. Ecotones (boundary areas between two habitats) of sage scrub and grassland provide ideal habitat for mourning dove, California quail, lazuli bunting, and lark sparrow. Rocky outcrops and cliffs provide breeding sites for white-throated swift, cliff swallow, Say's phoebe, and rock wren.

LLNL Site 300 supports a population of nesting raptors. Several great horned owl and barn owl nests were found on rock ledges of steeper cliffs. The great horned owl nested onsite in 1986 and 1991, while the barn owl nested onsite only in 1986. These cliffs also provide potential nest sites for the golden eagle and prairie falcon, although these species are not known to nest onsite. Several pairs of red-tailed hawks nested in large trees and on a utility pole onsite. Areas with taller grasses may allow ground-nesting raptors such as the northern harrier and short-eared owl to successfully breed onsite; however, there is no indication that these species nested onsite in 1991.

A total of 26 mammal species have been observed onsite (see Table F-8 in Appendix F). Mammals were recorded during threatened and endangered species surveys that included ground surveys over the entire site, night spotlighting, and establishment of scent stations in 1986 and 1991, and small-mammal trapping in 1986 (Orloff, 1986).

Productive and diverse grasslands on LLNL Site 300 support an abundance of rodents and lagomorphs (rabbits and hares). Conditions are ideal for California ground squirrels in the northern portion of LLNL Site 300 where the terrain is less rugged. Other common rodents include the house mouse, deer mouse, kangaroo rat, pocket gopher, and, in the higher grass cover, the California vole and western harvest mouse. Lagomorphs such as black-tailed hares and desert cottontails are also widespread and abundant, with the latter tending to occupy areas with more cover.

Rocky areas with associated coastal sage scrub support the California pocket mouse and desert woodrat. The woodrat occurs primarily in rocky areas in this northern extreme of its range.

Many mammalian predators are supported by this rich prey base. Grassland predators include long-tailed weasel, spotted skunk, striped skunk, coyote, American badger, and bobcat. Only the American badger is restricted to open grasslands. Red foxes, which have been reported from nearby areas to the east and north of the site (California Department of Fish and Game, 1983; Bio-Tech, 1983), have greatly expanded their range in the Central Valley in recent years. They show a preference for more disturbed areas, often denning in roadside culverts. Sage scrub, wooded, and riparian habitats attract other mammalian predators not normally found in grasslands, including gray fox, raccoon, and mountain lion. Although these habitats are preferred, they are relatively limited on LLNL Site 300; consequently, grassland areas are used as well. Only minor areas of riparian vegetation are associated with the seeps and springs that occur along the canyon bottoms. Black-tailed deer prefer these habitats but are frequently seen in the open grasslands.

The maintenance of fire roads, fire breaks, and weed control are current operations that adversely affect wildlife through the elimination of vegetation; however, these areas typically become revegetated each year and provide some wildlife habitat. The controlled burn and the exclusion of grazing and other agricultural practices promote a diversity of wildlife habitat at LLNL Site 300. Burns are usually uneven, with vegetation burned to the ground in some places, partially burned in others, and some patches unburned. This patchiness is beneficial to wildlife. Although the controlled burn may be detrimental to small grassland-nesting birds and other small species of wildlife, together with the exclusion of livestock grazing and other agricultural practices the burn has created a positive effect by creating diverse habitat that supports a variety of wildlife species.

The clearing of 18.5 acres of land for the LLNL Site 300 Revitalization Plan, as described in section 4.9.1, would displace wildlife typical of the grassland plant community. Much of this area (15.1 acres) represents a long-term loss of wildlife habitat. However, this habitat has marginal value to wildlife because it is in highly disturbed land along roads.

SNL, Livermore

Wildlife use at SNL, Livermore is similar to that described above for the LLNL Livermore site.

4.9.3 Threatened and Endangered Species

Detailed studies for threatened, endangered, and other species of concern (referred to as sensitive species in this section) were conducted at the LLNL Livermore site, LLNL Site 300, and SNL, Livermore. Other species of concern refers to federal candidate species and California species of special concern. The details regarding these studies appear in the biological assessment in Appendix F, section F.2; the results are summarized in this section.

Informal consultation was initiated on February 6, 1991, when the U.S. Fish and Wildlife Service was requested to provide a list of potential sensitive species that may occur at the sites. Such a list was provided on March 5, 1991 (The Fish and Wildlife Service letter is Attachment 1 of Appendix F). A meeting to discuss proposed studies of sensitive species was held with the Fish and Wildlife Service on April 9, 1991. During this time and later, informal consultations were held with the California Department of Fish and Game to review proposed studies and to receive input regarding potential sensitive species to be addressed. This consultation process, along with knowledge of additional sensitive species that may occur near the site, resulted in the identification of 40 plant and animal sensitive species that may occur at the sites (Table 4.9-1).

The methods used to evaluate the status of the species listed in Table 4.9-1 are presented in section F.2.4 of Appendix F. The methods were consistent with federal and/or state guidelines where such guidelines exist. Where such guidelines do not exist, survey methods consistent with accepted biological techniques were used. Surveys were conducted by botanists and zoologists with training and experience in conducting surveys for the species in question.

LLNL Livermore Site

There were no sensitive plants, invertebrates, amphibians, reptiles, birds, or mammals observed during surveys at the LLNL Livermore site.

LLNL Site 300

The location of sensitive habitats at LLNL Site 300 is shown in Figures 4.9-1, 4.9-1A, 4.9-1B, and 4.9-1C. (Figure 4.9-1 is an index map for these figures). The only sensitive plant species known to occur at LLNL Site 300 is the federal and state endangered large-flowered fiddleneck. This species is known to exist naturally in only three locations; two are at LLNL Site 300 (Figure 4.9-1B), and one is on a nearby ranch. The largest population onsite (Drop Tower population) was discovered in the 1960s and during recent years has fluctuated between 23 and 355 individual plants. The second onsite population was discovered near the bottom of a deep canyon in 1988 and is approximately 2 miles west of the Drop Tower population. The large-flowered fiddleneck is considered one of the most endangered plant species in California and perhaps the nation (Pavlik, 1990). Surveys in 1986 (Taylor and Davilla, 1986b) and surveys of nine canyons and several side canyons in 1991 failed to identify any additional populations of the large-flowered fiddleneck at LLNL Site 300. The recovery plan for this species that was prepared by the U.S. Fish and Wildlife Service called for the establishment of four additional populations of this species within its historic range to reduce the possibility of extinction. A population of this species was successfully introduced near Antioch in 1990 (Pavlik, 1990) and three additional sites were established during the fall of 1991 (Pavlik, 1991). (See Appendix F for further details regarding protection of this species.)

The valley elderberry longhorn beetle is the only sensitive insect (federal threatened) of those listed on Table 4.9-1 that has the potential to occur at LLNL Site 300. This species occurs almost exclusively on elderberry bushes, so elderberry that grow within the range of this species are considered potential habitat. A fairly large stand of elderberry occurs in a series of canyons just north of Elk Ravine, while a lesser stand occurs in the wooded riparian zone along Elk Ravine. Elderberry is known to occur in small clumps in three other locations on LLNL Site 300 (see Figure 4.9-1A and Figure 4.9-1B). No valley elderberry longhorn beetles were observed during the 1991 survey; however, this species is secretive and often difficult to find.

Four species of fairy shrimp (federal candidate species) have the potential to occur at LLNL Site 300. Sampling of water and soil in appropriate habitat did not result in the observation of these species.

The California tiger salamander and red-legged frog (both federal candidate and state species of special concern) were observed at LLNL Site 300 during 1986 surveys (Orloff, 1986). These species were not observed onsite during 1991 surveys except for red-legged frog tadpoles in the LLNL Site 300 sewage lagoon.

The Alameda whipsnake (federal candidate and state threatened species) was observed onsite in 1986 (Orloff, 1986). This species was not observed at LLNL Site 300 in 1991, although the closely related California whipsnake was recorded in two locations in 1991. Potential habitat for the whipsnake subspecies is chaparral brush, broken by grassy patches and rocky gullies, or stream courses with scattered trees and shrubs (Orloff, 1986). This type of habitat was mapped at LLNL Site 300 (mostly the coastal sage scrub plant community type) and is designated as potential habitat for this state threatened and federal candidate species (Figure 4.9-1B).

The California horned lizard (state species of special concern) was observed during the 1991 field surveys. This species was observed in the more open grasslands with sandy or gravelly areas at the northern portion of the site.

Of the bird species listed in Table 4.9-1, only the golden eagle and burrowing owl (both state species of special concern) were observed during the 1991 surveys. Immature and adult golden eagles were observed frequently at LLNL Site 300 soaring and feeding, mostly in the rolling terrain in the northern segment of the site. All cliffs and other appropriate areas were searched for nests and none were observed for the golden eagle.

In 1986, the burrowing owl was a relatively common nesting species at LLNL Site 300, especially in the more gently rolling terrain in the north (Orloff, 1986). Surveys in 1991 confirmed that this species is still nesting, but at reduced levels, at LLNL Site 300.

The tricolored blackbird (federal candidate species) was observed nesting in cattail at two locations at LLNL Site 300 in 1986 (Orloff, 1986). This species was not observed nesting at LLNL Site 300 in 1991.

Of the mammals listed on Table 4.9-1, the San Joaquin pocket mouse (formerly a federal candidate species) and the American badger (state species of special concern) were the only species observed onsite. Detailed surveys for the San Joaquin kit fox (federal endangered, state threatened) were conducted at LLNL Site 300 in 1980 (Rhoads et al., 1981), 1986 (Orloff, 1986), and 1991. Neither the kit fox nor active dens were observed at LLNL Site 300 during these surveys; however, three possible kit fox scats and one possible track were observed onsite in 1991. At present the kit fox is not considered a resident species at LLNL Site 300, although this area is potential habitat.

The San Joaquin pocket mouse was observed during the 1986 (Orloff, 1986) and 1991 surveys and is considered a resident species at LLNL Site 300. Potential habitat for this species at LLNL Site 300 is extensive since this species inhabits grassland with fine soils and scattered shrubs. This species was recently removed from the list of federal candidate species (56 Fed. Reg. 53,804-58,836, 1991).

The American badger was observed at LLNL Site 300, occurring in the more rolling terrain at the northern segment of the site.

A summary of potential impacts of current LLNL Site 300 operations on sensitive species that occur or have the potential to occur onsite appears on Table 4.9-2. A more detailed discussion of these impacts is included in Appendix F. As indicated in the table, while the impacts of the annual controlled burn are generally beneficial or inconsequential for most species, the practice has the potential to injure the young of ground-nesting raptors (short-eared owl and northern harrier) and negatively affect fairy shrimp habitat. However, the two raptor species referred to did not nest onsite in 1991, and sampling for fairy shrimp indicates that these species do not occur at LLNL Site 300. The impact of the exclusion of grazing has had a beneficial effect or no effect on sensitive species. Taken together, the controlled burn and lack of livestock grazing have promoted a high degree of habitat and species diversity that occurs in few grassland ecosystems in California. These practices have had an overall positive impact on sensitive wildlife species at LLNL Site 300.

As indicated on Table 4.9-2, the impact of ground squirrel poisoning (conducted as needed for rodent control) has the potential to be slightly adverse to most sensitive species. This poisoning occurs principally at the two high explosives wastewater surface impoundments. These impoundments are fenced, preventing access to most species of wildlife, and are in an area of relatively high human activity. Sensitive species were not observed at or near these impoundments during the 1991 surveys. Potential kit fox dens were not observed at or near these impoundments during the sitewide sensitive species surveys in 1986 (Orloff, 1986) or during the 1991 surveys. In addition, burrows and dens of the burrowing owl and American badger; raptor nests; and potential habitat of the valley elderberry longhorn beetle, tiger salamander, red-legged frog, and Alameda whipsnake do not occur in the area of these impoundments. Further, there have been no reported occurrences of sensitive species mortality in the impoundments. Therefore, the ground squirrel poisoning at the surface impoundments does not appear to affect sensitive species.

The disking of fire roads and fire breaks to prevent the spread of fire onto ranches bordering LLNL Site 300 has the potential to have an adverse effect on some species and to be beneficial to others (see Table 4.9-2). This activity has the potential to trap species such as the San Joaquin pocket mouse, American badger, burrowing owl, and San Joaquin kit fox in their dens and burrows. Vehicle traffic has no impact or only a slightly adverse impact depending on the type of sensitive species (see Table 4.9-2). One San Joaquin pocket mouse (formerly listed as a candidate species) was found dead along a road in 1986 (Orloff, 1986) and 1991. No records exist of other sensitive species mortality related to vehicle traffic. The potential for sensitive species mortality remains low because of LLNL's policy regarding speed limits and limited vehicle traffic on the fire trails. The potential for sensitive species to be killed or injured by traffic on the road is negligible. There is also judged to be no impact from onsite fencing because there are sufficient openings (except the fencing around the surface impoundment) for the passage of large and small mammals. Explosives testing has no impacts or only slightly adverse impacts depending on the type of sensitive species (see Table 4.9-2). The use of warning sounds before explosives testing reduces any potential impact to raptors soaring overhead. The surface impoundments could have an adverse impact on two sensitive bat species if they were to forage for food over the impoundments; however, these species are not known to occur at LLNL Site 300. In addition, as indicated above for ground squirrel poisoning, sensitive species or potential habitat for sensitive species do not occur in the area of the surface impoundments. Also, these impoundments are fenced to exclude most wildlife and are in an area with a relatively high degree of human activity. Therefore, the surface impoundments do not have a negative impact on sensitive species. The sewage lagoon is judged to have a beneficial impact or no impact on sensitive species.

The site revitalization project at LLNL Site 300 will result in the clearing of 18.5 acres in the introduced grassland plant community (as described in section 4.9.1); this area is potential sensitive species habitat. The California horned lizard, burrowing owl, San Joaquin pocket mouse, and American badger are sensitive species that have the potential to occur in this grassland habitat. In addition, this area represents potential San Joaquin kit fox habitat even though this species was not observed during sitewide sensitive species surveys in 1986 (Orloff, 1986) or 1991, or at any other time. LLNL performs preconstruction surveys for the burrowing owl, American badger, and San Joaquin kit fox so these species can be protected from potential harm. The potential also exists for some incidental effects to the California horned lizard and the San Joaquin pocket mouse (formerly listed as a candidate species) from construction projects associated with site revitalization projects.

Because sensitive habitats are protected, operations at the site do not affect other sensitive species, including the large-flowered fiddleneck, valley elderberry longhorn beetle habitat, Alameda whipsnake, California tiger salamander, and California red-legged frog, or birds of prey. The large-flowered fiddleneck populations onsite are currently protected from human disturbance. A plan to protect the valley elderberry longhorn beetle habitat from any disturbance would be implemented through the establishment of a 300-foot protected zone around the clumps of elderberry bushes (see mitigation measure 7.2.6B in section 5.1.7.3). The whipsnake habitat that occurs in the coastal sage scrub plant community in the southern part of the site has been designated sensitive habitat. The two amphibians may occupy springs at LLNL Site 300. These areas also have been designated as sensitive habitat (see Figure 4.9-1).

SNL, Livermore

No sensitive plants, invertebrates, amphibians, reptiles, birds, or mammals were observed during surveys at SNL, Livermore.

Table 4.9-1 Sensitive Species That May Occur at the LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

	Site		Status	
Species	**LLNL Livermore Site SNL, Livermore**	**LLNL Site 300**	**Federal**	**State**
Plants				
Palmate bird's beak	X		Endangered	Endangered
Large-flowered fiddleneck		X	Endangered	Endangered
Valley spearscale	X		Candidate	---
Hispid bird's-beak	X		Candidate	Rare
Contra Costa buckwheat		X	Candidate	---
Diamond-petaled poppy		X	Candidate	---
Hairless allocarya	X		Candidate	---
Showy Indian clover		X	Candidate	---
Caper-fruited tropidocarpum		X	Candidate	---
Invertebrates				
Valley elderberry longhorned beetle		X	Threatened	---
Ricksecker's water scavenger beetle		X	Candidate	---
Curved-foot hygrotus diving beetle		X	Candidate	---
Molestan blister beetle		X	Candidate	---
Callippe silverspot butterfly		X	Candidate	---
Vernal pool fairy shrimp	X	X	Candidate	---
California linderiella	X	X	Candidate	---
Conservancy fairy shrimp	X	X	Candidate	---
Longhorned fairy shrimp	X	X	Candidate	---
Amphibians				
California tiger salamander	X	X	Candidate	Species of special concern
California red-legged frog	X	X	Candidate	Species of special concern
Reptiles				
Alameda whipsnake	X	X	Candidate	Threatened
California horned lizard	X	X	---	Species of special concern
Birds				
Golden eagle		X	---	Species of special

				concern
Bald eagle	X	X	Endangered	Endangered
Black-shouldered kite		X	---	California protected
Cooper's hawk		X	---	Species of special concern
Northern harrier		X	---	Species of special concern
Peregrine falcon		X	Endangered	Endangered
Prairie falcon		X	---	Species of special concern
Swainson's hawk		X	---	Threatened
Sharp-shinned hawk		X	---	Species of special concern
Short-eared owl		X	---	Species of special concern
Burrowing owl		X	---	Species of special concern
Tricolored blackbird		X	Candidate	---
Mammals				
Pacific western big-eared bat	X	X	Candidate	Species of special concern
Great western mastiff bat	X	X	Candidate	Species of special concern
San Joaquin kit fox	X	X	Endangered	Threatened
San Joaquin pocket mouse		X	Candidate*	---
Riparian woodrat		X	Candidate	Species of special concern
American badger	X	X	---	Species of special concern

* No longer a federally listed candidate species (Fed. Reg., November 21, 1991).

Table 4.9-2 Summary of Impacts Matrix for Sensitive Species That Occur or Have the Potential to Occur at LLNL Site 300a

Species	Annual Controlled Burning	Lack of Livestock Grazing	Ground Squirrel Poisoning	Disking Fire Roads and Fire Breaks	Vehicle Traffic	Fencing Facilities	Explosive Testing	Surface Impoundments	Sewage Lagoon
Large-flowered	none	beneficial	none	none	none	none	none	none	none

fiddleneck[b]									
San Joaquin kit fox[c]	beneficial	mixed	slightly adverse	adverse	slightly adverse	none	slightly adverse	none	none
San Joaquin pocket mouse[e]	beneficial	beneficial	slightly adverse	adverse	slightly adverse	none	none	none	none
American badger[b]	beneficial	beneficial	slightly adverse	adverse	slightly adverse	none	slightly adverse	none	none
Pacific western big-eared bat[d]	none	none	none	none	none	none	none	adverse	beneficial
Great western mastiff bat[d]	none	none	none	none	none	none	none	adverse	beneficial
Golden eagle[b]	beneficial	mixed	slightly adverse	beneficial	none	none	slightly adverse	none	none
Prairie[d] falcon	beneficial	beneficial	slightly adverse	beneficial	none	none	slightly adverse	none	none
Burrowing owl[b]	beneficial	mixed	slightly adverse	slightly adverse	none	none	slightly adverse	none	none
Short-eare[d] owld	mixed	beneficial	slightly adverse	slightly adverse	none	none	slightly adverse	none	none
Black-shouldered kite[d]	beneficial	none	slightly adverse	beneficial	none	none	slightly adverse	none	none
Northern harrier[d]	mixed	beneficial	slightly adverse	beneficial	none	none	slightly adverse	none	none
Tricolored blackbird[d]	none	beneficial	none	none	none	none	none	none	beneficial
Alameda whipsnake[b]	none	none	none	none	none	none	none	none	none
California tiger salamander[d]	none	beneficial	slightly adverse	none	slightly adverse	none	none	slightly adverse	beneficial
Red-legged frog[b]	none	beneficial	none	none	slightly adverse	none	none	slightly adverse	beneficial
Fairy shrimp[d]	slightly adverse	beneficial	none	slightly adverse	slightly adverse	none	none	none	none
Valley elderberry longhorn beetle	none	beneficial	none	none	none	none	none	none	none

potential habitat[b]									
California horned lizard[b]	none	none	slightly adverse	slightly adverse	slightly adverse	none	none	none	none

[a]This matrix represents the types of impacts that may be expected to occur as a result of current operations. However, except for limited vehicle-traffic–related mortality for such species as the San Joaquin pocket mouse, there is no evidence that these types of impacts have occurred onsite.

[b]Species observed during 1991 surveys.

[c]Potential habitat observed in 1991.

[d]Species not observed during 1991 surveys.

[e]No longer a federally listed candidate species (Fed. Reg., November 21, 1991).

4.9.4 Wetlands

Wetlands were mapped at LLNL and SNL, Livermore using the unified federal method (Federal Interagency Committee for Wetland Delineation, 1989). Although revisions to that document have been proposed, the 1989 version remains in effect until the revisions become final (56 Fed. Reg. 40,446–40,480, 1990). A detailed analysis of wetlands appears in Appendix G; the following is a summary of that appendix. The location of the natural wetlands at LLNL Site 300, including the vernal pool, are shown on Figures 4.9-1A, 4.9-1B, and 4.9-1C. Figures G-9 through G-23 in Appendix G are detailed maps of the LLNL Site 300 wetlands.

LLNL Livermore Site

Wetlands, though very limited at the LLNL Livermore site, do occur along Arroyo Las Positas at the northern perimeter of the site. These wetlands occur in three distinct areas and are associated with culverts that channel runoff from the surrounding area into this arroyo. Two areas totaling 0.3 acre were dominated by salt grass with a species of *Carex* also common. Willow, curly dock, primrose, and alkali ryegrass also occur here. The third wetland occurs along the arroyo near Building 194, and is a small area (0.06 acre) dominated by cattail.

Operations at the LLNL Livermore site do not affect the approximately 0.36 acre of wetlands along Arroyo Las Positas at the site other than to contribute to the amount of water discharged into the arroyo. Over time, wetland vegetation may increase along this arroyo from flow out of the onsite retention basin, which may fill with water from the ground water remediation program (this program is part of current operations). There is also the potential for wetlands to develop around the edge of the retention basin.

LLNL Site 300

LLNL Site 300 has 6.76 acres of wetlands. These wetlands are small and are in areas associated with the springs, runoff from some of the buildings, and one vernal pool (Figures 4.9-1A, 4.9-1B, and 4.9-1C). Many of the wetlands occur at springs in the bottom of deep canyons in the southern half of the site. These springs occur where water-bearing sandstone units outcrop in the canyon or valley bottoms. The wetlands that have developed at these springs are confined by the steep-sided canyon wall; they range in width from 5 to 30 ft and most are 10 to 20 ft wide. Most are relatively short, 100 to 600 ft; the longest in Oasis Canyon is approximately 2800 ft long. The plant species observed in these wetlands grew in relatively homogenous stands. Cattail was dominant in areas of flowing or totally saturated soil, forming dense stands, typically at the spring and downstream. Species such as rush, seep-spring monkey flower, and, in some places, white watercress were frequently observed in areas of flowing water. In some limited areas, rush was dominant in standing water or saturated soil. In drier areas, the alkali ryegrass forms dense stands and then intergrades into the upland plant communities. Large, isolated cottonwood were often present in the deep canyon spring-fed wetlands.

Of the 6.76 acres of wetlands, 1.88 acres are formed from runoff from four building complexes onsite. The dominant plant species are cattail, alkali ryegrass, and rush, as in the natural wetlands. These wetlands tend to occur in drainage ditches along roads or on steep banks near the buildings.

The only non–spring-fed natural wetland observed onsite is a 0.3 acre vernal pool in the northwest section of LLNL Site 300 (Figure 4.9-1A). This pool was oval shaped and had concentric rings of plant species such as annual hairgrass, cupped downingia, and smooth spike-primrose that are considered typical of vernal pools (Holland and Jain, 1977; Taylor and Davilla, 1986a). The surface was dry (May 1991), but moist soil was encountered a few inches below the surface, with clay hardpan at a depth of 12 to 15 inches.

Operations at LLNL Site 300 do not affect any natural wetlands, including the vernal pool. The major component of the current operations that has the potential to affect wetlands is the site revitalization plan. Diagnostic upgrades at Bunker 851 involve internal improvements, and, therefore, would not affect the artificial wetland near this site. The remaining revitalization activities (road upgrades, water supply pipeline and tanks, and construction of a central control post) would not affect wetlands. Part of the road upgrade along Linac Road will be near artificial wetlands created by runoff from Building 865; however, this section of road would be widened only 3 ft on either side and would not affect these wetlands.

Contaminated ground water plumes at LLNL Site 300 have the potential to contaminate some of the spring-fed wetlands onsite; however, detailed analysis of contaminated ground water plumes from Buildings 833, 834, and 850, the high explosives process area, landfill Pit 6 area, and the General Services Area have shown that these plumes have not contaminated any of the natural wetlands onsite (Bryn, Landgraf, and Booth, 1990; Crow and Lamarre, 1990; Ferry, Lamarre, and Landgraf, 1990; Taffet et al., 1991; Taffet and Oberdorfer, 1991; Webster-Scholten et al., 1991). Although a ground water plume from the General Services Area has contaminated the alluvial/shallow bedrock aquifer under a segment of Corral Hollow Creek offsite (Ferry, Lamarre, and Landgraf, 1990), there is no indication that springs along Corral Hollow Creek have been contaminated by this plume.

As part of its responsibilities under CERCLA, LLNL Site 300 is extracting and treating contaminated ground water at the eastern General Services Area and then discharging this treated water into Corral Hollow Creek. Treated ground water from this operation was released into Corral Hollow Creek starting in June 1991. Corral Hollow Creek, in the General Services Area, is bordered by wooded riparian vegetation with cottonwood the dominant canopy tree species. Mulefat and willow occur in the understory. One spring dominated by rush (*Juncus* sp.) occurs approximately 700 ft downstream from the eastern General Services Area (Ferry, Lamarre, and Landgraf, 1990). The wooded riparian vegetation is well developed in some areas and sparse in others.

Ground water restoration is an ongoing project at LLNL Site 300 and treated water from other ground water remediation projects at LLNL Site 300 would be discharged from a number of release points into Corral Hollow Creek. These flows would likely result in an increase in wetland vegetation with such species as cattail, rush, and alkali ryegrass becoming established. Also, an increase in cottonwood and willow can be expected. This increase in riparian wetland vegetation would benefit wildlife. One possible negative impact could be the development of an extensive area of perennial flow, which could promote fish migration up the creek and result in a reduction of sensitive amphibian species such as the tiger salamander and red-legged frog. However, the low flows at the discharge points (60 to 100 gal per minute at each point), the high porosity of the Corral Hollow Creek bed, and low rainfall–high evapotranspiration all make this outcome unlikely.

SNL, Livermore

The wetlands at SNL, Livermore consist of 1.44 acres at the east end of Arroyo Seco within the security zone. Most of this wetland is a 1.32-acre remnant wooded riparian area with valley oak and sycamore the dominant trees. Other common species are red willow, cattail, and rush. The remainder (0.12 acre) is an alkali marsh dominated by alkali ryegrass and salt grass (Environmental Science Associates, Inc., 1990).

Current operations at SNL, Livermore would not affect the 1.44 acres of wetlands at SNL, Livermore because current site activities, including projects now under construction, would not fill in, alter the drainage of, or cause indirect effects to the wetlands.

SECTION 5 ENVIRONMENTAL CONSEQUENCES

5.1 PROPOSED ACTION

This section discusses the potential environmental consequences of the proposed action and alternatives to the proposed action. The proposed action for the EIS is the continued operation of LLNL and SNL, Livermore including near-term (5 to 10 years) proposed projects. The proposed action for the EIR is the renewal of the contract between DOE and UC for UC's continued operation and management of LLNL from October 1, 1992 through September 30, 1997. The alternatives are no action, modification of operations, shutdown and decommissioning, and discontinued University management of LLNL.

The following discussion follows the order of issues presented in Section 4. Each impact section begins with a brief summary of the existing conditions, followed by a list of the standards of significance relevant to the area being discussed. The use of specific standards of significance is typical of CEQA; however, their use is acceptable in an EIS. They are used in this EIS/EIR in the discussion of all significance decisions to meet CEQA requirements. After listing the standards of significance, each section discusses impacts and mitigation measures as appropriate. These sections also discuss cumulative impacts both locally and regionally when applicable. (See Section 3 and Appendix A for a more detailed discussion of all the projects included in the proposed action and alternatives.)

To provide a conservative estimate of possible impacts of the proposed action, where appropriate, the analyses use estimates of impacts based on a projected percentage increase in square footage for the Laboratories. Many numerical values used in this document are derived directly from this formula.

Cumulative impacts result from impacts of the proposed action in combination with impacts of future development, either in the vicinity (described in Section 10), or within a regional area appropriate to the resource being analyzed. LLNL Livermore site cumulative air impacts, for example, consider the entire air resource region designated by the Bay Area Air Quality Management District. Cumulative impact discussions in this EIS/EIR analyze impacts that result from implementation of the proposed action at LLNL and SNL, Livermore. This combined analysis is a logically appropriate approach because the LLNL Livermore site and SNL, Livermore are adjacent to each other, separated only by a road. However, responsibility for the administration and implementation of the proposed action and accompanying mitigation measures remains with DOE and the individual operating contractors: the Sandia Corporation at SNL, Livermore, and the University of California at LLNL.

Consistent with CEQA and the UC CEQA Handbook, four descriptive categories are used to discuss environmental impacts: less than significant, significant, significant and unavoidable, and beneficial. These categories have been created and assigned to individual impacts only for the purposes of compliance with CEQA requirements, and thus are used here only in a CEQA context. Under NEPA, the significance of environmental impacts determines the need for the NEPA document. Once that decision has been made, specific impacts are not categorized according to level of impact in an EIS. The following describes the environmental impact categories utilized in this document:

Less than significant. Impacts that are considered to be less than significant result in no substantial adverse change to existing environmental conditions.

Significant. Impacts that are considered to be significant constitute a substantial adverse change to existing environmental conditions. For the purposes of this document, significant impacts are adverse environmental effects that can be mitigated or avoided. For impacts considered to be significant, mitigation actions or measures are employed to modify, lessen, or nullify the adverse environmental effects, to the extent feasible.

Significant and unavoidable. Impacts that are considered to be significant and unavoidable constitute a substantial adverse change to existing environmental conditions that cannot be mitigated or avoided by implementing feasible mitigation measures. Under CEQA, significant and unavoidable impacts require that findings of overriding considerations be made prior to project approval.

Beneficial. Impacts that are considered to be beneficial are ones that result in a positive change to environmental conditions.

Impacts on the following pages appear in bold print. Unless otherwise noted, impacts are considered to be significant, and the accompanying mitigation measures are sufficient to mitigate impacts to a less than significant level. Mitigation measures are actions that are over and above actions already contained in the proposed action and/or required by state or federal laws and regulations. All mitigation measures are recommended to UC and DOE at the time decision makers consider the proposed action, and become binding only in the event of approval of the proposed action and adoption of the mitigation measures. DOE commits to mitigation in its Record of Decision (see section 1.2) and UC commits when the Regents adopt findings after certifying the Final EIR (see section 1.3).

Impacts and mitigation measures are numbered for consistency and ease of reference, using a system of three numbers separated by decimals (i.e., x.y.z.). The first digit "x" identifies the corresponding section (e.g., Ecology). The second digit "y" is coded to identify the specific location, that is,

1 = LLNL Livermore site

2 = LLNL Site 300

3 = SNL, Livermore

4 = Cumulative impacts

The third digit "z" provides a sequential numbering of impacts within the section and site. For example, Impact 4.3.2 would be an impact discussed under section 5.1.4, would pertain to SNL, Livermore, and would be the second such impact listed. Each mitigation measure is numbered to correspond to the impact it addresses.

Summary of Proposed Action

LLNL Livermore Site

For this EIS/EIR it is assumed that proposed projects at the LLNL Livermore site would add approximately 530,000 gross sq ft, resulting in a 9 percent increase in developed space. The new facilities would consist mostly of light laboratory and office space. It is estimated that the increase in personnel would be about 2000 workers. Under the proposed action a portion of the tritium operations in Building 331 may be moved to Building 298, the Fusion Target Fabrication Facility, and to Building 391, the Inertial Confinement Fusion Facility. In this event, the three buildings would have a combined administrative limit of 10 g with no more than 5 g in any one building. For these facilities, the administrative limit would therefore be reduced from 300 g in one facility (Building 331) to 10 g total in three facilities (Buildings 298, 331, and 391).

Based on the 9 percent projected increase in gross square footage of developed space, it is assumed that the overall chemical inventory would increase by approximately 19,000 gal and 210,000 lb, and that wastes would increase in the following amounts: radioactive, 2000 gal (low-level liquid wastes), 26,000 lb (low-level solid wastes), and 240 cu ft (transuranic solid wastes); hazardous, 28,000 gal (liquid wastes) and 51,000 lb (solid wastes); mixed, 2100 gal (liquid wastes) and 4600 lb (solid wastes); and medical, 230 lb (solid wastes). These increased inventories and wastes have been calculated solely for the purposes of defining the proposed action and analyzing potential environmental consequences of the proposed action in this EIS/EIR.

LLNL Site 300

Proposed projects at LLNL Site 300 would add approximately 32,000 gross sq ft, resulting in a 9 percent increase in developed space. It is estimated that the increase in personnel would be 50 employees. Based on the 9 percent projected increase in gross square footage of developed space, it is projected that the overall chemical inventory would increase by approximately 7600 gal, 9000 lb, and 171,000 cu ft; and that wastes would increase over the 5- to 10-year growth period in the following amounts: radioactive, 27,000 lb; hazardous, 3700 gal and 3300 lb; high explosive, 405 lb; mixed, 180 lb; and medical, 1 lb. Again, these increases have been calculated solely for the purposes of defining the proposed action and analyzing potential environmental consequences of the proposed action in this EIS/EIR.

SNL, Livermore

Proposed projects at SNL, Livermore would add approximately 50,000 gross sq ft, resulting in a 6 percent increase in developed space. These new facilities would consist predominantly of light laboratory and office space. It is estimated that the increase in personnel would be 15 employees. It is also estimated that there would be no net increase in the overall administrative limits for tritium and uranium. Based on the 6 percent projected increase in gross square footage of developed space, it is projected that the overall chemical inventory would increase by 210 gal, 380 lb, and 11,900 cu ft; and that wastes would increase in the following amounts: radioactive, 460 gal (liquid low-level wastes) and 540 lb (solid low-level wastes); hazardous, 240 gal (liquid wastes) and 380 lb (solid wastes); mixed, 15 lb (liquid wastes: scintillation cocktails) and 4 lb (solid wastes); and medical, 7 lb. These inventories have been calculated solely for the purposes of defining the proposed action and analyzing potential environmental consequences of the proposed action in this EIS/EIR.

The decontamination and decommissioning of the Tritium Research Laboratory would temporarily increase SNL, Livermore low-level and mixed waste generation over the 3 years of the project. However, since this facility generates over 90 percent of the radioactively contaminated wastes at SNL, Livermore, the transition of this laboratory to a non-nuclear facility would substantially reduce future waste quantities. The wastes generated during decontamination are estimated to include 100,000 lb of equipment and scrap materials as low-level radioactive wastes and 310 gal of oils as mixed wastes. The total residual activity of tritium in these wastes is conservatively estimated to be between 5000 and 10,000 Ci (0.5 to 1 g). A more detailed description of this project is presented in Appendix A.

5.1.1 LAND USES AND APPLICABLE PLANS

LLNL Livermore Site

Onsite land uses at the LLNL Livermore site include offices, laboratory buildings, support facilities (e.g., cafeterias, storage areas, maintenance yards, and a fire station), roadways, parking areas, and landscaping. Surrounding land uses include SNL, Livermore, grazing land, industrial parks, and residences. New facility construction and upgrades, totaling approximately 9 percent of the current developed gross square footage, are proposed for the LLNL Livermore site. No land acquisition, other than the possible acquisition of the part of East Avenue between Vasco Road and Greenville Road, is included as part of the proposed action. While the types of land uses at the LLNL Livermore site would not change under the proposed action, some infill and modernization would occur. Existing perimeter open space areas would be retained, with the exception of construction of one new facility in the currently undeveloped western perimeter area.

LLNL Site 300

LLNL Site 300, located on approximately 7000 acres of largely undeveloped land, has two high explosive remote firing areas supported by a chemistry processing area, a weapons test area, a general services area at the site entrance, and maintenance facilities. Most land surrounding LLNL Site 300 is agricultural land used for grazing cattle and sheep. The Carnegie State Vehicular Recreation Area and two privately owned research and testing facilities are located in the immediate vicinity of LLNL Site 300. The proposed action includes construction of new facilities and upgrading of several existing facilities, roadways, and utilities totaling approximately 9 percent of the current developed gross square footage. No land acquisitions are included as part of the proposed action. The types of land uses at LLNL Site 300 are not proposed to change, and the open space character of the site would be retained.

SNL, Livermore

Onsite land uses at SNL, Livermore include offices, laboratory buildings, support facilities, roadways, parking areas, and landscaping. Surrounding land uses include the LLNL Livermore site, vineyards, grazing land, and residences. New facility construction and upgrades, totaling approximately 6 percent of the current developed gross square footage, are proposed for SNL, Livermore. No land acquisition, other than the possible acquisition of the part of East Avenue between Vasco Road and Greenville Road, is included as part of the proposed action. The types of land uses at SNL, Livermore would not change under the proposed action, although some infill and modernization would occur. Existing, undeveloped buffer areas would be retained in their current open space condition.

Standards of Significance

A project is considered to have a significant adverse land use impact if it:

- Conflicts with adopted environmental plans and goals;
- Displaces a large number of people;
- Disrupts or divides the physical arrangement of an established community;
- Conflicts with established recreational, educational, religious, or scientific uses;
- Converts prime agricultural land to nonagricultural use or impairs agricultural productivity of prime agricultural land;
- Conflicts with federal, regional, state, or local land use plans, policies, and controls;
- Conflicts with existing or proposed uses at the periphery of the facility or with local land use plans; or
- Results in nuisance impacts attributable to incompatible land uses.

Because LLNL and SNL, Livermore are federally owned facilities, local planning agencies have no jurisdiction over these sites.

All identified impacts are considered to be significant adverse impacts, unless otherwise noted, and the proposed mitigation measures following each impact discussion will reduce the impacts to a less than significant level.

IMPACTS—LLNL LIVERMORE SITE

Under the proposed action, the primary effect on land uses at the LLNL Livermore site would be from the additional development associated with certain projects included in the proposed action. No alteration in the types of land uses would result (see discussion under Impact 1.1.1). The LLNL Livermore site is exempt from local plans, policies, and zoning regulations. However, it is DOE and UC policy to cooperate with local governmental planning agencies, in this case the City of Livermore and County of Alameda, whenever possible.

Land uses surrounding the LLNL Livermore site include undeveloped open space, industrial, agricultural, and residential (see section 4.2). The existing LLNL Livermore site facilities, with the 500-ft-wide buffer areas to the north and west, are compatible with existing and approved future land uses surrounding the site, and with open space policies regarding open space resources in the vicinity of the site. Because no new types of land uses would be introduced and the buffer and perimeter areas would not substantially change, no change in the site's compatibility with existing and approved future land uses would result from the proposed action.

Impact 1.1.1 The proposed action would result in additional development at the site to be used for the same types of uses as existing facilities. This is a less than significant impact.

Under the proposed action, several new facilities would be constructed, others would be upgraded, and a number of trailers would be relocated, replaced, or removed as the permanent facilities are completed (see Section 3 and Appendix A). Most proposed new facility construction (laboratory and office space) at the LLNL Livermore site would occur in the southwest quadrant. Facility upgrades, such as modernization and building refurbishment, would occur in the southwest and northwest quadrants. While the types of land uses at the LLNL Livermore site would not change under the proposed action, some infill and modernization would occur.

The land use effect would be a relatively small increase in the amount of developed space at the site (assuming a 9 percent increase in square footage). New structures would be used for the same types of uses as existing facilities. Therefore, it would not represent a change in land uses, nor lead to a conflict with existing and approved future land uses adjacent to the site. As discussed in section 4.2, existing onsite land uses are compatible with the existing land use and open space policies of the City of Livermore and County of Alameda.

It is acknowledged that growth of the facilities at the site could have secondary effects due to increased personnel and activity at the site (i.e., additional traffic, noise, vehicular exhaust emissions, demands for community services, increased consumption of natural resources, increased waste generation, etc.). These potential effects are addressed in the applicable parts of Section 5 of this document.

Mitigation Measure: None warranted.

Impact 1.1.2 DOE acquisition of a portion of East Avenue would alter a segment of this road's use from a local government–owned, unrestricted access roadway to a federal government–owned, possibly restricted access roadway. This is a less than significant impact.

Acquisition by DOE of a portion of East Avenue between Vasco and Greenville roads would potentially alter this road's status from a local government–owned roadway to a restricted public access or no public access federal government–owned roadway to improve security for a portion of the LLNL Livermore site. This change in status is less than significant because no users other than the LLNL Livermore site and SNL, Livermore take direct access to their property from this roadway. It could lead to an effect on traffic circulation patterns in the vicinity of the site, but these are considered to be less than significant (see section 5.1.11 for discussion of potential traffic circulation effects).

Mitigation Measure: None warranted.

IMPACTS—LLNL SITE 300

Under the proposed action, the primary effect on land uses at LLNL Site 300 would be from the development of additional square footage associated with certain projects included in the proposed action. No major alteration in the types of land uses would result (see discussion under Impact 1.2.1).

LLNL Site 300 is exempt from local plans, policies, and zoning regulations. However, it is DOE and UC policy to cooperate with local governmental planning agencies, in this case the counties of San Joaquin and Alameda, whenever possible. Land uses surrounding LLNL Site 300 include other high explosives testing facilities, undeveloped open space, agricultural land, and an off-road vehicle recreation area (see section 4.2). The uses at LLNL Site 300 are compatible with the existing land uses and approved land use designations surrounding the site, and with open space policies regarding open space resources in the vicinity of the site. Because proposed action activities represent a continuation of existing land uses, they are also considered to be compatible with existing and approved future land uses surrounding the site.

Impact 1.2.1 The proposed action would result in additional development at the site to be used for the same types of uses as existing facilities. This is a less than significant impact.

The proposed action includes upgrading of several existing facilities, roadways, and utilities, and construction of new facilities. Section 3 and Appendix A provide more detailed descriptions of the proposed action. Because LLNL Site 300 is located on approximately 7000 acres of largely undeveloped land, and the proposed construction projects and upgrades are dispersed throughout the site, they would not represent a substantial infill of land uses, and the existing character of the site would remain largely unaltered.

The land use effect would be a relatively small increase in development at the site (assuming a 9 percent increase in square footage on the site). These new structures would be used for the same types of uses as existing facilities. Therefore, it would not represent a change in land uses, nor lead to a conflict with existing and approved future land uses adjacent to the site. As discussed in section 4.3, existing land uses are compatible with the existing land use and open space policies of the counties of San Joaquin and Alameda.

It is acknowledged that growth of the facilities at the site could have secondary effects due to increased personnel and activity at the site (i.e., additional traffic, noise, vehicular exhaust emissions, demands for community services, increased consumption of natural resources, increased waste generation, etc.). These potential effects are addressed in the applicable parts of Section 5 of this document.

Mitigation Measure: None warranted.

IMPACTS—SNL, LIVERMORE

Impact 1.3.1 The proposed action would result in additional development at the site to be used for the same types of uses as existing facilities. This is a less than significant impact.

The majority of new facility construction at SNL, Livermore is proposed for laboratory use, with a smaller amount of space dedicated to office and other uses. Facility upgrades, such as roof replacement and infrastructure modernization, are proposed for various areas throughout SNL, Livermore. While the types of land uses at SNL, Livermore would not change under the proposed action, some infill and modernization would occur.

The land use effect would be a relatively small increase in the number of structures at the site (assuming a 6 percent increase in square footage on the site). These new structures would be used for the same types of uses as existing facilities. Therefore, it would not represent a change in land uses, nor lead to a conflict with existing and approved future land uses adjacent to the site. As discussed in section 4.2, the existing land uses are compatible with the existing land use and open space policies of the City of Livermore and County of Alameda.

It is acknowledged that growth of the facilities at the site could have secondary effects due to increased personnel and activity at the site (i.e., additional traffic, noise, vehicular exhaust emissions, demands for community services, increased consumption of natural resources, increased waste generation, etc.). These potential effects are addressed in the applicable parts of Section 5 of this document.

Mitigation Measure: None warranted.

Impact 1.3.2 DOE acquisition of a portion of East Avenue would alter a segment of this road's use from a local government–owned, unrestricted access roadway to a federal government–owned, possibly restricted access roadway. This would be a less than significant land use effect.

See discussion in Impact 1.1.2 for LLNL Livermore site, which is also applicable to SNL, Livermore.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

While they are distinct operations managed and operated by different contractors, for purposes of this discussion, the LLNL Livermore site and SNL, Livermore are addressed together because of their proximity.

The cumulative impact study area with regard to land uses and planning programs for the LLNL Livermore site and SNL, Livermore is defined as that area of Alameda County generally east of Tassajara Road in the City of Dublin and Santa Rita Road in the City of Pleasanton, which encompasses the City of Livermore and eastern unincorporated Alameda County. Section 10 describes relevant planned and proposed projects within this study area.

Large undeveloped open space areas exist in Alameda County in the northern, eastern, and southern portions of the county. A majority of the undeveloped areas are used for agricultural purposes, primarily for grazing. Agricultural lands in the South Livermore Valley General Plan Amendment area support an active wine industry.

A continuing land use trend in Alameda County has been the encroachment of residential, commercial, and industrial uses upon agricultural and open space areas. Development of the planned and proposed projects listed in Section 10 would contribute to the cumulative loss of agricultural land and open space. However, the proposed action would not contribute to the cumulative effect on the loss of agricultural land and open space, because the LLNL Livermore site and SNL, Livermore are already committed to research and development land uses and no acquisition of open space or agricultural land is proposed.

CUMULATIVE IMPACTS—LLNL SITE 300

The cumulative impact study area with regard to land uses and planning programs for LLNL Site 300 is defined as that portion of San Joaquin County generally south of I-205 that encompasses the City of Tracy and southwestern unincorporated San Joaquin County. Section 10 describes relevant planned and proposed projects within the study area.

Land uses in the area south of I-580 in unincorporated San Joaquin County include agricultural (primarily grazing), commercial recreation, and high explosives testing facilities (including LLNL Site 300). The city of Tracy, located approximately 8 miles northeast of LLNL Site 300, has a developed core of residential and commercial uses, which becomes less dense along the outer boundaries of the city. Industrial and agricultural land uses surround the perimeter of the city.

In an effort to preserve agricultural land on the valley floor, the City of Tracy Planning Department is encouraging new development in the hillsides (Conant, 1991). Such planned and proposed projects in the southwestern San Joaquin County hillsides include Tracy Hills and Tracy Highlands. These hillside projects would contribute to a cumulative loss of open space near LLNL Site 300. However, the proposed action would not contribute to the cumulative effect on the loss of agricultural land and open space. The majority of the site is designated by the County of San Joaquin for "public and quasi-public" uses, and is not designated by the County for conservation or open space uses.

Tracy Hills is a community being considered for development on approximately 5900 acres immediately northeast of LLNL Site 300. This residential community could be incompatible with LLNL Site 300, depending on the final design and siting of residences. Preliminary plans for the Tracy Hills community show a 0.5-mile open space buffer along the southern boundary of the development (Anthony Guzzardo and Associates, Inc., 1990). This buffer, in addition to the existing 0.25-mile area between LLNL Site 300 facilities and the site's northeastern boundary, is expected to reduce potential land use incompatibilities between LLNL Site 300 and the proposed Tracy Hills community. In accordance with CEQA, at such time as a specific development proposal application is filed, independent environmental documentation for the Tracy Hills community would be prepared by the appropriate lead agency to further address land use compatibility and other environmental impacts, and appropriate mitigation, associated with that project.

Tracy Highlands is a community being considered for development on approximately 1400 acres immediately north of LLNL Site 300. Land use incompatibilities could result between LLNL Site 300 uses and the residential uses proposed within the Tracy Highlands community. In accordance with CEQA, at such time as a specific development proposal is filed, independent environmental documentation for said proposal would be prepared by the appropriate lead agency.

5.1.2 SOCIOECONOMIC CHARACTERISTICS

As of September 1991, approximately 11,400 personnel worked at LLNL. Approximately 7026 LLNL workers reside in the cities of Livermore, Pleasanton, Tracy, and Manteca (LLNL, 1991b). The rest are distributed relatively uniformly throughout the Bay Area and the Central San Joaquin Valley.

The operation of LLNL generates substantial revenue within the local and regional economy. The total LLNL annual payroll was $432 million in 1990. The total annual expenditure generated by LLNL on goods and services was $466.9 million in 1990. Of that total, $13.4 million was spent on goods and services in the Tri-Valley area.

LLNL Livermore Site

As of 1991, approximately 11,200 personnel worked at the LLNL Livermore site. To develop estimates of employment growth, future employment projections were extrapolated from the historical employment trend. The projections for the proposed action assume that employment could increase by approximately 20 percent over 10 years, increasing the LLNL Livermore site to a total of approximately 13,200 personnel. This figure has been rounded for purposes of this analysis. Therefore, the proposed action may create an additional 2000 employment opportunities in Alameda County, generate additional revenue from increased purchases of goods and services, and create increases in population and subsequent increases in housing demand. The employment projections are conservatively high for purposes of evaluating reasonably foreseeable environmental impacts associated with employment growth; however, due to recent federal budget constraints, actual employment growth is expected to be significantly lower.

LLNL Site 300

As of 1991, approximately 200 personnel worked at LLNL Site 300. Assuming approximately 20 percent increase in employment for LLNL, the proposed action may result in an additional 50 employment opportunities in San Joaquin County. (For purposes of this EIS/EIR analysis, this number has been increased to 50 additional personnel at LLNL Site 300.) The proposed action would generate additional revenue in the area from increased purchases of goods and services and create increases in population and subsequent increases in housing demand. The employment projections are conservatively high for purposes of evaluating reasonably foreseeable environmental impacts associated with employment growth; however, due to recent federal budget constraints, actual employment growth is expected to be somewhat less than the 50 assumed.

SNL, Livermore

Approximately 1500 personnel work onsite at SNL, Livermore. Approximately 1037 SNL, Livermore personnel reside within the cities of Livermore, Pleasanton, Tracy, and Manteca (SNL, Livermore, 1991). The rest are distributed relatively uniformly throughout the Bay Area and the Central Valley. The total annual payroll of SNL, Livermore was $51.6 million as of 1990, and annual expenditures totalled $91.8 million for this same period (SNL, Livermore, 1990).

For purposes of this analysis, it is assumed that employment at SNL, Livermore could increase by 1 percent over the 10-year project period of the proposed action. The proposed action may result in the creation of an additional 15 employment opportunities in Alameda County, which would generate additional revenue from increased purchases of goods and services and create a small increase in population and a subsequent increase in housing demand.

Standards of Significance

A project is considered to have a significant adverse socioeconomic impact if it:

- Induces substantial growth or concentration of population;
- Conflicts with adopted environmental plans and goals of a community (such as housing, jobs, and population goals); or
- Creates a demand for housing that exceeds the available supply. For the purposes of this analysis, growth beyond that which can be accommodated by the affected counties and cities is considered a significant adverse impact.

All identified impacts are considered to be significant adverse impacts, unless otherwise noted, and the proposed mitigation measures following each impact discussion will reduce the impacts to a less than significant level.

IMPACTS—LLNL

Population impacts for the LLNL Livermore site are analyzed in combination with LLNL Site 300 because employee statistics for LLNL are gathered centrally by the LLNL administration and cannot be subdivided by individual site.

In addition, data on the geographic distribution of the residences of potential new hires associated with the proposed action is based on the existing distribution of the work force residences. It is acknowledged that this demographic pattern could change over the proposed action period (e.g., due to lower housing costs in San Joaquin County versus Alameda County, or other economic factors). However, for purposes of this analysis, no change in the distribution is assumed because data is not available to substantiate or quantify such a change in the trend among LLNL or SNL, Livermore personnel.

Impact 2.1.1 Total employment in Alameda and San Joaquin counties would increase with the implementation of the proposed action. This represents a beneficial impact.

Total employment in Alameda County was estimated at 662,800 in 1989 (California Employment Development Department, 1990a). The proposed action is assumed to generate approximately 2000 additional jobs at the LLNL Livermore site. Employment projections for the county estimate that employment opportunities will increase 13.5 percent to 752,278 by the year 2000 (Association of Bay Area Governments, 1989). The additional jobs created by the proposed action at LLNL would represent 2.2 percent of the projected increase in employment within the county. This minimal increase in employment, a 0.3 percent increase over the 1989 employment level, would represent a small economic benefit to the county.

Total employment in San Joaquin County in 1989 was estimated to be 181,000 (California Employment Development Department, 1990b). The proposed action could generate approximately 50 additional jobs at LLNL Site 300 over the 10-year project period. Employment projections for the county estimate a 9.5 percent increase in employment by the year 1993, which represents an additional 17,200 jobs within the county (California Employment Development Department, 1990b). The additional employment opportunities created by the proposed action would represent 0.3 percent of the projected increase in employment within the county. This minimal increase in employment, a 0.03 percent increase over the 1989 employment levels, would represent a small economic benefit to the county.

Mitigation Measure: None warranted.

Impact 2.1.2 An increase in population level and housing demand within Alameda County would occur as a result of the proposed action. This impact is less than significant.

For this analysis, increases in population level and housing demand from the proposed action are projected to be conservatively high. It was assumed that each new job would be filled by someone outside of the project region, that all new employees would migrate to the region, and that each employee would represent a new household. In reality, a percentage of new employees would already reside in the project region, and some households would produce more than one employee. While this method overestimates potential migration of new employees to the project region, it also allows for the "backfilling" of vacancies left as some employees leave their current jobs in the region to work at the Laboratory. The geographic distribution of future LLNL employees is expected to be similar to the current distribution (see Table 5.1.2-1).

Based on the anticipated geographic distribution of personnel residences (see Table 5.1.2-1), the proposed action is estimated to result in a potential in-migration of approximately 1132 workers to Alameda County over the next 10 years (this represents 55 percent of new LLNL personnel). Assuming the current figure of 2.51 persons per household for the county (Association of Bay Area Governments, 1989), the population associated with the additional work force potentially migrating into the county is estimated to be 2841 persons. This represents approximately 0.2 percent of the current population within the county. Population projections for the county anticipate an 8.5 percent increase by the year 2000 (Association of Bay Area Governments, 1989). The incremental population increase associated with the proposed action is within growth projections for the county.

Assuming one worker per household, housing demand generated by the additional work force is estimated at approximately 1132 dwelling units over the 10-year project period. In 1990 the county had 506,449 housing units. The vacancy rate in the county was 2.3 percent, an estimated 11,648 available units (California Department of Finance, 1990a). Potential demand for housing associated with the project's additional personnel assumed to live in Alameda County would represent approximately 9.7 percent of the currently available housing supply within the county.

Mitigation Measure: None warranted.

Impact 2.1.3 An increase in population level and housing demand within the City of Livermore would occur as a result of the proposed action. This would result in a potentially significant and unavoidable impact.

As seen in Table 5.1.2-1, the majority of potential new LLNL personnel (41 percent, or 841) are projected to reside in

Livermore, based on the historic pattern of employee residence location. Using the current person-per-household figure of 2.82 for the city (Association of Bay Area Governments, 1989), and assuming one worker per household, the population increase associated with the work force migrating into the city is estimated to be 2371 persons. This represents a 4 percent increase over the city's 1990 population. Growth projections for the city, inclusive of projections for Laboratory growth, anticipate a 26.4 percent increase in the city's population by the year 2000 (Association of Bay Area Governments, 1989).

Assuming each new worker migrating into the city creates a demand for one additional housing unit, a total of 841 units over the 10-year period would be required as a result of the proposed action. In 1990 the city had a housing supply of 20,932 units, and a vacancy rate of 1.0 percent (California Department of Finance, 1990a). This represents approximately 209 available housing units, a minimal amount. The City of Livermore Housing Implementation Program limits residential growth to a maximum of 2.5 percent up to the year 1993. After 1993 growth rates up to 3.5 percent may be implemented (Clemens, 1991). Assuming a growth rate of 3.5 percent for the years 1993 to 2000, a total of 30,046 units would be available by the year 2000. The demand for housing in the city associated with potential new employees would represent 2.8 percent of the projected number of housing units. However, because the estimated demand attributable to work force growth cannot be accommodated by the existing City of Livermore housing market, and because housing growth and personnel growth may not coincide, the impact is considered significant and unavoidable for purposes of this EIS/EIR.

Mitigation Measure: Mitigation measures to reduce impacts on housing availability in the City of Livermore are beyond the authority of DOE or UC.

Impact 2.1.4 An increase in population level and housing demand within the City of Pleasanton would occur as a result of the proposed action. This impact is less than significant.

Approximately 170 (or 8.3 percent) of the potential new workers generated by the proposed action are expected to locate in Pleasanton, based on the anticipated geographic distribution of personnel (see Table 5.1.2-1). Using the current person-per-household figure of 2.91 for the city (Association of Bay Area Governments, 1989), the City of Pleasanton population increase associated with new personnel is estimated to be 495 persons. This represents a 1 percent increase over the 1990 population level of 50,553. This increase would be within growth projections for the city, which project a 43.4 percent population increase by the year 2000 (Association of Bay Area Governments, 1989).

Housing demand generated by new workers as a result of the proposed action is estimated to be approximately 170 housing units over the 10-year period (assuming one household per new employee). The 1990 housing supply within the city was 19,790 units, with a vacancy rate of 2.4 percent. This represents an available supply of approximately 475 units. The demand for housing units associated with potential new workers would represent 36 percent of the current number of available (vacant) units. In addition, the city projects a 12.6 percent increase in the supply of housing by the year 1994 (City of Pleasanton, 1990). (Housing growth projections for the city beyond 1994 currently do not exist.) It is assumed that housing growth to the year 2000 would follow a similar growth rate. Because population growth as a result of the proposed action could be accommodated in the current housing market and housing growth is projected to continue, no adverse impacts are anticipated.

Mitigation Measure: None warranted.

Impact 2.1.5 An increase in population level and housing demand in San Joaquin County would occur as a result of the proposed action. This impact is less than significant.

Based on the anticipated geographic distribution of personnel, approximately 334 of the potential new LLNL employees are projected to reside within San Joaquin County (see Table 5.1.2-1). Based on the current person-per-household figure of 2.89 in the county (California Department of Finance, 1990b), the San Joaquin County population associated with the new employees would be approximately 965 persons. This represents 0.2 percent of the total population within the county. County growth projections estimate that the population will increase to 709,887 by the year 2010, a 47.4 percent increase (Williams, 1991). The incremental population increase associated with the proposed action would be accommodated within county growth projections.

Housing demand generated by new employees (assuming one employee per household) in the county is estimated to total 334 units over the 10-year project period. The 1990 housing supply within the county was 168,306 units, with a vacancy rate of 6.22 percent (California Department of Finance, 1990b). The total number of vacant units was 10,469. County projections estimate a 54.5 percent increase in the number of housing units within the county by 2010 (Williams, 1991). Because the demand generated by the project would be minimal relative to the number of available and planned units, no adverse impacts are anticipated.

Mitigation Measure: None warranted.

Impact 2.1.6 An increase in population level and housing demand within the City of Tracy would occur as a result of the proposed action. This impact is less than significant.

Based on the anticipated geographic distribution of new personnel, it is estimated that approximately 150 new workers could move to the City of Tracy over the next 10 years. Based on the current person-per-household figure of 2.9 for the city (California Department of Finance, 1990b), the city population associated with the proposed action would be 435 persons. This represents 1.3 percent of the 1990 population within the city, and 1.2 percent of the population within the city's planning area (the area that includes the city and surrounding area within which future growth and annexation to the city are expected).

Projections for the planning area anticipate a 181 percent increase in population by 2010 (Williams, 1991). The high projected population increase is due to current and anticipated job growth in the Livermore-Amador Valley area. These projections anticipate that people will settle in the City of Tracy and surrounding area since commute times from employment centers in the Livermore-Amador Valley and the Bay Area are similar to other Bay Area commute times, and housing prices in southern San Joaquin County are substantially lower (County of San Joaquin, 1987). Population increases associated with the proposed action would be consistent with projections of growth for the planning area.

Housing demand anticipated to occur within the City of Tracy due to project implementation is estimated to be an additional 150 dwelling units. The current housing supply within the city is 11,500 units (California Department of Finance, 1990b). The vacancy rate for the city was 3.44 percent in 1990, which represents 396 available units. The demand generated by the new workers would represent 38 percent of the existing supply of available (vacant) housing. In addition, the number of housing units in the city is projected to increase 47 percent by the year 1995 to a total of 16,905 (Bell, 1991). Thus, the housing demand associated with the proposed action could be accommodated in the current and projected housing supply, and no adverse impacts are anticipated.

Mitigation Measure: None warranted.

Impact 2.1.7 The proposed action would generate additional employment income and expenditures in the region. This is considered a beneficial impact.

The proposed action would provide additional employment opportunities in the region and would increase the payroll at LLNL. Assuming a 20 percent increase in payroll, the additional payroll generated by the proposed action would be $86.4 million. A portion of this increased payroll would enter the local economy as the new workers purchase additional goods and services.

In addition, it is anticipated that the proposed action would result in an increase in expenditures by LLNL. Additional goods and services would be required to support the additional activities, facilities, and workers generated by the proposed action. The additional expenditures of both new personnel and LLNL would generate additional income and employment opportunities within the region as the expenditures filter throughout the economy. The additional income and employment opportunities generated by the proposed action would represent a beneficial economic impact to the region.

Mitigation Measure: None warranted.

IMPACTS—SNL, LIVERMORE

The distribution of SNL, Livermore's work force is similar to that of LLNL. However, SNL, Livermore projects only a 1 percent growth in employment under the proposed action, which would have only minor implications for localities other than Alameda County and the City of Livermore; thus, only impacts upon these localities are analyzed below.

Impact 2.3.1 Total employment in Alameda County would increase with the implementation of the proposed action. This is considered a beneficial impact.

The proposed action is estimated to generate a total of approximately 15 additional jobs at SNL, Livermore. As discussed under Impact 2.1.1 for LLNL, growth projections for the county anticipate a 13.5 percent increase in employment within the county by the year 2000 (Association of Bay Area Governments, 1989). The additional jobs created by the proposed action at SNL, Livermore would represent 0.02 percent of the projected increase in employment within the county. This minimal increase in employment would represent a small beneficial impact to the county.

Mitigation Measure: None warranted.

Impact 2.3.2 An increase in population level and housing demand within Alameda County would occur as a result of the proposed action. This impact is less than significant.

Based on the anticipated geographic distribution of worker residences (see Table 5.1.2-1), the proposed action is estimated to result in a potential in-migration of approximately nine workers to Alameda County upon completion of the proposed action. As discussed under Impact 2.1.2, the incremental population increase associated with the proposed action would be accommodated within growth projections for the county.

Assuming one worker per household, housing demand generated by the new employees is estimated at approximately nine dwelling units. As discussed under Impact 2.1.2, no adverse impacts are anticipated as a result of this growth, because the housing demand can be accommodated within the county's current housing supply, and future housing growth is anticipated.

Mitigation Measure: None warranted.

Impact 2.3.3 An increase in population level and housing demand within the City of Livermore would occur as a result of the proposed action. This impact is less than significant.

As seen in Table 5.1.2-1, approximately seven new SNL, Livermore workers are anticipated to reside in the City of Livermore. Using the current person-per-household figure of 2.82 for the city (Association of Bay Area Governments, 1989), and assuming one worker per household, the population increase associated with the SNL, Livermore work force moving into the city is estimated at 20 persons. This growth is accommodated in population projections for the city, which anticipate a 26.4 percent increase in population by the year 2000.

Assuming each new worker migrating into the city creates a demand for one additional housing unit, a total of seven units would be required. As discussed in the analysis of Impact 2.1.3, the city had an approximate available housing supply of 209 units in 1990. This is a minimal amount of available housing. However, because the projected demand attributable to work force growth under the proposed action can be accommodated by the existing City of Livermore market, this is a less than significant impact.

Mitigation Measure: None warranted.

Impact 2.3.4 The proposed action would generate additional employment income and expenditures in the region. This is considered a beneficial impact.

The proposed action would provide additional employment within the region, and would increase the payroll at SNL, Livermore. Assuming a 1 percent increase in payroll at SNL, Livermore, the additional payroll generated by the proposed action would be $561,000. A portion of this increased payroll would enter the local economy as the additional workers purchase goods and services.

An increase in the amount of goods and services purchased by SNL, Livermore would be required in order to support the additional activities, facilities, and workers generated by the proposed action. The additional expenditures from both new personnel and SNL, Livermore would generate additional income and employment opportunities throughout the region as the expenditures filter through the economy. The additional income and employment opportunities generated by the proposed action would represent a beneficial economic impact to the region.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS

Impact 2.4.1 The proposed action would contribute to cumulative housing demand in the region. This is a significant and unavoidable impact.

It is assumed that new personnel associated with the proposed action would reside in the communities listed in Table 5.1.2-1. The number of new hires residing in these communities is anticipated to range from approximately 850 persons in the City of Livermore to approximately 41 in the City of Dublin. In addition, approximately 530 personnel would be distributed throughout other communities in the Bay Area and Central San Joaquin Valley. The proposed action would, therefore, contribute to the cumulative demand for housing in the region associated with new employment opportunities created by planned and approved projects in the region. It is assumed that certain parts of the region could meet the housing demand created by the increase in local job opportunities. However, other parts of the region may have a more limited housing supply or selection (e.g., Livermore) and thus would be subject to a cumulative housing demand that would be considered significant. Due to the high proportion of new hires assumed to require housing in the Livermore area, and the limited supply of available housing there, further evaluation of the cumulative demand for housing in the city is presented below.

Population projections for the City of Livermore anticipate a 26.4 percent increase in population by the year 2000. These projections include the approximately 850-person population increase associated with growth at LLNL and SNL, Livermore. The projected growth in the City of Livermore would result in a total population of 71,700 persons. Based on the current person per household figure of 2.82, the year 2000 projected population would require 25,426 housing units. The projected increase in population could not be accommodated by the current housing stock of 20,932 housing units within the city. Thus, cumulative development may result in a potentially significant adverse impact.

It should be acknowledged that the City of Livermore growth management plan limits housing growth to 2.5 percent per year up to 1993, but the plan can assume a housing growth rate up to 3.5 percent from 1993 to the year 2000. Assuming a housing growth rate of 3.5 percent after 1993, a total of 30,046 housing units would be available by the year 2000. This total would be sufficient to address the projected cumulative demand. However, the timing of additional housing construction and the cumulative projects within the city cannot be guaranteed to coincide.

Mitigation Measure: Mitigation measures to reduce impacts on housing availability in the region are beyond the authority of DOE or UC.

Table 5.1.2-1 Anticipated Geographic Distribution of LLNL and SNL, Livermore Employees as a Result of the Proposed Action

City	LLNL (Includes LLNL Site 300)		SNL, Livermore	
	Number of Employees Residing in City[a]	Percent of Total[c]	Number of Employees Residing in City[b]	Percent of Total[c]

Livermore	841	41.0	7.0	48.0
Pleasanton	170	8.3	1.4	9.5
Tracy	150	7.3	1.0	6.2
Manteca	103	5.0	0.8	5.5
Danville	58	2.8	0.4	2.4
Modesto	58	2.8	0.3	1.8
Stockton	49	2.4	0.4	2.5
San Ramon	47	2.3	0.4	2.5
Dublin	41	2.0	0.5	3.1
Other	533	26.0[d]	2.7	18.6[d]
Total:	2,050		15	

[a] February 20, 1990.
[b] distribution as of March 27, 1991.
[c] may not total 100 because figures are rounded off.
[d] percent of this category would reside throughout Alameda County and throughou San Joaquin County.

Source: LLNL, 1991b; SNL, Livermore, 1991.

5.1.3 COMMUNITY SERVICES

The following section evaluates the effect of the proposed action on the provision of adequate fire, police, school, and nonhazardous solid waste facilities and services to the Laboratory sites. To evaluate the effects of the proposed action on the provision of community services, onsite service departments and their offsite counterparts were contacted to determine existing levels of interaction and service needs. Onsite departments and potentially affected offsite agencies were also surveyed to determine how the proposed action would affect their operations. Estimates of the increased levels of service needed with the proposed action were made and evaluated.

Personnel statistics for employees at the LLNL Livermore site and LLNL Site 300 are combined; thus, some of the projections and analyses in this section discuss impacts of employee growth at the LLNL Livermore site and LLNL Site 300 combined.

LLNL Livermore Site

<u>Fire Protection and Emergency Services</u>

The LLNL Livermore site has its own onsite fire protection services. Currently the LLNL Fire Department participates in an automatic aid agreement with the City of Livermore Fire Department and mutual aid agreements with the Alameda County Fire Patrol and State of California Department of Forestry to serve the LLNL Livermore site. As discussed below, the proposed action could result in a need for increased fire protection services onsite. However, it is not anticipated that there would be a significant increase in interaction with offsite agencies.

Police Protection and Security Services

The LLNL Livermore site provides onsite security services and participates in emergency response agreements with the City of Livermore Police Department and Alameda County Sheriff's Department for additional police protection services at the LLNL Livermore site. As discussed further below, the proposed action could result in a need for increased security personnel and/or equipment onsite.

School Services

Approximately 41 percent of the current LLNL Livermore site and LLNL Site 300 personnel reside in the City of Livermore. Approximately 1700 students who have one or more parents employed at LLNL are currently enrolled in the Livermore Valley Joint Unified School District. The proposed action could impact school services provided by the Livermore Valley Joint Unified School District.

Solid Waste Disposal

Projections for nonhazardous solid waste generation are based on the estimated personnel increase associated with the proposed action. This method of analysis was used because existing data on the volume of nonhazardous solid waste generated by LLNL and SNL, Livermore are aggregate figures that do not distinguish waste generated by building type or by program. Thus, the most accurate measure of the increase in nonhazardous solid waste generation is assumed to be more closely associated with the increase in personnel generated by the proposed action.

The LLNL Livermore site currently generates approximately 24,000 cu yd of nonhazardous solid waste per year, which is disposed of at the Vasco Road Sanitary Landfill. Assuming increases in nonhazardous solid waste are related to the assumed increases in site employment, it is estimated that the proposed action would result in an increase of approximately 4400 cu yd of nonhazardous solid waste per year to be disposed of at the landfill.

LLNL Site 300

Fire Protection and Emergency Services

LLNL Site 300 has its own onsite fire protection services. Currently the LLNL Fire Department participates in mutual aid agreements with the City of Tracy Fire Department, Tracy Rural Fire Protection District, and State of California Department of Forestry to serve LLNL Site 300. The proposed action could result in a need for a small increase in fire protection services onsite. However, it is not anticipated that there would be a significant increase in interaction with offsite agencies.

Police Protection and Security Services

LLNL Site 300 provides onsite security services and participates in a emergency response agreement with the San Joaquin County Sheriff's Department for additional police protection services at LLNL Site 300. As discussed below, it is anticipated that the proposed action could result in a need for increased security services onsite. However, interaction with offsite agencies is not anticipated to increase significantly.

School Services

The existing setting and impact analysis for school services is combined for the LLNL Livermore Site and LLNL Site 300. See the discussion of school services under the LLNL Livermore site heading above.

Solid Waste Disposal

Projections for nonhazardous solid waste generation are based on the estimated personnel increase associated with the proposed action. This method of analysis was used because existing data on the volume of nonhazardous solid waste generated by LLNL and SNL, Livermore are aggregate figures that do not distinguish waste generated by building type or by program. Thus, the most accurate measure of the increase in nonhazardous solid waste generation is assumed to be more closely associated with the increase in personnel generated by the proposed action.

LLNL Site 300 currently disposes of approximately 2200 cu yd of solid waste per year at the Corral Hollow Sanitary Landfill. It is anticipated that the proposed action would result in an increase of approximately 550 cu yd of solid waste per year disposed of at the Corral Hollow Sanitary Landfill.

SNL, Livermore

Fire Protection and Emergency Services

Primary fire protection and emergency services for SNL, Livermore are provided by the LLNL Fire Department through a Memorandum of Understanding. The proposed action would not result in a change in this relationship and would not have a significant impact on the ability of the LLNL Fire Department to provide adequate service to SNL, Livermore.

Police Protection and Security Service

SNL, Livermore provides onsite security services and maintains emergency response agreements with the City of Livermore Police Department and Alameda County Sheriff's Department for additional police protection services. As discussed further below, it is anticipated that the proposed action would not result in a significant change to onsite security services or mutual aid agreements with offsite agencies.

School Services

Approximately 48 percent of the current SNL, Livermore employees reside in the City of Livermore. Approximately 205 students who have one or more parents employed at SNL, Livermore are currently enrolled in the Livermore Valley Joint Unified School District. The proposed action would result in an increase of approximately 2 students over a 10-year period within the Livermore Valley Joint Unified School District.

Solid Waste Disposal

SNL, Livermore currently disposes of approximately 3600 cu yd of solid waste per year at the Vasco Road Sanitary Landfill. By projecting solid waste generation as a factor of site employment, it is anticipated that the proposed action would result in an increase of 36 cu yd per year of solid waste disposed of at the Vasco Road Sanitary Landfill from SNL, Livermore.

Standards of Significance

For purposes of this EIS/EIR, the proposed action would be considered to have a significant impact on community services if:

- The service provider anticipates great difficulty in providing increased service, or
- The required service expansion results in major adverse secondary effects such as a substantial use of a limited resource.

The project is considered to have a significant adverse impact on school services if it:

- Requires expansion or realignment of the existing school system, or
- Results in an increase in local enrollment contributing to cumulative increases beyond the capacity of the affected schools.

The project is considered to have a significant adverse impact on nonhazardous solid waste disposal services if it:

- Increases generation of nonhazardous solid waste beyond the capacity to accommodate the project or cumulative

demand at affected disposal sites, or
- Violates published federal, state, or local standards relating to solid waste.

All identified impacts are considered to be significant adverse impacts, unless otherwise noted, and the proposed mitigation measures following each impact discussion will reduce the impacts to a less than significant level.

IMPACTS—LLNL LIVERMORE SITE

Impact 3.1.1 The proposed action could result in a need for increased onsite fire protection personnel, equipment, and/or facilities. This is a less than significant impact.

All new projects proposed for the LLNL Livermore site would be within existing Laboratory boundaries in areas already receiving fire protection and emergency services. Employment at the LLNL Livermore site could increase up to approximately 20 percent, and there would be a projected 9 percent overall increase in building square footage onsite over the next 10 years. However, as described in Section 3 and Appendix A, the proposed action includes several fire protection infrastructure improvements, which include replacement of a 206,000-gal water tank with a 700,000-gal water storage tank (the tank is to be built on the SNL, Livermore site and will serve both SNL, Livermore and the LLNL Livermore site) and two fire-rated pumps and upgrades to the existing building fire alarm system. The adequacy of existing services would continue to be evaluated by the LLNL Fire Department on an annual basis by reviewing current operations against National Fire Protection Standards. It is anticipated that as LLNL Livermore site needs increase, personnel, equipment, and facilities would be increased or upgraded, as necessary. Therefore, the proposed action would result in a less than significant impact on onsite fire protection and emergency services.

Mitigation Measure 3.1.1: The LLNL Fire Department will continue to review current operations at the LLNL Livermore site against National Fire Protection standards on an annual basis. If additional needs are identified, personnel, equipment, and facilities would be increased or upgraded as necessary.

Impact 3.1.2 Implementation of the proposed action would potentially result in an increased demand for fire protection services within the mutual aid network. This is a less than significant impact.

For purposes of evaluating impacts of the proposed action, square footage at the LLNL Livermore site is assumed to increase 9 percent. Under their automatic aid agreement, the City of Livermore Fire Department responds to an average of 10 calls a year at the LLNL Livermore site. By projecting the possible increased impact upon the City of Livermore Fire Department as a factor of growth under the proposed action, an increase of one call annually can be conservatively estimated. An average of 10 calls per year at the LLNL Livermore site, for the City of Livermore Fire Department, currently does not have a significant impact on that agency's ability to provide adequate fire protection and mutual and automatic aid service (Brown, 1991). Because the proposed action would not substantially increase the number of calls, and the City of Livermore Fire Department indicates the ability to provide adequate fire protection service, impacts on the City of Livermore Fire Department would be less than significant.

The Alameda County Fire Patrol has not responded to any LLNL Fire Department calls in the past 3 years. As discussed above, implementation of the proposed action is not anticipated to substantially increase the number of calls for assistance. Therefore, the proposed action would result in a less than significant impact on the Alameda County Fire Patrol's ability to provide adequate fire protection within its service area or to carry out its mutual aid responsibilities with other agencies.

Through mutual aid, the California Department of Forestry responds to an average of two LLNL calls a year, which is less than 1 percent of the agency's total calls. The frequency of mutual aid responses is not expected to increase substantially because of the minimal increase in building square footage associated with the proposed action and the similarity between existing onsite uses and those included as part of the proposed action. Due to the infrequency of interaction between the California Department of Forestry and the LLNL fire stations, the proposed action would result in a less than significant impact on the California Department of Forestry's ability to provide an adequate level of fire protection and mutual aid service.

Mitigation Measure: None warranted.

Impact 3.1.3 Implementation of the proposed action would potentially result in a need for increased security personnel and/or equipment onsite. This is a less than significant impact.

All new projects proposed for the LLNL Livermore site would be located within the area already receiving onsite security services and offsite police protection. Employment at the LLNL Livermore site is assumed to increase up to approximately 20 percent, and an overall 9 percent increase in building gross square footage onsite over the next 10 years is also assumed. The adequacy of services provided is based on compliance with DOE Orders 5632.7, 5632.5, and 5632.2A of the Safeguards and Security Manual. The Safeguards and Security Department is subject to several programs designed to evaluate compliance with these DOE Orders. These programs include ongoing self-assessments required by DOE; surveys conducted by UC and DOE auditors, including an annual DOE San Francisco Site Safeguards and Security Survey; periodic inspections by the Office of Security Evaluations (OSE) from DOE Headquarters; and a Laboratory Directors Office Oversight Review through the Assurance Review Office (ARO). Based on these evaluation programs, actions would be taken to ensure that adequate service is being provided through compliance with applicable DOE Orders. Therefore, the proposed action would have a less than significant impact on onsite security services.

Mitigation Measure: None warranted.

Impact 3.1.4 Implementation of the proposed action at the LLNL Livermore site and LLNL Site 300 would increase the demand for school services in the region. This is a potentially significant and unavoidable impact.

It is assumed that new personnel associated with the proposed action would reside in the communities listed in Table 5.1.2-1. The number of LLNL new hires residing in these communities is estimated to range from 840 in the City of Livermore to approximately 41 in the City of Dublin. In addition, approximately 530 personnel would be distributed throughout the Bay Area and Central San Joaquin Valley in other communities. Thus, a secondary effect of the proposed action would be an increase in student enrollment in those school districts where LLNL employees reside. It is assumed that some of these school districts could accommodate the increase in student enrollment generated by the proposed action. However, other school districts in the region may have more limited enrollment capacity and thus would be subject to an enrollment demand that would be considered significant; for example, the San Ramon Unified School District has identified an existing overcrowding problem at some grade levels (Huston, 1992).

Due to the high proportion of new hires assumed to reside in the Livermore area, further evaluation of the demand for school services focuses on the Livermore Valley Joint Unified School District.

The Livermore Valley Joint Unified School District encompasses approximately 240 sq miles of service area, including the City of Livermore, portions of unincorporated Alameda County, and a small portion of unincorporated Contra Costa County.

DOE participates in the Impact Aid Program, a federal program that provides fees in lieu of property taxes to school districts impacted by federal programs. The Livermore Valley Joint Unified School District receives money from the federal government through this program for pupils with at least one parent employed at LLNL or SNL, Livermore (Sonanberg, 1991). The amount of impact aid fees varies from year to year depending on the amount of money budgeted by the federal government and the number of school districts eligible for such aid (Sonanberg, 1991). The impact aid fees assist the Livermore Valley Joint Unified School District in providing adequate school services. However, continuation of this program alone would not be sufficient to fully address the impact of the proposed action on school services in the Livermore Valley Joint Unified School District.

It is assumed that the number of personnel at the LLNL Livermore site and LLNL Site 300 combined could increase from approximately 11,400 to approximately 13,450 persons by the year 2002 under the proposed action. Based on the approximately 4600 LLNL personnel who reside in the City of Livermore and a current enrollment of approximately 1700 students within the Livermore Valley Joint Unified School District who have one or more parents employed at LLNL (Livermore Valley Joint Unified School District, 1991a), a student-generation factor of 0.37 students per worker is assumed. The total number of students (K–12) currently associated with LLNL personnel is estimated to be approximately 4200 in all affected school districts. Based on the generation rate of 0.37 students per worker, the proposed action could result in a total student population of approximately 5000 students, an increase of approximately 800 students, by the year 2002. Approximately 41 percent of the new personnel generated under the proposed action are expected to reside in Livermore. This could, therefore, result in approximately 2000 students, an increase of approximately 300 students, associated with LLNL personnel within the Livermore Valley Joint Unified School District by the year 2002. The remaining 500 students would be expected to enroll in school districts in other parts of the region where they reside.

Additional students generated from increased employment at LLNL are expected to be added to the school system incrementally over the next 10 years. For purposes of analysis in this EIS/EIR, it is assumed that the school district would receive no augmentation of district funding or approval for new facilities over the next 10 years. The Livermore Valley Joint Unified School District is currently experiencing problems with capacity at some schools. The Christensen School is currently undergoing expansion. The Leo R. Croce School is currently open only to kindergarten and would not have capacity to accommodate other elementary grades until subsequent years. Livermore High School, Granada High School, and Junction Avenue Middle School are currently undergoing rehabilitation. Additionally, several schools, including Rancho Las Positas, Jackson, and Junction Avenue, are currently at or close to capacity (Livermore Valley Joint Unified School District, 1991b). Therefore, because of the district's current facility needs, the addition of 300 students to the existing facilities would result in a potentially adverse impact on the district's ability to provide an adequate level of service within its jurisdiction.

Mitigation Measure 3.1.4: Impacts to area schools (beyond DOE's participation in the federal goverment's Impact Aid Program) cannot be mitigated by DOE or UC.

Impact 3.1.5 The proposed action would result in an increased demand for nonhazardous solid waste disposal services at the Vasco Road Sanitary Landfill. This is a less than significant impact.

Based on an existing work force level of approximately 11,200 persons and a solid waste generation rate of approximately 24,000 cu yd per year, the LLNL Livermore site generates approximately 2.2 cu yd of solid waste per worker per year, which is disposed of at the Vasco Road Sanitary Landfill. The assumed increase in the work force of 2000 personnel for the proposed action could result in an increase of approximately 4400 cu yd of solid waste per year taken to the landfill. This increase would occur gradually over an approximate 10-year period and ignores source reduction and recycling strategies that are currently in place.

The Vasco Road Sanitary Landfill has a remaining capacity of 23.6 million cu yd as of May 1990. The lifespan of the landfill under current conditions is 17 years (Lydick, 1991). Additional capacity is available, although it is not yet fully permitted (Edminster, 1991).

Discussions with the Alameda County Waste Management Authority indicate that while LLNL and SNL, Livermore are major generators of solid waste within the county, the additional 4400 cu yd of solid waste generated at LLNL by the proposed action would not be significant and could be accommodated by the existing landfill (Edminster, 1991). Therefore, due to the remaining lifespan of the landfills within the county, impacts to solid waste disposal within the county are anticipated to be less than significant.

Mitigation Measure: None warranted.

IMPACTS—LLNL SITE 300

Impact 3.2.1 The proposed action would potentially result in a need for increased fire protection personnel, equipment, and/or facilities onsite. This is a less than significant impact.

All new projects at LLNL Site 300 would be within existing boundaries in areas already receiving fire protection and emergency services. Personnel at LLNL Site 300 could increase by up to approximately 20 percent, and a projected 9 percent overall increase in building gross square footage may occur. However, the proposed action includes the replacement of Fire Station No. 2 at LLNL Site 300, a significant fire safety measure. The adequacy of existing services would continue to be evaluated by the LLNL Fire Department on an annual basis by reviewing current operations against National Fire Protection Standards. Therefore, the proposed action would result in a less than significant impact on onsite fire protection and emergency services.

Mitigation Measure 3.2.1: The LLNL Fire Department will continue to review current operations at LLNL Site 300 against National Fire Protection Standards on an annual basis. If additional needs are identified, personnel, equipment, and facilities would be increased or upgraded as necessary.

Impact 3.2.2 The proposed action would potentially result in an increased demand for offsite fire protection services within the mutual aid network. This is a less than significant impact.

In the past 3 years, the LLNL Site 300 fire station and the City of Tracy Fire Department have not responded to any calls in each other's jurisdictions under their mutual aid agreement. The number of mutual aid responses is not expected to increase significantly for either agency under the proposed action, which assumes a 9 percent increase in building gross square footage at LLNL Site 300; therefore, the proposed action would have a less than significant impact on the City of Tracy Fire Department's ability to provide adequate fire protection services or mutual aid services.

Through mutual aid, the Tracy Rural County Fire Protection District currently responds to an average of two calls a year at LLNL Site 300. The fire station at LLNL Site 300 has never received a request for assistance from the Tracy Rural County Fire Protection District. It is anticipated that the number of responses for each agency would not significantly increase under the proposed action; therefore, the proposed action would result in a less than significant impact on the Tracy Rural County Fire Protection District's ability to provide adequate fire protection within its service area or to fulfill its mutual aid responsibilities with other agencies.

Also, as discussed above, LLNL Site 300 participates in a mutual aid network with the California Department of Forestry. No significant impact is projected on the California Department of Forestry's ability to provide an adequate level of fire protection and mutual aid service.

Mitigation Measure: None warranted.

Impact 3.2.3 The proposed action would result in an increased demand for nonhazardous solid waste disposal services at the Corral Hollow Sanitary Landfill. This is a significant and unavoidable impact.

LLNL Site 300 currently disposes of approximately 2200 cu yd of solid waste per year at the Corral Hollow Sanitary Landfill in San Joaquin County. A generation rate of approximately 11 cu yd per employee per year can be assumed based on the current amount of solid waste generated and disposed each year by the existing 200 persons at the site. Therefore, based on a projected increase of 50 persons in the next 10 years, the proposed action would result in an increase of approximately 550 cu yd per year of solid waste to be disposed of at the Corral Hollow Sanitary Landfill, or another landfill if necessary.

The Corral Hollow Sanitary Landfill is scheduled to close in January 1995. The San Joaquin County Public Works Department is currently evaluating long-term alternatives for solid waste disposal in the county (Karam, 1991). These alternatives include expansion of the existing landfill, siting of a new landfill, and construction of a transfer station for disposal at another landfill.

The projected annual total volume of solid waste generated at LLNL Site 300 under the proposed action would be 2750 cu yd. The projected increase in solid waste generation of 550 cu yd would occur gradually over a 10-year period and ignores source reduction and recycling strategies.

Because no long-term landfill alternatives have been identified to receive solid waste during the projected period of the proposed action, this estimated increase is a significant and unavoidable impact.

Mitigation Measure 3.2.3: LLNL will continue to implement solid waste reduction and recycling strategies at LLNL Site 300.

IMPACTS—SNL, LIVERMORE

Impact 3.3.1 The proposed action would potentially increase the demand for fire protection and emergency services at SNL, Livermore. This is a less than significant impact.

Primary fire protection and emergency services for SNL, Livermore are provided by the LLNL Fire Department. The upgrading and addition of facilities planned under the proposed action are within the developed area of SNL, Livermore, which already receives fire protection and emergency services. It is assumed that there could be a 6 percent growth of developed space and a 1 percent increase in employment at SNL, Livermore over the next 10 years. Because of the location of new facilities within an area that already receives fire protection and the minimal increase in employment, impacts on the LLNL Fire Department's ability to provide service to SNL, Livermore anticipated from the proposed action would be considered less than significant.

Mitigation Measure: None warranted.

Impact 3.3.2 The proposed action would potentially increase the demand for security services to provide adequate protection at SNL, Livermore. This is a less than significant impact.

Proposed facilities for SNL, Livermore are within the developed area of the Laboratory that already receives police protection and security services. Assuming a 1 percent increase in employment and a 6 percent growth in developed space at SNL, Livermore over the next 10 years, it is anticipated that the proposed action would result in a less than significant impact on the ability of onsite security services to provide adequate protection. Any necessary increase in the Protective Force staff or facilities would be evaluated in accordance with DOE Orders in the Safeguards and Security Manual as discussed under Impact 3.1.3, and personnel and equipment would be added as appropriate.

Mitigation Measure: None warranted.

Impact 3.3.3 The proposed action would result in additional demand for school services in the region. This is a less than significant impact.

The existing work force of 1500 persons at SNL, Livermore is anticipated to increase no more than 1 percent over the next 10-year period under the proposed action. Approximately 48 percent of the current SNL, Livermore work force resides in the City of Livermore. A student generation rate of 0.28 students per worker is assumed, based on the approximately 720 SNL, Livermore personnel who reside in the City of Livermore and an existing Livermore Valley Joint Unified School District enrollment of 205 students of SNL, Livermore personnel (Livermore Valley Joint Unified School District, 1991a). Therefore, the proposed action could result in a total generation of approximately four additional students over a 10-year period. Based on the number of current SNL, Livermore personnel residing in the City of Livermore, approximately 48 percent of the new workers who would be generated as a result of the proposed action are expected to reside in Livermore. This would result in two of the four ?additional students of SNL, Livermore personnel enrolled within the Livermore Valley Joint Unified School District. It is assumed the other two students would attend school elsewhere in the region. This minimal increase would result in a less than significant impact on the ability of the Livermore Valley Joint Unified School District or other school districts to provide adequate school services.

Mitigation Measure 3.3.3: DOE will continue to participate in the federal government's Impact Aid Program, which contributes funds to the Livermore Valley Joint Unified School District to compensate for impacts to the district resulting from the provision of school services to pupils with at least one parent employed on federal lands.

Impact 3.3.4 The proposed action would result in an increase in demand for nonhazardous solid waste disposal services at the Vasco Road Sanitary Landfill. This is a less than significant impact.

SNL, Livermore currently disposes of approximately 3600 cu yd of solid waste per year at the Vasco Road Sanitary Landfill. This existing solid waste generation and existing employment of 1500 results in a generation factor of approximately 2.4 cu yd per worker per year. Employment projections associated with the proposed action are assumed to be no more than 1 percent over the next 10 years, which would result in an increase of approximately 36 cu yd per year of solid waste disposed of at the Vasco Road Sanitary Landfill.

The discussion under the impact to solid waste disposal at the LLNL Livermore site is also applicable to SNL, Livermore. Due to the lifespan of the landfills within Alameda County, impacts to solid waste disposal within the county are anticipated to be less than significant.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS

Cumulative development associated with the planned and approved projects in the area would contribute to the cumulative demand for fire and police services in the jurisdictions in which these developments occur. However, since fire and security services at LLNL and SNL, Livermore are independent departments that do not rely on offsite community agencies to provide primary responses to fire and police emergency calls, additional demand for these services onsite associated with the proposed action are not considered to add to the cumulative demand for offsite fire and police services.

Impact 3.4.1 Cumulative development would increase demand for school services in the region. This is a significant and unavoidable impact.

The proposed action would contribute to the cumulative demand for school services in the region. Due to the high proportion of new hires assumed to reside in the Livermore area, a further evaluation of the demand for school services in the Livermore Valley Joint Unified School District is presented below.

For purposes of this EIS/EIR, it is assumed that the Livermore Valley Joint Unified School District would receive no augmentation of district funding or approval for new facilities over the next 10 years. As discussed under Impact 3.1.4, the district is currently experiencing overcapacity at some schools. Additionally, the district anticipates an increase of approximately 1200 students through the 1995–1996 school year (Livermore Valley Joint Unified School District, 1991b). Therefore, student generation from cumulative development within the district's jurisdiction could not be accommodated by existing school facilities. The proposed action would contribute approximately 300 students to the cumulative student generation and would therefore contribute to a significant and unavoidable impact on the district's ability to provide adequate school services within its jurisdiction.

Mitigation Measure: None available to DOE and UC.

Impact 3.4.2 Cumulative development would increase the demand for nonhazardous solid waste disposal services at the Vasco Road Sanitary Landfill in Alameda County. This is a less than significant impact.

The proposed action would contribute to the cumulative demand for solid waste disposal service associated with planned and approved projects in the area. Both the LLNL Livermore site and SNL, Livermore send solid waste to the Vasco Road Sanitary Landfill. Alameda County authorities project the existing capacity of this landfill at 17 years, well beyond the projected time period for the proposed action.

The County of Alameda is planning to expand the Vasco Road Sanitary Landfill to increase its lifespan by 12 years (Lydick, 1991). The County of Alameda also has plans to site a new landfill in Eastern Alameda County (Martinson, 1991). A study is currently underway to identify and evaluate alternative sites in that area (Edminster, 1991).

The environmental review process for the proposed expansion of the Vasco Road Sanitary Landfill and another landfill within the county is scheduled to begin shortly. The county plans to have a fully permitted landfill capacity of 50 years which includes a new landfill in the county and the planned expansion of the two landfills (Edminster, 1991). With existing, planned, and proposed landfill capacity in Alameda County, this is a less than significant impact.

Mitigation Measure: None warranted.

Impact 3.4.3 Cumulative development in the vicinity of LLNL Site 300 would increase the demand for nonhazardous solid waste disposal services at the Corral Hollow Sanitary Landfill. This is a potentially significant and unavoidable impact.

The proposed action would contribute to the cumulative demand for solid waste disposal service associated with planned and approved projects in the area. The Corral Hollow Sanitary Landfill is scheduled to close in January 1995. The San Joaquin County Public Works Department is currently evaluating long-term alternatives for solid waste disposal in the county. These alternatives include expansion of the existing landfill, siting of a new landfill, and construction of a transfer station for disposal at another landfill.

The proposed action would contribute an additional 550 cu yd to the cumulative waste disposed of at the Corral Hollow Sanitary Landfill, which currently cannot accept waste after 1995. Because no long-term landfill capacity has been identified, this cumulative contribution of solid waste would be considered a significant and unavoidable impact.

Mitigation Measure: Impacts to solid waste disposal services cannot be fully mitigated by DOE or UC.

5.1.4 PREHISTORIC AND HISTORIC CULTURAL RESOURCES

This section presents an evaluation of the potential impacts to prehistoric and historic cultural resources resulting from the proposed action. A delineation of the steps required to fully evaluate cultural resources in compliance with National Historic Preservation Act requirements is also provided. LLNL and SNL, Livermore's contribution to cumulative impacts to prehistoric and historic resources within the defined cumulative impact study areas is also discussed.

LLNL Livermore Site

The Area of Potential Effect for evaluation of prehistoric and historic cultural resources at the LLNL Livermore site is defined as the entire site. As discussed in Appendix H, no prehistoric resources have been identified at the LLNL Livermore site.

An evaluation of the historical importance of the Laboratory has recently been conducted (William Self Associates, 1992). If portions of the LLNL Livermore site are ultimately determined, in consultation with the State Historic Preservation Office, to be eligible for the National Register of Historic Places, implementation of the proposed action could affect important historic resources.

LLNL Site 300

The Area of Potential Effect for evaluation of prehistoric and historic resources at LLNL Site 300 is shown in Figure 5.1.4-1 and includes several discrete areas across the site. Previous surveys at LLNL Site 300 have identified the presence of both prehistoric and historic resources on the site. Activities under the proposed action could affect these resources.

SNL, Livermore

The Area of Potential Effect at SNL, Livermore is defined as the entire site. SNL, Livermore has been the subject of a thorough cultural resources overview and inventory (Busby and Garaventa, 1990) and cultural resources assessment (Busby, Garaventa, and Harmon, 1990). These surveys have determined that no National Register–listed or –eligible properties are located at SNL, Livermore (State Historic Preservation Office, 1990). Activities associated with the proposed action would not affect any prehistoric or historic cultural resources at this facility.

Standards of Significance

According to NEPA, prehistoric or historic impacts are significant if substantial disturbance or disruption occurs to a resource that is listed on, eligible for, or potentially eligible for the National Register of Historic Places. According to CEQA, activities that disrupt or adversely affect "important" prehistoric or historic archaeological (cultural) sites are considered significant adverse impacts. An "important" archaeological resource is defined as one that:

- Is associated with an event or person of either recognized significance in California or American history or recognized archaeological importance in prehistory;
- Can provide information that is both of demonstrable public interest and useful in addressing scientifically consequential and reasonable or archaeological research questions;
- Has a special or particular quality such as oldest, best example, largest, or last surviving example of its kind;
- Is at least 100 years old and possesses substantial stratigraphic integrity; or
- Involves important research questions that historical research has shown can be answered only by the use of archeological methods.

For purposes of this EIS/EIR, potential disturbances of "important" archaeological resources, or of historic resources that are listed on any national, state, or local historical registers, are considered to be significant adverse impacts.

For both prehistoric and historic resources the impact assessment methodology is similar. The resources within the Area of Potential Effect, defined as part of the historic property identification phase requirements of Section 106 of the National Historic Preservation Act , were identified through literature search and/or field reconnaissance. (See Appendix H for a more detailed description of the Section 106 process.) Resources outside that area are determined not to be affected by the proposed action. Resources within the Area of Potential Effect will be evaluated for eligibility for the National Register of Historic Places (in consultation with the State Historic Preservation Office) or other designation by state (such as a State Historic Landmark) or local government as an important resource.

If a resource is determined to be within the Area of Potential Effect and is potentially eligible for the National Register of Historic Places or is otherwise designated an important resource, it will be evaluated for potential adverse effects. The evaluation of adverse effects in this EIS/EIR does not constitute the formal Determination of Effect element of the Section 106 process. It does, however, provide an overview analysis of the potential for disturbance or disruption of cultural resources under the proposed action. The Section 106 process will be completed prior to approval of federal funding for the individual projects included in the proposed action.

All identified impacts are considered to be significant adverse impacts, unless otherwise noted, and the proposed mitigation measures following each impact discussion will reduce the impacts to a less than significant level.

IMPACTS—LLNL LIVERMORE SITE

Impact 4.1.1 Impacts to prehistoric resources are unlikely to result from the proposed action. This is a less than significant impact.

No prehistoric resources were identified during surveys of the LLNL Livermore site (see Appendix H), including the currently undeveloped perimeter areas in the western and northern portions of the property. Due to lack of shelter, food, and water resources in prehistoric times, the Livermore Valley floor area, where the LLNL Livermore site is located, has a low probability of containing prehistoric resources. Therefore, implementation of the proposed action is not expected to affect prehistoric resources. Although no impacts to prehistoric resources are expected, there is the potential for encountering subsurface prehistoric resources during construction or operation activities. Thus, the following mitigation measure would be implemented.

Mitigation Measure 4.1.1: The Laboratory would require LLNL employees and contractors to report any evidence of cultural resources unearthed during development excavation at the LLNL Livermore site. An archaeologist would assess any unearthed resources at the construction site. If necessary, construction would be stopped to preclude disturbance of any cultural resources, conduct testing, and recommend mitigation measures in accordance with DOE and CEQA guidelines.

Impact 4.1.2 Implementation of the proposed action has the potential to adversely affect important historic resources on the LLNL Livermore site. This is a less than significant impact.

The importance of historic resources at the LLNL Livermore site has not yet been determined. The process for such a determination, which is being undertaken as part of the Section 106 process, includes an evaluation of whether portions of the Laboratory are eligible for the National Register, and development of a cultural resources management plan for the management of these resources. This process is discussed below, and in Appendix H. If portions of the LLNL Livermore site are found to be eligible for the National Register, implementing the proposed action may affect important historic resources. Consultation with the State Historic Preservation Office and the Advisory Council on Historic Preservation, and subsequent execution of an agreement, if required, would lead to the formulation of mitigation measures which will reduce potentially adverse effects to National Register–listed or –eligible properties. Because LLNL is required by law to comply with the National Historic Preservation Act, and compliance with National Historic Preservation Act requirements will identify and delineate mitigation for potential impacts to historic resources at the LLNL Livermore site, impacts to historic resources are considered to be less than significant.

Prior to approval of federal funding for proposed action construction projects, and in compliance with Section 106 of the National Historic Preservation Act, a comprehensive evaluation of the historic importance of buildings and facilities within the LLNL Livermore site has recently been conducted to identify any that are potentially eligible for the National Register. This evaluation's objective was to identify the discrete facilities within the LLNL Livermore site that are eligible. LLNL and DOE will prepare appropriate documentation to allow a Determination of Effect to be made in consultation with the State Historic Preservation Office. Should it be determined that the undertaking will have an effect on properties eligible for the National Register, then an appropriate agreement document will be prepared in coordination with the Advisory Council on Historic Preservation and the State Historic Preservation Office. Approval of the programmatic agreement by all parties would conclude compliance with Section 106 requirements. The programmatic agreement will outline the process for establishing a cultural resources management plan for handling any eligible facilities at the site. The agreement document and cultural resources management plan would (1) define which facilities, if any, are eligible for the National Register, (2) determine how alterations of those facilities will be managed considering their historic importance (i.e., data recovery), (3) define when and how consultation with the State Historic Preservation Office will occur, and (4) describe the role that the LLNL Livermore site archives and visitor center will play in preserving and interpreting historic information.

Prior to execution of an agreement document, if individual projects of the proposed action are being considered for federal funding, Section 106 compliance will occur through the normal environmental review of individual projects in accordance with the National Historic Preservation Act, NEPA and CEQA.

Although potential impacts to historic resources at the LLNL Livermore site are considered to be less than significant because LLNL will comply with the National Historic Preservation Act, the following measure would be implemented.

Mitigation Measure 4.1.2: Following completion of the Section 106 review process (i.e., compliance with the National Historic Preservation Act), the cultural resource management plan outlining the methodology for managing identified historic resources at the LLNL Livermore site would be made available to the public. In addition, management and mitigation activities implemented at the LLNL Livermore site would be reported annually.

IMPACTS—LLNL SITE 300

Impact 4.2.1 Impacts to prehistoric resources at LLNL Site 300 are unlikely to result from the proposed action. This is a less than significant impact.

No recorded prehistoric resources fall within the Area of Potential Effect (see Figure 5.1.4-1); therefore, no adverse impacts to prehistoric resources at LLNL Site 300 are expected. Should forthcoming, required consultation with the State Historic Preservation Office lead to agreement with this conclusion, no additional Section 106 responsibilities are required (see Appendix H for a description of the National Historic Preservation Act, Section 106 process). The possibility that Native American traditional use areas and/or sacred resources exist within LLNL Site 300 that could potentially be affected by the proposed action has been evaluated. The State Native American Heritage Commission was contacted in 1981 and ethnographic literature was reviewed for the 1981 report (Busby, Garaventa, and Kobori, 1981); no resources were found. The Native American Heritage Commission was recontacted in 1991 and informed of the prehistoric sites found in the project area to review the possibility of ethnically important resources at LLNL Site 300; no traditional use areas or sacred resources were identified in the project area.

Although no impacts to prehistoric resources are expected, there is the potential for encountering subsurface prehistoric resources during construction or operation activities. Thus, the following mitigation measure would be implemented.

Mitigation Measure 4.2.1: The Laboratory would require LLNL employees and contractors to report any evidence of cultural resources unearthed during development excavation at LLNL Site 300. An archaeologist would assess any unearthed resources at the construction site. If necessary, construction would be stopped to preclude disturbance of any cultural resources, conduct resting, and recommend mitigation measures in accordance with DOE and CEQA guidelines.

Impact 4.2.2 Potential impacts to historic resources at LLNL Site 300 could occur as a result of the proposed action. This is a less than significant impact.

Reconnaissance in 1981 (Busby, Garaventa, and Kobori, 1981) located 21 historic resources (see Section 4.5 and Appendix H). During recent (1991) field surveys by Holman & Associates, 13 historic resources were relocated; seven of the historic resources, none of which were considered by the researchers in 1981 to be eligible for the National Register, could not be relocated and may no longer exist; and one historic resource had been removed during the 1981 field survey. The recorded locations of four of the missing historic resources fall within the Area of Potential Effect in the southeastern portion of LLNL Site 300. It was recommended by the researchers that because the sites no longer exhibit a visible cultural component, they do not meet the criteria for eligibility for the National Register. No record of a formal Determination of Eligibility from the State Historic Preservation Office is currently available on these or other properties identified during the 1981 cultural resources investigations.

The 1981 report (Busby, Garaventi, and Kobori, 1981) stated that the inventory of potentially important historic resources at LLNL Site 300 was not complete. Additional archival research was, therefore, recommended to clarify identification of existing resources and to locate new areas of potential historic resources associated with turn of the century industrial uses of the Carnegie area in the southern portion of the site. Additional research and site evaluation has been conducted for the portion of site CA-SJo-173H, the Carnegie townsite, that falls within the LLNL Site 300 boundary (William Self Associates, 1992).

Prior to approval of federal funding for proposed action construction projects, and in compliance with Section 106 of the National Historic Preservation Act, the results of the additional archival research will be compiled and used as a basis from which to prepare detailed, updated Archaeological Site Records (Department of Parks and Recreation Form 422) and Historic Resources Inventory Forms (Department of Parks and Recreation Historic Resources Inventory Form 523) for the site. A complete mapping of the site and its numerous components would also be prepared for attachment to the site record. If exact resource boundaries cannot be defined, resource areas would be mapped to include a buffer area to protect the cultural deposits or features.

Information on the Carnegie site, as well as appropriate documentation of the history and prehistory of LLNL Site 300, will be provided to the State Historic Preservation Office with a request for concurrence as to National Register recommendations contained in those documents. Should the State Historic Preservation Office concur that a site(s) meets the National Register eligibility criteria, a Determination of Effect process then ensues, with the State Historic Preservation Office and DOE applying for Criteria of Effect as contained in 36 C.F.R. 800.4. Documentation of a finding of No Adverse Effect would terminate DOE's Section 106 compliance responsibilities regarding the properties.

If adverse effects on an eligible property are identified, then an agreement document will be developed in coordination with the Advisory Council on Historic Preservation and the State Historic Preservation Office, outlining DOE responsibilities in the process and measures to mitigate effects to the resource. Depending on the type of agreement document used, signatories would include DOE, the Advisory Council, the State Historic Preservation Office and other interested parties. Execution of the document and implementation of any required action would conclude DOE's Section 106 responsibilities.

Until such time as an agreement document is executed which covers the resources in question, projects that require federal funding would be subject to Section 106 review as part of DOE's responsibility under the National Historic Preservation Act. Section 106 compliance will occur through the specific environmental review of individual projects, in accordance with the National Historic Preservation Act, NEPA, and CEQA requirements.

Although potential impacts to historic resources at LLNL Site 300 are considered to be less than significant because LLNL will comply with the National Historic Preservation Act, the following measures will be implemented.

Mitigation Measure 4.2.2A: Following completion of the Section 106 review process (i.e., compliance with the National Historic Preservation Act), the cultural resource management plan outlining the methodology for managing identified historic resources at LLNL Site 300 would be made available to the public. In addition, management and mitigation activities implemented at LLNL Site 300 would be reported annually.

Mitigation Measure 4.2.2B: During construction activities at LLNL Site 300, access to any identified prehistoric or historic site located near the Area of Potential Effect, but not directly impacted by construction, would be restricted by means of stakes and flagging or warning fences.

Mitigation Measure 4.2.2C: Monitoring during grading would be conducted in areas where historic resources are determined to exist within the Area of Potential Effect.

IMPACTS—SNL, LIVERMORE

Impact 4.3.1 Impacts to prehistoric or historic resources at SNL, Livermore are unlikely to result from the proposed action. This is a less than significant impact.

No prehistoric resources were discovered during the archival and subsequent field inspections of the SNL, Livermore facilities or adjacent grounds (Busby and Garaventa, 1990). Consequently, no adverse impacts to prehistoric resources are expected from implementation of the proposed action and no further Section 106 evaluation is necessary (State Historic Preservation Office, 1990).

Based on the comprehensive evaluation of SNL, Livermore conducted in 1990 (Busby and Garaventa, 1990; Busby, Garaventa, and Harmon, 1990), it was not anticipated that any facilities at this site would qualify for the National Register. The State Historic Preservation Office concurred with this recommendation (State Historic Preservation Office, 1990). Consequently, no impacts to historic resources are anticipated inside the borders of the facility, and no further Section 106 review is necessary.

Although no impacts to prehistoric or historic cultural resources are expected at SNL, Livermore, there is the potential for encountering subsurface cultural resources during construction or operation activities. The Laboratory has in place a Discovery Plan to be used by the facility engineering group when construction, remodeling, or upgrade is planned. The Discovery Plan requires employees and contractors to report any evidence of cultural resources unearthed during development excavation.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

While they are distinct operations managed and operated by different contractors, for purposes of this cumulative discussion the LLNL Livermore site and SNL, Livermore are addressed together because of their proximity.

Impact 4.4.1 Cumulative impacts to prehistoric resources could result from regional development in the vicinity of the LLNL Livermore site and SNL, Livermore. This is a potentially significant impact.

The cumulative impact study area for prehistoric and historic resources at the LLNL Livermore site and SNL, Livermore is defined as the Livermore Valley. The full extent of prehistoric resources within this study area cannot be delineated as part of this EIS/EIR; however, it is assumed that future development within the area could potentially impact these resources. While no prehistoric resources have been recorded either on the LLNL Livermore site or at SNL, Livermore, proposed project activities at these two facilities could result in impacts to heretofore undiscovered prehistoric resources. At this time, however, it is too speculative to determine whether the potential cumulative impact would be significant or not.

Mitigation Measure 4.4.1: The impacts of the proposed action will be mitigated as set forth in Mitigation Measure 4.1.1 . Impacts to prehistoric resources by other projects within the identified cumulative impact study area, but outside the boundaries of the LLNL Livermore and SNL, Livermore sites, cannot be mitigated by DOE or UC.

Impact 4.4.2 Cumulative impacts to historic resources could result from regional development in the vicinity of the LLNL Livermore site and SNL, Livermore. This is a potentially significant impact.

The full extent of historic resources within the identified cumulative impact study area in the Livermore Valley cannot be delineated in this EIS/EIR; however, it is assumed that future development within the area could potentially impact these resources. While impacts to potentially important historic resources at LLNL would be mitigated by compliance with the National Historic Preservation Act, the Laboratory could contribute to potentially significant cumulative impacts. No impacts to historic resources are currently identified at SNL, Livermore; however, proposed project activities at this facility could result in impacts to heretofore undiscovered historic resources. However, at this time it is too speculative to determine whether the potential cumulative impact would be significant or not.

Mitigation Measure 4.4.2: The impacts of the proposed action will be mitigated as set forth in Mitigation Measure 4.1.2. Impacts to historic resources by other projects within the identified cumulative impact study area, but outside the boundaries of the LLNL Livermore and SNL, Livermore sites, cannot be mitigated by DOE or UC.

CUMULATIVE IMPACTS—LLNL SITE 300

Impact 4.4.3 Cumulative impacts to prehistoric resources could result from regional development in the vicinity of LLNL Site 300. This is a potentially significant impact.

The cumulative impact study area for prehistoric resources at LLNL Site 300 is the area along the eastern Coast Range of eastern Contra Costa, Santa Clara, and Alameda counties, southwestern San Joaquin County, and western Stanislaus County, which in late prehistoric times was occupied primarily by the Valley Yokut and the Ohlone Indians. Of particular importance within the study area are special use sites, camp sites, and village sites located in the valley, and special use areas (such as rock quarries, rock shelters, acorn-gathering and hunting areas) located throughout the mountain range. Currently, there is a lack of information on prehistoric resources within this study area due to limited prehistoric inventory of the area. Therefore, cumulative impacts to prehistoric resources within the study area cannot be delineated as part of this EIS/EIR. However, because prehistoric resources are known to occur in the study area, it is assumed that future development within the area could potentially impact these resources. Although no prehistoric sites recorded at LLNL Site 300 are within the Area of Potential Effect, potential impacts to heretofore undiscovered subsurface resources could occur as a result of the proposed action. However, at this time it is too speculative to determine whether the potential cumulative impact would be significant or not.

Mitigation Measure 4.4.3: The impacts of the proposed action would be mitigated as set forth in Mitigation Measure 4.2.1. Impacts to prehistoric resources by other projects within the identified cumulative impact study area, but outside the boundary of LLNL Site 300, cannot be mitigated by DOE or UC.

Impact 4.4.4 Cumulative impacts to historic resources could result from regional development in the vicinity of LLNL Site 300. This is a potentially significant impact.

The cumulative impact study area for historic resources at LLNL Site 300 is defined as an approximate 5-mile radius around the site, which encompasses the Corral Hollow area and the former Carnegie townsite described in Appendix H. The historic importance of this area arises from the exploratory, ranching, mining, and historic manufacturing activities that occurred there. As discussed previously, cumulative impacts to these resources cannot be delineated as part of this EIS/EIR evaluation. However, because historic resources are known to occur within the study area, it is assumed that future development within the area could potentially impact historic resources. The potential project-specific impact to historic resources at LLNL Site 300 would be reduced to below a level of significance by compliance with the National Historic Preservation Act. At this time, however, it is too speculative to determine whether the potential cumulative impact would be significant or not.

Mitigation Measure 4.4.4: The impacts of the proposed action would be mitigated as set forth in Mitigation Measures

4.2.2A, B, and C. Impacts to historic resources by other projects within the identified cumulative impact study area, but outside the boundaries of LLNL Site 300, cannot be mitigated by DOE or UC.

5.1.5 AESTHETICS AND SCENIC RESOURCES

LLNL Livermore Site

The area east of the LLNL Livermore site is generally rural and pastoral in character because of the surrounding hillside open space. West of the LLNL Livermore site is a residential development and to the south is SNL, Livermore. The area extending north from the LLNL Livermore site to I-580 is industrial, and provides a visual continuation of the research, business, and industrial character of the LLNL Livermore site. New facility construction and upgrades proposed for the LLNL Livermore site, a 9 percent increase in existing developed space, are not expected to adversely affect views from surrounding scenic roadways and adjacent residences.

LLNL Site 300

The area surrounding LLNL Site 300 is primarily undeveloped and rural in character, with topography varying from rolling hills to steep ridges and valleys. Corral Hollow Road is the 5 only public roadway in the vicinity with a view of the site. The proposed action, a 9 percent increase in existing developed space, includes several construction projects and facility improvements throughout the interior of LLNL Site 300 and in the vicinity of the General Services Area. The visual character of LLNL Site 300 would not be changed by the implementation of the proposed action.

SNL, Livermore

SNL, Livermore is adjacent to the LLNL Livermore site, and the surrounding area is similar in character. The proposed action, a 6 percent increase of existing developed space, is not expected to adversely affect views from surrounding scenic roadways and residences.

Standards of Significance

A project is considered to have a significant adverse aesthetic impact if it:

- Substantially obstructs long-range views;
- Substantially obstructs unique environmental or man-made visual features;
- Substantially obstructs views from important public gathering places;
- Conflicts with adopted environmental plans and goals (e.g., scenic resources policies);
- Significantly alters the existing natural viewsheds, including natural terrain;
- Significantly changes the existing visual quality of the region or eliminates visual resources; or
- Significantly increases light and glare in the project vicinity.

All identified impacts are considered to be significant adverse impacts, unless otherwise noted, and the proposed mitigation measures following each impact discussion will reduce the impacts to a less than significant level.

IMPACTS—LLNL LIVERMORE SITE

Impact 5.1.1 New development under the proposed action would involve construction of additional buildings and upgrading or replacement of other buildings and infrastructure at the LLNL Livermore site, with possible impacts on the visual quality of the Laboratory. This is a less than significant impact.

A tract of single-family residences on the southwest corner of Patterson Pass Road and Vasco Road has direct views of the northwest corner of the LLNL Livermore site. This view consists primarily of the 500-ft-wide security buffer area and an adjacent 600-ft-wide undeveloped area with a row of trees in the background. The proposed action would retain the 500-ft-wide security buffer area. One new facility, a 40,000-sq-ft Atmospheric Emergency Response

Facility, is proposed for construction within the currently undeveloped perimeter area along Westgate Road, approximately 600 ft east of Vasco Road. This new facility would be visible in the distance from the residential area. Construction activities for the new facility and supporting infrastructure would cause a short-term adverse impact on the view. The new facility would not create a significant long-term adverse impact since the facility's appearance would be similar in size and character to that of other existing structures at the LLNL Livermore site. The LLNL Livermore site is also prominently visible when approaching the site from the south on Vasco Road. Several scattered residences along Vasco Road, south of East Avenue, have views of the LLNL Livermore site. The LLNL Livermore site is visible from Greenville Road (designated as a scenic roadway in the general plans of the City of Livermore and Alameda County). A panoramic view of the LLNL Livermore site is available from the roadway when approaching from the south on Greenville Road. Structures, parking lots, and onsite landscaping of facilities are visible in the background.

Foreground views of the LLNL Livermore site are dominated by the presence of 9-ft-high security fencing and the 500-ft-wide buffer area at the site perimeter. While long-distance views may evidence increases in built space as a result of the proposed action, no significant alteration of the existing character and quality of the site is anticipated and, therefore, the impact is less than significant.

Mitigation Measure: None warranted.

Impact 5.1.2 The proposed action would alter views from roadways designated as scenic resources under plans and policies of the County of Alameda and the City of Livermore. This is a less than significant impact.

The following roadway segments in the vicinity of the LLNL Livermore site are designated as scenic routes according to the scenic route element of the County of Alameda General Plan (County of Alameda, 1966): Interstate 580, Vasco Road, Patterson Pass Road, Tesla Road, Greenville Road, Altamont Pass Road, and Cross Road (see section 4.6.3). Of these scenic roadways, Vasco Road, Patterson Pass Road, and Greenville Road have views of the LLNL Livermore site. The view of the LLNL Livermore site from Vasco Road, which consists primarily of the security buffer and undeveloped areas with a row of trees in the background, would not change under the proposed action. The view of the LLNL Livermore site from Patterson Pass Road consists of the 500-ft-wide security buffer, a row of pine trees, and the tops of structures in the background. This view would not be altered by the proposed action. The panoramic view of the LLNL Livermore site from Greenville Road south of East Avenue would remain essentially unchanged because of the distance of the proposed new structures from this segment of the roadway and because of intervening existing structures. Impacts on the views from these scenic roadways are anticipated to be less than significant.

The following roadways in the vicinity of the LLNL Livermore site are designated as "scenic routes" in the Scenic Route Element of the Livermore General Plan 1976–2000 (City of Livermore, 1977): Interstate 580, Greenville Road, Tesla Road, Altamont Pass Road, Patterson Pass Road, and Flynn Road. Of these scenic roadways, Patterson Pass Road and Greenville Road have views of the LLNL Livermore site. As discussed above, the views from Patterson Pass Road and Greenville would remain essentially unchanged. Impacts on the views from these scenic roadways are anticipated to be less than significant.

Mitigation Measure: None warranted.

IMPACTS—LLNL SITE 300

Impact 5.2.1 New development under the proposed action includes several construction projects and facility improvements at LLNL Site 300, with possible impacts on the visual quality of the site. This is a less than significant impact.

Corral Hollow Road, which is adjacent to and south of LLNL Site 300, is the only public roadway in the vicinity with a view of the site. The LLNL Site 300 viewshed from Corral Hollow Road consists of the General Services Area in the foreground and rolling hillsides with a few scattered small structures on the hilltops. Most of the proposed new construction and facility upgrades would be located in the interior of LLNL Site 300 and would not be visible from Corral Hollow Road; however, the proposed action also includes construction projects and facility improvements near the more visible General Services Area. These projects include the replacement of Fire Station No. 2, the implementation of road improvements, and the construction of a new 1.7-mile water supply line from the General Services Area to the Hetch Hetchy tunnel within an existing access road right-of-way. During the construction phase, these projects could cause an adverse impact on views from Corral Hollow Road; however, because of their short-term nature and the limited area of landscape to be disturbed by these actions, potential view impacts would be less than significant.

Mitigation Measure: None warranted.

Impact 5.2.2 Implementation of the proposed action at LLNL Site 300 would alter views from roadways designated as scenic resources under plans and policies of the County of San Joaquin or the County of Alameda. This is a less than significant impact.

A 16-mile portion of I-580 and I-5 between Stanislaus and Alameda counties is designated as an official state scenic highway (County of San Joaquin, 1978). LLNL Site 300, located approximately 4 miles south of this segment of I-580, is only partially visible from the roadway due to distance and intervening topography; therefore, the proposed action would not significantly alter the view from this state scenic highway.

Tesla Road in Alameda County (from Vasco Road to the San Joaquin County border) is designated as a scenic route by the scenic route element of the County of Alameda General Plan. Tesla Road is adjacent to the southern border of the portion of LLNL Site 300 that lies within Alameda County. (Tesla Road becomes Corral Hollow Road across the San Joaquin County border.) When approaching LLNL Site 300 from the west on Tesla Road, views of the site consist of rolling hillsides. No structures or landscaping on LLNL Site 300 are presently visible and no construction or upgrade activities are proposed in the southwest corner of the site from this roadway. In general, views of LLNL Site 300 from Corral Hollow Road are limited due to distance and intervening topography. Proposed structures would be located in portions of the site that are remote from Corral Hollow Road. Thus, impacts to views along this scenic roadway from the proposed action are expected to be less than significant.

Mitigation Measure: None warranted.

IMPACTS—SNL, LIVERMORE

Impact 5.3.1 New development under the proposed action would involve construction of new facilities and upgrade or replacement of buildings and infrastructure at SNL, Livermore, with possible impacts on the visual quality of the Laboratory. This is a less than significant impact.

Like the LLNL Livermore site, SNL, Livermore is visible from Greenville Road, a scenic roadway under the City of Livermore and Alameda County general plans. In general, while long- distance views of SNL, Livermore may evidence increases in built space under the proposed action, no significant alteration of the existing character and quality of the site is anticipated.

Mitigation Measure: None warranted.

Impact 5.3.2 The proposed action would alter views from roadways designated as scenic resources under plans and policies of the County of Alameda and the City of Livermore. This is a less than significant impact.

The discussion presented under the LLNL Livermore site Impact 5.1.2 is also applicable to this impact.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

Impact 5.4.1 Buildout of approved and proposed developments in the vicinity of the Laboratories would potentially alter the visual quality of the region. This would be a potentially significant impact.

The proposed action would contribute a small increment to cumulative impacts on visual resources in the area. The cumulative impact study area with regard to viewshed impacts and scenic resource policies is defined as the area within a 2-mile radius surrounding the LLNL Livermore site and SNL, Livermore. The major approved and proposed projects within the vicinity of the LLNL Livermore site and SNL, Livermore include new residential, commercial, and business development north of I-580 in the North Livermore General Plan Area, several industrial projects south of I-580 and north of Patterson Pass Road, and the South Livermore General Plan Amendment area located south, southwest, and east of the LLNL Livermore site and SNL, Livermore. Section 10 provides a description of these projects, and Figure 10-1 shows their approximate locations. Development of these approved and proposed projects could result in substantial alteration of natural viewsheds, and thus could lead to a cumulative impact on the visual resources of the area. At this time, however, it is too speculative to determine whether or not this impact would be significant.

Mitigation Measure: Measures to mitigate this impact are outside the authority of DOE or UC.

CUMULATIVE IMPACTS—LLNL SITE 300

Impact 5.4.2 Buildout of approved and proposed developments in the vicinity of the Laboratories would potentially alter the visual quality of the region. This would be a potentially significant impact.

The proposed action would contribute a small increment to cumulative impacts on visual resources of the area. The cumulative impact study area with regard to viewshed impacts and scenic resource policies is defined as the area within a 2-mile radius surrounding LLNL Site 300. Major planned and proposed projects near LLNL Site 300 include two new communities, Tracy Hills and Tracy Highlands. Section 10 provides a description of these projects, and Figure 10-1 shows their locations. Development of Tracy Hills and Tracy Highlands could result in substantial alteration of natural viewsheds, and thus could lead to a cumulative impact on the visual quality of the area. At this time, however, it is too speculative to determine whether or not this impact would be significant.

Mitigation Measure: Measures to mitigate this impact are outside the authority of DOE or UC.

5.1.6 GEOLOGIC RESOURCES AND HAZARDS

This section evaluates the impacts of the proposed action in relation to geologic (or geotechnical) hazards such as seismically induced hazards and nonseismic earth movements. It also discusses possible impacts to geologic resources such as mineral and construction material resources, soils, and fossils. As discussed in Section 4, the LLNL Livermore site, LLNL Site 300, and SNL, Livermore are located in a geologic setting characterized by seismic activity, geotechnical hazards, and the potential presence of various geologic resources including mineral deposits, fossils, and soil resources.

LLNL Livermore Site

The LLNL Livermore site is located in a relatively flat area near the foothills of the Altamont Hills. Potential sources for future ground motion include the Greenville, Las Positas, Vernon, Corral Hollow–Carnegie, and Williams faults. The site is also located in the Livermore Valley area, an area of documented mineral and construction material resources. These include gravel resources currently mined to the west of the City of Livermore and the Livermore oil field to the east. The LLNL Livermore site is bordered by fertile soils historically used for grazing and farming. The proposed action projects a 9 percent increase in gross square footage of developed space. New buildings and structures proposed as part of the proposed action could be affected both by dynamic hazards such as ground motion and fault rupture, and by static hazards such as differential settlement. Such hazards will be evaluated before construction activities under the proposed action begin.

LLNL Site 300

LLNL Site 300 is located in the rugged terrain of the Altamont Hills, characterized by ridges and steep-sided canyons and drainages. The active Corral Hollow–Carnegie fault zone crosses the southern portion of the site. Geologic outcrops are common, and exposures have been identified that contain both minerals and fossils. Land use has historically included grazing, though soils are not typically well developed or sufficiently thick for significant farming activities. The proposed action projects a 9 percent increase in gross square footage of developed space, which includes construction of structures that must consider seismicity, landslides, differential settlement, and protection of geologic resources such as fossils and mineral deposits.

SNL, Livermore

SNL, Livermore is located at the eastern end of the Livermore Valley. The majority of the site is relatively flat; the southeastern corner of SNL, Livermore is located on hilly terrain, characterized by steep slopes in some places. The hilly and flat terrains are separated by the Las Positas fault, which crosses the SNL, Livermore site. The proposed action projects a 6 percent increase in gross square footage of developed space. Any construction will involve seismic issues, the close proximity to faults and associated ground motion and surface faulting, hazards associated with building on steep slopes, and differential settlement. As part of the proposed action, SNL, Livermore is conducting a site seismic evaluation and modification for over 40 permanent buildings. Implementation of this proposed action would help reduce potential impacts relating to seismic hazards at SNL, Livermore.

Standards of Significance

For this EIS/EIR, significant seismic hazards would pertain to seismic conditions so unfavorable that they could not be overcome by special design using reasonable construction and/or maintenance practices. A project is considered to have a significant adverse geologic impact if it:

- Exposes people or structures to major geologic hazards;
- Is subject to liquefaction or other secondary seismic hazards in the event of ground shaking;
- Is located within a known active fault zone or area characterized by surface rupture;
- Is subject to static hazards, such as landsliding or excessively steep slopes, that could result in slope failure;
- Substantially contaminates soils with toxic and hazardous materials;
- Is subject to soil that is likely to collapse due to unique physical characteristics or because of subsidence due to ground water drawdown; shrink or swell, potentially causing structural failure; or cause ponding/flooding due to low permeability and drainage characteristics; or
- Causes damage or destruction to a unique geologic feature, such as fossil-bearing formations, mineral deposits, or agriculturally valuable soils.

Unless otherwise noted, all identified impacts are considered to be significant adverse, and the proposed mitigation measures following each impact discussion will reduce the impacts to a less than significant level.

Evaluation of impacts on geologic resources from geologic (or geotechnical) hazards was performed through review of appropriate geologic, mineral resources, soils, and facility maps and related publications. These included published regional fault maps and associated publications, maps and publications regarding regional and local seismicity, published maps showing landslides and other geologic mass movement features, mineral resources maps and documents published by the California Division of Mines and Geology (CDMG), and soil maps published and recently developed by the U.S. Department of Agriculture Soil Conservation Service.

All identified impacts are considered to be significant adverse impacts, unless otherwise noted, and the proposed mitigation measures following each impact discussion would reduce the impacts to a less than significant level.

IMPACTS—LLNL LIVERMORE SITE

Geologic Resources

No known geologic resources (aggregates, clay, coal, minerals, and fossils) would be adversely impacted by the proposed action. None of the proposed action activities are near or on any known or exploitable mineral resources, fossil beds, unique geologic outcrops, or other unique geologic features. None of the proposed action activities would impact farming or grazing activities.

Geologic Hazards

Impact 6.1.1 Siting of facilities in areas subject to strong ground shaking at the LLNL Livermore site may result in structural damage and increased exposure of people to risks associated with ground shaking.

Potentially strong earthquake ground motion sources at the LLNL Livermore site are discussed in section 4.8.3 and Appendix I, and include the major (San Andreas fault system) regional fault zones as well as local faults (including the Greenville, Las Positas, Verona, Corral Hollow–Carnegie, and Williams faults). Potential impacts expected from an earthquake generating ground motion of 0.8g are discussed in Appendix D, Appendix J, and section 5.6. As discussed here, significant adverse impacts to proposed structures and related infrastructure and surrounding communities could occur from hazardous materials releases and/or structural failure of buildings and facilities following a major seismic event. All new structures for human occupancy (occupied more than 2000 person-hrs/year) will be located more than 50 ft from an active fault trace. According to the Alquist-Priolo Special Studies Zones Act of 1972, an active fault is defined as a fault that has had surface displacement during Holocene time (the last 11,000 years). In addition all waste management facilities will be located a minimum of 200 ft from an active fault.

The following mitigation measures are proposed to reduce the impacts associated with ground motion to a less than significant level.

Mitigation Measure 6.1.1A: All buildings and facilities under the proposed action at the LLNL Livermore site, including retrofits, would be built or modified (or retrofitted) according to established seismic design criteria based on their hazard ranking and location as stated in DOE Order 5481.1B (see Appendix I).

Mitigation Measure 6.1.1B: Engineering and administrative measures would be taken to anticipate and prevent releases of hazardous substances resulting from strong ground shaking at any given facility. Discussions of these measures are included in Appendix D.

Impact 6.1.2 Expansive or shrink-swell soils and soils with low permeability could adversely affect proposed action development projects at the LLNL Livermore site.

Significant adverse impacts may result from building in areas with either expansive or poorly drained, low-permeability soils. The following mitigation measure will be continued to reduce these impacts to a less than significant level.

Mitigation Measure 6.1.2: Site-specific geotechnical investigations by a California Certified Engineering Geologist, or by a California Registered Geologist or a California Registered Civil Engineer specializing in geotechnical studies, would be performed for proposed structures. The recommendations of the geotechnical investigation regarding foundations and subterranean drainage would be included in project design.

IMPACTS—LLNL SITE 300

Geologic Resources

No known geologic resources (aggregates, clay, coal, minerals, and fossils) would be adversely impacted at LLNL Site 300 as a result of the proposed action. None of the proposed action activities are situated near or on any known or exploitable mineral resources, fossil beds, unique geologic outcrops, or other unique geologic features. The newly discovered vertebrate fossil location at LLNL Site 300 is located over 500 ft from the nearest LLNL Site 300 building, and no construction activities are planned in the area.

Geologic Hazards

Impact 6.2.1 Siting of facilities in areas subject to strong ground shaking at LLNL Site 300 may result in structural damage and increased exposure of people to risks associated with ground shaking.

Potentially strong earthquake ground motion sources at LLNL Site 300 are discussed in section 4.8.3 and Appendix I and include the major regional fault zones as well as the local faults (including the Greenville, Las Positas, Verona, Corral Hollow–Carnegie, and Williams faults). Potential impacts from an earthquake generating ground motion of 0.8g are discussed in Appendix D, Appendix J, and section 5.6. As discussed in these sections, significant adverse impacts to the Laboratory and surrounding communities could occur from hazardous materials releases and/or structural failure of buildings and facilities following a seismic event. All new structures for human occupancy (occupied more than 2000 person-hrs/year) will be located more than 50 ft from an active fault trace. In addition, all waste management facilities will be located at a minimum of 200 ft from an active fault trace.

The following mitigation measures are proposed to reduce the impacts associated with ground motion to a less than significant level.

Mitigation Measure 6.2.1A: All buildings and facilities would be built according to established seismic design criteria based upon their hazard ranking and location as stated in DOE Order 5481.1B (see Appendix I).

Mitigation Measure 6.2.1B: Engineering and administrative measures would be taken to anticipate and prevent releases of hazardous substances resulting from strong ground shaking at any given facility. Discussions of these measures are included in Appendix D and Appendix I.

Impact 6.2.2 Expansive or shrink-swell soils and soils with low permeability could adversely affect proposed action development projects at LLNL Site 300.

Construction of subterranean structures in poorly drained subsurface sediments could result in seepage problems. The following mitigation measure would be continued to reduce the impact from building in areas with either shrink-swell or poorly drained, low-permeability soils to a less than significant level.

Mitigation Measure 6.2.2: Site-specific geotechnical investigations by a California Certified Engineering Geologist, a California Registered Geologist or a California Registered Civil Engineer specializing in geotechnical studies would be performed for proposed structures. The recommendations of the geotechnical investigation would include those regarding foundations and subterranean drainage and would be included in project design.

IMPACTS—SNL, LIVERMORE

Geologic Resources

No known geologic resources (aggregates, clay, coal, minerals, and fossils) would be adversely impacted at SNL, Livermore from the proposed action. None of the proposed action activities are on or near any known or exploitable mineral resources, fossil beds, unique geologic outcrops, or other unique geologic features.

Geologic Hazards

Impact 6.3.1 Siting of facilities in areas subject to strong ground shaking at SNL, Livermore may result in structural damage and increased exposure of people to risks associated with ground shaking.

Potential strong earthquake ground motion sources at SNL, Livermore are discussed in section 4.7.3 and Appendix I and include the major regional fault zones as well as the local faults (including the Greenville, Las Positas, Verona, Corral Hollow–Carnegie, and Williams faults). Potential impacts from an earthquake generating ground motion of 0.8g are discussed in Appendix D, Appendix J, and section 5.2.1.3. As discussed in these sections, significant adverse impacts to SNL, Livermore and surrounding communities could occur from hazardous materials releases, and/or structural failure of buildings and facilities, following a seismic event. All new structures for human occupancy (occupied more than 2000 person-hrs/year) will be located more than 50 ft from an active fault trace. In addition, all waste management facilities will be located at a minimum of 200 ft from an active fault trace.

The following mitigation measures are proposed to reduce the impacts associated with ground motion to a less than significant level.

Mitigation Measure 6.3.1A: All new buildings and facilities would be built according to established seismic design criteria based upon their hazard ranking and location as stated in DOE Order 5481.1B (see Appendix I).

Mitigation Measure 6.3.1B: Engineering and administrative measures would be taken to anticipate and prevent releases of hazardous substances resulting from strong ground shaking at any given facility. Discussions of these measures are included in Appendix D and Appendix I.

Mitigation Measure 6.3.1C: Site-specific geotechnical investigations by a California Certified Engineering Geologist or by a California Registered Geologist and a California Registered Civil Engineer specializing in geotechnical investigation would continue to be performed for proposed structures. The recommendations of the geotechnical investigation would include those regarding foundations and subterranean drainage and would be included in project design.

Impact 6.3.2 The potential exists for surface faulting at SNL, Livermore, near the north branch of the Las Positas fault, which may result in structural failure or expose people to potential safety hazards. This is a significant impact.

Proposed development projects under the proposed action are generally not on or immediately near the known trace of the Las Positas fault. However, the possibility for surface rupture in this active tectonic setting results in a significant adverse impact. The following mitigation measures are proposed to reduce the impacts associated with surface rupture to a less than significant level. All structures for human occupancy (occupied more than 2000 person-hrs/year) would be located more than 50 ft from an active fault trace. All waste management facilities will be located at a minimum of 200 ft from an active fault trace.

Mitigation Measure 6.3.2A: All new buildings and facilities would be built according to established seismic design criteria based upon their hazard ranking and location as stated in DOE Order 5481.1B (see Appendix I).

Mitigation Measure 6.3.2B: Site-specific geotechnical investigations by a California Certified Engineering Geologist or by a California Registered Geologist and a California Registered Civil Engineer specializing in geotechnical studies would continue to be performed for proposed structures. The recommendations of the geotechnical investigation would include those regarding foundations and seismicity and would be included in project design.

Impact 6.3.3 Expansive or shrink-swell soils and soils with low permeability could adversely affect proposed action development projects at SNL, Livermore.

Construction of subterranean structures in poorly drained subsurface sediments could result in seepage problems. The following mitigation measure is proposed to reduce the impacts associated with building in areas with either expansive or poorly drained, low-permeability soils to a less than significant level.

Mitigation Measure 6.3.3: Site-specific geotechnical investigations by a California Certified Engineering Geologist or by a California Registered Geologist and a California Registered Civil Engineer specializing in geotechnical studies would continue to be performed for proposed structures. The recommendations of the geotechnical investigation would include those regarding foundations and subterranean drainage and would be included in project design.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

Impact 6.4.1 Proposed development projects and population growth could expose people to geologic hazards. This is a less than significant impact.

People working in structures at the LLNL Livermore site and SNL, Livermore, and those living in the area of those facilities would be exposed to landslides, ground shaking, and associated hazards that commonly occur in a seismically active area.

The implementation of the mitigation measures described in section 5.1.6 for planned construction projects under the proposed action would reduce the risk of seismically induced structural damage and personal injury at the Laboratories. A major seismic event, however, would likely expose entire communities surrounding the Laboratories to similar risks, and the potential cumulative impacts due to seismically induced structural failure and resultant injury would be significant. An evaluation of the cumulative impacts associated with such an event, including those impacts from surrounding communities, is beyond the scope of this document. For a discussion of various seismic accident scenarios and related cumulative impacts, see section 5.6. To the extent that the mitigation measures described in section 5.1.6 are applied and the LLNL Seismic Safety Program and comparable seismic guidelines for SNL, Livermore are applied, Laboratory contributions to cumulative impacts would be minimized.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—LLNL SITE 300

Impact 6.4.2 Proposed development projects and population growth could expose people to geologic hazards. This is a less than significant impact.

People working in structures at LLNL Site 300 and those living in the area of this facility would be exposed to landslides, ground shaking, and associated hazards that commonly occur in a seismically active area. The potential for injuries from a major seismic event would increase if the appropriate mitigation measures described in section 5.1.6 were not implemented for new buildings, and if engineering and administrative measures were not taken to anticipate and prevent releases of hazardous substances resulting from ground shaking at any given facility.

The implementation of the mitigation measures described in section 5.1.6 for planned construction projects under the proposed action would reduce the risk of seismically induced structural damage and personal injury at LLNL Site 300. A major seismic event, however, would likely expose entire communities surrounding LLNL Site 300 to similar risks, and the potential cumulative impacts due to seismically induced structural failure and resultant injury would be significant. An evaluation of the cumulative impacts associated with such an event, including those impacts from surrounding communities, is beyond the scope of this document. For a discussion of various seismic accident scenarios and related cumulative impacts, see section 5.6. To the extent that the mitigation measures described in section 5.1.6 are applied and the LLNL Seismic Safety Program guidelines are applied, Laboratory contributions to cumulative impacts would be minimized.

Mitigation Measure: None warranted.

5.1.7 ECOLOGY

This section analyzes the potential impacts of the proposed action on biological resources, including vegetation, wildlife, threatened and endangered species and other sensitive species, and wetlands. The current operations and existing biological resources are discussed in detail in Appendices F and G and summarized in section 4.9 of this EIS/EIR.

Standards of Significance

A project is considered to have a significant adverse impact on flora and fauna if it:

- Substantially affects an endangered, threatened, or other sensitive species or its habitat;
- Substantially interferes with movement of any resident or migratory fish and/or wildlife species;
- Substantially diminishes habitat for fish, wildlife, or plants;
- Causes a fish and/or wildlife population to drop below self-sustaining levels; or
- Adversely affects significant riparian lands, wetlands, marshes, or other wildlife habitats.

All identified impacts are considered to be significant adverse impacts, unless otherwise noted, and, except for the cumulative impacts, the proposed mitigation measures following each impact discussion will reduce the impacts to a less than significant level.

Vegetation

LLNL Livermore Site

The vegetation at the LLNL Livermore site consists of areas of planted lawns and ornamental vegetation, fields dominated by early successional plant species, annual grasslands in the security zone, and remnant wooded riparian vegetation along Arroyo Seco. The proposed action at the LLNL Livermore site, which projects a 9 percent increase in gross square footage of developed space, consists mainly of building construction, facility upgrades, and operational modifications. These actions would affect plant communities in the built-up areas at the LLNL Livermore site.

LLNL Site 300

LLNL Site 300 vegetation consists of a diverse interspersion of four upland plant community types including perennial native grasslands. The proposed action, which projects a 9 percent increase in gross square footage of developed space, consists of three projects that would have an effect on vegetation at LLNL Site 300.

SNL, Livermore

Vegetation at SNL, Livermore consists of areas of planted lawns and ornamental vegetation, fields dominated by early successional plant species, annual grasslands in the security zone, and remnant riparian vegetation along Arroyo Seco. The proposed action at SNL, Livermore, which projects a 6 percent increase in gross square footage of developed space, consists mainly of building construction and infrastructure modernization. These activities would affect vegetation in the built-up areas at the SNL, Livermore site.

IMPACTS—LLNL LIVERMORE SITE

Impact 7.1.1 The proposed action would affect vegetation principally by clearing land for construction projects. This is a less than significant impact.

These activities include building construction, upgrading existing buildings, road and parking lot repairs, modification of site energy management, and other activities. These activities would take place on land that currently does not support vegetation, has been landscaped, or supports an early successional plant community indicative of recent land disturbances. Therefore, the impact of the proposed action on vegetation is less than significant.

Mitigation Measure: None warranted.

IMPACTS—LLNL SITE 300

Impact 7.2.1 The proposed action would affect vegetation (introduced grassland plant communities) principally by clearing land for construction projects. This is a less than significant impact.

Six proposed projects have the potential to impact plant communities at LLNL Site 300: (1) the Explosives Waste Storage Facility and Explosives Waste Treatment Facility; (2) the Contained Firing Facility; (3) the replacement of Fire Station No. 2; (4) the Cheap Access to Orbit Facility; (5) the Flash X-Ray upgrade; and (6) the elimination of surface water runoff from the cooling towers. These projects are described in greater detail in section 3.1.2 and in Appendix A (section A.2.5). The Explosives Waste Storage Facilities Project would consist of the rearrangement of four existing high explosives storage units for the storage of explosive wastes. The Explosives Waste Treatment Facility would replace the high explosive waste open burning facility at Building 829. These projects would result in a very limited amount of disturbance to the grassland plant community (less than 0.1 acre).

The Contained Firing Facility at the Building 801 complex would result in the enclosure of firing operations at the weapons test facility, Bunker 801. Construction of this enclosure would take place at this existing facility. It is estimated that 0.25 acre of the introduced grassland plant community would be disturbed by this project.

The replacement of Fire Station No. 2 would take place in the built-up General Services Area and would not involve any disturbance to the natural plant communities.

The Cheap Access to Orbit Facility would be constructed near Building 865 on previously disturbed ground and in the introduced grassland plant community. An estimated 0.9 acre would be disturbed for the construction of this project. This facility would be tested for 3 years and then disassembled and removed.

The Flash X-Ray Upgrade would involve upgrades at Building 801 and would not involve clearing any land.

The elimination of surface runoff from onsite cooling towers would involve constructing leach fields near the cooling towers for the runoff. At this time, it is estimated that leach fields would be constructed for 21 of the 24 cooling towers on site (leach fields would not be constructed for Buildings 810, 836a, and 865). The location and size of the leach fields have not been determined. However, they would likely be constructed in disturbed areas near the cooling towers. Assuming each of the 21 leach fields would require 120×20 ft of linear trenching, then this project would result in the disturbance of approximately 1.2 acres of land in previously disturbed areas or, possibly, in the introduced grassland plant community.

The proposed action would, then, result in the clearing of approximately 2.4 acres of land in previously disturbed areas and within the introduced grassland plant community. Because the disturbed areas would not be substantial or in sensitive plant communities, the impact is less than significant.

Mitigation Measure: None warranted.

IMPACTS—SNL, LIVERMORE

Impact 7.3.1 The proposed action would affect vegetation principally by clearing land for building construction projects and infrastructure modernization (e.g., roof replacements, resurfacing paved areas, renovation of site fire water system). This is a less than significant impact.

These activities would occur on land that currently does not support vegetation, has been landscaped, or supports an early successional plant community indicative of recent land disturbances. Therefore, the impact of the proposed action on vegetation is less than significant.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

While operated by separate contractors and managed by different DOE operational offices, for purposes of this discussion of cumulative impacts on vegetation, the LLNL Livermore site and SNL, Livermore are addressed together because of their proximity.

Impact 7.4.1 Cumulative impacts to vegetation may result from regional development in the vicinity of the LLNL Livermore site and SNL, Livermore. This has the potential to be a significant unavoidable impact.

The cumulative impacts study area for vegetation is defined as the Livermore Valley. The full extent of undeveloped plant communities within this study area cannot be delineated as part of this EIS/EIR; however, it is assumed that the future development within the area could impact this resource. As essentially no undeveloped plant communities would be impacted at either the LLNL Livermore site or at SNL, Livermore, activities associated with the proposed action would not contribute to any potential cumulative impacts to undeveloped plant communities within the study area.

Mitigation Measure 7.4.1: Impacts to vegetation within the cumulative impact study area cannot be mitigated by DOE or UC.

CUMULATIVE IMPACTS—LLNL SITE 300

Impact 7.4.2 Cumulative impacts to vegetation may result from regional development in the vicinity of LLNL Site 300. The contribution of the proposed action to this impact would be less than significant.

The cumulative impact study area for vegetation is the rolling terrain and steep canyon areas in the Diablo Range. The full extent of undeveloped plant communities within this study area is not fully known and cannot be delineated as part of this EIS/EIR. However, it is known that at least four developments totaling approximately 10,000 acres have the potential to be constructed in the area of LLNL Site 300 (see Section 10) and these projects would, if constructed, impact this resource. Because only 2.4 acres of plant communities would be impacted at LLNL Site 300, activities associated with the proposed action would not significantly contribute to cumulative impacts on native or sensitive plant communities within the study area. The overall impact of operations at LLNL Site 300 has had a positive cumulative impact on vegetation in that these operations (e.g., exclusion of grazing and the annual controlled burn) have promoted the development of a diverse mosaic of largely undisturbed plant communities, including large stands of native perennial grasslands which are now rare in California.

Mitigation Measure: None warranted.

Wildlife

LLNL Livermore Site

The wildlife diversity at the LLNL Livermore site is low because of the highly altered nature of the site. The proposed action consists mainly of construction projects in the developed areas of the site. These activities would affect resident wildlife in the built-up areas.

LLNL Site 300

LLNL Site 300 supports a diversity of wildlife species because much of the area has not been disturbed. The proposed action consists of three projects that would have an effect on wildlife at LLNL Site 300.

SNL, Livermore

The wildlife diversity at SNL, Livermore is low because the site has been highly altered. The proposed action consists of construction projects in the built-up part of the site that would have an effect on resident wildlife.

IMPACTS—LLNL LIVERMORE SITE

Impact 7.1.2 The proposed action would affect wildlife principally by clearing land for construction projects. This is a less than significant impact.

These activities include building construction, upgrading of existing buildings, modification of site energy management, and other activities. These activities would take place in areas that do not support wildlife, in areas that support wildlife typical of built-up areas, or in areas that support species typical of early successional habitats. Therefore, the impact of the proposed action on wildlife is less than significant.

Mitigation Measure: None warranted.

IMPACTS—LLNL SITE 300

Impact 7.2.2 The proposed action would affect wildlife principally by clearing wildlife habitat for construction projects. This is a less than significant impact.

The proposed action would result in the clearing of approximately 2.4 acres of wildlife habitat on previously disturbed ground or in the introduced grassland plant community (see section 5.1.7.1 for a description of the projects that would result in this disturbance). This land represents marginal wildlife habitat because it occurs on previously disturbed ground or grassland habitat in areas of relatively high levels of human activity (e.g., next to Building 801 for the Contained Firing Facility, near Building 865 for the Cheap Access to Orbit Facility, and next to existing structures for the cooling tower water runoff leach fields). Therefore, this is a less than significant impact.

Mitigation Measure: None warranted.

Impact 7.2.3 The Contained Firing Facility would reduce noise-related impacts to wildlife. This is a beneficial impact.

The operation of the Contained Firing Facility would result in a reduction in noise levels because explosives testing that now takes place outdoors would take place inside a building. The degree to which noise would be reduced by this facility cannot be quantified because information regarding the noise attenuation capabilities of this facility are currently unavailable (see section 5.1.10 for more details).

Mitigation Measure: None warranted.

Impact 7.2.4 The Contained Firing Facility would eliminate the potential impact to wildlife from flying debris. This is a beneficial impact.

The operation of the Contained Firing Facility would eliminate the potential for flying debris from explosives testing to strike wildlife. While there has been no verified occurrence of flying debris injuring or killing wildlife, the potential does exist, especially for birds of prey that may be flying or soaring over the facility at the time of a test.

Mitigation Measure: None warranted.

Impact 7.2.5 The Cheap Access to Orbit Facility would result in noise impacts to wildlife because of the loud noise generated during testing. This is a less than significant impact.

The Cheap Access to Orbit Facility would result in elevated noise levels during the tests. It is predicted that noise levels would be 116 dB and 108 dB at distances of 1300 and 2600 ft from the facility, respectively, and that these tests would occur once every 7 days (DOE, 1991). While it is difficult to quantify the impacts of noise on wildlife, it is known that current explosives testing onsite have resulted in comparable or higher noise levels at the site boundary (see section 4.12). Therefore, since LLNL Site 300 supports a diverse assemblage of wildlife under current noise conditions, since the Cheap Access to Orbit Facility would not result in an increase in noise over current levels, and since noise from explosives testing would be reduced (see Impact 7.2.3 above), this impact is less than significant.

Mitigation Measure: None warranted.

IMPACTS—SNL, LIVERMORE

Impact 7.3.2 The proposed action would affect wildlife principally by disrupting habitat through building construction and infrastructure modernization. This is a less than significant impact.

These activities would take place on land that does not currently support wildlife, supports wildlife found in built-up areas, or supports wildlife typical of early successional habitat. Therefore, the impact of the proposed action on wildlife would be less than significant.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

While operated by separate contractors and managed by different DOE operational offices, for purposes of this discussion of cumulative impacts on vegetation, the LLNL Livermore site and SNL, Livermore are addressed together because of their proximity.

The cumulative impacts study area for wildlife is defined as the Livermore Valley. The full extent of undeveloped wildlife habitat within this study area is not known and cannot be delineated as part of this EIS/EIR; however, it is assumed that future development within the area could impact this resource. As essentially no undeveloped wildlife habitat would be impacted at either the LLNL Livermore site or at SNL, Livermore, activities associated with the proposed action would not contribute to any potential cumulative impacts to undeveloped wildlife habitat within the study area.

CUMULATIVE IMPACTS—LLNL SITE 300

The cumulative impact study area for wildlife habitat is the rolling terrain and steep canyon areas in the Diablo Range. The full extent of undeveloped wildlife habitat within this study area cannot be delineated as part of this EIS/EIR. However, it is known that at least four developments totaling approximately 10,000 acres have the potential to be constructed in the area of LLNL Site 300 (see Section 10) and these projects would, if constructed, impact this resource. Because only 2.4 acres of wildlife habitat would be impacted at LLNL Site 300, activities associated with the proposed action would not contribute to any potential cumulative impacts to undeveloped wildlife habitat within the study area. The overall impact of operations at LLNL Site 300 has had a positive cumulative impact on wildlife in that these operations (e.g., exclusion of grazing and the annual controlled burn) have promoted the development of a diverse mosaic of largely undisturbed plant communities that supports a diverse assemblage of wildlife.

Threatened and Endangered Species

LLNL Livermore Site

Threatened, endangered, or other sensitive species of concern (sensitive species) have not been observed at the LLNL Livermore site.

LLNL Site 300

Sensitive species occur at LLNL Site 300. Implementation of the proposed action would result in the disturbance of potential sensitive species habitat.

SNL, Livermore

Sensitive species have not been observed at SNL, Livermore.

IMPACTS—LLNL SITE 300

Impact 7.2.6 The proposed action would affect sensitive species principally by disrupting habitat for construction projects.

Surveys indicated that the following sensitive species or sensitive species potential habitats occur at LLNL Site 300: large-flowered fiddleneck, potential valley elderberry longhorn beetle habitat, California tiger salamander, California red-legged frog, potential Alameda whipsnake habitat, California horned lizard, golden eagle, burrowing owl, potential tricolored blackbird habitat, San Joaquin pocket mouse, American badger, and potential San Joaquin kit fox habitat.

Of the species listed above, the clearing of approximately 2.4 acres of disturbed land and grassland habitat has the potential to impact the California horned lizard, burrowing owl, San Joaquin pocket mouse, American badger, and potential San Joaquin kit fox habitat. This potential impact is less than significant given the small area of land that would be cleared and the implementation of the mitigation measures listed below.

The proposed action would not have the potential to impact other sensitive species at LLNL Site 300. However, the mitigation measures listed below are also designed to protect these sensitive species from activities that may inadvertently impact them. These include such measures as protecting the large-flowered fiddleneck populations and creating buffer zones around areas of elderberry bushes (potential habitat for valley elderberry longhorned beetle). In addition, current operational practices that are a benefit to sensitive species, such as the employee awareness program, maintaining a 35-mph speed limit, continuing the controlled burn, and excluding livestock grazing, will continue.

Except for Mitigation Measure 7.2.6D, the following measures apply only to LLNL Site 300.

Mitigation Measure 7.2.6A: DOE and UC will enhance their current employee awareness program to reflect biological mitigation measures. The employee awareness program will include all LLNL employees and contract personnel working at LLNL Site 300.

Mitigation Measure 7.2.6B: DOE and UC will ensure that no construction-related activities occur within a 300-ft radius of known locations of elderberry bushes (see Figure F-18 in Appendix F). Elderberry bushes are habitat for the federally listed valley elderberry longhorn beetle.

Mitigation Measure 7.2.6C: DOE and UC will evaluate the U.S. Fish and Wildlife Service's fairy shrimp sampling protocol when published. The evaluation will focus on the need for additional sampling to ensure consistency between survey techniques described in section F.2.4.5 and those of the U.S. Fish and Wildlife Service.

Mitigation Measure 7.2.6D: DOE and UC will continue to limit the use of sulfur cartridges and anticoagulant ground squirrel poisons such as fumarin, sevin, and diphazinone (except within the fenced surface impoundments on LLNL Site 300). Zinc phosphite, which is much less injurious to canids, will remain the rodenticide of choice. (This measure also applies to the LLNL Livermore site and SNL, Livermore.)

Mitigation Measure 7.2.6E: Consistent with current practice, speed limits of 35 miles per hour or less at LLNL Site 300 will be maintained. Vehicle traffic will also be confined to existing roads (paved and unpaved) to the extent possible.

Mitigation Measure 7.2.6F: Warning sounds will continue to be broadcast from each testing facility before a detonation. In addition to warning personnel working in the area, this broadcast would scare away birds, particularly raptors, from the explosion test site.

Mitigation Measure 7.2.6G: To maintain and promote habitat diversity, DOE and UC will continue to exclude livestock grazing and will continue the annual controlled burning program on LLNL Site 300.

Mitigation Measure 7.2.6H: DOE and UC will continue to protect the large-flowered fiddleneck population near the Drop Tower by maintaining the fence, controlling access, and prohibiting activities that may adversely impact the population. A second population is in a remote canyon at a distance from current or proposed activities and requires no additional protection.

Mitigation Measure 7.2.6I: DOE and UC will continue to maintain the fire roads and disked areas in the same locations to the extent possible. After evaluation, where possible, duplicate roads paralleling other roads will be eliminated.

Mitigation Measure 7.2.6J: Herbicide use will remain limited to areas around buildings and other facilities or eliminated, if possible.

Mitigation Measure 7.2.6K: Consistent with current construction practices, all food-related trash items such as wrappers, cans, bottles, and food scraps will be disposed of in a closed container or removed from the construction site.

Mitigation Measure 7.2.6L: Undisturbed areas (i.e., areas having minimal recent surface disturbance) that may be affected by proposed construction projects will be surveyed for dens of the San Joaquin kit fox no earlier than 60 days prior to the beginning of construction activities. The survey area will include a minimum 300-ft buffer zone around the proposed construction zone. For new fire trails, linear trenching, or the rediskng of the fire break in the northeastern corner of LLNL Site 300, the buffer zone will cover 50 ft on either side of the right-of-way. In addition, a 50-ft buffer zone will be established around monitor well installations. Methods employed during these surveys will follow techniques acceptable to the U.S. Fish and Wildlife Service and the California Department of Fish and Game (U.S. Fish and Wildlife Service, 1989). Disturbed areas will not be surveyed because of the enhanced awareness program, however, personnel would be aware of the potential for kit fox at the site.

Depending upon the results of the survey outlined in mitigative measure 7.2.6L, the following measures may be implemented.

Mitigation Measure 7.2.6M: Consistent with U.S. Fish and Wildlife Service (1989) recommendations, protective exclusion zones will be established around kit fox dens (see Table F-14 in Appendix F for kit fox den classifications) observed in the 300- or 50-ft buffer zone. These exclusion zones will be the following distances:

- Known kit fox dens = 200 ft
- Pupping kit fox dens (dens with sign of pupping activity) = 300 ft
- Potential kit fox dens = 25 ft

DOE and UC will restrict activities within these exclusion zones: only essential vehicle operation will be allowed, and construction, materials storage, or other types of surface-disturbing activity will be prohibited or minimized. New roads will be kept to a minimum and vehicle traffic will be restricted to roads that are necessary for construction. If it is impossible to maintain acceptable exclusion zones, DOE and UC will consult with the U.S. Fish and Wildlife Service and the California Department of Fish and Game to modify exclusion zone dimensions or time restrictions. Alternative courses of action may also be taken (e.g., mitigation measures 7.2.6Q and 7.2.6R below).

Mitigation Measure 7.2.6N: Any known and pupping kit fox dens found will be posted with a sign near the den entrance stating the presence of the sensitive resource. To ensure protection of these dens, fencing will be installed around each one following the exclusion distances specified above. The exclusion fencing will consist of large stakes (4- to 5-ft metal or 1×1-inch wooden stakes) connected with a heavy rope or cord, and will be maintained for the duration of the construction project. The exclusion area can be modified as described in measure 7.2.6M.

Potential kit fox dens found within a proposed construction site buffer zone will have 2-ft wooden stakes with flagging placed at the den's entrance and will be maintained for the duration of the construction project.

Mitigation Measure 7.2.6O: Monthly checks of known and pupping dens will be conducted to ensure that the signs, stakes, and fencing are still intact. Monitoring will be done as unobtrusively as possible, staying outside the exclusion zones.

Mitigation Measure 7.2.6P: To prevent the kit fox (and other species of concern) from being injured or trapped during the construction phase of a project, excavated steep-walled holes or trenches greater than 2 ft deep will be covered with plywood at the close of each working day, or provided with one or more escape ramps constructed of earth fill or wooden planks. Before such holes or trenches are filled, they will be thoroughly inspected for trapped animals.

Mitigation Measure 7.2.6Q: If potential kit fox dens would be unavoidably destroyed by construction or other related activities, the following procedures will be initiated prior to disturbance. The dens will be monitored by a trained kit fox biologist for 2 to 3 days to determine if they are being used by kit fox. Activity at the dens can be monitored by placing tracking medium at the den's entrance and by night spotlighting. If there is sign of kit fox activity, the dens will be observed for 2 to 3 more days to allow the animal to move to another den during its normal activities. If there is no activity, the den will be destroyed.

Mitigation Measure 7.2.6R: If known kit fox dens occur within the areas of proposed disturbance or development, and impact to these resources is unavoidable, the following procedures will be implemented. Prior to the onset of construction and den destruction, the U.S. Fish and Wildlife Service and the California Department of Fish and Game will be notified in writing of the intent to destroy dens, and reasons will be provided why alternative courses of action are not possible. The dens will not be impacted until the U.S. Fish and Wildlife Service and the California Department of Fish and Game are provided the opportunity to review and comment on the proposed action. These agencies may recommend alternative courses of action to avoid den destruction or reduce impacts.

If permission is given by these agencies, excavation of known kit fox dens may then proceed. When the den is thought to be unoccupied, the entrance can then be progressively plugged with loose dirt for several days to discourage the use of the den while still allowing resident animals to escape easily. When signs of activity at the den cease and it is deemed safe to do so by a trained kit fox biologist, the den can be dug out with hand tools to a point at which it is certain no kit fox is using the den. The den will be fully excavated and then filled with dirt and compacted to ensure that a kit fox cannot reenter the den during the construction period. If at any point a kit fox is thought to be using the den, the plugging or excavation activity will stop, and the U.S. Fish and Wildlife Service and the California Department of Fish and Game will be contacted. All plugging and excavation efforts will be conducted by a trained kit fox biologist.

If excavation of a pupping den is unavoidable, the plugging and excavation activities will not take place during the breeding season (January through June).

Den monitoring and plugging activities will be fully documented and reported in writing to the U.S. Fish and Wildlife Service and the California Department of Fish and Game as part of the Mitigation Monitoring and Reporting Program.

Mitigation Measure 7.2.6S: If construction activities impact known kit fox dens, then artificial dens may be installed at an agreed-upon location. LLNL will consult with the U.S. Fish and Wildlife Service and the California Department of Fish and Game on the appropriate placement and design of artificial dens.

Because the burrowing owl and American badger are state species of special concern, occur on LLNL Site 300, and may be impacted by the proposed action, the following mitigation measures will be undertaken coincident with kit fox activities.

Mitigation Measure 7.2.6T: Undisturbed areas that might be affected by proposed construction projects will be surveyed (including a 300-ft buffer zone) for known burrows or dens of the burrowing owl and American badger no sooner than 60 days prior to the beginning of construction activities. For new fire trails, the buffer zone will cover 50 ft on either side of the right-of-way.

Mitigation Measure 7.2.6U: If known dens are identified within the survey area, exclusion zones of 50 ft will be established and delineated.

Mitigation Measure 7.2.6V: LLNL will restrict activities within these exclusion zones: only essential vehicle operation will be allowed, and construction materials storage, or other types of surface-disturbing activity, will be prohibited or minimized. New roads will be kept to a minimum and vehicle traffic will be restricted to roads that are necessary for construction. If it is impossible to maintain acceptable exclusion zones, LLNL will consult with the California Department of Fish and Game to modify exclusion zone dimensions.

Mitigation Measure 7.2.6W: If known dens will be unavoidably impacted, consultation with the California Department of Fish and Game will occur to determine acceptable procedures for destruction of the dens.

Impact 7.2.7 The Contained Firing Facility would reduce potential noise-related impacts on sensitive species. This is a beneficial impact.

This would be a beneficial impact for reasons given under Impact 7.2.3 above.

Mitigation Measure: None warranted.

Impact 7.2.8 The Contained Firing Facility would eliminate the potential impact to wildlife from flying debris. This is a beneficial impact.

This impact would be beneficial for reasons given under Impact 7.2.4 above.

Mitigation Measure: None warranted.

Impact 7.2.9 The Cheap Access to Orbit Facility would result in potential noise impacts to sensitive species. This is a less than significant impact.

This impact would be less than significant for reasons given under Impact 7.2.5 above.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

While operated by separate contractors and managed by different DOE operational offices, for purposes of this discussion of cumulative impacts on vegetation and wildlife, the LLNL Livermore Site and SNL, Livermore are addressed together because of their proximity.

The cumulative impact study area for sensitive species varies with each species. In general, this area is considered the occupied and/or historic range of the species in question. The occurrence of sensitive species within their specific ranges is not fully known and cannot be delineated as part of this EIS/EIR; however, it is assumed that future development within these ranges would impact sensitive species. Since no sensitive species were recorded at either study site, activities associated with the proposed action would not contribute to any potential cumulative impacts on sensitive species.

CUMULATIVE IMPACTS—LLNL SITE 300

Impact 7.4.3 Cumulative impacts to sensitive species may result from development in the vicinity of LLNL Site 300.

The cumulative impact study area for sensitive species varies with each species. In general, this area is considered the occupied and/or historic range of the species. The cumulative impact study areas for sensitive species or sensitive species potential habitat were extracted from the biological assessment (Appendix F, section F.2) and are as follows:

1. Large-flowered fiddleneck: Alameda, Contra Costa, and San Joaquin counties, California.
2. Valley elderberry longhorn beetle: Central Valley, California.
3. California tiger salamander: Sonoma County south to the Santa Rita Hills in Santa Barbara County and east to the foothills of the Sierras, California.
4. California red-legged frog: California coastal counties to the Sierra foothills, California.
5. Alameda whipsnake: Coastal ranges of Alameda and Contra Costa counties, California.
6. California horned lizard: Occurs throughout much of California, west of the deserts.
7. Golden eagle: Throughout California and much of North America.
8. Burrowing owl: Occurs in open grasslands throughout much of central California.
9. Tricolored blackbird: Occurs in wetlands east of the Sierras in California.
10. San Joaquin pocket mouse: Occurs in the Sacramento Valley from Tehama county southward and the San Joaquin Valley to Rose Station, California.
11. American badger: Occurs throughout most of California, the western and central states of the United States, and the provinces of Canada.
12. San Joaquin kit fox: Occurs in the low foothills surrounding the San Joaquin Valley, portions of the San Joaquin Valley Floor, and the interior Coast Range valleys.

The occurrence of the above-listed sensitive species within their specific ranges is not fully known and cannot be delineated as part of this EIS/EIR. However, it is known that at least four developments totaling approximately 10,000 acres have the potential to be constructed in the area of LLNL Site 300 (see Section 10) and would, if constructed, result in cumulative impacts to sensitive species. As only 2.4 acres of potential sensitive species habitat would be impacted at LLNL Site 300 and mitigation measures would be implemented as described above in this section, activities associated with the proposed action would not significantly contribute to cumulative impacts to sensitive species. The overall impact of operations at LLNL Site 300 has had a positive cumulative impact on sensitive species in that these operations (e.g., exclusion of grazing, the annual controlled burn, and restricted access) have promoted the development of a largely undisturbed mosaic of habitats conducive to the occurrence of sensitive species.

Mitigation Measure 7.4.3: The impacts of the proposed action will be mitigated as set forth under Impact 7.2.6. Impacts to sensitive species by other projects within the cumulative impact study areas cannot be mitigated by DOE or UC.

Wetlands

LLNL Livermore Site

Wetlands at the LLNL Livermore site consist of 0.36 acre in three areas along Arroyo Las Positas. The proposed action would not impact these wetlands.

LLNL Site 300

There are an estimated 6.76 acres of wetlands at LLNL Site 300. Because the 2.4 acres of lands to be cleared under the proposed action are in upland areas, there would be no direct or indirect impact upon natural wetlands. Some impact upon artificial wetlands may occur.

SNL, Livermore

Wetlands at SNL, Livermore consist of 1.44 acres. The proposed action would not impact these wetlands.

IMPACTS—LLNL SITE 300

Impact 7.2.10 The proposed action would result in the elimination of artificial wetlands as a result of a project designed to stop surface water runoff from onsite cooling towers.

Artificial wetlands created by surface water runoff occur near Buildings 801, 827, 851, and 865. The cooling tower runoff project would eliminate surface water runoff from 21 of the 24 onsite cooling towers including the cooling towers at Buildings 827 and 851. Therefore, the 0.5 acre of wetlands near these two buildings would disappear. Artificial wetlands at Buildings 801 and 865 would not be impacted by this project. This 0.5 acre of wetlands would not be regulated by the U.S. Army Corp of Engineers. However, the State of California has a no net loss policy regarding wetlands including artificial wetlands such as those at Buildings 827 and 851. The following mitigation measure will reduce the impact to less than significant.

Mitigation Measure 7.2.10: The 0.5 acre of lost wetlands would be replaced pursuant to consultation with the California Department of Fish and Game. One potential measure would be to use the artificial wetland vegetation that would likely be created in Corral Hollow Creek as a result of the ground water restoration project at LLNL Site 300 as mitigation for these lost wetlands. The ground water restoration project is an ongoing project at LLNL Site 300 that is part of continuing operations. See Appendix G, section G.5 for additional details regarding this mitigation option.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

While operated by separate contractors and managed by different DOE operational offices, for purposes of this discussion of cumulative impacts on vegetation, the LLNL Livermore site and SNL, Livermore are addressed together because of their proximity.

The cumulative impact study area for wetlands is defined as the Livermore Valley. The full extent of wetlands within this study area cannot be delineated as part of this EIS/EIR; however, it is assumed that the future development within the area could impact this resource. As no wetlands would be impacted at the LLNL Livermore site or at SNL, Livermore, activities associated with the proposed action would not contribute to any potential cumulative impacts to wetlands within the study area.

CUMULATIVE IMPACTS—LLNL SITE 300

Impact 7.4.4 Cumulative impacts to wetlands may result from regional development in the vicinity of LLNL Site 300. This is potentially a significant and unavoidable impact.

The cumulative impact study area for wetlands is the rolling terrain and steep canyon areas in the Diablo Range. The full extent of wetlands within this study area is not known and is beyond the scope of this EIS/EIR. However, it is known that at least four developments totaling approximately 10,000 acres have the potential to be constructed in the area of LLNL Site 300 (see Section 10) and these projects would, if constructed, impact this resource. Because only 0.5 acre of artificial wetlands would be impacted at LLNL Site 300, and these wetlands would be replaced consistent with the California Department of Fish and Game Policy, activities associated with the proposed action would not significantly contribute to any potential cumulative impacts to wetlands within the study area. The overall impact of operations at LLNL Site 300 has had a positive cumulative impact on wetlands in that these operations (e.g., exclusion of grazing) have promoted the development of unaltered wetlands, which are rare in California.

Mitigation Measure 7.4.4: The impacts of the proposed action will be mitigated as set forth under Impact 7.2.10. Impacts to wetlands by other projects within the cumulative impact study areas cannot be mitigated by DOE or UC.

5.1.8 AIR QUALITY

The existing ambient air quality and emissions estimates of pollutants associated with the LLNL Livermore site, LLNL Site 300, and SNL, Livermore are discussed in Section 4 of this document. The types of pollutants considered in this EIS/EIR are those historically regulated by federal, state, and local air pollution agencies. These pollutants are typically categorized as follows: criteria pollutants regulated through National Ambient Air Quality Standards (NAAQS) (ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, and lead) and various permitting processes for sources that could emit or contribute to the formation of these chemicals in the ambient air; hazardous air pollutants regulated under the National Emissions Standards for Hazardous Air Pollutants (NESHAP) (i.e., asbestos, beryllium, mercury, vinyl chloride, benzene, radionuclides, and lead); and toxic air contaminants (TAC), primarily regulated at this time through state laws such as the California Air Toxics "Hot Spots" Information and Assessment Act (AB2588) and Assembly Bill 1807, the Tanner Act. Criteria pollutants may be emitted from a variety of sources including boilers, furnaces, and vehicles. Toxic air contaminants and pollutants regulated under the NESHAP may be released from various activities at the laboratories including research, physical plant operations, and vehicles.

Because of the nature of research and because at this time precise designs are not available for buildings associated with the proposed action, the exact types and quantities of air pollutants that may be emitted as a result of implementation of the proposed action cannot be accurately predicted. Without specific designs, it is not possible to indicate accurately the increase in the number of emissions sources or the location of these sources for the proposed action. Due to the uncertainties in estimating the types and quantities of air pollutants that might be emitted under the proposed action and the locations of the emissions, it is conservatively assumed for purposes of this EIS/EIR that emissions would increase proportionally to the increase in gross square footage of the Laboratories and would be emitted uniformly among the proposed potential new air pollution emission sources.

Both the Bay Area Air Quality Management District and the San Joaquin Unified Air Pollution Control District have "No Net Increase" permitting programs in accordance with the 1988 California Clean Air Act. Two aspects of these programs apply to potential increases in emissions associated with the proposed action. The first would require Best Available Control Technology (BACT) for emissions of criteria pollutants (except ozone), precursor organic compounds (POC) or nonprecursor organic compounds if emissions exceed or are likely to exceed 5 lb on any one day or 365 lb per year; BACT requirements also apply to several hazardous air pollutants if emissions are likely to exceed levels specified in the rule. The second aspect of the "No Net Increase" programs addresses "offsets" (i.e., emission reductions) before the issuance of any required operating permits. Offset requirements would apply only if emissions of certain pollutants exceed specified threshold amounts. These pollutants include POC, nitrogen oxides, particulate matter, PM10, and sulfur dioxide. For each of these pollutants, the programs establish limitations of 5 lb on any one day or a facility-wide cumulative increase, after April 5, 1991, of 1 ton per year. Offset reductions are always required at a rate greater than the proposed increase (e.g., 1.2 tons of reduction per 1 ton of increase). In general, offsets must be obtained in the area where increases from new or modified stationary sources are proposed; the districts have also established emissions "banks" from which offsets may be purchased.

LLNL Livermore Site

The proposed action, as described in Section 3, is assumed to result in an approximate 9 percent increase in LLNL Livermore site facilities (based upon projected increase in square footage of developed space) and a 20 percent increase in number of employees at the end of implementation of the proposed action. For this EIS/EIR, this projected increase was used to conservatively estimate air emissions from sources as described below.

Although for purposes of the EIS/EIR the square footage increase was used to conservatively estimate the increase in emissions, the actual changes in emissions due to the proposed action may be different. Several modifications to facilities and operations in the proposed action may tend to increase the air pollution emitted at the LLNL Livermore site. Other modifications to facilities and operations may decrease air pollutants; for example, the potential installation of low nitrogen dioxide burners on boilers, space heaters, and generators. Other actions which may reduce pollutants include solvent substitutions, alternative cleaning methods, and installation of improved abatement devices.

Criteria Pollutants

Based on projected 1992 estimates of material usage, such as fossil fuel and solvents, and application of emissions factors (EPA, 1982) established for equipment, such as commercial boilers, the LLNL Livermore site estimated emissions are 3.2 lb/day of particulate matter, 183 lb/day of volatile organic compounds, 1 lb/day of sulfur oxides, 118 lb/day of nitrogen oxides, and 24 lb/day of carbon monoxide. These emissions of criteria pollutants were obtained by applying EPA emission factors that estimate emissions based on the amount of fuel used and the type of combustion or emission source. The emission estimates for 1992 represent maximum short-term (i.e., hourly) emission rates, which would not occur for every hour during the year since the sources of the criteria air pollutants do no operate every hour throughout the year. Upon completion of the proposed action, it is assumed that new sources of criteria pollutants would increase emissions by 9 percent over the 5- to 10-year period, which amounts to 0.3 lb/day of particulate matter, 16 lb/day of volatile organic compounds, 0.1 lb/day of sulfur oxides, 10 lb/day of nitrogen oxides, and 2 lb/day of carbon monoxide.

Hazardous Air Pollutants

Radionuclides. Members of the public in the area surrounding the LLNL and SNL, Livermore* may be exposed to low levels of radioactive materials that are released to the environment as a result of normal operations. The control procedures currently used to protect members of the public and to limit emissions of radionuclides into the environment will continue.

The collective dose to the public within a 50-mile radius of LLNL and SNL, Livermore was about 31 person-rem in 1990. The individual radiation doses to the public range from about 7×10^{-6} (0.0000007) rem (0.007 mrem) per year at distances of several tens of miles from the two laboratories to 2.5×10^{-4} (0.00025) rem (0.25 mrem) per year at the northeast fenceline. These calculated doses are small compared with the background radiation dose of 0.3 rem (300 mrem) per year and are well within DOE guidelines for protection of the public and the EPA annual dose limit of 0.01 rem (10 mrem) for airborne releases under the National Emission Standard for Hazardous Air Pollutants (40 C.F.R. 61). They are also lower than the National Council on Radiation Protection and Measurements negligible individual risk level of 0.001 rem (1 mrem) per year.

Currently Building 331, the Hydrogen Research Facility, has an *administrative limit* for tritium of 300 g and an *inventory* of less than 20 g. Under the proposed action, the administrative limit would be reduced from 300 g to 5 g and the inventory reduced accordingly. A portion of the tritium operations in Building 331 may be moved to Building 298, the Fusion Target Fabrication Facility, and to Building 391, the Inertial Confinement Fusion Facility, known as the NOVA-Upgrade/National Ignition Facility. In this event, the three buildings would have a combined administrative limit of 10 g with no more than 5 g in any one building. For these facilities, the administrative limit would therefore be reduced from 300 g in one facility (Building 331) to a total of 10 g in three facilities (Buildings 298, 331, and 391). These changes would reduce the releases of radioactive material into the environment, but the reduction would not necessarily be directly proportional to the reduction in the administrative limits. The releases and the resultant impacts depend on the amount of tritium being handled in specific operations, the nature of the operations, and the physical and chemical form of the tritium. LLNL has estimated that emissions may be reduced by a factor of 2 to 5.

LLNL is currently reducing the plutonium administrative limit for the combined Buildings 332 and 334 from 700 kg to 200 kg, with the inventory (actual inventory quantities are classified) being reduced accordingly. The reduction would be accomplished by shipping inventory to an offsite DOE facility and is targeted for completion during FY 1993.

The administrative limits for radionuclides other than tritium and plutonium will not be changed under the proposed action. Furthermore, there are no reported releases of radionuclides, other than tritium, that affect the level of radiation exposure of members of the public.

Beryllium. Beryllium is a nonradioactive material regulated by the National Emission Standard for Hazardous Air Pollutants (NESHAP) that is monitored at the LLNL Livermore site. Beryllium is also regulated by the Bay Area Air Quality Management District (BAAQMD).

The average monthly concentrations of airborne beryllium at the LLNL Livermore site perimeter for the last 5 years are less than 0.58 percent of the BAAQMD standard, which is equivalent to NESHAP, of 0.01 mg/m^3. Under the proposed action, the beryllium emissions are assumed to increase by approximately 9 percent over the EIS/EIR period. However, no increase is expected in the airborne beryllium concentration at the perimeter because the contribution from the LLNL Livermore site is indistinguishable from beryllium occurring in ambient dust.

Toxic Air Contaminants

Based on 1990 records of material usage and application of standardized emission factors (EPA, 1982), the LLNL Livermore site estimated emissions of toxic air contaminants were adjusted for interim square footage growth and rebaselined for FY 1992; they are presented in Table 5.1.8-1. Under the proposed action, toxic air contaminant emissions are assumed to increase by approximately 9 percent by the end of the planned project. The quantities of toxic air contaminants projected as emissions due to a 9 percent projected increase in facilities due to the proposed action are also shown in Table 5.1.8-1.

LLNL Site 300

The proposed action, as described in Section 3, is projected to result in an approximately 9 percent increase in LLNL Site 300 facilities (based upon a projected increase in square footage of developed space) at the end of the next 5- to 10-year planning period for purposes of the proposed actions. For purposes of this EIS/EIR, this projected growth was used to conservatively estimate the air emissions described below.

Criteria Pollutants

Based on projected 1992 estimates of material usage such as fossil fuel commercial boilers, LLNL Site 300 estimated emissions (EPA, 1982) are 5 lb/day of particulate matter, 14 lb/day of volatile organic compounds, 3 lb/day of sulfur oxides, 52 lb/day of nitrogen oxides, and 11 lb/day of carbon monoxide. These criteria pollutant emission estimates were obtained by applying EPA emission factors that estimate emission rates based on fuel use and the type of combustion or emission sources. These emission estimates represent maximum short-term (i.e., hourly) emission rates, which would not occur every day throughout the year. Under the proposed action, the criteria pollutants generated from stationary sources are assumed to increase 9 percent over the EIS period, which amounts to 0.45 lb/day of particulate matter, 1.3 lb/day of volatile organic compounds, 0.27 lb/day of sulfur oxides, 4.7 lb/day of nitrogen oxides, and 1 lb/day of carbon monoxide.

Hazardous Air Pollutants

Radionuclide. The administrative limits for radionuclides other than tritium will not be changed under the proposed action. Tritium use will resume at the firing tables with an administrative limit of 20 mg.

Beryllium. Some experiments performed at the firing tables (Buildings 801, 850, and 851) at LLNL Site 300 release beryllium. Although operations at LLNL Site 300 are not subject to NESHAP, the onsite results from ambient monitoring are compared to Bay Area Air Quality Management District standards for this EIS/EIR. Ambient monitoring at the Tracy, California Fire Station, and at seven other locations onsite, indicates that air quality levels are less than 0.52 percent of the Bay Area Air Quality Management District standard. For the purposes of this EIS/EIR, it is conservatively assumed that air emissions of beryllium would increase proportionally with the projected increase in facilities. Therefore, for the purposes of this analysis, beryllium emissions could increase 9 percent over the EIS/EIR period. The proposed action includes containment (enclosure) of a firing table, which if constructed would reduce release of radioactive material and beryllium to the environment.

Toxic Air Contaminants

The amounts of toxic air contaminants emitted at LLNL Site 300 are available for all emissions sources except the Iron Horse (LLNL, 1990b). Toxic air contaminant emissions estimates for the Iron Horse will be developed after performing emission testing approved by the San Joaquin Valley Unified Air Pollution Control District. Assuming, for the purposes of this EIS/EIR, that toxic air contaminant emissions would increase proportionally with the projected increase in facilities, toxic air contaminant emissions would increase by approximately 9 percent from current levels. The toxic air contaminant emissions due to the proposed action at Site 300 are presented in Table 5.1.8-2.

SNL, Livermore

The proposed action, as described in Section 3, would result in an approximate 6 percent increase in SNL, Livermore facilities (based upon projected increase in square footage of developed space) over the next 5 to 10 years. For purposes of this EIS/EIR, the projected growth was used to estimate criteria pollutants, hazardous air pollutants, and toxic air contaminants as described below.

Criteria Pollutants

Based on projected 1992 estimates of fossil fuel usage in boilers and emission factors (EPA, 1982) for commercial boilers, SNL, Livermore generated and emitted 0.35 lb/day of particulate matter, 14.1 lb/day of volatile organic compounds, 0.01 lb/day of sulfur oxides, 18.7 lb/day of nitrogen oxides, and 2.4 lb/day of carbon monoxide. These criteria pollutant emission estimates were obtained by applying EPA emission factors that estimate emission rates based on fuel use and the type of combustion or emission sources. These emission estimates represent maximum short-term (i.e., hourly) emission rates, which would not occur every day throughout the year. Under the proposed action, the criteria pollutants generated from stationary sources are assumed to increase 6 percent over the EIS period, which amounts to 0.02 lb/day of particulate matter, 0.85 lb/day of volatile organic compounds, 0.001 lb/day of sulfur oxides, 1.12 lb/day of nitrogen oxides, and 0.14 lb/day of carbon monoxide.

It should be noted that for purposes of the EIS/EIR and conformance with CEQA, since the project is located in a nonattainment area for ozone and PM10, any air pollutant emissions associated with the project and contributing to the nonattainment status would be considered significant.

All identified impacts are considered to be significant adverse impacts, unless otherwise noted, and the proposed mitigation measures following each impact discussion will reduce the impacts to a less than significant level.

IMPACTS—LLNL LIVERMORE SITE

To assess the ambient air quality impact from the proposed action at the LLNL Livermore site, the air pollutant concentrations from the air quality dispersion modeling for the existing or baseline operations were linearly increased by 9 percent, reflecting a 9 percent increase in gross square footage associated with complete implementation of the proposed action. Stationary sources of air emission for the existing or baseline operations such as stacks were modeled as point sources, using the EPA-approved Industrial Source Complex Short-Term (ISCST) air quality dispersion model (EPA, 1987). Modeling was based on the onsite meteorological data from the LLNL Livermore site and Site 300 for the 4-year period 1986 through 1989 (LLNL, 1991a). The results of modeling the baseline operations provided estimates of ambient concentrations, which were then linearly increased by 9 percent to represent the ambient concentrations due to the proposed action. The estimated ambient criteria air pollutant concentrations for the proposed action are presented in Table 5.1.8-4.

Impacts of mobile sources of air emission, such as cars and trucks, due to the proposed action were estimated by proportionally increasing the ambient impacts from 1991 traffic conditions. The estimated carbon monoxide ambient concentrations for 1991 conditions, obtained from air quality modeling with Mobile 4 emission factors (EPA, 1990) and CAL3QHC (CARB, 1987), were increased by 20 percent to reflect a 20 percent increase in the LLNL Livermore site employee and related traffic volume.

Impact 8.1.1 Growth at the LLNL Livermore site would result in short-term impacts due to construction activities. This is a significant and unavoidable impact.

Short-term impacts relating to particulate (fugitive dust) emissions may occur from construction activities associated with the proposed action. Construction-related emissions would include dust generated from earth moving, excavation, and grading, and exhaust emissions from powered construction equipment and motor vehicles. Additionally, volatile organic compounds (VOCs) would be emitted from oil-based architectural coatings, paints, and asphalt used in construction. Volatile organic compounds are a precursor of ozone, for which the Bay Area is in nonattainment; therefore, even this temporary incremental increase in volatile organic compounds is a significant and unavoidable impact.

Exhaust emissions during construction would result from vehicular traffic generated by construction activities and from construction equipment and machinery. Emission levels for construction activities would vary with the type of equipment, duration of use, operation schedules, and number of construction workers. Exhaust emissions from construction activities would include NOx, a precursor to ozone formation. These impacts are temporary and localized to the area of construction, and therefore less than significant.

Mitigation Measure 8.1.1: General construction practices at the LLNL Livermore site, including contract specifications, would require that fugitive emissions be reduced by means such as water spraying of roads and the wheels and lower portions of construction vehicles and covering exposed piles of excavated material.

Impact 8.1.2 Assumed growth at the LLNL Livermore site under the proposed action would result in an increase of criteria pollutant emissions. This is a significant and unavoidable impact.

The estimated highest criteria pollutant concentrations from the proposed action at the LLNL Livermore site are presented in Table 5.1.8-4. This table also includes representative ambient background concentrations for these pollutants, as measured by the Bay Area Air Quality Management District for the Livermore area, as well as corresponding state and federal ambient air quality standards. As shown in the table, none of the predicted criteria air pollutant concentrations for the proposed action, when combined with existing background pollutant levels, would cause or substantially contribute to existing or new violations of air quality standards. However, the San Francisco Bay Area air basin is a nonattainment area for ozone and PM10. Nitrogen dioxide and volatile organic compound emissions are precursors for ozone formation.

Although the potential increases in nitrogen dioxide, volatile organic compounds, and particulate emissions from the proposed action at the LLNL Livermore site are individually small, they contribute to the nonattainment status of the air basin for ozone and PM10 standards, so the impact is considered a significant adverse impact.

Although the following mitigation measure would reduce projected increases in emissions, there would still be an increase in emissions in a nonattainment area; thus, for the purposes of this document this is a significant and unavoidable impact.

Mitigation Measure 8.1.2: On a project-specific basis, the LLNL Livermore site will evaluate the feasibility of designing buildings to minimize the contribution of criteria pollutants to the offsite ambient concentrations.

Impact 8.1.3 Assumed growth at the LLNL Livermore site under the proposed action would result in an increase of beryllium emissions. This is a less than significant impact.

For the purposes of this impact, it is assumed that beryllium emissions may increase under the proposed action by 9 percent. A 9 percent increase in beryllium emissions from current levels would still be below the Bay Area Air Quality Management District standards for beryllium. Therefore, the impact is considered less than significant.

Mitigation Measure: None warranted.

Impact 8.1.4 Assumed growth at the LLNL Livermore site under the proposed action would result in potential increases of toxic air contaminants. This is a less than significant impact.

For the purposes of this EIS/EIR, assuming potential emissions of toxic air contaminants are proportional to growth, the estimated highest ambient concentration predicted by the ISCST dispersion model for toxic air contaminant emissions under the provisions of AB2588 for baseline conditions was adjusted to account for a 9 percent increase in toxic air contaminant emissions under the proposed action. The carcinogenic compounds represented a risk of approximately 0.3 cancer fatalities in 1 million, and the noncarcinogenic compounds represented a hazard index of 0.089 and 0.42 for chronic and acute exposures, respectively. All these values are well below the California Air Resources Board threshold level and are, therefore, considered to be less than significant.

Mitigation Measure: None warranted.

Impact 8.1.5 Assumed growth at the LLNL Livermore site under the proposed action would result in an increase in carbon monoxide emissions from mobile sources. This is a less than significant impact.

Under the proposed action, assuming a 20 percent increase in the number of LLNL employees and in related traffic volume, and ignoring institutional controls on vehicular traffic such as carpooling and incentive programs for ridesharing in the Livermore Valley, a maximum 1-hour carbon monoxide concentration of 4 ppm at the intersection of Vasco Road and East Avenue is estimated to occur. This represents 15 percent of the 1-hour ambient air quality standard for carbon monoxide imposed by the California Air Resources Board and does not cause or contribute to a violation of AAQS standards; this increase, therefore, is considered less than significant and no mitigation measures are warranted for this impact.

As discussed in section 4.10, the Bay Area Air Quality Management District is currently reassessing the areas designated as nonattainment. Should the area be classified as nonattainment for carbon monoxide in the future, LLNL would consider the potential impact significant and unavoidable, but would continue to implement transportation control measures to reduce the contribution of carbon monoxide.

Mitigation Measure: None warranted.

Impact 8.1.6 Assumed growth at the LLNL Livermore site under the proposed action would result in an increase in nitrogen dioxide emissions from mobile sources. This is a significant and unavoidable impact.

The increase in traffic volume related to the proposed action would cause an increase in nitrogen dioxide emissions. Since the San Francisco Bay Area basin is a nonattainment area for ozone, and nitrogen dioxide is a precursor of ozone formation, any increase in nitrogen dioxide emissions would contribute to nonattainment conditions. It is therefore considered a significant and unavoidable impact.

To mitigate the contribution of nitrogen dioxide emissions from the proposed action to an impact on the attainment of ozone standards, the following measure would be implemented.

Mitigation Measure 8.1.6: Continue the existing LLNL programs to enhance, to the extent feasible, Transportation System Management programs that would revitalize and expand the vanpooling and ridesharing programs in an organized effort to reduce vehicle use and associated air emissions.

Impact 8.1.7 The reduction in the administrative limit for tritium in Building 331 will be greater than the increase in the administrative limits for tritium in Building 298 and 391. The sum of the administrative limits for tritium in the three buildings will decrease from 300 g in Building 331 to a total of no more than 10 g in three buildings (331, 298, 391). The reduction in the level of tritium operations would decrease releases of tritium into the environment. This is a less than significant impact and may be beneficial.

Currently Building 331, the Hydrogen Research Facility, has an *administrative limit* for tritium of 300 g and an *inventory* of less than 20 g. Under the proposed action, the administrative limit for Building 331 would be reduced from 300 g to 5 g and the inventory reduced accordingly. A portion of the tritium operations in Building 331 may be moved to Building 298, the Fusion Target Fabrication Facility, and to Building 391, the Inertial Confinement Fusion Facility, known as the NOVA-Upgrade/National Ignition Facility. In this event, the three buildings would have a combined administrative limit of 10 g with no more than 5 g in any one building. For these facilities, the administrative limit would therefore be reduced from 300 g in one facility (Building 331) to 10 g total in three facilities (Buildings 298, 331, and 391.) This would reduce the release of tritium to the environment and the resulting radiation doses to the public. LLNL has estimated that the reduction would be by a factor of 2 to 5 based on the amount of tritium that would be handled in specific operations, the nature of the operations, and the physical and chemical form of the tritium.

Mitigation Measure: None warranted.

IMPACTS—LLNL SITE 300

Impact 8.2.1 Assumed growth at LLNL Site 300 under the proposed action would result in short-term impacts due to construction activities. This is a significant and unavoidable impact.

Short-term impacts relating to particulate (fugitive dust) emissions may occur from construction activities associated with the proposed action. Construction-related emissions would include dust generated from earth moving, excavation, and grading, and exhaust emissions from powered construction equipment and motor vehicles. Additionally, volatile organic compounds would be emitted from oil-based architectural coatings, paints, and asphalt used in construction. Volatile organic compounds are a precursor of ozone, for which the area is in nonattainment.

Exhaust emissions during construction would result from vehicular traffic generated by construction activities and from construction equipment and machinery. Emission levels for construction activities would vary with the type of equipment, duration of use, operation schedules, and number of construction workers. Exhaust emissions from construction activities would include NOx, a precursor to ozone formation.

Mitigation Measure 8.2.1: General construction practices at LLNL Livermore Site 300, including contract specifications, would require that fugitive emissions be reduced by means such as water spraying of roads and the wheels and lower portions of construction vehicles and covering exposed piles of excavated material.

Impact 8.2.2 Construction of the Contained Firing Facility at LLNL Site 300 under the proposed action would result in decreased beryllium emissions from Building 801. This is a beneficial impact.

Beryllium emissions may decrease under the proposed action if a contained firing facility, which would restrict air emissions, is constructed. Since plans for such a facility are not yet definitive, the amount of beryllium emission reduction associated with the facility is speculative at this time. However, since the existing beryllium ambient air quality levels are currently less than the Bay Area Air Quality Management District standards used for comparison, and emissions would be further reduced by the proposed actions, this is a beneficial impact.

Mitigation Measure: None warranted.

Impact 8.2.3 Growth at LLNL Site 300 would result in an increase in criteria pollutant emissions. This is a significant and unavoidable impact.

The estimated highest criteria pollutant concentrations under the proposed action at LLNL Site 300 are presented in Table 5.1.8-4. These concentrations were obtained using the same methodology used at the LLNL Livermore site; that is, linearly increasing the ambient criteria pollutant concentrations obtained by modeling the emissions sources of the baseline operations. As shown in the table, none of the predicted criteria air pollutant concentrations, when combined with background pollutant levels, would cause or substantially contribute to existing or new violations of air quality standards. However, nitrogen dioxide, volatile organic compound, and PM10 emissions from LLNL Site 300 are a significant impact since the San Joaquin Valley Air Basin is a nonattainment area for ozone and PM10. Although mitigation measures would reduce the nitrogen dioxide, volatile organic compounds, and PM10 emissions, there would still be an increase in a nonattainment area. This is a significant and unavoidable adverse impact.

Mitigation Measure 8.2.3: Mitigation measures for nitrogen dioxide, volatile organic compound, and PM10 emissions for the LLNL Livermore site identified in Mitigation Measure 8.1.2 would also be employed at LLNL Site 300.

Impact 8.2.4 The Contained Firing Facility at LLNL Site 300 would essentially eliminate dispersion of uranium and any other constituent of explosive devices into the environment from Building 801. This is a less than significant impact and may be a beneficial impact.

Containment of the firing tables would essentially eliminate dispersion of uranium and other constituents into the environment from this firing table.

Mitigation Measure: This is a beneficial impact and would require no mitigation.

Impact 8.2.5 Construction of the Explosives Waste Treatment Facility at LLNL Site 300 under the proposed action would result in the same or less air emissions. This is a less than significant impact.

No change would be expected from this project; therefore, this is a less than significant impact.

Mitigation Measure: None warranted.

Impact 8.2.6 Resumed use of a small amount of tritium at the LLNL Site 300 firing tables would increase the potential release of radioactivity into the atmosphere. The releases would be limited and would comply with NESHAP. This is a less than significant impact.

Tritium use is planned to be resumed at the LLNL Site 300 firing tables with an administrative limit of 20 mg (about 200 Ci). Radiation releases would be controlled to be as low as reasonably achievable and comply with regulatory limits. Therefore, this is a less than significant impact.

Mitigation Measure: None warranted.

IMPACTS—SNL, LIVERMORE

Impact 8.3.1 The administrative limit for tritium at the Tritium Research Laboratory will be reduced from 50 g to zero over the next 10 years and the building will be converted to alternative uses. This is a less than significant impact and may be beneficial.

This would reduce tritium emissions to zero.

Mitigation Measure: This is a less than significant impact and may be beneficial; no mitigation would be required.

Impact 8.3.2 Assumed growth at SNL, Livermore under the proposed action would result in short-term impacts due to construction activities. This is a less than significant impact.

Particulate emissions may occur due to construction activities associated with the proposed action at SNL, Livermore. These impacts are short-term, temporary, and localized. This impact is, therefore, less than significant.

Mitigation Measure 8.3.2: SNL, Livermore would require general construction practices to minimize generation of fugitive dust by water spray application.

Impact 8.3.3 Assumed growth at SNL, Livermore under the proposed action would result in an increase in criteria pollutant emissions.

The estimated highest criteria pollutant concentrations under the proposed action at SNL, Livermore are presented in Table 5.1.8-3. These concentrations were estimated using the same methodology used at the LLNL Livermore site. As shown in the table, none of the predicted criteria air pollutant concentrations, when combined with existing background pollutant levels, would cause or substantially contribute to existing or new violations of air quality standards. These impacts are therefore considered less than significant.

The San Francisco Bay Area air basin is a nonattainment area for ozone and PM10. Nitrogen dioxide, volatile organic compound, and PM10 emissions are individually small and contribute to an ozone and PM10 nonattainment condition. These impacts are, therefore, considered potentially significant and unavoidably adverse.

Mitigation Measure 8.3.3: The mitigation measures discussed for nitrogen dioxide, volatile organic compound, and PM10 emissions from the LLNL Livermore site would also be employed at SNL, Livermore.

Impact 8.3.4 Assumed growth at SNL, Livermore under the proposed action would result in an increase of toxic air contaminants. This is a less than significant impact.

The estimated emission rates of the proposed action at SNL, Livermore are 6 percent of the current toxic air contaminants emission rates. The current toxic air contaminants emission rates were considered by the BAAQMD to be at a level that does not require a health risk assessment and therefore does not pose an unacceptable risk to the surrounding public. Since the toxic air contaminants emissions from the proposed action are 6 percent of the current toxic air contaminants emissions they are also considered to be below the level which could pose an unacceptable risk. Therefore the impact is considered less than significant.

Mitigation Measure: None warranted.

Impact 8.3.5 Decontamination and decommissioning of the Tritium Research Laboratory will result in tritium air emissions during the decontamination activities. This is a less than significant impact.

During the decommissioning and decontamination activities, outgassing of glovebox and piping may occur as they are disconnected in preparation for shipment to licensed disposal facilities. Based on a conservative estimate of 5000 to 10,000 curies of residual tritium in the various equipment, tritium outgassing may be as much as 2500 Ci. This averages to 800 Ci/year for the 3-year decommissioning operations, compared to the approximately 300 Ci/year now being released by this facility (see section 4.10.2 and Appendix C).

Thus, this level of tritium emission is within the same order of magnitude as the normal operating stack releases of the Tritium Research Laboartory. Furthermore, as a matter of DOE and Laboratory policy, these emissions are kept as low as reasonably achievable (ALARA), which would be supported by extensive personnel training, use of state-of-the-art technology, and utilization of experience from other DOE tritium facility decommissioning operations. As such, this would be determined to be a short-term and less than significant impact.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE, LLNL SITE 300, AND SNL, LIVERMORE

Impact 8.4.1 Assumed growth under the proposed action at the Laboratories and surrounding communities would increase criteria pollutant emissions. This is a significant and unavoidable impact.

The development of approved and proposed projects near the LLNL Livermore site, LLNL Site 300, and SNL, Livermore, as identified in section 4.2.3, would result in increased criteria air pollutants due to stationary and mobile sources. While the carbon monoxide standards are not expected to be exceeded from the cumulative impacts, cumulative growth would result in the emission of primary pollutants such as NOx and VOCs that are precursors to ozone. Since the Livermore area exceeds federal and state ozone standards, any increase in pollutants that could lead to the formation of ozone is considered a potentially significant and unavoidable adverse impact.

Mitigation Measure: None available. Mitigation measures to reduce the impacts to less than significant are beyond the authority of DOE and UC.

Impact 8.4.2 Radiation exposures to the public from activities at LLNL and SNL, Livermore would decrease under the proposed action. This is a less than significant impact and may be beneficial.

Releases of radionuclides into the environment from the LLNL Livermore site and SNL, Livermore would decrease from current levels and the resulting radiation doses to members of the public would remain well below the limits required by NESHAP (40 C.F.R. Part 61).

Currently, there are no major facilities projected to be built in the region that would be expected to release radionuclides into the environment. If any such facilities were built, they would have to comply with the release limits specified by the EPA, Cal EPA, the U.S. Nuclear Regulatory Commission, and other regulatory authorities. Because the release limits are set to protect public health and because any new facility would have to comply with these limits to operate, the cumulative radiation exposure to the surrounding public is considered to be less than significant.

Mitigation Measure: None warranted.

Impact 8.4.3 Assumed growth under the proposed action at the Laboratories and the surrounding communities would increase toxic air contaminants. This is a less than significant impact.

The development of approved and proposed projects near the LLNL Livermore site, LLNL Site 300, and SNL, Livermore would result in increased toxic air contaminants due to stationary sources. Although the specific development plans that would lead to increases in toxic air contaminants due to the proposed projects are not known at the time of this EIS/EIR, any increases in toxic air contaminant emission would be regulated under AB2588. Since this regulation requires that the human health risk from toxic air contaminant emissions be at acceptable levels, the increase in toxic air contaminant emissions due to approved and proposed projects is considered less than significant.

Mitigation Measure: None warranted.

Table 5.1.8-1 Annual Emissions Estimates of Toxic Air Contaminants for Baseline Conditions and Proposed Action LLNL Livermore Site

Contaminant	Baseline Condition Annual Amount (lb/year)	Assumed Increase over the EIS Period Due to Proposed Action (lb increase by tenth year)
Chlorine	675	61
Ethylene glycol ethyl ether acetate	212	19
Fluorocarbons	28,770	2,589
Glycol ethers (other)	24	2

Hydrogen fluoride	<0.1	0.01
Methanol	1,230	111
Toluene	274	25
1,1,1-Trichloroethane	16,270	1,464
Xylenes	117	11
Benzene	196	18
Carbon tetrachloride	493	44
Chloroform	633	57
Dioxane (1,4-)	161	14
Ethylene dichloride	<1	0.1
Formaldehyde	35	3
Methylene chloride	738	66
Trichloroethylene	728	66

Table 5.1.8-2 Annual Emissions of Toxic Air Contaminants for Baseline Conditions and the Proposed Action LLNL Site 300

Contaminant	Projected 1992 Baseline Condition Annual Amount (lb/year)	Assumed Increase over the EIS Period Due to Proposed Action (lb increase by tenth year)
5 Boilers/Diesel Fuel		
Arsenic	0.43	0.039
Beryllium	0.026	0.002
Cadmium	0.11	0.010
Chromium	0.014	0.001
Copper	2.9	0.261
Formaldehyde	4.2	0.378
Lead	0.092	0.008
Magnesium	0.27	0.024
Mercury	0.031	0.003
Nickel	1.8	0.162

PAH	0.23	0.021
Fuel Dispensers Gasoline		
Dispensers	110.7	9.963
Tank Loading	968.5	87.165
Spray Booths		
Glycol Ethers	117	10.530
Toluene	40	3.600
Xylene	11	0.990
High Explosive Detonation 801, 850, 851		
Ammonia	20.9	1.881
Benzene	0.18	0.016
HCL	7.3	0.657
HCN	3.9	0.351
HF	26.5	2.385
PAH	0.000003	0.000
Toluene	0.3	0.027
High Explosive Metals		
Beryllium	0.31	0.028
Nickel	0.42	0.038
High Explosive Waste		
Cooling Tower		0.000
Chloroform	0.12	0.011
Sodium Hydroxide	13.3	1.197
Limited Chemistry Lab		
Ethylene Dichloride	1	0.090
Fluorocarbons	3.9	0.351
Methlyene Chloride	55	4.950
Toluene	0.36	0.032

Drinking Water Chlorination		
Chlorine Hydroxide	15	1.350
Cold Cleaning		0.000
Freon 113	721	64.890
Vapor Extraction System		
Trichloroethylene	8	0.720
Refrigerants		0.000
R12	145	13.050
R13	80	7.200
R22	375	33.750
R113	66	5.940
R502	100	9.000
R503	70	6.300
Automotive Parts Cleaning		
Cresol	1.8	0.162
Methylene Chloride	4.8	0.432
Linear Accelerator X-Ray Equipment		
R12	580	52.200

Table 5.1.8-3 Annual Emissions of Toxic Air Contaminants for Baseline Conditions and Proposed Action SNL, Livermore Site

Contaminant	Projected 1992 Annual Amount (lb)	Assumed Increase by Tenth Year (lb)
Trichloroethane	1765	88.3
Gasoline Vapors	170	8.5
Chlorofluorocarbons	300	15.0

Table 5.1.8-4 Predicted Highest Ambient Pollutant Concentration (mg/m3) Due to Atmospheric Releases of Criteria Pollutants from Stationary Sources of the Proposed Action

		Pollutant Concentration		

Pollutant	Average Period	(mg/m^3) LLNL Livermore Site	LLNL Site 300	SNL, Livermore	Monitored Background Concentration[a] (mg/m^3)	AAQS[b] (mg/m^3) California	National
Carbon monoxide	1 Hour	1.13	4.59	1.03	6057	22,800	40,000
	8 Hour	0.379	0.806	0.205	N/A	10,000	10,000
Nitrogen dioxide	1 Hour	2.02	1.07	0.030	264	470	N/A
	Annual	0.202	0.107	0.003	43.4	N/A	100
Particulate matter of 10 microns or less (PM10)	24 Hour	0.024	0.136	0.067	108	50	150
	Annual	0.005	0.009	0.008	37.4	30	50
Sulfur dioxide	3 Hour	0.019	0.615	0.007	N/A	N/A	1300
	24 Hour	0.005	0.102	0.001	N/A	130	365
	Annual	0.001	0.007	0.0002	N/A	N/A	80

[a] California Air Resources Board, 1985–1989, Air Quality Summary for the Livermore Station.
[b] AAQS= Ambient Air Quality Standard (40 Fed. Reg. section 50, 1990).
N/A = Not available.

5.1.9 WATER

This section describes impacts to surface water and ground water resources from the proposed action. Current operations potentially impacting surface water and ground water quality are discussed in sections 4.11 and 4.17. Hydrologic impacts to surface water and ground water bodies from the proposed action including ground water recharge, flooding, and decreases in ground water level are presented below.

LLNL Livermore Site

The LLNL Livermore site is located at the eastern end of the Livermore Valley ground water basin. Recharge to the basin is largely from arroyos that originate in the foothills, including Arroyo Seco and Arroyo Las Positas, which cross the LLNL Livermore site. Arroyo Las Positas is the only potential source of flooding onsite. Under the proposed action, LLNL Livermore site gross square footage is projected to increase by 9 percent.

LLNL Site 300

LLNL Site 300 is located in the eastern Altamont Hills in the San Joaquin ground water basin. Surface water bodies inventoried include intermittent streams that drain to Corral Hollow Creek, which in turn flows eastward into the San Joaquin Valley. The Altamont Hills represent a recharge area for the San Joaquin ground water basin. Three drainages, Oasis/Draney, Elk, and Middle, serve as pathways for storm water runoff and are the main drainages, along with Corral Hollow Creek, with potential for flooding. Gross square footage at LLNL Site 300 is projected to increase by 9 percent under the proposed action.

SNL, Livermore

SNL, Livermore is located near the eastern end of the Livermore Valley ground water basin. All drainages from SNL, Livermore flow into Arroyo Seco, a major source of recharge for the ground water basin. Various other sources of ground water recharge at SNL, Livermore include landscape irrigation and a recharge pond constructed for LLNL's ground water remediation activities. Arroyo Seco is the only potential source for flooding at SNL, Livermore. Gross square footage at SNL, Livermore facilities is projected to increase by 6 percent under the proposed action.

Standards of Significance

A project is considered to have a significant adverse hydrologic impact if it:

- Substantially degrades water quality by exceeding applicable water quality standards;
- Contaminates a public water supply;
- Substantially degrades or depletes ground water resources;
- Interferes substantially with ground water recharge;
- Causes substantial flooding, erosion, or siltation; or
- Locates facilities in flood-prone areas.

Seasonal rainfall, together with the additional paving included under the proposed action, may increase runoff flows in local drainage channels. Although such increased flows would likely be minor, they could result in increased intermittent flow for some local streams, including Arroyo Seco and Arroyo Las Positas.

Documents relating to urban water management were reviewed to assess compatibility of the proposed action with anticipated ground water use.

IMPACTS—LLNL LIVERMORE SITE

Impact 9.1.1 As a result of the proposed action, a 9 percent increase in gross square footage of developed space is assumed, which may result in impacts to surface water runoff and ground water recharge. This is a less than significant impact.

An increase in surface water runoff and a reduction in the amount of recharge to the local ground water aquifer would occur as a result of the increase in impermeable surface under the proposed action. This is a less than significant impact. Because LLNL Livermore site soils are highly permeable and abundant uncovered acreage remains for ground water recharge, the impact of the reduction in recharge surface area under the proposed action would be less than significant.

Mitigation Measure: None warranted.

IMPACTS—LLNL SITE 300

Impact 9.2.1 As a result of the proposed action, a 9 percent increase in gross square footage of developed space is assumed, which may result in impacts to surface water runoff and ground water recharge. This is a less than significant impact.

None of the proposed action projects would contribute significant amounts of surface water runoff to cause substantial flooding. Due to the high infiltration rates and lack of appreciable flood plains at LLNL Site 300, hydrologic impacts from the proposed action are less than significant. At LLNL Site 300, elimination of discharges from three cooling towers would reduce surface water runoff. This action, however, would not substantially reduce surface water runoff.

Mitigation Measure: None warranted.

IMPACTS—SNL, LIVERMORE

Impact 9.3.1 As a result of the proposed action, a 6 percent increase in gross square footage of developed space is assumed, which may result in impacts to surface and ground water quality. This is a less than significant impact.

Based on the analyses conducted and the standards of significance, no significant adverse impacts to surface water bodies or ground water recharge are expected from reduced recharge or increased surface water runoff associated with the projected 6 percent increase under the proposed action.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

Impact 9.4.1 Cumulative impacts from the proposed action and other regional development may impact surface and ground water quality. This is a less than significant impact.

The cumulative impact study area includes the eastern Livermore Valley ground water basin and surface water bodies within the basin. Increased development at the LLNL Livermore site and SNL, Livermore would further reduce ground water recharge areas. Development would also increase storm water runoff to Arroyo Las Positas and Arroyo Seco. In the absence of specific regional development information, it is not possible to quantify the potential runoff increases or actual contaminants in storm water runoff. However, because of the high infiltration rates within the arroyos and abundant remaining surface area for ground water recharge, and because the majority of development at the Laboratories would occur on built-up space that already includes a substantial amount of impervious surface, no significant adverse cumulative impacts from the combined proposed action projects at the LLNL Livermore site and SNL, Livermore are anticipated.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—LLNL SITE 300

Impact 9.4.2 Cumulative impacts from the proposed action and other regional development may impact surface and ground water quality. This is a less than significant impact.

The cumulative impacts study area is LLNL Site 300 and related drainages, and the San Joaquin Valley ground water basin. Cumulative impacts associated with the proposed action and other offsite development or recharge programs are considered less than significant due to high infiltration rates of local soils and abundant remaining surface area for ground water recharge. The overall increase in stormwater runoff from regional development in the LLNL Site 300 area would depend on a variety of factors including inherent soil permeability, the total amount of impervious surfacing (e.g., paving), intensity of development, slope, and other characteristics. In the absence of specific regional development information, it is not possible to quantify the potential runoff increases or actual contaminants in stormwater runoff. No diversions of major drainages, destruction of springs, nor removal of any surface water bodies are proposed in the western San Joaquin Valley ground water basin or at LLNL Site 300.

Mitigation Measure: None warranted.

5.1.10 NOISE

LLNL Livermore Site

Existing noise sources at the LLNL Livermore site include vehicular traffic; stationary noise sources such as heating, ventilating, and air conditioning equipment; and construction activities. In addition, noise is generated by aircraft used by LLNL for transportation through both the Livermore Municipal Airport and the Tracy Municipal Airport. Under the proposed action, the nearest residences could experience a short-term increase in exterior noise levels as a result of increased construction activities. The nearest offsite noise-sensitive receptors from the LLNL Livermore site include residences east of Greenville Road, approximately 200 ft from the eastern boundary of the LLNL Livermore site, and residences west of Vasco Road, approximately 200 ft from the western boundary of the LLNL Livermore site. Aircraft noise associated with LLNL operations would not increase since no change in LLNL's use of air transportation would occur as part of the proposed action.

LLNL Site 300

Existing noise sources at LLNL Site 300 include vehicular traffic; heating, ventilating, and air conditioning equipment; construction activities; a pistol and rifle firing range; and high explosives testing. In addition, noise is generated by aircraft used by LLNL for transportation through both the Livermore Municipal Airport and the Tracy Municipal Airport. Under the proposed action, noise-sensitive receptors could experience a short-term increase in exterior noise levels from increased construction-related activities. Noise-sensitive receptors could experience changes in impulse-type noise levels due to proposed action projects: a reduction in noise associated with high explosives testing due to the use of a contained firing facility, and an increase in noise from operation of the Cheap Access to Orbit project. The nearest offsite noise-sensitive receptors include a single-family residence west of the LLNL Site 300 western boundary, less than 1 mile from the southwestern boundaries of the site (more than 2 miles from existing LLNL Site 300 facilities). Aircraft noise associated with LLNL operations would not increase since no change in LLNL's use of air transportation would occur as part of the proposed action.

SNL, Livermore

Existing noise sources at SNL, Livermore include vehicular traffic; heating, ventilating, and air conditioning equipment; construction activities; and a pistol and rifle firing range. In addition, noise is generated by aircraft used by SNL, Livermore for transportation through the Livermore Municipal Airport. Under the proposed action, a short-term increase in exterior noise levels could occur in nearby areas due to construction-related activities. The nearest offsite noise-sensitive receptor is a single-family residence between SNL, Livermore and Tesla Road, approximately 400 ft from the southern boundaries of the property and approximately 1000 ft from existing Laboratory facilities. Aircraft noise associated with SNL, Livermore operations would not increase since no change in SNL, Livermore's use of air transportation would occur as part of the proposed action.

Standards of Significance

A project is considered to have significant adverse noise impacts if it:

- Substantially increases ambient noise levels for adjoining areas;
- Conflicts with adopted environmental plans and goals;
- Causes noise that would conflict with a local noise ordinance;
- Exceeds state or local guidelines for long-term exposure, acceptable interior noise levels, and 24-hour average noise levels; or
- Exceeds the peak impulse noise level limit of 126 dB in populated areas for high explosive testing at LLNL Site 300.

All identified impacts are considered to be significant adverse impacts, unless otherwise noted, and the proposed mitigation measures following each impact discussion will reduce the impacts to a less than significant level.

IMPACTS—LLNL LIVERMORE SITE

Impact 10.1.1 Increases in construction-related noise could occur intermittently near the LLNL Livermore site as a result of the proposed action. This is a less than significant impact.

The principal short-term noise impacts from the proposed action would occur during the construction activities. Construction noise represents a short-term and less than significant impact on ambient noise levels on and around the site over the entire period of construction. Noise generated by construction equipment, including earth movers, material handlers, and portable generators, can reach relatively high levels. The EPA has found that the noisiest equipment at construction sites typically ranges from 88 A-weighted decibels (dBA) to 91 dBA at a distance of 50 ft. Typical operating cycles may involve 2 minutes of full power, followed by 3 or 4 minutes at lower settings. Although noise ranges were found to be similar for all construction phases, the building phase tended to be less noisy. Noise levels vary from 79 dBA to 88 dBA at a distance of 50 ft during the building phase of construction.

Noise from localized sources (such as construction activities) typically diminishes by approximately 6 dBA with each doubling of distance between the source and the receptor. Outdoor receptors that have an uninterrupted view of a construction site and that are within 100 ft of the site would experience noise greater than 82 dBA when the noise level on the construction site exceeds 88 dBA. The nearest offsite noise-sensitive receptors include residences east of Greenville Road, approximately 200 ft from the eastern boundary of the LLNL Livermore site, and residences west of Vasco Road, approximately 200 ft from the western boundary of the LLNL Livermore site.

Construction activities associated with the proposed action could potentially cause a short-term annoyance to residential land uses in the surrounding area. However, most of these construction activities would be located inside the site boundary at 400 ft or more from the residential areas. (See Appendix A for locations of construction projects associated with the proposed action.) Thus, the closest residential areas could experience a noise level of approximately 70 dBA during construction phases. While activities at the LLNL Livermore site are not subject to local noise regulations, it is DOE and UC policy to cooperate with local agencies whenever feasible. Outside of the LLNL Livermore and SNL, Livermore sites, noise regulations of the City of Livermore and County of Alameda would apply. These regulations do not establish noise standards for construction activities except to limit construction activities to daytime hours to reduce the level of potential annoyance. Because it is assumed that most of the construction activity associated with the proposed action would occur during daytime hours, potential annoyance associated with construction noise at the site would not conflict with local noise regulations and thus would be less than significant. Although construction noise impacts would be less than significant, the following mitigation measure would be implemented.

Mitigation Measure 10.1.1: Construction equipment and vehicles at the LLNL Livermore site would be properly muffled to reduce noise impacts.

Impact 10.1.2 Long-term increases in traffic-related noise levels in the vicinity of the LLNL Livermore site would occur as a result of the proposed action. These increases would be less than significant.

New facilities associated with the proposed action are primarily offices and laboratories. Such uses are not expected to produce significant noise generation that would affect noise-sensitive receptors at or near the LLNL Livermore site.

Potential noise impacts could occur from an increase in traffic associated with an increase in personnel at that site. The proposed action's contribution to community noise levels from traffic-related noise near all three sites is shown in Table 5.1.10-1. Noise data in the table are based on existing plus project-related traffic volumes, including the traffic increase associated with the proposed action.

As the table shows, noise levels near these three sites are expected to increase over existing levels with implementation of the proposed action. However, these noise level increases are, for the most part, negligible (0.7 dBA increase or smaller). These increases would not be audible and would not be regarded as significant, since the 65 dB acceptable outdoor level for residential areas, or Community Noise Equivalent Level contour, would fall up to approximately 10 ft outside the road right-of-way (assumed to be approximately 100 ft). Accordingly, potential impacts to community noise levels would be less than significant.

Mitigation Measure: None warranted.

IMPACTS—LLNL SITE 300

Impact 10.2.1 Short-term increases in construction-related noise could occur near LLNL Site 300 as a result of the proposed action. This is a less than significant impact.

The LLNL Livermore site discussion of short-term construction noise is also applicable to LLNL Site 300. Offsite noise-sensitive receptors include the single-family residence less than 1 mile from the southwestern boundaries of the site and more than 2 miles from proposed construction projects at LLNL Site 300 (see Appendix A for locations of construction projects included as part of the proposed action). Any construction noise experienced at this residence would be less than significant due to its distance from the proposed construction sites at LLNL Site 300. Although construction noise impacts would be less than significant, the following mitigation measure would be implemented.

Mitigation Measure 10.2.1: Construction equipment and vehicles at LLNL Site 300 would be properly muffled to reduce noise impacts.

Impact 10.2.2 Long-term increases in noise from operations at LLNL Site 300 could result from the Cheap Access to Orbit project of the proposed action. This increase would be a less than significant impact.

The proposed Cheap Access to Orbit (CATO) project (formerly called Super-High-Altitude Research Project or SHARP) would introduce a new LLNL Site 300 noise source. A two-stage light gas gun, which will propel projectiles of nonexplosive light metals and polymers weighing up to 10 kg, is proposed. Peak impulse noise levels from the firing of the gun are estimated to be less than 120 dB at the site boundary and thus would not exceed the LLNL standard (DOE, 1991). Therefore, any offsite noise impacts from this new project would be less than significant.

Mitigation Measure 10.2.2: LLNL's weather and noise monitoring program at LLNL Site 300 will continue to restrict operations when peak impulse noise levels are predicted to exceed 126 dB in populated areas. The results will be documented in LLNL's publicly available annual Environmental Report.

Impact 10.2.3 Long-term traffic-related noise levels along Corral Hollow Road would increase as a result of the proposed action. This impact would be less than significant.

Results of traffic-related noise modeling for Corral Hollow Road are included in Table 5.1.10-1. As shown in the table, noise levels along Corral Hollow Road are expected to increase by a small increment over existing levels due to increased traffic associated with the proposed action. However, these increases would be negligible when compared to existing conditions, and would not conflict with any local noise guideline or ordinance. Thus, the increase in noise would be less than significant.

Mitigation Measure: None warranted.

Impact 10.2.4 Noise-sensitive receptors surrounding LLNL Site 300 could experience a reduction in noise from high explosives testing. This is a beneficial impact.

The LLNL Site 300, Bunker 801, proposed contained firing facility is expected to reduce noise generated by high explosives testing at the bunker because detonations would occur inside the proposed structure and would be attenuated by it. Noise-sensitive receptors in the City of Tracy, as well as existing and future nearby residences, could benefit from the reduction in noise from high explosives tests from use of the new facility. However, the degree to which noise levels would be reduced cannot be quantified because specific information on the facility's noise attenuation capabilities is currently unavailable.

Mitigation Measure: None warranted.

IMPACTS—SNL, LIVERMORE

Impact 10.3.1 Short-term increases in construction-related noise could occur near SNL, Livermore as a result of the proposed action. This is a less than significant impact.

The LLNL Livermore site discussion of short-term construction noise is also applicable to SNL, Livermore. The closest offsite noise-sensitive receptor includes the single-family residence between SNL, Livermore and Tesla Road, approximately 400 ft from the southern boundaries of the property, and approximately 800 ft from existing Laboratory facilities. Construction activities associated with the proposed action would be located 800 ft or more from these residences. Thus, the noise level at the closest residence could reach 64 dBA during construction phases. While activities at SNL, Livermore are not subject to local noise regulations, it is DOE policy to cooperate with local agencies whenever feasible, in this case the City of Livermore and County of Alameda. These agencies have not established noise standards for construction activities except to limit construction activities to daytime hours to reduce the level of potential annoyance. Because it is assumed that most of the construction activity associated with the proposed action would occur during daytime hours, potential annoyance associated with construction noise at the site would not conflict with local noise regulations and thus would be less than significant. Although construction noise impacts would be less than significant, the following mitigation measure would be implemented.

Mitigation Measure 10.3.1: Construction equipment and vehicles would be properly muffled to reduce noise impact.

Impact 10.3.2 Long-term increases in traffic-related noise levels in the vicinity of SNL, Livermore would occur as a result of the proposed action. These increases would be less than significant.

Potential noise impacts affecting areas adjacent to SNL, Livermore would be from the increased traffic associated with an increase in the number of employees at the site. Table 5.1.10-1 presents traffic-related noise levels along roadways near all three sites (see discussion of long-term noise impacts for the LLNL Livermore site). As shown on the table, no significant traffic-related noise level increases are expected from the proposed action when compared to existing conditions.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

While they are distinct operations managed and operated by different contractors, for purposes of this discussion the LLNL Livermore site and SNL, Livermore are addressed together because of their proximity.

Impact 10.4.1 The proposed action would contribute a small increment to cumulatively significant roadway noise levels that are expected to occur in the future along some roads in the study area. This is a significant and unavoidable adverse impact.

The cumulative traffic noise study area includes roadways that receive most of the Laboratories-generated traffic. Results of noise modeling for the cumulative traffic condition, including traffic associated with the proposed action and future development in the vicinity, are presented in Table 5.1.10-2. Because the projected CNEL 50 ft from the centerline of the near travel lane on some modeled roadways is above the City of Livermore and County of Alameda standards for noise-sensitive uses, this is a significant and unavoidable impact because measures to reduce offsite traffic-related noise are not within the jurisdiction of DOE or UC.

Mitigation Measure 10.4.1: The contribution to noise levels by the proposed action will be reduced by Mitigation Measure 11.1.2. However, incremental noise impacts would not be completely eliminated. Measures to reduce cumulative roadway noise levels resulting from other projects are beyond the authority of DOE or UC to implement.

CUMULATIVE IMPACTS—LLNL SITE 300

Impact 10.4.2 The proposed action would contribute a small increment to cumulative, but less than significant, roadway noise levels that are expected to occur in the future along Corral Hollow Road. This would be a less than significant impact.

The cumulative traffic noise study area at LLNL Site 300 would primarily include Corral Hollow Road. Results of noise modeling for the cumulative traffic condition, including traffic associated with the proposed action and future development in the vicinity, are presented in Table 5.1.10-2. Because the projected CNEL 50 ft from the centerline of the near travel lane on Corral Hollow Road would not exceed the noise standards of San Joaquin and Alameda counties, cumulative traffic-related noise levels would be less than significant on Coral Hollow Road.

Table 5.1.10-1 Roadway Noise as a Result of the Proposed Action Compared to Existing Conditions

	Estimated Distance from		

Roadway Segment	Roadway Centerline to CNEL (in ft)			Estimated CNEL 50 ft from Centerline of the Near Travel Lane (dBA)	Increase Over Existing Level (dBA)
	70 CNEL	65	60		
First Street, N. Mines Road to Las Positas Road	< 50	96	207	68.6	0.0
Vasco Road, I-580 to Patterson Pass Road	71	147	312	69.7	0.7
Vasco Road, Patterson Pass Road to East Avenue	58	116	246	68.2	0.5
Vasco Road, East Avenue to Tesla Road	< 50	< 50	60	60.5	0.3
Greenville Road, I-580 to Patterson Pass Road (4 lanes)	< 50	69	142	64.5	0.5
Greenville Road, I-580 to Patterson Pass Road (2 lanes)	< 50	< 50	78	62.2	0.5
Greenville Road, Patterson Pass Road to East Avenue	< 50	< 50	71	61.6	0.4
Greenville Road, East Avenue to Tesla Road	< 50	< 50	< 50	57.3	0.7
East Avenue, West of Buena Vista Avenue	57	117	250	68.7	0.3
East Avenue, Buena Vista Avenue to Vasco Road	< 50	102	216	67.8	0.7
East Avenue, Vasco Road to Greenville Road (4 lanes)	< 50	88	186	66.8	0.6
East Avenue, Vasco Road to Greenville Road (2 lanes)	< 50	57	123	65.1	0.6
North Mines Road, East Avenue to Patterson Pass Road	< 50	< 50	73	60.5	0.4
Patterson Pass Road, Vasco Road to Greenville Road	< 50	< 50	< 50	56.5	0.0
Tesla Road, Buena Vista Avenue to Vasco Road	< 50	< 50	79	62.3	0.2
Tesla Road, Vasco Road to Greenville Road	< 50	< 50	< 50	58.2	0.0
Corral Hollow Road, West of LLNL Site 300	< 50	< 50	< 50	52.9	0.3
Corral Hollow Road, East of LLNL Site 300	< 50	< 50	< 50	54.0	0.5

dBA = Decibel (A-weighted frequency). CNEL = Community Noise Equivalent Level.

Table 5.1.10-2 Future Roadway Noise as a Result of Cumulative Development Including the Proposed Action Compared to Existing Conditions

Roadway Segment	Estimated Distance from Roadway Centerline to CNEL (in ft)			Estimated CNEL 50 ft from Centerline of the Near Travel Lane (dBA)	Increase Over Existing Level (dBA)
	70 CNEL	65 CNEL	60 CNEL		
First Street, N. Mines Road to Las Positas Road	63	135	290	70.8	2.2
Vasco Road, I-580 to Patterson Pass Road	72	147	314	69.8	0.8
Vasco Road, Patterson Pass Road to East Avenue	61	123	261	68.5	0.8
Vasco Road, East Avenue to Tesla Road	< 50	< 50	86	62.8	2.6
Greenville Road, I-580 to Patterson Pass Road (4 lanes)	65	132	281	69.0	5.0
Greenville Road, I-580 to Patterson Pass Road (2 lanes)	< 50	73	156	66.7	5.0
Greenville Road, Patterson Pass Road to East Avenue	< 50	61	131	65.6	4.4
Greenville Road, East Avenue to Tesla Road	< 50	< 50	< 50	56.8	0.2
East Avenue, West of Buena Vista Avenue	< 50	103	219	67.8	- 0.6
East Avenue, Buena Vista Avenue to Vasco Road	< 50	97	206	67.4	0.3
East Avenue, Vasco Road to Greenville Road (4 lanes)	< 50	90	191	67.0	0.8
East Avenue, Vasco Road to Greenville Road (2 lanes)	< 50	59	126	65.3	0.8
North Mines Road, East Avenue to Patterson Pass Road	< 50	62	129	64.3	4.2
Patterson Pass Road, Vasco Road to Greenville	< 50	80	166	65.6	4.8

Road					
Tesla Road, Buena Vista Avenue to Vasco Road	< 50	< 50	98	63.7	1.6
Tesla Road, Vasco Road to Greenville Road	< 50	< 50	< 50	58.2	0.0
Corral Hollow Road, West of LLNL Site 300	< 50	< 50	< 50	54.8	2.2
Corral Hollow Road, East of LLNL Site 300	< 50	< 50	< 50	55.6	2.1

dBA = Decibel (A-weighted frequency). CNEL = Community Noise Equivalent Level.

Mitigation Measure: None warranted.

5.1.11 TRAFFIC

LLNL Livermore Site

Existing traffic conditions in the vicinity of the LLNL Livermore site are described in section 4.13. The LLNL Livermore site currently generates approximately 23,960 vehicle trips per day and contributes a high proportion of the vicinity's daily traffic in the a.m. peak hour. Based on an assumed 20 percent growth in personnel at LLNL, approximately 2000 additional personnel are projected at the LLNL Livermore site. Assuming approximately two trips per person per day, this would result in an additional 4000 vehicle trips per day of traffic, for a total of 27,960 vehicle trips per day.

LLNL Site 300

Existing traffic conditions along Corral Hollow Road in the vicinity of LLNL Site 300 are described in section 4.13. LLNL Site 300 currently generates approximately 700 vehicle trips per day. Based on the assumed 20 percent increase in the number of personnel at LLNL (approximately 50 workers at LLNL Site 300), and a trip rate of 3.5 trips per person per day, LLNL Site 300 average daily traffic is projected to increase by 175 vehicle trips, for a total of 875 vehicles per day.

SNL, Livermore

Existing traffic conditions in the vicinity of SNL, Livermore are described in section 4.13. SNL, Livermore currently generates approximately 3100 vehicle trips per day. Based on the assumed 1 percent employment growth at SNL, Livermore (15 additional persons), and a trip rate of 2 trips per person per day, approximately 30 additional vehicle trips would be generated, resulting in a total of 3130 vehicle trips per day.

Standards of Significance

For purposes of this traffic analysis, an impact is considered to be significant if the increment of traffic contributed by the project is substantial in relation to the existing traffic load and capacity of the roadway network (Appendix G of the CEQA Guidelines), or causes a change in the volume-to-capacity (V/C) ratio and/or corresponding level of service (LOS) to an unacceptable level. The standard utilized in this EIS/EIR for evaluating traffic conditions in the vicinity of the LLNL Livermore site and SNL, Livermore is that used by the City of Livermore: a congestion condition exceeding a peak-hour V/C ratio of 0.85 per average day at a major intersection is considered unacceptable. For evaluation of LLNL Site 300 traffic conditions, the current San Joaquin County LOS C standard is used (i.e., LOS D and worse are considered unacceptable). See Appendix K for more detail on these standards of significance and for a discussion of the relationship between V/C ratio and LOS. In addition, a significant impact would be identified if the proposed action resulted in inadequate provision of internal parking and circulation (University of California CEQA Guidelines).

All identified impacts are considered to be significant adverse impacts, unless otherwise noted, and the proposed mitigation measures following each impact discussion will reduce the impacts to a less than significant level.

IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

The following section describes the projected traffic conditions in the vicinity of the Laboratories with implementation of the proposed action. Due to the proximity of the two sites, and the fact that some LLNL Livermore site workers park at SNL, Livermore, it was not considered feasible to conduct separate traffic analyses for the two sites for purposes of this EIS/EIR. The respective increment of traffic (i.e., vehicle trips per day) contributed by each Laboratory was determined based on existing and projected personnel numbers at each facility. However, while it is acknowledged that the Laboratories are distinct operations managed and operated by different contractors, the evaluation of Laboratories-related traffic effects on the local circulation network was conducted for the two Laboratories combined, due to the difficulty in distinguishing between LLNL- and SNL, Livermore-related traffic at a given intersection or roadway segment. A separate analysis was performed for LLNL Site 300 due to its distance from the other Laboratories.

Separate traffic analyses were not conducted in the vicinities of LLNL's offsite leased properties because activities associated with the proposed action are not expected to alter the levels of activity at the leased properties and thus would not affect the existing traffic conditions in these areas.

The new vehicle trips projected in conjunction with the proposed action were distributed onto the existing roadway network in the same proportion as the existing Laboratories-related traffic, then added to the existing trips. The daily traffic volumes representing this existing plus proposed action scenario are depicted in Figure 5.1.11-1. An analysis of peak-hour trips at key intersections is provided in Table 5.1.11-1.

Impact 11.1.1 Short-term traffic impacts could result during construction activities on the Laboratory sites. This is a less than significant impact.

Building construction and rehabilitation of several onsite roadways on the Laboratory sites are planned in conjunction with the proposed action. Roadway rehabilitation could include upgrading of some existing roadways with an overlay of new material, patching existing pavement, and installation of curbs and gutters along certain road segments. Short-term circulation impacts could occur on the sites if vehicles are rerouted through the site to avoid construction areas. However, it is anticipated that adequate detour routes and signage would be provided and that the impacts would be brief in nature. No significant short-term traffic impacts are identified for the LLNL Livermore site or SNL, Livermore, and no mitigation is required.

Mitigation Measure: None warranted.

Impact 11.1.2 Implementation of the proposed action would result in increased congestion along local roadways and at intersections in the vicinity of the Laboratories. This is a less than significant impact.

With the implementation of the proposed action, it is assumed that an approximately 20 percent growth in personnel could occur at LLNL over a 10-year period, resulting in a total of approximately 13,200 workers at the LLNL Livermore site. Estimated growth at SNL, Livermore is assumed to be 1 percent over the 10-year period, resulting in approximately 1515 workers (an increase of 15 employees over the current 1500 employees). Using a rate of approximately two trips per day per person at the Laboratories, the following average daily trips are estimated: 27,960 vehicle trips per day for the LLNL Livermore site and 3130 for SNL, Livermore.

As shown in Figure 5.1.11-1, daily traffic increases range from 8 to 15 percent on East Avenue, from 12 to 18 percent on Vasco Road, and from 9 to 12 percent on Greenville Road. In all cases, the traffic resulting from the existing plus proposed action scenario is less than the existing capacity of the affected streets and no significant traffic impacts are identified.

An analysis of peak-hour trips was made for the existing plus proposed action scenario (see Table 5.1.11-1). In order to determine which impacts are significant, a comparison should be made with the City of Livermore's level of service standard, which indicates that the highest desirable V/C ratio at intersections is 0.85, or midlevel LOS D. The First Street intersections were included in the list of study intersections to evaluate future conditions with the planned roadway network in which the effects of the North Mines Road extension could be determined (see Table 5.1.11-1). When North Mines Road is extended, it is expected that the use of this route would be attractive to some Laboratories-related traffic. For the existing, existing plus proposed action, and cumulative scenarios without the planned roadway network, no peak-hour Laboratories-related traffic is expected to use First Street due to its inaccessibility to primary Laboratory access roads. It is noted that two of these study intersections, First Street at Las Positas Boulevard and First Street at North Mines Road, exceed the 0.85 V/C ratio in the existing plus proposed action scenario during the p.m. peak hour (0.89 and 0.87, respectively). However, the same unacceptable V/C ratios currently exist at these intersections, indicating that no additional peak-hour traffic generated in conjunction with the proposed action is expected to utilize these intersections prior to the extension of North Mines Road.

At the Vasco Road/I-580 interchange, the proposed action could increase peak-hour traffic using some portions of the interchange by an estimated 10 to 15 percent. As noted in section 4.13, this interchange does not currently contain intersections involving either of the two ramps serving the major flow of Laboratories-related traffic, and the configuration of the ramps does not lend itself to conventional peak-hour intersection evaluation. Field observations indicate that neither of these off-ramps currently experiences peak-hour congestion (TJKM Transportation Consultants, 1992). It is expected that anticipated traffic increases at this interchange that are associated with the proposed action would not result in unsatisfactory traffic conditions.

In summary, no street segments, intersections, or interchanges are expected to experience unsatisfactory traffic conditions as a result of the existing plus proposed action scenario. Therefore, no significant traffic impacts are identified.

Although no significant project-specific traffic impacts are identified in conjunction with the proposed action, the Laboratories are developing an expanded Transportation Systems Management Program to promote more efficient use of the transportation network. This program would be an extension of the current ridesharing and transit opportunities available to Laboratory employees. In addition to reducing traffic congestion, this program would aid LLNL in complying with federal and state mandates related to vehicle emissions reductions. The program would include such elements as carpools, vanpools, public transit, bicycles, telecommuting, emergency ride home, guaranteed ride home, and flexible work schedules. Therefore, although no significant impacts are identified, the following mitigation measure is delineated.

Mitigation Measure 11.1.2: While no mitigation is required, LLNL would implement an expanded Transportation Systems Management Program to aid in reducing traffic congestion.

Impact 11.1.3 Acquisition of a portion of East Avenue, and subsequent alteration of the traffic flow along this roadway segment, could affect traffic conditions in the vicinity of the LLNL Livermore site and SNL, Livermore. This is a less than significant impact.

As part of the proposed action, DOE proposes to acquire East Avenue between Vasco and Greenville Roads. This acquisition is being considered to allow one of the following alternatives for East Avenue to be implemented:

- Security gates at both ends of the road with unlimited access to the public.
- Security gates at both ends of the road with limited access to the public.

Under the first alternative, East Avenue would remain open to the public following acquisition. Fences, gates, signs, a vehicle turn-around area, and traffic stacking lanes would be installed so that the road could be closed to the public, if necessary, based on security requirements. Under the restricted access alternative, the controls would be for vehicles, personnel, or a combination of both. The vehicle control would allow entrance to all cars with LLNL or SNL, Livermore decals, while the personnel control would require identity verification (touch- badge) for every person entering. A variation would require vehicle control during normal working hours and touch-badge at all other times.

A traffic study, conducted by TJKM Transportation Consultants in 1989, evaluated the potential traffic impacts associated with "closing" or limiting public access to East Avenue if it is required for security reasons. The study concluded that under future buildout conditions in the City of Livermore, levels of service at intersections in eastern Livermore would not be substantially altered if East Avenue were closed to the public (TJKM Transportation Consultants, 1989). Therefore, while traffic patterns would be expected to change, no significant traffic impacts are expected if closure of East Avenue is required for security reasons.

Mitigation Measure: None warranted.

Impact 11.1.4 An increased demand on public transportation would occur. This is a less than significant impact.

Based on the assumed 20 percent increase in personnel at LLNL and the 1 percent increase at SNL, Livermore, an incremental increase in the demand for public transportation would occur with the proposed action. As discussed in section 4.13, the Stockton Metropolitan Transit District supplies six buses (three from Manteca, two from Stockton, and one from Tracy), driven by LLNL employees, which provide ridesharing opportunities to approximately 115 workers from outlying cities. Based on a capacity of 40 seated passengers per bus, it is anticipated that the existing fleet of six buses would be able to accommodate the projected increase in bus riders due to an increase of approximately 2015 workers at the LLNL Livermore site and SNL, Livermore with implementation of the proposed action. It is also estimated that the existing direct transit service to the LLNL Livermore site and SNL, Livermore by the local Wheels bus service and by the BART Express would not be adversely affected by projected personnel increases. It is anticipated that the public transportation network currently serving the sites could accommodate the projected increase in personnel, and no significant impacts to public transportation services would occur.

Mitigation Measure: None warranted.

Impact 11.1.5 An increase in demand for parking at the LLNL Livermore site would occur.

As discussed in section 4.13, the current parking stall deficit at the LLNL Livermore site is 923 stalls. Based on the estimated demand for parking of 0.71 stall per person delineated in the Parking Master Plan (LLNL, 1988a), the proposed action would result in an increase in the current parking deficit of 1420 stalls (2000 additional personnel×0.71 stalls per person), for a total deficit of 2343 stalls. This is a potentially significant impact which would be mitigated to less than significant.

Mitigation Measure 11.1.5: LLNL would continue to monitor the parking supply at the LLNL Livermore site and schedule capital improvements as necessary to alleviate any parking stall deficiencies. Implementation of Mitigation Measure 11.1.2 would also decrease the need for parking.

Impact 11.1.6 An increase in demand for parking at SNL, Livermore would occur. This is a less than significant impact.

As discussed in section 4.13, no parking stall deficiencies are currently identified at SNL, Livermore and the addition of 15 employees in conjunction with the proposed action is not anticipated to create any parking deficiencies.

Mitigation Measure: None warranted.

IMPACTS—LLNL SITE 300

Impact 11.2.1 Traffic volumes along Corral Hollow Road and at the Corral Hollow Road/I-580 interchange would increase. This is a less than significant impact.

As described earlier, LLNL Site 300 average daily traffic is estimated to increase by up to approximately 175 vehicles per day (50 additional personnel×3.5 trips per person per day). Based on the existing trip distribution pattern, approximately 105 of the additional trips (60 percent) would be directed on Corral Hollow Road toward Tracy, and approximately 70 of the additional trips (40 percent) would be directed toward Livermore.

The existing peak-hour condition at the Corral Hollow Road/I-580 eastbound and westbound on/off ramps is LOS A (see Table 5.1.11-1). With traffic added from the proposed action, conditions at the interchange would remain at acceptable levels. There are no adverse traffic circumstances anticipated anywhere in the vicinity of LLNL Site 300 as a result of increased traffic from the proposed action.

Mitigation Measure: None warranted.

Impact 11.2.2 An increase in demand for parking at LLNL Site 300 would occur. This is a less than significant impact.

As discussed in section 4.13, no parking stall deficiencies are currently identified at LLNL Site 300. There is currently an average of 50 to 60 empty stalls. The assumed increase of 50 personnel at LLNL Site 300 in conjunction with the proposed action is not expected to create any parking deficiencies.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

The cumulative impact study area for the assessment of traffic impacts at the LLNL Livermore site and SNL, Livermore includes the Tri-Valley area. Future traffic conditions (which assume an approximate year 2010 buildout of the General Plan land uses within the study area and, therefore, are also considered to represent cumulative conditions) were analyzed using the MINUTP travel forecasting model of the Tri-Valley area developed by TJKM Transportation Consultants (1992) and described in more detail in Appendix K. This Tri-Valley traffic model consists of a detailed transportation network and traffic zone system for the entire Tri-Valley area (defined as the incorporated cities of Livermore, Pleasanton, Danville, San Ramon, and Dublin as well as adjacent portions of unincorporated Alameda and Contra Costa counties). The model also incorporates assumptions for the balance of the nine-county Bay Area Region and key external stations such as San Joaquin County.

The land use data for the Tri-Valley area are based on the general plans of the individual jurisdictions while the data for the rest of the nine Bay Area counties are based on the Association of Bay Area Governments *Projections '90* (Association of Bay Area Governments, 1989). The Association of Bay Area Governments, in its role as the metropolitan council of governments, prepares projections of Bay Area employment and household growth and allocates this growth to various jurisdictions within the Bay Area.

Cumulative analyses for the proposed action and the no action alternative involved the distribution of Laboratory traffic and general plan buildout traffic onto the existing roadway network. (The existing roadway network includes any approved but not yet constructed roadway improvements that would be completed in FY 1992). In addition, model runs were conducted for the no action and proposed action scenarios assuming various roadway improvements in the model area that are not yet, but are expected to be, approved, funded, and completed. The purpose of these analyses was to demonstrate how traffic conditions would be improved with implementation of these improvements. These improvements are described in Appendix K.

The proposed action cumulative analysis essentially represents future conditions with implementation of proposed projects at the Laboratories and with the surrounding area developed to buildout levels contemplated in the general plans of the various city and county jurisdictions and this traffic distributed onto the existing roadway network. The no action cumulative analysis (see section 5.2.11) represents future conditions without the increment of traffic contributed by the proposed action. Therefore, the increment of cumulative traffic congestion attributable to the proposed action can be determined by a comparison of the proposed action and no action projected traffic volumes and peak-hour analyses.

Impact 11.4.1 Cumulative development in the area would result in an increase in traffic congestion along roadways in the vicinity of the site. This is a significant unavoidable impact.

The projected future cumulative average daily traffic volumes on all key roadway segments in the vicinity of the project sites are shown in Figure 5.1.11-2 and Table 5.1.11-1. On Vasco Road, traffic near the Laboratories would increase only slightly from current levels. However, on Vasco Road near I-580, daily traffic volumes are projected to increase from the current volume of approximately 21,000 vehicles per day to approximately 40,000 vehicles per day, largely due to the development of industrial uses in the area between the Laboratories (LLNL Livermore site and SNL, Livermore) and I-580 (TJKM Transportation Consultants, 1992). On Greenville Road, traffic increases are also projected to be substantial due to the development of these industrial land uses. In addition, the projected congestion and lower travel speeds on Vasco Road are anticipated to cause a diversion of traffic (primarily due to Laboratories-related traffic) from the Vasco Road corridor to the Greenville Road corridor, particularly during peak periods. Approximately 24,000 vehicles per day are forecast on the section of Greenville Road south of Southfront Road. Approximately 40 percent more Laboratories-related traffic is projected to be on Greenville Road in the cumulative buildout scenario.

Table 5.1.11-2 presents a description of the anticipated Laboratories-related traffic volumes on the Vasco Road and Greenville Road corridors under future conditions for both the no action and the proposed action cumulative scenarios.

Under the proposed action cumulative scenario, Vasco Road is projected to carry approximately 1400 Laboratories-related vehicles per day in the a.m. peak hour, compared with 1500 vehicles per day under existing conditions and 1200 vehicles per day in the no action cumulative scenario. On the Greenville Road corridor, there are projected to be 1550 vehicles per day under the proposed action, compared with 1050 vehicles under the existing condition and 1350 vehicles under the no action cumulative scenario.

The Laboratories would contribute to this significant cumulative effect on local roadways. Roadway improvements would be required to mitigate the effects of cumulative development; however, these measures are not under the jurisdiction of DOE or UC. Thus, this impact is considered to be significant and unavoidable.

Mitigation Measure: No measures are implementable by DOE or UC.

Impact 11.4.2 Planned and proposed development in the cumulative study area would result in a cumulative increase in traffic congestion at certain intersections in the vicinity of the Laboratories. This is a significant unavoidable impact.

Intersection operations were evaluated using a method of intersection capacity analysis known as the Intersection Capacity Utilization method, which is described in more detail in Appendix K. The LOS and V/C ratios at all study intersections under the no action and proposed action cumulative scenarios are presented in Table 5.1.11-1. As shown in this table, a total of eight intersections are projected to operate at an unacceptable LOS F (TJKM Transportation Consultants, 1992) with implementation of the proposed action. This is considered to be a significant cumulative effect.

Two intersections along Greenville Road (at Altamont Pass Road and at Southfront Road) would change from existing LOS C or better to LOS F and LOS E, respectively. This is considered to be a significant cumulative traffic impact. The City of Livermore is in the process of improving the intersection of Greenville Road and Southfront Road. Other improvements are anticipated in conjunction with future development projects in this area. Specifically, Greenville Road would likely be widened to a six-lane road, and a new interchange at I-580/Greenville Road would be required.

The intersection of Greenville Road/East Avenue is projected to change from the existing LOS A condition to an unacceptable LOS F. This is a significant impact for purposes of this EIS/EIR. This intersection would operate at LOS E under the no action cumulative scenario.

The intersection of Greenville Road/Patterson Pass Road would change from the existing LOS A condition in the p.m. peak hour to LOS D under both the no action and the proposed action cumulative scenarios. The V/C ratio would increase to 0.88 with cumulative development associated with buildout of the study area. Because the City of Livermore standard for acceptable traffic conditions at an intersection is a V/C ratio of 0.85 or below, this is considered a significant impact for purposes of this EIS/EIR.

Improvements at the intersections of Greenville Road/Patterson Pass Road and Greenville Road/East Avenue are likely to be necessary to mitigate projected unacceptable traffic conditions at these intersections. These improvements, which would mitigate cumulative impacts from new development activities proposed in the vicinity, are described below, and the resulting traffic conditions following implementation of these improvements are delineated in Table 5.1.11-1 in the "Cumulative Proposed Action (Planned Roadway Network)" column.

The following improvements are suggested future mitigations but have not been formally proposed or funded at this time. These improvements would be the responsibility of the city or county jurisdiction in which the intersections are located.

Intersection of Greenville Road/Patterson Pass Road. Add one northbound and one southbound through lane and traffic signals at such time as the V/C ratio at this intersection approaches unacceptable levels.

Intersection of Greenville Road/East Avenue. Add an additional east to north left-turn lane and traffic signals at such time as the V/C ratio at the intersection approaches unacceptable levels.

Five intersections along First Street (at North Mines Road, Las Positas Boulevard, Southfront Road, the I-580 westbound on/off ramps, and the I-580 eastbound on/off ramps) would change from the existing LOS D to an unacceptable LOS F under the proposed action cumulative scenario. These intersections would also operate at LOS F under the no action cumulative scenario. One intersection along Vasco Road (at Preston Avenue) would also change from the existing LOS C to an unacceptable LOS F. This intersection would operate at LOS F under the no action cumulative scenario as well. Cumulative traffic congestion at this intersection is considered to be significant. The Vasco Road/I-580 interchange is expected to operate at unacceptable levels and to require improvements.

Various roadway and intersection improvement projects are underway or are anticipated in conjunction with future new development projects in the vicinity of the LLNL Livermore site and SNL, Livermore. The proposed widening of First Street from north of North Mines Road to the I-580 ramps (currently being evaluated by Caltrans) is expected to improve traffic conditions to within acceptable City of Livermore standards at the five First Street intersections identified above. Additional improvements along Vasco Road and at the Vasco Road/I-580 interchange would likely be required in conjunction with the anticipated new development along the Vasco Road corridor (primarily between the LLNL Livermore site and I-580). These improvements, which are the responsibility of the city or county jurisdiction in which the roadways and intersections are located, are discussed in more detail in Appendix K. The LOS and V/C ratios at these intersections that would result from implementation of these improvements are shown in Table 5.1.11-1 under "Cumulative Proposed Action (Planned Roadway Network)."

The four Vasco Road intersections nearest the Laboratories (at Patterson Pass Road, Mesquite Way, Westgate Drive, and East Avenue) are projected to operate at LOS C or better.

In summary, cumulative development within the study area would result in significant cumulative traffic congestion. Roadway and intersection improvements in the vicinity of the LLNL Livermore site and SNL, Livermore, only some of which are already planned and approved, would be necessary to mitigate this significant cumulative impact in the vicinity of the Laboratories. These improvements would not be on DOE-owned property and would be the responsibility of the city or county agency with jurisdiction over the area. Thus, the impact of cumulative development on traffic congestion in the vicinity of the Laboratories remains significant and unavoidable.

Mitigation Measure: No measures are implementable by DOE or UC.

CUMULATIVE IMPACTS—LLNL SITE 300

Impact 11.4.3 Cumulative development would result in an increase in traffic congestion on roadways in the vicinity of LLNL Site 300. This is a less than significant impact.

The cumulative impact study area for evaluation of LLNL Site 300 traffic impacts encompasses existing and proposed development along Corral Hollow Road, including the Corral Hollow Road interchange with I-580. As stated earlier in this section, the proposed action at LLNL Site 300 is not expected to result in any significant project-specific traffic impacts. As shown in Figure 5.1.11-2, future traffic volumes along Corral Hollow Road are projected to be approximately 1150 vehicles per day west of LLNL Site 300 and 1405 vehicles per day east of the site, which is an increase of 450 and 555 vehicles per day, respectively, over existing conditions. This increase would occur mostly due to future development in the vicinity of LLNL Site 300. As indicated above, the amount of traffic related to LLNL Site 300 is not expected to increase substantially along this roadway. The projected volumes along Corral Hollow Road would not exceed the design capacity of the roadway; therefore, no significant cumulative traffic impact is identified.

Mitigation Measure: None warranted.

Impact 11.4.4 Traffic congestion at the Corral Hollow Road/I-580 interchange would increase significantly under cumulative buildout in the vicinity of LLNL Site 300. This is a significant unavoidable impact.

Based on the analysis and modeling conducted for purposes of this EIS/EIR, traffic congestion at the interchange of Corral Hollow Road and the I-580 eastbound and westbound on/off ramps could potentially increase to unacceptable levels from the present LOS A condition as a result of new development (including the proposed Tracy Hills project) in the vicinity of I-580 and LLNL Site 300. Roadway and interchange improvements would be required to mitigate the effects of cumulative development on this intersection. However, these measures are not under the jurisdiction of DOE or UC. Thus, the impact is considered to be significant and unavoidable.

Mitigation Measure: No measures are implementable by DOE or UC.

Table 5.1.11-1 Intersection Levels of Service—Existing, Existing Plus Proposed Action, Cumulative No Action, and Cumulative Proposed Action

Intersection ID Number (Refer to Figure K-3 in Appendix K)	Intersection		Existing		Existing Plus Proposed Action		Cumulative No Action		Cumulative No Action (Planned Roadway Network)		Cumulative Proposed Action		Cumulative Proposed Action (Planned Roadway Network)	
			V/C	LOS	V/C	LOS	V/C	LOS	V/C	LOS	V/C	LOS	V/C	LOS
1	Corral Hollow Rd/ I-580 SB off-ramp	A.M. P.M.	0.20 0.24	A A	ND ND	ND ND	ND ND	ND ND	ND ND	ND ND	ND ND	ND ND	ND ND	ND ND
2	Corral Hollow Rd/ I-580 NB off-ramp	A.M. P.M.	0.23 0.18	A A	ND ND	ND ND	ND ND	ND ND	ND ND	ND ND	ND ND	ND ND	ND ND	ND ND
920	First St./I-580 WB on-/off- ramps	A.M. P.M.	0.85 0.84	D D	0.85 0.84	D D	1.13 0.92	F E	0.79 0.54	C A	1.12 0.92	F E	0.78 0.53	C A
922	First St./I-580 EB on-/off- ramps	A.M. P.M.	0.75 0.84	C D	0.75 0.84	C D	1.42 1.16	F F	0.84 0.84	D D	1.45 1.15	F F	0.85 0.84	D D
894	First St./Southfront Rd.	A.M. P.M.	0.84 0.67	D B	0.84 0.67	D B	1.06 1.04	F F	0.67 0.85	B D	1.09 1.04	F F	0.66 0.85	B D
684	First St./Las Positas Blvd.	A.M. P.M.	0.84 0.89	D D	0.84 0.89	D D	1.67 2.07	F F	0.69 0.81	B D	1.69 2.05	F F	0.70 0.80	B C
615	First St./N.	A.M.	0.86	D	0.82	D	1.45	F	0.88	D	1.46	F	0.90	D

	Mines Rd	P.M.	0.87	D	0.87	D	1.51	F	0.86	D	1.54	F	0.86	D
655	S. Livermore Ave./East Ave./4th St./H St.	A.M. P.M.	0.57 0.66	A B	0.64 0.68	B B	0.74 0.87	C D	--- ---	--- ---	0.77 0.87	C D	--- ---	--- ---
588	East Ave./N. Mines Rd	A.M. P.M.	0.58 0.69	A B	0.66 0.74	B C	0.66 0.89	B D	0.49 0.80	A C	0.71 0.90	C D	0.54 0.83	A D
617	Vasco Rd./East Ave.	A.M. P.M.	0.61 0.62	B B	0.71 0.69	C B	0.62 0.63	B B	--- ---	--- ---	0.70 0.69	B B	--- ---	--- ---
671	Greenville Rd./East Ave.	A.M. P.M.	0.34 0.42	A A	0.41 0.46	A A	0.86 0.92	D E	0.72 0.51	C A	0.89 1.01	D F	0.79 0.56	C A
924	Vasco Rd./I-580 WB off-ramp	A.M. P.M.	NA	NA	NA	NA	NA	NA	0.77 0.57	C A	NA	NA	0.80 0.57	C A
926	Vasco Rd./I-580 EB off-ramp	A.M. P.M.	NA	NA	NA	NA	NA	NA	0.56 0.84	A D	NA	NA	0.57 0.88	A D
575	Vasco Rd/Preston Ave	A.M. P.M.	0.62 0.71	B C	0.72 0.77	C C	0.88 1.27	D F	0.66 0.84	B D	0.88 1.25	D F	0.62 0.84	B D
583	Vasco Rd./ Patterson Pass Rd.	A.M. P.M.	0.70 0.62	B B	0.78 0.69	C B	0.74 0.68	C B	--- ---	--- ---	0.79 0.71	C C	--- ---	--- ---
616	Vasco Rd./West Gate Dr.	A.M. P.M.	0.47 0.53	A A	0.55 0.59	A A	0.58 0.52	A A	--- ---	--- ---	0.66 0.60	B A	--- ---	--- ---
591	Vasco Rd./Mesquite Wy.	A.M. P.M.	0.41 0.47	A A	0.45 0.52	A A	0.32 0.38	A A	--- ---	--- ---	0.39 0.41	A A	--- ---	--- ---
16	Southfront Rd/I-580 EB off-ramp	A.M. P.M.	0.35 0.46	A A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15	Northfront Rd/I-580 WB off-ramp	A.M. P.M.	0.63 0.32	B A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
928	Greenville Rd/ Altamont Pass Road	A.M. P.M.	0.70 0.35	B A	0.75 0.37	C A	1.07 1.02	F F	0.65 0.64	B B	1.24 1.18	F F	0.74 0.73	C C
931	Greenville Rd/ Southfront Road	A.M. P.M.	0.70 0.43	C A	0.77 0.47	C A	0.66 0.92	B E	0.66 0.77	B C	0.67 0.97	B E	0.67 0.81	B D
581	Greenville Rd./ Patterson Pass Rd.	A.M. P.M.	0.75 0.60	C A	0.81 0.63	D B	0.80 0.84	C D	0.54 0.48	A A	0.85 0.88	D D	0.58 0.53	A A

V/C= Volume-to-capacity ratio.

LOS= Level of service.
--- = No mitigation required at this intersection; refer to the V/C ratio and LOS for unmitigated condition.
NA= Not applicable. No intersections exist at this interchange at the present time. See text for details.
ND= No data generated.
Source: TJKM Transportation Consultants, 1992.

Table 5.1.11-2 A.M. Peak Hour Laboratories-Related Traffic Volumes

Scenarios	Existing		Cumulative No Action		Cumulative Proposed Action	
	Volume	%*	Volume	%*	Volume	%*
Vasco Road north of Preston Avenue	1500	53	1200	22	1400	25
Greenville Road south of Southfront Road	1050	90	1350	39	1550	45

* Percent of estimated total A.M. peak-hour traffic volume on roadway that is attributable to LLNL and SNL, Livermore operations.

5.1.12 UTILITIES AND ENERGY

This section discusses the potential impacts of the proposed action on utilities and energy supplies. In several cases LLNL and SNL, Livermore receive utility services and energy resources through the same regional supply systems. While they are distinct operations managed and operated by different contractors, for purposes of this document the LLNL Livermore and SNL, Livermore sites are addressed together because of their proximity. Even so, utility and energy usage is discussed separately for the LLNL Livermore site, LLNL Site 300, and SNL, Livermore as often as is feasible. LLNL leased properties (i.e., Camp Parks, 2020 Research Drive, Almond Avenue, Graham Court, and the aircraft hangar at the Livermore Municipal Airport) are considered part of the LLNL Livermore site in assessing utility and energy impacts.

Standards of Significance

For this EIS/EIR, expansion of existing services due to project demand does not constitute a significant impact unless the service provider anticipates great difficulty in providing increased service or the service expansion results in major adverse secondary effects such as a substantial use of a limited resource.

A project is considered to have a significant adverse impact upon utilities and energy if it:

- Results in the use of large amounts of fuel, water, or energy;
- Uses fuel, water, or energy in a wasteful manner;
- Significantly increases the consumption of potable water; requires substantial expansion of water supply treatment and distribution capacity;
- Requires substantial expansion of wastewater treatment and distribution facilities; or
- Contributes to a cumulative wastewater treatment demand exceeding plant capacity.

All identified impacts are considered to be significant adverse impacts, unless otherwise noted, and the proposed mitigation measures following each impact discussion would reduce the impacts to a less than significant level.

Water Consumption

LLNL Livermore Site

The primary source of domestic water for the LLNL Livermore site is the City of San Francisco's Hetch Hetchy water system; an alternative backup source is Zone 7 of the Alameda County Flood Control and Water Conservation District (LLNL, 1991c). The LLNL leased properties have other sources of water. The City of Livermore provides water to 2020 Research Drive and 1460 South Vasco Road, and the California Water Service Company provides water to the Almond Avenue site.

Historically, the LLNL Livermore site has consumed an average of 261.8 million gal annually over the past five years. Water consumption rates at the LLNL Livermore site, however, have declined steadily since 1986, down to 223 million gal in 1990 (Parisotto, 1991a, 1991b).

LLNL Site 300

LLNL Site 300 is supplied with water from a system of wells. The existing capacity of usable wells is approximately 930,000 gal per day. The 5-year water consumption average for LLNL Site 300 is 31.8 million gal per year (Frahm, 1991). The 1990 consumption was 30 million gal. There is, however, a project to supply LLNL Site 300 with water pumped from the City of San Francisco's Hetch Hetchy water supply system. The capacity of this new water supply is estimated to be 500,000 gal per day, with the capability of expanding to 1.2 million gal per day (LLNL, 1990a). The expected completion date for this project is by the end of 1993.

SNL, Livermore

As with the LLNL Livermore site, the primary source of domestic water for SNL, Livermore is the City of San Francisco's Hetch Hetchy water system; an alternative backup source is Zone 7 of the Alameda County Flood Control Water Conservation District. The 5-year water consumption average for SNL, Livermore is 65.6 million gal per year. Water consumption rates at the site have declined steadily since 1986, down to 56 million gal in 1990 (Parisotto, 1991b).

IMPACTS—LLNL LIVERMORE SITE

Impact 12.1.1 Growth at the LLNL Livermore site may result in increased water consumption.

Based on projected 1992 estimates, the LLNL Livermore site consumes approximately 239.7 million gal of water per year. Assuming that water consumption would increase proportionally to the increase in gross square footage, the consumption of water is assumed to increase by 9 percent, to approximately 261.3 million gal per year by the tenth year. Given the severe drought conditions existing in California, this may be considered a significant impact.

Implementation of the following mitigation measures, some of which are drought related, will reduce impacts to a less than significant level:

Mitigation Measure 12.1.1A: LLNL would continue to reduce use of Hetch Hetchy and Zone 7 water for landscaping irrigation below 1989 levels.

Mitigation Measure 12.1.1B: LLNL would continue to reduce blowdown in cooling towers to minimal operable levels.

Mitigation Measure 12.1.1C: LLNL would limit car washing to only that which is essential.

Mitigation Measure 12.1.1D: LLNL would use reclaimed ground water in place of potable water in cooling towers to the greatest extent feasible.

Mitigation Measure 12.1.1E: LLNL would reassess new contracts for additional water-intensive landscaping (i.e., lawn and ground cover) and implement feasible conservation measures, including use of native, drought-resistant plants and drip versus spray irrigation.

Mitigation Measure 12.1.1F: LLNL would monitor all water use to discourage waste or unnecessary use.

Mitigation Measure 12.1.1G: LLNL would use reclaimed ground water in place of potable water for irrigation to the greatest extent possible.

Mitigation Measure 12.1.1H: LLNL would continue the employee water conservation awareness program.

IMPACTS—LLNL SITE 300

Impact 12.2.1 Growth at LLNL Site 300 may result in increased water consumption.

Based on projected 1992 estimates, LLNL Site 300 consumes approximately 30 million gal of water per year. Assuming that water consumption would increase proportionally to the increase in gross square footage, the consumption of water is assumed to increase by 9 percent, to approximately 32.7 million gal per year by the tenth year. Given the severe drought conditions existing in California, this may be considered a significant impact.

Implementation of the following mitigation measures will reduce impacts to a less than significant level:

Mitigation Measure 12.2.1A: LLNL would continue to reduce landscape irrigation below 1989 levels.

Mitigation Measure 12.2.1B: LLNL would continue to reduce blowdown in cooling towers to minimal operable levels.

Mitigation Measure 12.2.1C: LLNL would limit car washing to only that which is essential.

Mitigation Measure 12.2.1D: LLNL would monitor all water use to discourage waste or unnecessary use.

IMPACTS—SNL, LIVERMORE

Impact 12.3.1 Growth at SNL, Livermore may result in increased water consumption.

Based on projected 1992 estimates, SNL, Livermore consumes approximately 58 million gal of water per year. Assuming that water consumption would increase proportionally to the increase in gross square footage, the consumption of water would increase by 6 percent, to approximately 61.5 million gal per year by the tenth year. Given the severe drought conditions existing in California, this may be considered a significant impact.

Implementation of the following mitigation measures, some of which are drought related, will reduce impacts to a less than significant level:

Mitigation Measure 12.3.1A: SNL, Livermore would continue to reduce landscape watering below 1989 levels.

Mitigation Measure 12.3.1B: SNL, Livermore would continue to reduce blowdown in cooling towers to minimal operable levels.

Mitigation Measure 12.3.1C: SNL, Livermore would limit car washing to only that which is essential.

Mitigation Measure 12.3.1D: SNL, Livermore would reassess all new contracts for additional water-intensive landscaping (i.e., lawn and ground cover).

Mitigation Measure 12.3.1E: SNL, Livermore would monitor all water use to discourage waste or unnecessary use.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE

Impact 12.4.1 Cumulative development in the vicinity of the LLNL Livermore site would increase demand for and consumption of water. This is a significant and unavoidable adverse impact.

Population in Alameda County is projected to increase by about 8.5 percent by the year 2000 (Association of Bay Area Governments, 1989). In conjunction with the proposed action, this growth could constitute a significant adverse cumulative impact upon water resources and supply systems if the drought and other limiting factors continue. Despite LLNL's conservation measures described in the above mitigation measures, all steps necessary to mitigate this impact are not available to UC or DOE; therefore, it remains significant and unavoidable.

Mitigation Measure 12.4.1: Mitigation measures for the proposed action are set forth under Impact 12.1.1. No mitigation measures are available for other projects in the area.

CUMULATIVE IMPACTS—LLNL SITE 300

Impact 12.4.2 Cumulative development in the vicinity of LLNL Site 300 would increase demand for and consumption of water. This is a significant and unavoidable adverse impact.

Population in San Joaquin County is projected to increase by 47.7 percent by the year 2010 (Williams, 1991). This, added to the projected 9 percent increase in usage for LLNL Site 300, could constitute a significant adverse cumulative impact on water resources and on the supply systems if the drought and other limiting factors continue. Despite LLNL's conservation measures described in the above mitigation measures, all steps necessary to mitigate this impact are not available to UC or DOE; therefore, it remains a significant and unavoidable impact.

Mitigation Measure 12.4.2: Mitigation measures for the proposed action are set forth under Impact 12.2.1. No mitigation measures are available for other projects in the area.

CUMULATIVE IMPACTS—SNL LIVERMORE

Impact 12.4.3 Cumulative development in the vicinity of SNL, Livermore would increase demand for and consumption of water. This is a significant and unavoidable impact.

Population in Alameda County is projected to increase by 8.5 percent by the year 2000. In conjunction with the proposed action, this growth could constitute a significant adverse cumulative impact upon water resources and on the supply systems if the existing drought and associated limiting factors continue. Despite SNL, Livermore's conservation measures, described in the above mitigation measures, all steps necessary to mitigate this impact are not available to SNL or DOE; therefore, this growth remains a significant and unavoidable impact.

Mitigation Measure 12.4.3: Mitigation measures for the proposed action are set forth under Impact 12.3.1. No mitigation measures are available for other projects in the area.

Electricity Consumption

LLNL Livermore Site

Electrical power is supplied to the LLNL Livermore site (including offsite leased properties) by the Pacific Gas and Electric Company and the Western Area Power Administration. The electrical energy used at LLNL is devoted almost entirely to the operation of office buildings and research laboratory facilities. Electricity consumption for the site increased between 1986 and 1990, to 321.3 million kilowatt-hours per year in 1990 (LLNL, 1991c).

LLNL Site 300

Electrical power is supplied to LLNL Site 300 by the Pacific Gas and Electric Company and the Western Area Power Administration. Electricity consumption at the site increased between 1986 and 1989. A slight decline in consumption was observed during 1989 and 1990 (Hale, 1991).

SNL, Livermore

Electrical power is supplied to SNL, Livermore by the Pacific Gas and Electric Company and the Western Area Power Administration. Electricity consumption at the site increased between 1986 and 1989. A slight decline in consumption was observed during 1989 and 1990 (Hale, 1991).

IMPACTS—LLNL LIVERMORE SITE

Impact 12.1.2 Growth at the LLNL Livermore site would result in increased electricity consumption. This is a less than significant impact.

Based on projected 1992 estimates, the LLNL Livermore site consumes approximately 345.4 million kilowatt-hours per year. Assuming that the electrical power consumption would increase proportionally to the increase in gross square footage, the electricity consumption would increase by 9 percent to approximately 376.5 million kilowatt-hours per year by the tenth year. The LLNL distribution system and existing capacity for the utilities to supply energy (on both a total and a peak load basis) would adequately meet the projected increase in consumption.

Consumption increases are addressed in ongoing energy conservation studies, surveys, and audits. Moreover, LLNL will continue efforts to decrease energy use through modifications to heating, ventilation, and air conditioning controls; the design of more efficient buildings; boiler tuneups; and other site energy conservation efforts. The use of permanent, energy- efficient buildings (versus trailers and/or temporary buildings) is being evaluated.

Mitigation Measure: None warranted.

IMPACTS—LLNL SITE 300

Impact 12.2.2 Growth at LLNL Site 300 would result in increased electricity consumption. This is a less than significant impact.

To provide a conservative estimate for this EIS/EIR, a projected increase in electricity consumption of 9 percent is estimated for LLNL Site 300. Based on projected 1992 estimates, LLNL Site 300 consumes approximately 1.5 million kilowatt-hours of electricity per year. Assuming a proportional increase, the site would consume approximately 1.64 million kilowatt-hours by the tenth year. The existing utility and LLNL Site 300 capacity would adequately meet the projected increase in demand. Continuing efforts are being made to decrease energy use through modifications to heating, ventilation, and air conditioning (HVAC) controls; the design of more efficient buildings; boiler tuneups; and other site energy conservation efforts.

Mitigation Measure: None warranted.

IMPACTS—SNL, LIVERMORE

Impact 12.3.2 Growth at SNL, Livermore may result in increased electricity consumption. This is a less than significant impact.

To provide a conservative estimate for this EIS/EIR, a projected increase in electricity consumption of 6 percent is estimated for SNL, Livermore. Based on projected 1992 estimates, SNL, Livermore consumes approximately 40.1 million kilowatt-hours of electricity per year. Assuming a proportional increase, the site would be expected to consume approximately 42.5 million kilowatt-hours by the tenth year. The existing Laboratory distribution system capacity is not adequate to supply SNL, Livermore requirements beyond 1992; however, a new funded project is underway that would increase the power load capacity for SNL, Livermore planned through the year 2005. The existing capacity of the utilities to supply energy (on both a total and a peak load basis) would adequately meet this projected increase in electrical power consumption. Continuing efforts are being made to decrease energy use through modifications to heating, ventilation, and air conditioning controls; the design of more efficient buildings; boiler tuneups; and other site energy conservation efforts.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE

Impact 12.4.4 Cumulative development at the LLNL Livermore site under the proposed action would increase electric power demand. This is a less than significant impact.

Residential, commercial, industrial, and other uses in Alameda County are expected to increase from about 9334 gigawatt-hours (1 gigawatt-hour equals 1 million kilowatt-hours) in 1990 to over 10,480 gigawatt-hours per year by the year 2000, or an increase in demand of about 12 percent. The projected energy demand of 376.5 gigawatt-hours per year by the tenth year for the proposed action is between 3 and 4 percent of the total estimated demand for Alameda County. The utility supply companies plan to provide sufficient capacity to meet Alameda County electrical energy needs for the next 5 to 10 years. Therefore, the increase in LLNL Livermore site electrical power demand by the tenth year would be a less than significant impact.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—LLNL SITE 300

Impact 12.4.5 Cumulative development at LLNL Site 300 under the proposed action would increase electric power demand. This is a less than significant impact.

Residential, commercial, industrial, and other uses in San Joaquin County are expected to increase from about 4039 gigawatt-hours per year to about 5031 gigawatt hours per year by the year 2000, an increase in demand of about 25 percent. The projected annual energy demand of 1.64 gigawatt-hours per year by the tenth year for the proposed action is about .03 percent of the total estimated demand for San Joaquin County. While specific information regarding existing capacity is unavailable, the utility supply companies plan to provide sufficient capacity to meet San Joaquin County electrical energy needs through the year 2000. The increase in LLNL Site 300 power demand by the tenth year would be a less than significant impact.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—SNL, LIVERMORE

Impact 12.4.6 Cumulative development at SNL, Livermore under the proposed action would increase electric power demand. This is a less than significant impact.

Electrical demand for residential, commercial, industrial, and other uses in Alameda County is expected to increase 12 percent from 1990 to the year 2000. The projected energy demand for SNL, Livermore would be 42.5 million kilowatt-hours annually by the tenth year, or only about 0.4 percent of the projected Alameda County demand. The utility supply companies plan to provide sufficient capacity to meet Alameda County electrical energy needs for the next 5 to 10 years. Therefore, the increase in SNL, Livermore electrical power demand would be a less than significant impact.

Mitigation Measure: None warranted.

Fuel Consumption

<u>LLNL Livermore Site</u>

Gasoline, jet fuel, diesel, liquid propane gas (LPG), and natural gas are the primary fuels consumed at the LLNL Livermore site. The cumulative totals for the site show an increase in gasoline consumption and a decrease in diesel and jet fuel consumption (Holda, 1991). Liquid propane gas consumption remained constant from 1988 to 1990, but there was a decrease from 1986 and 1987 totals. Natural gas consumption for the site increased during each consecutive year from 1986 to 1989, but decreased in 1990. The proposed action projects a 9 percent increase in fuel consumption based on the projected increase in gross square footage of developed space at the Laboratory by the tenth year.

LLNL Site 300

LLNL Site 300 fuel oil consumption has decreased significantly since 1986, down to a 5-year average of 78,114 gal per year (Frahm, 1991) (1986 consumption was 94,391 gal). Fuel oil is used mostly for comfort heating in the building category. In the metered process category, fuel oil is used for comfort heating and in some experiments. The completion of HVAC retrofit projects and mild temperatures have contributed to the overall decrease in fuel oil consumption. The proposed action projects a 9 percent increase in fuel consumption based on the projected increase in gross square footage of developed space at the Laboratory by the tenth year.

SNL Livermore

Gasoline, diesel, LPG, and natural gas are the primary fuels consumed at SNL, Livermore. Gasoline consumption at the site increased from 1986 to 1990. Diesel consumption increased from 1986 to 1988, but has been decreasing since the 1988 high. One hundred and six 16-oz propane cylinders of LPG were used in the maintenance areas during 1986 to 1990. As with the LLNL Livermore site, natural gas consumption for SNL, Livermore increased during each consecutive year from 1986 to 1989, but decreased in 1990 (Hale, 1991). The proposed action projects a 6 percent increase in fuel consumption based on projected increase in gross square footage of developed space at the Laboratory by the tenth year.

IMPACTS—LLNL LIVERMORE SITE

Impact 12.1.3 Total fuel consumption would increase at the LLNL Livermore site as a result of the proposed action. This is a less than significant impact.

For the purposes of the EIS/EIR impact analysis, it is assumed that there would be an approximate 9 percent increase in fuel consumption at the LLNL Livermore site. Based on projected 1992 estimates, the LLNL Livermore site consumes approximately 815,000 gal of total fuel (gasoline, jet fuel, diesel, and LPG) per year. Assuming that the total fuel consumption would increase proportionally to the increase in gross square footage, the total fuel consumption is assumed to increase by 9 percent to approximately 888,200 gal per year by the tenth year. Because this would result in little impact upon supply, this impact is considered less than significant.

Mitigation Measure: None warranted.

IMPACTS—LLNL SITE 300

Impact 12.2.3 Total fuel consumption would increase at LLNL Site 300 as a result of the proposed action. This is a less than significant impact.

For the purposes of the EIS/EIR impact analysis, it is assumed that there would be an approximate 9 percent increase in fuel consumption at LLNL Site 300. Because this would result in little impact upon supply, this impact is considered less than significant.

Mitigation Measure: None warranted.

IMPACTS—SNL, LIVERMORE

Impact 12.3.3 Total fuel consumption at SNL, Livermore would increase as a result of the proposed project. This is a less than significant impact.

For the purposes of the EIS/EIR impact analysis, it is assumed that there would be an approximate 6 percent increase in fuel consumption at SNL, Livermore. Based on projected 1992 estimates, SNL, Livermore consumes approximately 16,600 gal of total fuel (gasoline and diesel) per year. Assuming that the total fuel consumption would increase proportionally to the increase in gross square footage, the total fuel consumption is assumed to increase by 6 percent to approximately 17,600 gal per year by the tenth year. Since fuel supplies are expected to remain ample, this increase represents a less than significant impact.

Mitigation Measure: None warranted.

Sewer Discharges

LLNL Livermore Site

The City of Livermore's Water Reclamation Plant (LWRP) currently receives a total of approximately 4.5 million gal of effluent per day. The capacity of this facility is 5 million gal of effluent per day. The facility is currently being expanded and the anticipated completion date is 1994. When completed, the facility would be able to treat 8.5 million gal per day which is expected to be sufficient for inflow treatment for the next 10 years. The 5-year sewer discharge average for the LLNL Livermore site is approximately 113 million gal per year.

LLNL Site 300

LLNL Site 300 sanitary sewage generated outside the General Services Area is disposed of through septic tanks and leachfields or cesspools at individual building locations. Sanitary sewage generated within the General Services Area is piped into an asphalt-membrane-lined oxidation pond east of the General Services Area at an average rate of 3500 gal per day (LLNL, 1991c).

SNL, Livermore

As with the LLNL Livermore site, the City of Livermore's Water Reclamation Plant (LWRP) handles sewage from SNL, Livermore (Grandfield, 1989). The 5-year average for SNL, Livermore is estimated to be approximately 28 million gal per year (Parisotto, 1991b).

IMPACTS—LLNL LIVERMORE SITE

Impact 12.1.4 Retention tank upgrades would reduce the potential for releases of radionuclides to the sewer. This is a beneficial impact.

Retention tanks will be upgraded at Buildings 241, 281, and 227. This would provide improved containment of contaminated wastewater and provide less chance for release to occur.

Mitigation Measure: None warranted.

Impact 12.1.5 An increase in the volume of sewage discharge would result from implementation of the proposed action at the LLNL Livermore site.

Based on projected 1992 estimates, the LLNL Livermore site discharges approximately 115 million gal of sewage per year. Under the proposed action, sewage production would increase by 9 percent to 125 million gal per year by the tenth year. This constitutes a significant impact.

The current daily sewage flows average 366,000 gal with a peak of 710,000 gal. A sewer diversion facility was completed in the spring of 1991 to protect against accidental contamination of City of Livermore treatment facilities (LLNL, 1991c).

Implementation of the following mitigation measure would reduce impacts associated with sewage discharges.

Mitigation Measure 12.1.5: LLNL would evaluate and install, where feasible, process conservation devices or modifications to reduce water consumption. This would result in lower sewage discharges.

IMPACTS—LLNL SITE 300

Impact 12.2.4 An increase in the volume of sewage discharge at LLNL Site 300 would result from the proposed action. This is a less than significant impact.

Based on projected 1992 estimates, LLNL Site 300 discharges approximately 1.3 million gal of sewage per year. Assuming that sewage discharges would increase proportionally to the increase in gross square footage, the sewage discharge would increase by 9 percent to approximately 1.4 million gal per year by the tenth year. This represents a less than significant impact, as the current infrastructure could withstand such an increase. No offsite sewage treatment is conducted for LLNL Site 300 wastes, so no additional impacts are expected.

It is likely, however, that the proposed action would have a minimal impact on the amount of sewer discharge, as the trend reflects a decrease. Even as more buildings are added, the amount of sewer discharge should continue to decrease. This is especially true in times of drought, as sewer discharges correlate directly with water supply. Water consumption has decreased and is expected to continue to decrease in the future. Because of this, it is expected that sewer discharges would also decrease.

Mitigation Measure: None warranted.

IMPACTS—SNL, LIVERMORE

Impact 12.3.4 An increase in the volume of sewage discharge at SNL, Livermore would result from the proposed action. This is a less than significant impact.

Based on projected 1992 estimates, SNL, Livermore produces approximately 27.7 million gal of sewage per year (Parisotto, 1991b). Under the proposed action, sewage production would increase by 6 percent to approximately 29.3 million gal per year by the tenth year. This constitutes a less than significant impact, as the current infrastructure could withstand such an increase.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

Impact 12.4.7 The proposed action would impact sewage services together with other development in the service area. This is a less than significant impact.

Sewage treatment facility improvements are already planned in the region. The City of Livermore Water Reclamation Plant (LWRP) currently receives a total of approximately 4.5 million gals of effluent per day. The capacity of this facility is 5 million gal of effluent per day. The facility is currently being expanded and the anticipated completion date is 1994. When completed, the facility would be able to treat 8.5 million gal per day, which is expected to be sufficient for inflow treatment for the next 10 years. Projected sewer discharge volumes could be treated at the LWRP even without the proposed expansion of this facility. Therefore, the cumulative impacts associated with the Laboratories' contribution of sewage discharge is less than significant.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—LLNL SITE 300

Because LLNL Site 300 sewer discharge and treatment programs are mostly self-contained, no cumulative impact is expected as a result of the proposed action. Therefore, LLNL Site 300 would not contribute to any sewage discharge cumulative impacts.

5.1.13 MATERIALS AND WASTE MANAGEMENT

This section discusses the potential impacts of the proposed action separately on materials and on waste management.

Materials Management

The types and quantities of hazardous and radioactive materials used in LLNL and SNL, Livermore program operations vary depending on the type of activities being conducted.

Several modifications to facilities and operations in the proposed action could impact the quantities and types of these materials now used at LLNL and SNL, Livermore. Because program activities under the proposed action are consistent with the existing missions of the Laboratories, however, hazardous materials with similar properties are expected to be used. This projection is based on the activities and projects included in the proposed action, as discussed in section 3.1 and Appendix A.

It is also conservatively assumed for the purposes of this EIS/EIR that use of these materials would increase proportionally to the growth of the Laboratories. As described in the proposed action, this growth would result in an approximate 9 percent increase in square footage at the LLNL Livermore site, 9 percent at LLNL Site 300, and 6 percent at SNL, Livermore.

LLNL Livermore Site

For this EIS/EIR, it is assumed that hazardous materials use and storage at the LLNL Livermore site would also increase by 9 percent. Accordingly, the chemical inventory is conservatively assumed to increase by 19,000 gal of liquids and 210,000 lb of solids by the tenth year. These qualities include compressed gas inventories (recorded in pounds at this site).

Currently, Building 331, the Hydrogen Research Facility, has an *administrative limit* for tritium of 300 g but an *inventory* of less than 20 g. Under the proposed action, the administrative limit for this facility would be reduced from 300 g to 5 g and the inventory reduced accordingly. A portion of the tritium operations in Building 331 may be moved to Building 298, the Fusion Target Fabrication Facility, and to Building 391, the Inertial Confinement Fusion Facility, known as the NOVA-Upgrade/National Ignition Facility. In this event, the three buildings would have a combined administrative limit of 10 g with no more than 5 g in any one building. For these facilities, the administrative limit would therefore be reduced from 300 g in one facility (Building 331) to a total of 10 g total in three facilities (Buildings 298, 331, and 391).

LLNL is currently reducing the plutonium administrative limit for the combined Buildings 332 and 334 from 700 kg to 200 kg, with the inventory (actual inventory quantities are classified) being reduced accordingly. The reduction would be accomplished by shipping inventory to an offsite DOE facility and is targeted for completion during FY 1993.

LLNL Site 300

The proposed action described in section 3.1.2 would result in an approximate 9 percent increase in site facilities by the tenth year. For purposes of this EIS/EIR, the chemical inventory presented in Section 4 is expected to increase proportionally by 9 percent. Accordingly, the chemical inventory is conservatively assumed to increase by 7600 gal of liquids, 9000 lb of solids, and 171,000 cu ft of gases by the tenth year. Tritium use would resume at the firing tables with an administrative limit of 20 mg.

SNL, Livermore

The proposed action described in section 3.1.3 would result in an approximate 6 percent increase in gross square footage of developed space at the Laboratory over the next 10 years. It is estimated for purposes of the discussion of impacts that the materials quantities would increase proportionally. Accordingly, the chemical inventory is conservatively assumed to increase by 210 gal of liquids, 380 lb of solids, and 11,900 cu ft of compressed gases by the tenth year.

The principal radionuclide used in SNL, Livermore research and development facilities is tritium, used at Building 968, the Tritium Research Facility. The existing administrative limit of 50 g is expected to decrease eventually under the proposed action to 0 g.

Standards of Significance

For purposes of this EIS/EIR, materials and waste management impacts would be considered significant if they:

- Create a potential public health hazard or involve the use, production, or disposal of materials that pose a hazard to people or to animal or plant populations;
- Interfere with emergency response plans or emergency evacuation plans;
- Result in unsafe conditions for employees or for surrounding neighborhoods;
- Expose building occupants to work situations that exceed health standards or present an undue potential risk of health-related accidents; or
- Conflict with any federal, state, or local regulations or DOE Order for the handling, packaging, storage, transport, or disposal of hazardous and radioactive materials and/or wastes.

All identified impacts are considered to be significant adverse impacts, unless otherwise noted, and the proposed mitigation measures following each impact discussion will reduce the associated impacts to a less than significant level.

IMPACTS—LLNL LIVERMORE SITE

Impact 13.1.1 Increased use of hazardous or radioactive materials would result in an increased number of shipments of materials to and from LLNL. This is a less than significant impact.

Hazardous and radioactive materials are transported both onsite and offsite in compliance with DOE Orders and U.S. Department of Transportation (DOT) regulations. Although transportation of hazardous materials and radioactive materials has associated risks of spills or leaks, appropriate management of transported materials in compliance with applicable laws and regulations would minimize these risks.

The increase in the amount of hazardous materials or radioactive materials transported to and from LLNL as a result of implementing the proposed action cannot be accurately predicted, due to varying research needs over time and changes in classification of hazardous and radioactive materials. The actual number of LLNL offsite shipments of hazardous and radioactive materials averaged 273 a year for 1987–1990 and was 253 for 1990 (see Table 4.15-4). In addition, vendors pick up approximately 250 shipments of hazardous materials from LLNL annually. Adding these vendor pickups to the four-year average of 273 results in a conservative estimate of 523 shipments of hazardous materials annually. If these quantities were to increase by 9 percent by the year 2002, as has been assumed for purposes of this EIS/EIR, the number of shipments would increase by about 47 shipments.

In principle, an increase in transportation of hazardous and radioactive materials to and from LLNL increases the possibility of accidents and resultant exposures to the public. To minimize the probability of accidental spills of hazardous and radioactive materials during transit, and to reduce the severity of such accidental spills, should they occur, the U.S. Department of Transportation, DOE, and the California Department of Transportation have established regulations for the packaging and handling of such materials. These regulations and guidelines are applicable to LLNL and its vendors. At LLNL, these regulations are embodied in written Laboratory procedures and policies that will continue to be updated to comply with changing regulatory requirements (see Appendix K). These procedures ensure that the increase in the number of shipments would not violate any of the conditions set forth as standards of significance. The impact of additional shipments under the proposed action is, therefore, less than significant.

Mitigation Measure: None warranted.

IMPACTS—LLNL SITE 300

Impact 13.2.1 Increased use of hazardous and radioactive materials would result in an increased number of shipments or transfers of materials to and from LLNL Site 300. This is a less than significant impact.

As described in Impact 13.1.1, shipments of hazardous and radioactive materials must comply with applicable DOE Orders and Department of Transporation requirements for safe packaging, vehicle inspections, and driver qualifications. Existing LLNL procedures to ensure compliance with these requirements would be modified in accordance with any applicable regulatory changes. Hence, compliance with these orders and requirements would continue as part of the proposed actions and the impact is considered less than significant.

Mitigation Measure: None warranted.

IMPACTS—SNL, LIVERMORE

Impact 13.3.1 An increase in the quantity of hazardous or radioactive materials transported to and from SNL, Livermore would result under the proposed action. This is a less than significant impact.

The number of SNL, Livermore offsite shipments of hazardous and radioactive materials during 1987–1990 averaged 338 per year. Assuming the projected 1992 shipments to be 350, a 6 percent increase in this number would add 21 shipments by the end of the 10 years. Beyond the difference in expected shipment increases, the discussion under Impact 13.1.1 applies equally to SNL, Livermore.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS

Impact 13.4.1 The projected growth of LLNL and SNL, Livermore, together with increased development in regional industrial areas, would result in an increased number of shipments of radioactive and hazardous materials. This is a less than significant impact.

The industries in the area around the Laboratories and those that may be expected to be developed during the 5- to 10-year period of the proposed action would use some of the same hazardous materials used by the LLNL Livermore site and SNL, Livermore. According to recent EIRs for local projects and other regional planning documents, development in the area is projected to be light industry, and its use of hazardous materials is expected to be much less intense than the Laboratories' use. The nature and amounts of hazardous materials that may be used are unknown, although none of these proposed nearby industries is expected to use radioactive materials. Regional hospitals, however, do use various radionuclides in their diagnostic procedures. What is known is that the usage and the transportation of these materials must comply with California and, where appropriate, U.S. Department of Transportation regulations.

The numbers of shipments of hazardous and radioactive materials to and from LLNL and SNL, Livermore are of course contingent on project and program activity at the Laboratories. Under the proposed action, however, the number of these shipments during the next 5 to 10 years is not expected to vary significantly from the trends illustrated in Tables 4.15-4 and 4.15-5. To provide a regional perspective on LLNL and SNL, Livermore hazardous shipments, however, Table 5.1.13-1 presents statistics compiled by the California Department of Transportation (CALTRANS) on the annual amount of heavy truck traffic in the three major counties of the region (Alameda, Contra Costa, and San Joaquin counties).

Based on the annual average daily traffic counts of truck activity on I-580, total *annual* hazardous material shipments (including an estimated 250 vendor pickups) from LLNL represent less than 6 percent of the shipments for the total *daily* truck traffic counted at the I-580 and Greenville Road intersection in 1989. SNL, Livermore *annual* shipments represent approximately 3 percent of the total *daily* truck traffic counted in 1989 at the same intersection. Assuming a 9 percent increase for LLNL and a 6 percent increase for SNL, Livermore shipments under the proposed action, these trends show a very small contribution to cumulative impacts (see Figure K-2, Appendix K).

Based on a 9 percent assumed increase, an assumed increase in the number of such shipments during the 5- to 10-year period of the proposed action would be less than 50 at LLNL. Based on a 6 percent assumed increase in shipments during the same 5- to 10-year period, the additional shipments at SNL, Livermore would be 21.

Mitigation Measure: None warranted. No mitigation measures are available for other projects in the area.

Table 5.1.13-1 Annual Average Daily Truck (AADT) Traffic on Interstates 580 and 205 at Selected Intersections in the Vicinity of LLNL and SNL, Livermore, 1985–1989[a]

I-580 Intersections	1985	1986	1987	1988	1989
Junction Route 84 (Alameda County)[b]	9,483	10,653	11,202	11,478	12,027
Greenville Road (Alameda County)[b]	9,434	10,746	11,238	11,894	10,314
Junction Route 205 East (San Joaquin County)[c]	8,120	9,280	9,715	10,295	13,332

[a] Represents daily traffic counts of Interstate 580 truck traffic averaged annually passing these intersections.
[b] Represents average of truck traffic counts made at both on- and off-ramps.
[c] Traffic count for this intersection is estimated.

Source: California Department of Transportation, 1991.

Waste Management

Future waste types are expected to be similar to those currently generated (see section 4.15.2 and Appendix B). This projection is based on the similarity of those activities and projects included in the proposed action, as discussed in Section 3, to current activities at the Laboratories.

Some proposed action activities, such as new experimental programs and research facilities, would most likely result in increased waste generation. Others, such as more efficient processes and waste separation and collection systems, and reduced operations at major waste generator facilities, are likely to reduce waste generation by individual facilities and programs.

In addition to the above factors influencing waste generation, the State of California and DOE have mandated the implementation of waste minimization programs. Both LLNL and SNL, Livermore are committed to reducing waste generation by implementing sitewide waste minimization programs, as discussed in Appendix B.

Based upon all the above factors, and considering future advances in technology, it is expected that increases in waste generation from the proposed action would be offset by reductions in other areas. However, due to the uncertainties in predicting waste generation, it is conservatively assumed (for purposes of this EIS/EIR) that waste generation would increase proportionally with growth of the Laboratories. This approach ignores benefits from future reductions in waste generation from waste minimization programs, advances in waste treatment/processing technologies, and efficiencies associated with modernized experimental and waste handling facilities.

Standards of Significance

The standards of significance relative to waste management are the same as those applied to materials management.

IMPACTS—LLNL LIVERMORE SITE

Impact 13.1.2 Implementation of the proposed action may result in an increase in the generation of hazardous, radioactive, mixed, and medical waste at the LLNL Livermore site. This is a less than significant impact.

The proposed action would result in an approximate 9 percent increase in the LLNL Livermore site facilities (based upon the projected increase in square footage of developed space) over the next 10 years. This projected growth was used to estimate waste generation as described below.

Radioactive Wastes. Based on projected 1992 estimates, the LLNL Livermore site generates approximately 287,000 lb of solid and 22,000 gal of liquid low-level radioactive waste (LLW) annually. In addition, the site generates approximately 2700 cu ft of transuranic waste per year. Under the proposed action, radioactive waste generation is conservatively assumed to increase by approximately 9 percent to add 26,000 lb of solid low-level waste, 2000 gal of liquid low-level waste, and 240 cu ft of transuranic waste by the tenth year.

Hazardous Waste. Based on projected 1992 estimates, the LLNL Livermore site generates approximately 567,000 lb of solid and 309,000 gal of liquid hazardous waste annually. Under the proposed action, hazardous waste generation is conservatively assumed to increase by approximately 9 percent, adding 51,000 lb and 28,000 gal by the tenth year.

Mixed Wastes. Based on projected 1992 estimates, the LLNL Livermore site generates approximately 45,000 lb and 23,000 gal of mixed waste annually. Under the proposed action, mixed waste generation is conservatively assumed to increase by approximately 9 percent, adding 4600 lb and 2100 gal by the tenth year.

Medical Waste. Based on projected 1992 estimates, the LLNL Livermore site generates approximately 2600 lb of medical waste annually. Under the proposed action, medical waste generation is conservatively assumed to increase by approximately 9 percent, adding 230 lb by the tenth year.

As discussed in section 4.15.2, many laws and regulations aim at minimizing the adverse environmental effects associated with the generation of these waste streams. One of the most important ways LLNL can minimize such effects is through continued compliance with laws and regulations that mandate, for example, how the waste is handled, stored, and transferred, record-keeping and reporting, and operational safety procedures. Additionally, new waste treatment facilities projected under the proposed action would provide additional waste treatment, thus reducing total waste quantities that have to be stored/handled.

Pollution prevention and waste minimization remain a priority at the Laboratories. Laboratory programs have been developed that emphasize source identification and reduction, and are discussed in section B.3.3 in Appendix B.

Because safety procedures mandated by federal, state, and local laws and regulations and LLNL policies and procedures would be implemented as part of the proposed action, this is considered a less than significant impact.

Mitigation Measure: None warranted.

Impact 13.1.3 Mixed waste generation may require onsite storage beyond storage limits prescribed by RCRA and could result in a need for additional storage capacity. This is a potentially significant and unavoidable impact.

The LLNL Livermore site generates transuranic and low-level mixed waste, almost all of which is prohibited from land disposal under RCRA without first being treated to meet defined standards. Currently, there are no treatment or disposal options available. Long-term storage of these mixed wastes would violate RCRA storage regulations (42 U.S.C. section 3004(j)). Because extended storage would violate federal regulations, the generation of these mixed wastes is considered to have a significant and unavoidable impact on the environment.

The EPA recognizes that "generators and storers of these wastes may find it impossible to comply with the section 3004(j) storage prohibition if there are no available options for treatment or disposal of the wastes" (56 Fed. Reg. 42731). The EPA also recognizes that "responsible management practices should minimize the environmental risks from these section 3004(j) storage violations" (56 Fed. Reg. 42731).

In addition to potential violation of RCRA land disposal restriction regulations, storage capacities currently operated under interim permit status may be exceeded. For both transuranic and low-level mixed waste, the LLNL Livermore site had approximately 580 cu yd and 71,900 gal of available capacity based on practical storage space in December 1991. Based on waste quantities projected for the proposed action, the remaining capacity would be exhausted within the next 5 to 10 years if treatment and disposal remain unavailable.

Implementation of the following mitigation measures would reduce impacts associated with extended storage of mixed waste.

Mitigation Measure 13.1.3A: LLNL would continue to enhance its waste minimization policies and practices to reduce generation of mixed wastes at the source.

Mitigation Measure 13.1.3B: When treatment, storage, and/or disposal options become available for these mixed wastes, LLNL would pursue those alternatives.

Mitigation Measure 13.1.3C: LLNL would treat increased quantities of treatable low-level liquid mixed wastes at the wastewater treatment tank farm to reduce total volumes. In addition, the planned Mixed Waste Treatment Facility would be used to reduce the volume of combustible mixed wastes.

Mitigation Measure 13.1.3D: If it appears that LLNL is approaching storage capacity limits, LLNL would apply for additional permitted capacity to accommodate storage until treatment, storage, and/or disposal become available.

Impact 13.1.4 Increased radioactive waste storage capability may be required under the proposed action. This is a less than significant impact.

Currently, the LLNL Livermore site is storing radioactive wastes onsite pending approval of waste certification plans to meet the waste acceptance criteria (NVO-325) at the Nevada Test Site (NTS). These wastes are being stored in accordance with applicable rules and regulations.

If the waste certification plans for the Nevada Test Site (or other approved facility) are not approved, LLNL must continue to store radioactive wastes onsite. This represents a worst- case scenario since other facilities have developed approved certification plans meeting the requirements of NVO-325, and LLNL fully expects to have its plans approved by early 1993. Although storage space for radioactive waste is limited by exposure considerations at a given location, these wastes can be stored onsite indefinitely provided that the waste is properly packaged, labeled, and monitored. Given the number of available storage locations, LLNL can store projected radioactive wastes in accordance with all applicable laws and regulations for the period covered by this EIS/EIR or until disposal at the Nevada Test Site (low-level waste), the Waste Isolation Pilot Plant (transuranic waste), or other approved storage and/or disposal facilities become available.

Compliance with applicable laws and regulations, available storage capacity, implementation of waste minimization programs, and the planned startup of new onsite waste treatment facilities (i.e., the Decontamination and Waste Treatment Facility) make the impacts associated with radioactive waste storage less than significant.

Mitigation Measure: None warranted.

Impact 13.1.5 Increased waste generation would result in an increased number of waste shipments. This is a less than significant impact.

Hazardous and radioactive wastes are transported both onsite and offsite in compliance with DOE Orders and DOT regulations. Compliance with these regulations through appropriate packaging, qualified vehicles and drivers, and required vehicle inspections provides protection to workers and to the public. The relative impacts of increased shipments of hazardous and radioactive wastes is less than significant.

Mitigation Measure: None warranted.

Impact 13.1.6 The Mixed Waste Treatment Facility is planned to provide treatment processes for mixed wastes with combustible organic constituents that are presently stored onsite and that have no disposal option. This is a beneficial impact.

The Mixed Waste Treatment Facility would be designed on the basis of the best demonstrated technologies that are currently available for treatment of combustible mixed wastes. This would reduce the inventory of such wastes stored onsite and reduce the potential exposure of workers in the vicinity of the storage area.

Mitigation Measure: None warranted.

Impact 13.1.7 The proposed Decontamination and Waste Treatment Facility would replace the current waste processing facility, improving waste management capability. This is a beneficial impact.

The Decontamination and Waste Treatment Facility would replace and upgrade current LLNL Livermore site waste management facilities used to process, treat, and store hazardous, radioactive, and mixed waste. The facility would substantially expand LLNL's capacity for treating these wastes. Treatment of a greater percentage of the wastes using advanced technologies would result in improvements in treatment efficiency and would reduce the quantity of releases of radionuclides to the sewer and to the atmosphere. This would also reduce quantities of waste that would otherwise be transported to an offsite permitted facility for treatment, thereby reducing potential impacts associated with transportation.

Mitigation Measure: None warranted.

Impact 13.1.8 Retention tank upgrades would reduce the potential for releases of radionuclides to the sewer. This is a beneficial impact.

Retention tanks would be upgraded at numerous building locations including at Buildings 241, 281, and 227. This would provide improved containment of contaminated wastewater and provide less chance for release to occur.

Mitigation Measure: None warranted.

IMPACTS—LLNL SITE 300

Impact 13.2.2 Implementation of the proposed action may result in an increase in the generation of radioactive, hazardous, mixed, and medical waste at LLNL Site 300. This is a less than significant impact.

The proposed action would result in an approximate 9 percent increase in LLNL Site 300 facilities (based upon the projected increase in square footage of developed space) over the next 10 years. This projected growth was used to estimate waste generation as described below.

Radioactive Waste. Based on projected 1992 estimates, LLNL Site 300 generates approximately 300,000 lb of solid low-level radioactive waste (LLW) annually. Under the proposed action, radioactive waste generation is conservatively assumed to increase by approximately 9 percent to add 27,000 lb of low-level radioactive waste by the tenth year. However, the construction of the Contained Firing Facility would greatly reduce the generation of this solid low-level radioactive waste, making this projection extremely conservative.

Hazardous Waste. Based on projected 1992 estimates, LLNL Site 300 generates approximately 37,000 lb and 41,000 gal of hazardous waste annually. In addition, LLNL Site 300 generates approximately 4500 lb of high explosive waste annually. Under the proposed action, hazardous waste generation is conservatively assumed to increase by approximately 9 percent to add 3300 lb and 3700 gal as well as approximately 400 lb of high explosive waste by the tenth year.

Mixed Waste. Based on projected 1992 estimates, LLNL Site 300 generates approximately 2000 lb of mixed waste annually. Under the proposed action, mixed waste generation is conservatively assumed to increase by approximately 9 percent to add 180 lb by the tenth year. Mixed waste generated at LLNL Site 300 is shipped to the LLNL Livermore site for storage.

Medical Waste. LLNL Site 300 generates approximately 12 lb of medical waste annually. Under the proposed action, medical waste generation is conservatively assumed to increase by approximately 9 percent to add 1 lb by the tenth year.

Because LLNL Site 300 and the LLNL Livermore site are operated under the same waste management program, the earlier discussions regarding impacts to the LLNL Livermore site under Impact 13.1.2 apply to LLNL Site 300; this is a less than significant impact. For a discussion of waste treatment facilities, available waste storage, and disposal options, see Appendix B.

Mitigation Measure: None warranted.

Impact 13.2.3 Increased radioactive waste storage capability may be required under the proposed action. This is a less than significant impact.

Currently, LLNL Site 300 is storing radioactive wastes onsite pending approval of waste certification plans to meet the waste acceptance criteria (NVO–325) at the Nevada Test Site. These wastes are being stored in accordance with applicable rules and regulations.

If the waste certification plans for NTS (or other approved facility) are not approved, LLNL must continue to store radioactive wastes onsite. This represents a worst-case scenario since other facilities have developed approved certification plans meeting the requirements of NVO-325, and LLNL fully expects to have its plans approved by early 1993. Although storage space for radioactive waste is limited by exposure considerations at a given location, these wastes can be stored onsite provided that the waste is properly packaged, labeled, and monitored. Given the number of available storage locations, LLNL Site 300 can store projected radioactive wastes in accordance with all applicable laws and regulations until disposal at the Nevada Test Site, or another approved disposal facility, becomes available.

Compliance with applicable laws and regulations, available storage capacity, and the implementation of waste minimization programs make the impacts associated with radioactive waste storage less than significant.

Mitigation Measure: None warranted.

Impact 13.2.4 Increased waste generation would result in an increased number of waste shipments. This is a less than significant impact.

Hazardous and radioactive wastes are transported both onsite and offsite in compliance with DOE Orders, Department of Transportation regulations, and California Department of Transportation requirements. Among the major safety factors in shipping hazardous and radioactive materials are the requirements for approved packaging, vehicle inspection, driver qualifications, routing restrictions, when appropriate, and placarding requirements. Compliance with these regulations provides protection to workers and to the public.

Mitigation Measure: None warranted.

IMPACTS—SNL, LIVERMORE

Impact 13.3.2 The projected growth at SNL, Livermore may result in the increased generation of radioactive, hazardous, mixed, and medical wastes. This is a less than significant impact.

The proposed action would result in an approximate 6 percent increase in SNL, Livermore facilities (based upon the projected increase in square footage of developed space) over the next 10 years. This projected growth was used to estimate waste generation as described below.

Radioactive Waste. Based on projected 1992 estimates, SNL, Livermore generates approximately 8860 lb and 7670 gal of solid low-level radioactive waste annually. Under the proposed action, radioactive waste generation is conservatively assumed to increase by approximately 6 percent to add 540 lb and 460 gal of low-level radioactive waste by the tenth year. Wastewater whose tritium content exceeds that permitted for discharge to the sanitary sewer is evaporated at the Tritium Research Laboratory.

Hazardous Waste. Based on projected 1992 estimates, SNL, Livermore generates approximately 6320 lb and 3940 gal of hazardous waste annually. Under the proposed action, hazardous waste generation is conservatively assumed to increase by approximately 6 percent to add 380 lb and 240 gal by the tenth year.

Mixed Wastes. Based on projected 1992 estimates, SNL, Livermore generates approximately 73 lb of solid mixed waste and 250 lb of scintillation cocktails annually. Under the proposed action, mixed waste generation is conservatively assumed to increase by approximately 6 percent to add 4 lb and 15 lb by the tenth year.

Medical Waste. Based on projected 1992 estimates, SNL, Livermore generates approximately 124 lb of medical waste annually. Under the proposed action, medical waste generation is conservatively assumed to increase by approximately 6 percent to add 7 lb by the tenth year.

As described throughout this report, there is a vast array of laws and regulations aimed at minimizing the adverse environmental effects associated with the generation of these waste streams. One of the most important means for SNL, Livermore to minimize such effects is continued compliance with such laws and regulations.

Pollution prevention and waste minimization remain a priority at the Laboratories. Laboratory programs have been developed that emphasize source identification and reduction, and are discussed in section B.3.3 in Appendix B.

Because safety procedures mandated by federal, state, and local laws and regulations and SNL, Livermore policies and procedures would be implemented as part of the proposed action, this is considered a less than significant impact.

Mitigation Measure: None warranted.

Impact 13.3.3 Mixed waste generation would require onsite storage beyond storage limits prescribed by RCRA. This is a potentially significant and unavoidable impact.

SNL, Livermore generates mixed waste, almost all of which is prohibited from land disposal under RCRA without first being treated to meet defined standards. Currently there are no treatment or disposal options available. Long-term storage of these mixed wastes would violate the RCRA storage regulations (42 U.S.C. section 3004(j)). Because extended storage would violate federal regulations, the generation of these mixed wastes is considered to be a significant and unavoidable impact.

The EPA recognizes that "generators and storers of these wastes may find it impossible to comply with the section 3004(j) storage prohibition if there are no available options for treatment or disposal of the wastes" (56 Fed. Reg. 42,731). The EPA also recognizes that "responsible management practices should minimize the environmental risks from these section 3004(j) storage violations" (56 Fed. Reg. 42,731).

Implementation of the following mitigation measures would reduce impacts associated with extended storage of mixed waste.

Mitigation Measure 13.3.3A: SNL, Livermore would continue to enhance its waste minimization policies and practices to reduce generation of mixed wastes at the source.

Mitigation Measure 13.3.3B: When treatment and disposal options become available for these mixed wastes, SNL, Livermore would pursue these alternatives.

Impact 13.3.4 Increased waste generation may result in increased storage requirements for radioactive and mixed waste. This is a less than significant impact.

Currently, SNL, Livermore is storing radioactive wastes onsite pending approval of waste certification plans to meet the waste acceptance criteria (NVO-325) at the Nevada Test Site. In addition, mixed wastes are being stored pending available treatment and disposal options (as discussed above). Storage of wastes complies with applicable rules and regulations.

If the waste certification plans for the Nevada Test Site (or another approved facility) are not approved, SNL, Livermore must continue to store radioactive wastes onsite. This represents a worst-case scenario since other facilities have developed approved certification plans meeting the requirements of NVO-325, and SNL, Livermore fully expects to have its plans approved. Although storage space for radioactive waste is limited by exposure considerations at a given location, these wastes can be stored onsite provided that the waste is properly packaged, labeled, and monitored. Given the number of available storage locations, SNL, Livermore can store projected radioactive wastes in accordance with all applicable laws and regulations for the period covered by this EIS/EIR or until disposal at the Nevada Test Site or another approved disposal facility becomes available.

For mixed waste, SNL, Livermore has sufficient permitted capacity at Building 961 to store projected mixed waste quantities for the period covered by this EIS/EIR or until treatment and disposal become available. Additionally, mitigation measures discussed earlier for mixed waste generation would help minimize the impact of mixed waste storage.

Compliance with applicable laws and regulations, available storage capacity, implementation of waste minimization programs, and the probability of approved disposal becoming available make the impacts associated with radioactive and mixed waste storage less than significant.

Mitigation Measure: None warranted.

Impact 13.3.5 Increased waste generation would result in an increased number of waste shipments. This is a less than significant impact.

Hazardous and radioactive wastes are transported both onsite and offsite in compliance with DOE Orders and DOT regulations. Compliance with these requirements through appropriate packaging, qualified vehicles and drivers, and required vehicle inspections provides protection to workers and to the public. The relative impacts of increased shipments of hazardous and radioactive wastes at SNL, Livermore are less than significant. The comparison of regional truck traffic for cumulative hazardous materials shipments (see Impact 13.4.1) would also apply to cumulative impacts for hazardous waste shipments.

Decommissioning of the Tritium Research Laboratory would add 15 to 20 shipments of low-level radioactive waste and radioactively contaminated equipment from SNL, Livermore over the 3 years of this project.

Mitigation Measure: None warranted.

Impact 13.3.6 Decommissioning of the Tritium Research Laboratory would result in an increased generation of low-level radioactive wastes for the three years of the project. This is a less than significant impact.

Decommissioning of the Tritium Research Laboratory would generate an estimated 100,000 lb of equipment and contaminated materials. These materials will be properly packaged and surveyed according to DOT regulations before shipment to offsite licensed disposal facilities in DOE- and DOT-approved containers. Refer to Appendix A, section A.3.5.3 for a detailed description of this project.

Mitigation Measure: None warranted

Impact 13.3.7 Decommissioning of the Tritium Research Laboratory would result in increased mixed waste generation during the 3 years of the project. This is a less than significant impact.

Decommissioning of the Tritium Research Laboratory would generate an estimated 310 gal of low-level mixed wastes, which include pump oils, Beckman scintillation cocktail fluids, and decontamination cleaning solvent (isopropyl alcohol).

Scintillation cocktails would continue to be sent to a permitted facility in Florida for incineration. Pump oils and cleaning solvent will be stored onsite. As discussed in Impact 13.3.4, SNL, Livermore has sufficient permitted capacity at Building 961 to store these waste quantities until treatment and disposal become available. Refer to Appendix A, section A.3.5.3 for a detailed description of this project.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS

Impact 13.4.2 Assumed growth at the Laboratories and at other waste-generating facilities may result in increased waste generation, treatment, and disposal. This is a significant and unavoidable impact.

Projected increases in waste generation at the Laboratories under the proposed action would result in increased treatment and disposal requirements for these wastes. In addition, increased waste generation from other waste generators around the country could impact treatment and disposal capacities.

In order to properly evaluate the cumulative impacts of increased waste generation on treatment and disposal, potential impacts must be evaluated on a national scale. Currently, different treatment and disposal options exist for various waste streams. For example, SNL, Livermore currently sends scintillation cocktails to a permitted facility in Florida for treatment and disposal. Similarly, other DOE facilities around the country ship radioactive waste to the Nevada Test Site for disposal.

DOE is evaluating national capacity and the relative cumulative impacts of waste generation on treatment and disposal facilities as part of the Programmatic EIS for Environmental Restoration and Waste Management. Due to lack of information currently available, the cumulative impacts associated with increased waste generation are assumed to be significant and unavoidable.

Both LLNL and SNL, Livermore will meet regulatory requirements in packaging, transporting, and disposing of increased waste materials.

Mitigation Measure 13.4.2: Mitigation measures to prevent or reduce these cumulative impacts are beyond the authority of UC. DOE is addressing the issue on a national scale as part of a Programmatic EIS.

Impact 13.4.3 Assumed growth at the Laboratories and surrounding facilities may result in increased hazardous and radioactive waste shipments in the area. This is a significant and unavoidable impact.

Other projects proposed or under construction in the area (e.g., the industrial park developments occurring in the region of the LLNL Livermore site, LLNL Site 300, and SNL, Livermore) would increase the quantity of hazardous wastes being transported in the area. Vendor and commercial haulers of these wastes, however, must have appropriate licenses and must comply with applicable laws concerning hazardous materials packaging, vehicle safety requirements, and driver qualifications (see Appendix K for a discussion of these requirements). Although the contribution of LLNL and SNL, Livermore to potential cumulative hazardous waste transportation impacts is small, the effects of increased hazardous waste shipments in the region could pose a significant and unavoidable impact from possible transportation accidents involving these wastes.

Decommissioning of the SNL, Livermore Tritium Research Laboratory would add 15 to 20 shipments of low-level radioactively contaminated equipment and scrap materials during the 3 years of this project, as discusssed in Impact 13.3.5 and Appendix A.

The impacts and risks of incident-free transportation and potential transportation accidents associated with LLNL shipments of defense-related transuranic wastes are analyzed in the Supplement Environmental Impact Statement for the Waste Isolation Pilot Plant (DOE, 1990). The EIS/EIR also includes bounding transportation accident analyses for both LLNL and SNL, Livermore, presented in Appendix D and summarized in section 5.6. The safeguards built into the packaging, vehicle, and driver regulatory requirements have served to prevent any appreciable release of radioactive waste in the more than 40 years of experience DOE (and its predecessor agencies) has had shipping these materials.

Nonetheless, many of the shipments of radioactive materials or waste that occur in the region are outside the control of DOE and UC and, therefore, the potential exists for a significant and unavoidable cumulative impact from the increased shipments of radioactive materials or wastes.

Mitigation Measure 13.4.3: Mitigation measures to prevent or reduce these cumulative impacts are beyond the authority of UC. DOE is addressing the issue on a national scale as part of a Programmatic EIS.

5.1.14 OCCUPATIONAL PROTECTION

This section presents information about impacts on occupational protection at LLNL and SNL, Livermore associated with changes in the use of radioactive materials, hazardous materials, and physical hazards that may result from the proposed action.

Occupational Protection—Radiation Protection

LLNL Livermore Site and LLNL Site 300

During 1990 the collective radiation dose to workers at LLNL (i.e., the radiation dose above background that is received collectively by all LLNL workers during the year) was about 28.5 person-rem effective dose equivalent. These exposures include those received by workers at LLNL Site 300 as well as those at the LLNL Livermore site. About two-thirds of this collective dose, or 19.6 person-rem, was due to external radiation received by workers at Building 332, the Plutonium Facility. The remainder of the external radiation doses occurred at diverse locations throughout the LLNL Livermore site and LLNL Site 300. In 1990, workers in Building 331, the Hydrogen Research Facility, received a collective internal radiation dose of about 0.5 person-rem from intakes of tritium. There are no other facilities on these sites where internal exposure could normally occur.

Current radiation doses are well within DOE guidelines for protection of worker safety. A number of changes in facilities and operations included in the proposed action, however, would have an impact on radiation exposure to workers at the LLNL Livermore site. These include:

- Upgrade of Building 332, the Plutonium Facility, providing technological improvements, new equipment, and state-of-the-art gloveboxes.
- LLNL is currently reducing the plutonium administrative limit for the combined Buildings 332 and 334 from 700 kg to 200 kg, with the inventory (actual inventory quantities are classified) being reduced accordingly. The reduction would be accomplished by shipping inventory to an offsite DOE facility and is targeted for completion during FY 1993.
- Currently, Building 331, the Hydrogen Research Facility, has an *administrative limit* for tritium of 300 g and an *inventory* of less than 20 g. Under the proposed action, the administrative limit for Building 331 would be reduced from 300 g to 5 g with the inventory reduced accordingly. A portion of the tritium operations in Building 331 may be moved to Building 298, the Fusion Target Fabrication Facility, and to Building 391, the Inertial Confinement Fusion Facility, known as the NOVA-Upgrade/National Ignition Facility. In this event, the three buildings would have a combined administrative limit of 10 g with no more than 5 g in any one building. For these facilities, the administrative limit would therefore be reduced from 300 g in one facility (Building 331) to 10 g total in three facilities (Buildings 298, 331, and 391).
- At LLNL Site 300, tritium use would resume at the firing tables with a limit of 20 mg.
- Decontamination and restoration of Building 292, which houses the Rotating Target Neutron Source Test

Facility; and Building 212, which housed the Rotating Target Neutron Source prototype.

The external radiation doses received by workers at LLNL Site 300 are included with the totals reported for the LLNL Livermore site; however, there are currently no facilities operating at LLNL Site 300 that made a major contribution to the collective radiation exposures to workers at LLNL Site 300 during 1990.

The proposed action would include an upgrade of the Flash X-Ray accelerator (FXR), which would be a source of potential external radiation exposure to workers. Also included in the proposed action is the restarting of the Advanced Test Accelerator. Tritium use would also resume at the firing tables with an administrative limit of 20 mg.

SNL, Livermore

The collective radiation dose to workers at SNL, Livermore during 1990 was approximately 3.5 person-rem. About 1 person-rem of this collective dose was due to internal exposure from the intake of tritium to personnel at Building 968, the Tritium Research Laboratory. The remaining radiation dose, 2.5 person-rem, was due to external exposures at other SNL, Livermore locations. These radiation doses are well within DOE guidelines for protection of worker safety.

The administrative limit for tritium in Building 968 has been reduced to 50 g; the current inventory is less than 45 g. The proposed action for SNL, Livermore includes reduction of the administrative limit in Building 968 for tritium to zero by the end of FY 1993, and decommissioning and conversion of the Tritium Research Laboratory to alternative uses. The potential for radiation exposure to tritium, therefore, would decrease, eventually falling to zero, as the inventory of tritium is reduced to zero and the building is converted to alternative uses.

During decommissioning of the Tritium Research Laboratory, a 10-worker decontamination team would be exposed to radiation. The collective radiation dose of these workers for the entire 3 years of this project is estimated to be 6 person-rem (0.2 rem per person per year × 3 years × 10 persons). These radiation doses are within the DOE guidelines for worker safety of 5 rem per year per person. In addition, according to DOE experience in decommissioning tritium facilities, there is a chance of inadvertent releases of tritium during the decontamination operations. These inadvertent releases could add an estimated 1 to 4 person-rem to the estimate.

Standards of Significance

For purposes of this EIS/EIR, occupational protection impacts would be considered significant if they:

- Create a potential public health hazard or involve the use, production, or disposal of materials that pose a hazard to people or to animal or plant populations in the area affected;
- Interfere with emergency response plans or emergency evacuation plans;
- Result in unsafe conditions for employees or for surrounding neighborhoods;
- Expose building occupants to work situations that exceed health standards or present an undue potential risk of health-related accidents; or
- Cause concentrations of radionuclides in water and air that exceed the appropriate DOE Derived Concentration Guidelines.

All identified impacts are considered to be significant adverse impacts, unless otherwise noted, and the proposed mitigation measures following each impact discussion will reduce the impacts to a less than significant level.

IMPACTS—LLNL LIVERMORE SITE

Impact 14.1.1 The planned upgrade of the Plutonium Facility would reduce external radiation exposures to workers by reducing the frequency and duration of exposures through design modifications that would provide additional shielding and ease of access to enhance the concept of "as low as reasonably achievable." This is a less than significant impact and may be beneficial.

The technical upgrades to the Plutonium Facility include new equipment, capabilities, and state-of-the-art gloveboxes, which would improve the efficiency of handling weapons-grade plutonium and reduce the potential for radiation exposure to workers.

Further, LLNL is currently reducing the plutonium administrative limit for the combined Buildings 332 and 334 from 700 kg to 200 kg, with the inventory (actual inventory quantities are classified) being reduced accordingly. The reduction would be accomplished by shipping inventory to an offsite DOE facility and is targeted for completion during FY 1993.

Mitigation Measure: None warranted.

Impact 14.1.2 Reduction of the administrative limit for plutonium in Building 332, the Plutonium Facility, would reduce the radiation exposure of workers handling plutonium. This is a beneficial impact.

The collective radiation dose to workers from current operations at LLNL is about 28.5 person-rem. About two-thirds of this collective radiation dose, 19.6 person-rem, is received by workers at Building 332, the Plutonium Facility. Reducing the inventory of weapons-grade plutonium and other Special Nuclear Materials would reduce the source of exposure and would result in reduction of radiation doses to workers handling the material. It is estimated that reducing the administrative limit for plutonium from 700 kg to 200 kg would reduce the radiation dose incurred by workers in Building 332 by about 10 to 15 person-rem, and would reduce the collective dose to all workers at LLNL from about 28.5 person-rem to a range of 13.5–18.5 person-rem. This corresponds to a reduction in the risk of fatal cancer from about 1 in 70 to a range of about 1 in 100 to 1 in 150. This is a beneficial impact.

Mitigation Measure: None warranted.

Impact 14.1.3 The combined administrative limit for tritium will be reduced from 300 g in one facility (Building 331) to 10 g total in three facilities (Buildings 298, 331, and 391). This is a less than significant impact and may be beneficial.

Currently Building 331, the Hydrogen Research Facility, has an *administrative limit* for tritium of 300 g and an *inventory* of less than 20 g. Under the proposed action, the administrative limit would be reduced from 300 g to 5 g and the inventory reduced accordingly. A portion of the tritium operations in Building 331 may be moved to Building 298, the Fusion Target Fabrication Facility, and to Building 391, the Inertial Confinement Fusion Facility, known as the NOVA-Upgrade/National Ignition Facility. In this event, the three buildings would have a combined administrative limit of 10 g with no more than 5 g in any one building. For these facilities, the administrative limit would therefore be reduced from 300 g in one facility (Building 331) to a total of 10 g in three facilities (Buildings 298, 331, and 391).

While it is not possible to project precisely the reduction in potential radiation exposure as the quantity of tritium handled at the LLNL Livermore site is reduced, the potential for exposure to workers would also decrease.

Mitigation Measure: None warranted.

Impact 14.1.4 Decontamination and decommissioning of Buildings 212 and 292 would reduce long-term worker radiation exposure. This is a less than significant impact and may be beneficial.

Building 292, which houses the Rotating Target Neutron Source Test Facility, would be decontaminated and restored; and Building 212, which housed the Rotating Target Neutron Source prototype, would be decontaminated, restored, and converted to other uses.

DOE Order 5480.11 requires that radiation doses to workers be kept as low as reasonably achievable (ALARA) and that they not exceed 5 rem per year effective dose equivalent. Although the workers engaged in the decontamination activities would potentially be exposed to ionizing radiation, the conditions would not exceed health standards nor present an undue potential risk of health-related accidents.

Mitigation Measure: None warranted.

IMPACTS—LLNL SITE 300

Impact 14.2.1 Upgrade and operation of the Flash X-Ray accelerator (FXR) would add a potential source for external radiation exposure of workers, but the exposures would remain as low as reasonably achievable and within regulatory guidelines. This is a less than significant impact.

There are essentially no measurable personnel radiation doses associated with the current operation of the Flash X-Ray accelerator at LLNL Site 300. With the implementation of standard design techniques there should be no measurable radiation doses associated with any planned upgrade to the Flash X-Ray accelerator.

Mitigation Measure: None warranted.

IMPACTS—SNL, LIVERMORE

Impact 14.3.1 Over the next 10 years, SNL, Livermore will phase out tritium operations at the Tritium Research Laboratory and convert the building to other uses. This could reduce radiation exposure to workers. This is a less than significant impact and may be beneficial.

Reduction to zero of the tritium inventory at the Tritium Research Laboratory would reduce the potential radiation doses to workers due to tritium intake to zero. This is a less than significant impact and may be beneficial because overall tritium exposure to workers would be reduced.

Mitigation Measure: None warranted.

Impact 14.3.2 Decommissioning of the Tritium Research Laboratory would increase radiation exposure to decontamination workers. This is a less than significant impact.

The collective dose to the 10-worker decontamination team is estimated to be 2 to 3.3 person-rem per year for the 3-year decommissioning of the Tritium Research Laboratory. These levels of exposure would be minimized by extensive worker training and practice, detailed planning, and the use of protective equipment, e.g., snorkels and bubble suits, where applicable.

The estimated individual radiation dose of 0.2 to 0.33 rem per year is well within the DOE guideline for worker safety of 5 rem per year per person. Therefore this is a less than significant impact.

Mitigation Measure: None warranted.

Occupational Protection—Toxic Substances and Physical Hazards

Under the proposed action, DOE would construct a number of facilities at LLNL and SNL, Livermore. For purposes of the EIS/EIR, it is assumed that the percentage increase in the facilities' square footage would be accompanied by an assumed increase in the amounts of hazardous substances used and stored onsite.

The estimates of the increases in chemical inventories are summarized in Tables 4.15-1, 4.15-2, and 4.15-3 (see section 4.15). At the LLNL Livermore site, the FY 1992 chemical inventory is projected to be 210,000 gal of liquids and 2.3 million lb of solids; by the end of the 5- to 10-year period of the proposed action, these quantities may increase by 9 percent, or by 19,000 gal and 210,000 lb. The corresponding figures for LLNL Site 300 are, at present, 84,000 gal of liquids, 100,000 lb of solids, and 1.9 million cu ft of compressed gases, and are projected to increase by 9 percent, or by 7600 gal, 9000 lb, and 171,000 cu ft. The corresponding figures for SNL, Livermore are, at present, 3420 gal of liquids, 6320 lb of solids, and 190,000 cu ft of compressed gases, and are projected to increase by 6 percent, or by 210 gal, 380 lb, and 11,900 cu ft, respectively, at the end of 10 years. Physical hazards such as noise, electrical shock, and nonionizing radiation are also assumed to increase under the proposed action.

LLNL Livermore Site and LLNL Site 300

Some research and development work requires workers at LLNL to be exposed periodically to toxic materials and physical hazards in the workplace. An established health and safety program ensures that workers are informed about the potential hazards present in the workplace and how to avoid these hazards. Workplaces are also monitored to identify and control potential hazards and to ensure compliance with applicable laws regarding protection of worker safety.

Although additional quantities of chemicals are assumed to be used under the proposed action, worker exposures would not necessarily increase since the proposed action includes projects providing improved facilities for handling hazardous chemicals and controlling physical hazards. These include:

- A Hazards Control Fire Science Facility.
- Upgrading of the fire alarm system.
- Enclosure of the system operation in the Building 322 Plating Facility.
- Renovation of Building 321.
- General upgrading of the electronic shop.
- Replacement of fume hoods in Building 151.

In addition, the health and safety program would be implemented at all new facilities to ensure that worker exposures to physical hazards are adequately controlled.

Protection of workers at LLNL Site 300 is an integral part of the LLNL worker protection program. The proposed projects are assumed to result in approximately a 9 percent increase in usage of hazardous chemicals. However, this is not expected to increase worker exposure since these facilities would include improved facilities for handling toxic chemicals and controlling physical hazards, such as the Explosives Waste Treatment Facility and the Contained Firing Facility.

SNL, Livermore

Workers at SNL, Livermore are potentially exposed to a variety of toxic substances and physical hazards. The frequency of these exposures depends upon the type of research being performed and the necessary equipment and chemicals. The proposed projects may involve additional usage of hazardous chemicals, which are assumed to increase by 6 percent. However, it is not likely that worker exposure would increase since the proposed actions would include facilities to better handle hazardous chemicals and control physical hazards, including a new Environmental Safety and Health facility.

Standards of Significance

The standards of significance used to evaluate the impact of toxic substances and physical hazards on occupational health under the proposed action are the same as those outlined in the Occupational Protection—Radiation Protection section.

IMPACTS—LLNL LIVERMORE SITE

Impact 14.1.5 Overall site usage of toxic substances and physical hazards is assumed to increase by 9 percent under the proposed action. This is a less than significant impact.

Although the use of additional quantities of chemicals may occur for the proposed action, it would not necessarily result in additional worker exposures since the modernized and new facilities would improve methods for handling hazardous chemicals and controlling physical hazards. Further, all work activities will continue to be conducted in compliance with laws and regulations concerning worker safety. Thus the impacts of this action are considered to be less than significant.

Mitigation Measure: None warranted.

Impact 14.1.6 The proposed Hazards Control Fire Science Facility would add new laboratories and control rooms, which will reduce worker exposure. This is a less than significant impact and may be beneficial.

The proposed Hazards Control Fire Science Facility would result in improved capabilities for the LLNL Fire Department as a result of improved facilities and work areas. This expansion would also allow the Fire Department to potentially improve and/or develop new plans or methodologies for dealing with fires or other related hazards. Therefore, the impact of this proposed facility is beneficial.

Mitigation Measure: None warranted.

Impact 14.1.7 Upgrading the fire alarm system would improve the capability of responding to a fire. This is a less than significant impact and may be beneficial.

Upgrading the fire alarm system would not decrease the frequency of fires at the facility; however, improved notification and detection may decrease the severity of fires and the number of injuries resulting from fires.

Mitigation Measure: None warranted.

Impact 14.1.8 The proposed tightening of controls and enclosure of the system operations in the Building 322 Plating Facility; renovation of Building 321, which houses all of the general and precision machining operations and the weld shop; and general upgrading of the electronic shop, including closed loop processing for the wire board facility, would decrease worker exposures to organic and inorganic toxic substances. This is a less than significant impact any may be beneficial.

Improvements to controls and enclosure of systems in Building 322 will decrease worker exposure to toxic substances by reducing the emission of these substances into the work space. Renovations of Building 321, such as closed loop processing, will minimize worker exposure to toxic substances by reducing emissions to the work space. These planned projects would result in a less than significant impact and may be beneficial.

Mitigation Measure: None warranted.

Impact 14.1.9 Replacement of the fume hoods in Building 151 would decrease worker exposure to toxic substances. This is a less than significant impact and may be beneficial.

Fume hood replacement in Building 151 will decrease worker exposure to toxic substances by reducing emissions to the work space from work conducted in the fume hoods.

Mitigation Measure: None warranted.

IMPACTS—LLNL SITE 300

Impact 14.2.2 The high explosive waste open burning facility would be replaced with a new Explosive Waste Treatment Facility. This is a less than significant impact and may be beneficial.

Improvements could reduce worker exposure to chemicals and physical hazards relative to the facilities that are currently being used.

Mitigation Measure: None warranted.

IMPACTS—SNL, LIVERMORE

Impact 14.3.2 Construction of a proposed Environmental Safety and Health facility at SNL, Livermore, with a new hazardous waste handling facility for temporary storage of toxic and mixed waste, would replace the current waste handling facility and would reduce worker exposure. This is a less than significant impact and may be beneficial.

Improvements could reduce potential worker exposure relative to the facilities that are currently being used for this purpose.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—OCCUPATIONAL PROTECTION

Impact 14.4.1 The collective radiation dose to workers at LLNL and SNL, Livermore would decrease from current levels. This is a less than significant impact and may be beneficial.

Under the proposed action, the collective radiation dose to workers at LLNL and SNL, Livermore would decrease from current levels because of projected decreases in the quantities of tritium, modifications in design of Building 332, the Plutonium Facility, and a reduction in the plutonium administrative limit for the combined Buildings 332 and 334 from 700 kg to 200 kg, targeted for completion during FY 1993. All work activities at LLNL and SNL, Livermore would continue to comply with applicable DOE orders, laws, and regulations for the radiation protection of workers.

Decommissioning of the Tritium Research Laboratory at SNL, Livermore would result in a collective dose of 6 to 10 person-rem to the 10-worker decontamination team for the 3-year project. The estimated individual radiation dose of 0.2 to 0.33 rem per year is well within the DOE guideline for worker safety of 5 rem per year per person.

Currently, there are no projected developments in the study area that are known to involve the handling of large quantities of radionuclides or sources of ionizing radiation. If facilities were to be developed that handled radionuclides or sources of ionizing radiation, the radiation doses to their workers would have to meet the regulatory limits specified by the U.S. Nuclear Regulatory Commission or other appropriate federal or state regulatory agencies. Because such facilities cannot operate unless they meet these regulations and because these regulations set limits to protect workers and the public, the cumulative impact is considered to be less than significant.

Mitigation Measure: None warranted.

Occupational Protection—Toxic Substances

Impact 14.4.2 Workers at LLNL and SNL, Livermore would continue to be exposed to approximately the same level of risk from toxic substances in the workplace as under current conditions. This is a less than significant impact.

Under the proposed action, workers at LLNL and SNL, Livermore would be exposed to approximately the same level of risks from toxic substances in the workplace as under current conditions because the projected increase in use of toxic substances is offset by improvements in facilities to reduce occupational risks. LLNL and SNL, Livermore will continue to comply with all applicable DOE orders, laws, and regulations concerning worker protection.

There are no known projected developments in the area that are known to involve the handling of toxic substances. If such facilities were developed, they would be required to comply with applicable laws and regulations concerning worker protection. Because such facilities cannot operate unless they meet these regulations and because these regulations set limits to protect workers and the public, the cumulative impact is considered to be less than significant.

Mitigation Measure: None warranted.

5.1.15 SITE CONTAMINATION

The following section analyzes impacts to contaminated soils and sediments, surface water, and ground water from the proposed action, and identifies mitigation actions for these impacts. For the purpose of this EIS/EIR, soils and sediments discussed below include surficial soils, both unconsolidated and consolidated sediments, and unsaturated bedrock. Hydrologic impacts not related to surface and ground water quality are presented in section 5.1.9.

LLNL Livermore Site

LLNL has identified over 17 areas with known soil/sediment contamination at the LLNL Livermore site (see section 4.17). An additional 17 areas are currently under investigation for potential sources of contaminants. Contaminants in soils include volatile organic compounds, fuel hydrocarbons, pesticides, polychlorinated biphenyls, metals, and tritium. The 9 percent growth projected under the proposed action includes proposed projects, and operational modifications that may disturb soils and sediments previously contaminated by one or more of the above constituents.

LLNL Site 300

LLNL has identified 10 areas where soil contamination has occurred at LLNL Site 300. Contaminants detected include volatile organic compounds, fuels, aromatic hydrocarbons, metals, radionuclides, and high explosive compounds. The 9 percent projected growth under the proposed action includes proposed projects, and operational modifications that may disturb soils and sediments previously contaminated by one or more of the above constituents.

SNL, Livermore

SNL, Livermore has evaluated nine source areas for the presence of soil and sediment contamination at SNL, Livermore. The contaminants detected include volatile organic compounds, fuel hydrocarbons, oil and grease, and metals. The 6 percent projected growth under the proposed action for SNL, Livermore includes construction of three new facilities and several operation/maintenance upgrades (including fire water system and natural gas system upgrades) that may involve movement of soils and sediments.

Standards of Significance

For this EIS/EIR, a significant adverse site contamination impact is any effect of the proposed action upon contaminated soils and ground water that might:

- Create a potential public health hazard or pose a hazard to people or to animal or plant populations in the area affected;
- Result in unsafe conditions for employees or for surrounding neighborhoods;
- Cause concentrations of radionuclides in water and air that exceed the appropriate DOE Derived Concentration Guidelines;
- Substantially degrade water quality by exceeding applicable water quality standards;
- Contaminate a public water supply; or
- Substantially degrade or deplete ground water resources.

Unless otherwise noted, all identified impacts are considered significant, and the proposed mitigation measures following each impact discussion will reduce the impacts to a less than significant level.

IMPACTS—LLNL LIVERMORE SITE

Impact 15.1.1 The proposed action may result in exposure of workers to site contaminants, or in the release of site contaminants to the air or surface water. This is a less than significant impact.

The projected growth of developed space by 9 percent has the potential to impact contaminated areas at the LLNL Livermore site. As currently cited, proposed projects would impact areas of known volatile organic compounds and tritium contaminants. Areas surrounding Buildings 141 and 321, which are scheduled for upgrade and retrofit, have been identified as having volatile organic compound concentrations greater than 10 ppb in soils (Figure 4.17-4). If proposed construction activities at these buildings or at other contamination sites disturb contaminated soils, low concentrations of volatile organic compounds could be released into the air or to surface water, or workers could come in contact with contaminated soils. However, the levels of these contaminants would not cause exposures above occupational limits.

Before any construction begins that has the potential to disturb areas of known soil contamination, an assessment of health risks and a health and safety plan will be prepared. Evaluation of health risks associated with remediation was considered in the Baseline Public Health Assessment (Thorpe et al., 1990). Measures in that assessment will ensure protection of human health and the environment during construction activities. Where there is potential for human contact with contaminated soils or sediments, the health and safety plan will specify procedures to be followed to protect human health.

Mitigation Measure: None warranted.

Impact 15.1.2 The proposed action may result in exposure of people to volatile organic compounds, or in the release of volatile organic compounds to the air. This is a less than significant impact.

Past handling and storage of hazardous materials at the LLNL Livermore site have resulted in the contamination of the subsurface environment. Volatile organic compounds in ground water occur in relatively large but diffuse plumes that underlie about 85 percent of the LLNL Livermore site and a total area in the vicinity of about 1.4 sq miles (Isherwood et al., 1990). Volatile organic compounds have migrated offsite into two areas: approximately 2500 ft west of Vasco Road and about 800 ft south of the southeastern portions of the LLNL Livermore site onto SNL, Livermore property (see section 4.17.2.3). A third plume of volatile organic compounds located in the northwest part of LLNL originates on private property (Thorpe et al., 1990; Dresen et al., 1991). The organic solvents were probably released from operations conducted at the site in the 1940s by the Livermore Naval Air Station and from subsequent releases from LLNL activities. Volatile organic compound vapors from ground water remediation will be treated using either catalytic oxidation or activated carbon to oxidize halogenated solvents. All volatile organic compound emissions will be within Bay Air Quality Management District emission requirements.

Mitigation Measure: None warranted.

Impact 15.1.3 The proposed action may result in exposure of people to chromium and tritium, or in the release of chromium and tritium to the air. This is a less than significant impact.

Two chromium plumes have also been identified in the northwest corner of the LLNL Livermore site (Dresen et al., 1991). One chromium plume is located in the vicinity of the west traffic circle. A smaller chromium plume extends northwesterly an undetermined distance offsite from the northwestern corner of the LLNL Livermore site (Dresen et al., 1991) This chromium plume may either originate on private property and be the result of industrial activities or result from natural processes. Soil concentrations are less than soluble threshold limit concentrations. In addition to the solvents and chromium, tritium has also been found at some locations. LLNL Livermore will shut down any treatment system that emits chromium to the atmosphere at concentrations greater than the limit acceptable by the Bay Air Quality Management District. This limit has not been presently defined. Similarly, the LLNL Livermore site will shut down any treatment system that emits tritium to the atmosphere at a rate predicted to cause exposure of greater than 10 millirem (mrem) per year according to the Federal Standard in the Clean Air Act (Dresen et al., 1991).

Mitigation Measure: None warranted.

IMPACTS—LLNL SITE 300

Impact 15.2.1 The proposed action may result in exposure of people to site contaminants, or in the release of site contaminants to the air or surface water. This is a less than significant impact.

The projected growth of developed space by 9 percent has the potential to impact contaminated areas at LLNL Site 300. Under the proposed action as currently cited, construction of a new water line and installation of new Tank 11 may disturb trichlorethylene-contaminated soil in this area (concentrations less than 500 ppb), possibly resulting in minor human exposure below occupational limits.

Before any construction begins that has the potential to disturb areas of known soil contamination, an assessment of health risks and a health and safety plan will be prepared. Measures delineated in this assessment would ensure protection of human health and the environment during construction activities. Where there is a potential for human contact with contaminated soils or sediments, the health and safety plan will specify procedures to be followed to protect human health.

Mitigation Measure: None warranted.

IMPACTS—SNL, LIVERMORE

None of the activities included in the proposed action are located in areas of known contamination. No adverse site contamination impacts are expected.

CUMULATIVE IMPACTS

Cumulative site contamination impacts can result when multiple events combine and exacerbate the extent or significance of contaminants. Soil and ground water contamination have been detected at a number of areas at the LLNL Livermore site, LLNL Site 300, and SNL, Livermore.

The potential for future intensification of contamination, however, has been substantially reduced because of changes in effluent control procedures and implementation of restoration procedures by the Laboratories.

DOE has established the Environmental Restoration Program to provide funding and technical support for cleanup of areas contaminated with hazardous and/or radioactive materials.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE

Impact 15.4.1 The cumulative site contamination setting may result in low concentrations of contaminants impacting the use of ground water. This is a less than significant impact.

The beneficial use of ground water as a source of drinking water has been impacted in the combined area of all the plumes and the cumulative impacts to the local ground water resource could be significant and adverse for over 50 years. If other unknown areas of ground water contamination exist near potential receptors, both onsite and offsite (such as near the City of Livermore municipal water supply wells), or if additional spills occur at the Laboratories and reach ground water, the impacts could generally be additive. Based on the very low predicted concentrations that might arrive at municipal well locations, it is unlikely that a significant cumulative impact would result from this accumulation.

Administrative controls on local ground water use should continue to be implemented in areas currently impacted and potentially impacted by the contaminant plume and by potential future contributions. Based on the current availability of municipal water, state and local administrative controls regarding ground water use, and the fact that the ground water is currently not used as a drinking water source by the LLNL Livermore site, the adverse cumulative impacts under the proposed action would be less than significant. LLNL will continue to work closely with appropriate regulatory agencies and local property owners to ensure that administrative controls regarding limiting ground water use are implemented during the remediation period.

As discussed in section 4.11.2, ground water in the vicinity of the LLNL Livermore site is generally not suitable for use as drinking water without treatment, and is not suitable for some agricultural purposes because of either high levels of naturally occurring constituents (such as boron or total dissolved solids), or the presence of high levels of constituents introduced by agricultural and/or historic industrial activities (such as nitrates). The volatile organic and inorganic plumes emanating from the LLNL Livermore site and adjacent private properties further limit the beneficial use of the local ground water resource.

Cumulative impacts could result from the combined additive effect of water level declines due to drought conditions, from remedial ground water extraction under the proposed action, and from local domestic or agricultural pumping. Lower water levels could further limit the effectiveness of remedial pumping by extending the time required for cleanup, particularly if further regional development of irrigation water sources occurs. Lower water levels could also be accompanied by a reduction in water quality.

LLNL has conducted an extensive environmental restoration program to investigate the level and extent of the contamination and to remediate the contaminated areas. This remediation, combined with improved effluent control procedures and systems, would reduce the levels and extent of the contamination and thus prevent future cumulative impacts.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—LLNL SITE 300

Impact 15.4.2 The proposed action may result in cumulative impacts through exposure of people to site contaminants, or in the release of site contaminants to the air or surface water. This is a less than significant impact.

Three areas at LLNL Site 300 have been contaminated, primarily with mixed waste from the detonation of test assemblies containing depleted uranium, thorium, and tritium and toxic materials such as lead, beryllium, barium, copper, and vanadium. Liquids containing high explosive fines, solvents, metals, and tritium have also been released from unlined evaporation ponds.

Volatile organic compounds, tritium, and in isolated cases high explosive compounds have impacted ground water in both perched and shallow aquifers at LLNL Site 300. Movement of contamination in the bedrock aquifers discussed in section 4.17 does carry implications for ground water resources and for potential land use. Ground water is the only identified source of water that could be available to supply future land development activities in the areas surrounding LLNL Site 300. Contamination of the ground water would severely curtail the amount and types of development activities that could occur in the future. If the contamination were allowed to continue to move through the bedrock aquifers, there would be an ever-increasing area with limitations on the ground water resources, and these limitations would affect potential land use. Although LLNL Site 300 is located in a recharge area of the San Joaquin Basin, most of the affected aquifers are hydraulically isolated and/or physically remote from the regional aquifers in the San Joaquin Valley; therefore, significant cumulative impacts are limited to the local ground water resource.

Three areas that require remediation are the:

- Environmental Test Area.
- General Services Area.
- High Explosives Process Area.

Other areas being investigated and evaluated for potential remediation at LLNL Site 300 include:

- Landfill Pit 6.
- Landfill Pit 8.
- Landfill Closures at Pit 1 and 7.
- The Tritium Project.
- Building 865, Advanced Test Accelerator experimental project.

Trichloroethylene remediation has begun through an ongoing pilot remedial program. Contaminated soil from leaking underground storage tanks is being remediated using bioremediation. Mitigation of the tritium contamination is being addressed by the installation of a permanent plastic cover over the tritium source areas in the soil to isolate the source from further migration. The situation will also continue to be monitored.

Mitigation Measure: None warranted.

Impact 15.4.3 The proposed action will have an overall beneficial impact on ground water resources and land use.

Implementation of proposed remedial actions at LLNL Site 300 would have an overall beneficial impact on ground water resources and land use limitations. The estimated duration of ground water extraction and treatment at LLNL

Site 300 is about 30 to 50 years. Limitations on ground water use would result for several decades while tritium activities in ground water naturally decline. During the 30- to 50-year time period, the local beneficial uses of the deeper aquifers within the plume areas would be significantly impacted and therefore the cumulative impacts would continue to be significant until cleanup below regulatory limits is achieved.

Current and future activities at LLNL Site 300 are being and will be conducted in a manner that minimizes the potential for inadvertent releases into the soil and ground water. Prevention of future releases and remediation of contaminated sites would reduce future levels of contamination and reduce cumulative impacts.

Mitigation Measure: None warranted.

CUMULATIVE IMPACTS—SNL, LIVERMORE

Impact 15.4.4The proposed action may result in exposure of people to site contaminants, or in the release of site contaminants to the air or surface water. This is a less than significant impact.

From 1942 until 1947, the U.S. Navy disposed of trash and construction debris at the southern end of the Navy property, the location of the present SNL, Livermore Navy Landfill. Following two separate investigations there does not appear to be contaminated soil or ground water at the Navy Landfill site.

In February 1975, a 59,500-gal spill of No. 2 diesel fuel oil resulted from the accidental puncture of an underground transfer line and the oil infiltrated the soil to 100 feet. Ground water has not been significantly impacted to date.

In addition, six miscellaneous areas located throughout the SNL, Livermore site have been investigated, including: Arroyo Seco; the former trash dump at the edge of Arroyo Seco on the north side of Sandia Crossing; the fire extinguisher training area; the storage area adjacent to Building 918; the decontamination and waste storage area associated with Building 961; and a burn pit within the Navy Landfill. Investigation findings concluded that no organic or inorganic contaminants above RCRA action levels were present. These results have been submitted to the Regional Water Quality Control Board, and no further action at these locations by SNL, Livermore is expected.

Current and future activities at SNL, Livermore are being and will be conducted in a manner that minimizes the potential for inadvertent releases into the soil and ground water. Prevention of future releases and remediation of contaminated sites would reduce future levels of contamination and reduce cumulative impacts.

Mitigation Measure: None warranted.

5.1.16 PROPOSED ACTION IMPACTS SUMMARY

The individual and cumulative impacts of the proposed action and potential mitigation measures are summarized in Table 5.1.16-1 for LLNL and in Table 5.1.16-2 for SNL, Livermore. The information in these tables is consistent with the impacts discussed in more detail in sections 5.1.1 through 5.1.15. It is compiled to provide a concise yet comprehensive review of these environmental impacts and associated mitigation measures. Mitigation measures are actions that are over and above those already contained in the proposed action and/or required by state or federal laws and regulations.

These mitigation measures are in the Mitigation Monitoring and Reporting Program document, which details responsibilities for implementating and reporting the progress of the mitigation of impacts associated with the proposed action.

Table 5.1.16-1 Summary of Impacts and Mitigation Measures Lawrence Livermore National

Laboratory

Issue Area and Impacts	Level of Significance*	Mitigation Measures	Level of Significance with Mitigation
Land Uses and Applicable Plans			
LLNL Livermore site 1.1.1 The proposed action would result in additional development at the site to be used for the same types of uses as existing facilities.	Less than significant	None warranted	Same
1.1.2 DOE acquisition of a portion of East Avenue would alter a segment of this road's use from a local government–owned, unrestricted access roadway to a federal government–owned, possibly restricted access roadway.	Less than significant	None warranted	Same
LLNL Site 300 1.2.1 The proposed action would result in additional development at the site to be used for the same types of uses as existing facilities.	Less than significant	None warranted	Same
Socioeconomic Characteristics			
LLNL Livermore site and LLNL Site 300 2.1.1 Total employment in Alameda and San Joaquin counties would increase with the implementation of the proposed action.	Beneficial	None warranted	Same
2.1.2 An increase in population level and housing demand within Alameda County would occur as a result of the proposed action.	Less than significant	None warranted	Same
2.1.3 An increase in population and housing demand within the City of Livermore would occur as a	Potentially significant and unavoidable	Mitigation measures to reduce impacts on housing availability in the City of Livermore are beyond the authority of DOE or UC.	Same

result of the proposed action.			
2.1.4 An increase in population level and housing demand within the City of Pleasanton would occur as a result of the proposed action.	Less than significant	None warranted	Same
2.1.5 An increase in population level and housing demand in San Joaquin County would occur as a result of the proposed action.	Less than significant	None warranted	Same
2.1.6 An increase in population level and housing demand within the City of Tracy would occur as a result of the proposed action.	Less than significant	None warranted	Same
2.1.7 The proposed action would generate additional employment income and expenditures in the region.	Beneficial	None warranted	Same
Cumulative Impacts—Socioeconomic Characteristics			
2.4.1 The proposed action would contribute to cumulative housing demand in the region.	Significant and unavoidable	Mitigation measures to reduce impacts on housing availability in the region are beyond the authority of DOE or UC.	Same
Community Services			
LLNL Livermore site 3.1.1 The proposed action could result in a need for increased onsite fire protection personnel, equipment, and/or facilities.	Less than significant	3.1.1 The LLNL Fire Department will continue to review current operations at the LLNL Livermore site against National Fire Protection Standards on an annual basis. If additional needs are identified, personnel, equipment, and facilities would be increased or upgraded as necessary.	Same
3.1.2 Implementation of the proposed action would potentially result in an increased demand for fire protection services within the mutual aid network.	Less than significant	None warranted	Same
3.1.3 Implementation of the proposed action would potentially result in a need for increased security personnel and/or equipment onsite.	Less than significant	None warranted	Same

3.1.4 Implementation of the proposed action at the LLNL Livermore site and LLNL Site 300 would increase the demand for school services in the region.	(Potentially) Significant and unavoidable	3.1.4 Impacts to area schools (beyond DOE's participation in the federal government's Impact Aid Program) cannot be mitigated by DOE or UC.	Same
3.1.5 The proposed action would result in an increased demand for nonhazardous solid waste disposal services at the Vasco Road Sanitary Landfill.	Less than significant	None warranted	Same
LLNL Site 300 3.2.1 The proposed action would potentially result in a need for increased fire protection personnel, equipment, and/or facilities onsite.	Less than significant	3.2.1 The LLNL Fire Department will continue to review current operations at LLNL Site 300 against National Fire Protection standards on an annual basis. If additional needs are identified, personnel, equipment, and facilities would be increased or upgraded as necessary.	Same
3.2.2 The proposed action would potentially result in an increased demand for offsite fire protection services within the mutual aid network.	Less than significant	None warranted	Same
3.2.3 The proposed action would result in an increased demand for nonhazardous solid waste disposal services at the Corral Hollow Sanitary Landfill.	Significant and unavoidable	3.2.3 LLNL will continue to implement solid waste reduction and recycling strategies at LLNL Site 300.	Same
Cumulative Impacts—Community Services			
LLNL Livermore site and LLNL Site 300 3.4.1 Cumulative development would increase demand for school services in the region.	Significant and unavoidable	None available to DOE and UC.	Same
3.4.2 Cumulative development would increase the demand for nonhazardous solid waste disposal services at the Vasco Road Sanitary Landfill in Alameda County.	Less than significant	None warranted	Same
3.4.3 Cumulative development in the vicinity of LLNL Site 300 would increase the demand for	(Potentially) Significant and unavoidable	Impacts to solid waste disposal services cannot be fully mitigated by DOE or UC.	Same

nonhazardous solid waste disposal services at the Corral Hollow Sanitary Landfill.			
Prehistoric and Historic Cultural Resources			
LLNL Livermore site 4.1.1 Impacts to prehistoric resources are unlikely to result from the proposed action.	Less than significant	4.1.1 The Laboratory would require LLNL employees and contractors to report any evidence of cultural resources unearthed during development excavation at the LLNL Livermore site. An archaeologist would assess any unearthed resources at the construction site. If necessary, construction would be stopped to preclude disturbance of any cultural resources, conduct testing, and recommend mitigation measures in accordance with DOE and CEQA guidelines.	Same
4.1.2 Implementation of the proposed action has the potential to adversely affect important historic resources on the LLNL Livermore site.	Less than significant	4.1.2 Following completion of the Section 106 review process (i.e., compliance with the National Historic Preservation Act), the cultural resource management plan outlining the methodology for managing identified historic resources at the LLNL Livermore site would be made available to the public. In addition, management and mitigation activities implemented at the LLNL Livermore site would be reported annually.	Same
LLNL Site 300 4.2.1 Impacts to prehistoric resources at LLNL Site 300 are unlikely to result from the proposed action.	Less than significant	4.2.1 The Laboratory would require LLNL employees and contractors to report any evidence of cultural resources unearthed during development excavation at LLNL Site 300. An archaeologist would assess any unearthed resources at the construction site. If necessary, construction would be stopped to preclude disturbance of any cultural resources, conduct testing, and recommend mitigation measures in accordance with DOE and CEQA guidelines.	Same
4.2.2 Potential impacts to historic resources at LLNL Site 300 could occur as a result of the proposed action.	Less than significant	4.2.2A Following completion of the Section 106 review process (i.e., compliance with the National Historic Preservation Act), the cultural resource management plan outlining the methodology for managing identified historic resources at LLNL Site 300 would be made available to the public. In addition, management and mitigation activities implemented at LLNL Site 300 would be reported annually.	Same
		4.2.2B During construction activities at LLNL Site 300, access to any identified prehistoric or historic site located near the Area of Potential Effect, but not directly impacted by construction, would be restricted by means of stakes and	

		flagging or warning fences.	
		4.2.2C Monitoring during grading would be conducted in areas where historic resources are determined to exist within the Area of Potential Effect.	
Cumulative Impacts—Prehistoric and Historic Cultural Resources			
LLNL Livermore site 4.4.1 Cumulative impacts to prehistoric resources could result from regional development in the vicinity of the LLNL Livermore site and SNL, Livermore.	(Potentially) Significant	4.4.1 The impacts of the proposed action will be mitigated as set forth in Mitigation Measures 4.1.1. Impacts to prehistoric resources by other projects within the identified cumulative impact study area, but outside the boundaries of the LLNL Livermore and SNL, Livermore sites, cannot be mitigated by DOE or UC.	Same
4.4.2 Cumulative impacts to historic resources could result from regional development in the vicinity of the LLNL Livermore site and SNL, Livermore.	(Potentially) Significant	4.4.2 The impacts of the proposed action will be mitigated as set forth in Mitigation Measures 4.1.2. Impacts to historic resources by other projects within the identified cumulative impact study area, but outside the boundaries of the LLNL Livermore and SNL, Livermore sites, cannot be mitigated by DOE or UC.	Same
LLNL Site 300 4.4.3 Cumulative impacts to prehistoric resources could result from regional development in the vicinity of LLNL Site 300.	(Potentially) Significant	4.4.3 The impacts of the proposed action would be mitigated as set forth in Mitigation Measure 4.2.1. Impacts to prehistoric resources by other projects within the identified cumulative impact study area, but outside the boundaries of the LLNL Site 300, cannot be mitigated by DOE or UC.	Same
4.4.4 Cumulative impacts to historic resources could result from regional development in the vicinity of LLNL Site 300.	(Potentially) Significant	4.4.4 The impacts of the proposed action would be mitigated as set forth in Mitigation Measures 4.2.2A, B, and C. Impacts to historic resources by other projects within the identified cumulative impact study area, but outside the boundaries of LLNL Site 300, cannot be fully mitigated by DOE or UC.	Same
Aesthetics and Scenic Resources			
LLNL Livermore site 5.1.1 New development under the proposed action would involve construction of additional buildings and upgrading or replacement of other buildings and infrastructure at the LLNL Livermore site, with possible impacts on the visual quality of the Laboratory.	Less than significant	None warranted	Same

5.1.2 The proposed action would alter views from roadways designated as scenic resources under plans and policies of the County of Alameda and the City of Livermore.	Less than significant	None warranted	Same
LLNL Site 300 5.2.1 New development under the proposed action includes several construction projects and facility improvements at LLNL Site 300, with possible impacts on the visual quality of the site.	Less than significant	None warranted	Same
5.2.2 Implementation of the proposed action at LLNL Site 300 would alter views from roadways designated as scenic resources under plans and policies of the County of San Joaquin or the County of Alameda.	Less than significant	None warranted	Same
Cumulative Impacts—Aesthetics and Scenic Resources			
LLNL Livermore site 5.4.1 Buildout of approved and proposed developments in the vicinity of the Laboratory would potentially alter the visual quality of the region.	(Potentially) Significant	Measures to mitigate this impact are outside the authority of DOE or UC.	Same
LLNL Site 300 5.4.2 Buildout of approved and proposed developments in the vicinity of the Laboratories would potentially alter the visual quality of the region.	(Potentially) Significant	Measures to mitigate this impact are outside the authority of DOE or UC.	Same
Geologic Resources and Hazards			
LLNL Livermore site 6.1.1 Siting of facilities in areas subject to strong ground shaking at the LLNL Livermore site may result in structural damage and increased exposure of people to risks associated with ground shaking.	Significant	6.1.1A All buildings and facilities under the proposed action at the LLNL Livermore site, including retrofits, would be built or modified (or retrofitted) according to established seismic design criteria based on their hazard ranking and location as stated in DOE Order 5481.1B (see Appendix I). 6.1.1B Engineering and administrative measures	Less than significant

		would be taken to anticipate and prevent releases of hazardous substances resulting from strong ground shaking at any given facility. Discussions of these measures are included in Appendix D.	
6.1.2 Expansive or shrink-swell soils and soils with low permeability could adversely affect proposed action development projects at the LLNL Livermore site.	Significant	6.1.2 Site-specific geotechnical investigations by a California Certified Engineering Geologist, a California Registered Geologist or a California Registered Civil Engineer specializing in geotechnical studies, would be performed for proposed structures. The recommendations of the geotechnical investigation regarding foundations and subterranean drainage would be included in project design.	Less than significant
LLNL Site 300 6.2.1 Siting of facilities in areas subject to strong ground shaking at LLNL Site 300 may result in structural damage and increased exposure of people to risks associated with ground shaking.	Significant	6.2.1A All buildings and facilities would be built according to established seismic design criteria based upon their hazard ranking and location as stated in DOE Order 5481.1B (see Appendix I).	Less than significant
		6.2.1B Engineering and administrative measures would be taken to anticipate and prevent releases of hazardous substances resulting from strong ground shaking at any given facility. Discussions of these measures are included in Appendix D and Appendix I.	
6.2.2 Expansive or shrink-swell soils and soils with low permeability could adversely affect proposed action development projects at LLNL Site 300.	Significant	6.2.2 Site-specific geotechnical investigations by a California Certified Engineering Geologist, a California Registered Geologist or a California Registered Civil Engineer specializing in geotechnical studies, would be performed for proposed structures. The recommendations of the geotechnical investigation would include those regarding foundations and subterranean drainage and would be included in project design.	Less than significant
Cumulative Impacts—Geologic Resources and Hazards			
LLNL Livermore site 6.4.1 Proposed development projects and population growth could expose people to geologic hazards.	Less than significant	None warranted	Same
LLNL Site 300 6.4.2 Proposed development projects and population growth could expose people to geologic hazards.	Less than significant	None warranted	Same
Ecology			
LLNL Livermore site 7.1.1	Less than	None warranted	Same

The proposed action would affect vegetation principally by clearing land for construction projects.	significant		
7.1.2 The proposed action would affect wildlife principally by clearing land for construction projects.	Less than significant	None warranted	Same
LLNL Site 300 7.2.1 The proposed action would affect vegetation (introduced grassland plant communities) principally by clearing land for construction projects.	Less than significant	None warranted	Same
7.2.2 The proposed action would affect wildlife principally by clearing wildlife habitat for construction projects.	Less than significant	None warranted	Same
7.2.3 The Contained Firing Facility would reduce noise-related impacts to wildlife.	Beneficial	None warranted	Same
7.2.4 The Contained Firing Facility would eliminate the potential impact to wildlife from flying debris.	Beneficial	None warranted	Same
7.2.5 The Cheap Access to Orbit Facility would result in noise impacts to wildlife because of the loud noise generated during testing.	Less than significant	None warranted	Same
7.2.6 The proposed action would affect sensitive species principally by disrupting habitat for construction projects.	Significant	7.2.6A DOE and UC will enhance their current employee awareness program to reflect all biological mitigation measures. The employee awareness program will include all LLNL employees and contract personnel working at LLNL Site 300.	Less than significant
		7.2.6B DOE and UC will ensure that no construction-related activities occur within a 300-ft radius of known locations of elderberry bushes (see Figure F-18 in Appendix F). Elderberry bushes are habitat for the federally listed valley elderberry longhorn beetle.	
		7.2.6C DOE and UC will evaluate the U.S. Fish and Wildlife Service's fairy shrimp sampling	

protocol when published. The evaluation will focus on the need for additional sampling to ensure consistency between survey techniques described in section F.2.4.5 and those of the U.S. Fish and Wildlife Service.

7.2.6D DOE and UC will continue to limit the use of sulfur cartridges and anticoagulant ground squirrel poisons such as fumarin, sevin, and diphazinone (except within the fenced surface impoundments on LLNL Site 300). Zinc phosphite, which is much less injurious to canids, will remain the rodenticide of choice. (This measure also applies to the LLNL Livermore site and SNL, Livermore.)

7.2.6E Consistent with current practice, speed limits of 35 miles per hour or less at LLNL Site 300 will be maintained. Vehicle traffic will also be confined to existing roads (paved and unpaved) to the extent possible.

7.2.6F Warning sounds will continue to be broadcast from each testing facility before a detonation. In addition to warning personnel working in the area, this broadcast would scare away birds, particularly raptors, from the explosion test site.

7.2.6G To maintain and promote habitat diversity, DOE and UC will continue to exclude livestock grazing and will continue the annual controlled burning program on LLNL Site 300.

7.2.6H DOE and UC will continue to protect the large-flowered fiddleneck population near the Drop Tower by maintaining the fence, controlling access, and prohibiting activities that may adversely impact the population. A second population is in a remote canyon at a distance from current or proposed activities and requires no additional protection.

7.2.6I DOE and UC will continue to maintain the fire roads and disked areas in the same locations to the extent possible. After evaluation, where possible, duplicate roads paralleling other roads will be eliminated.

7.2.6J Herbicide use will remain limited to areas around buildings and other facilities or eliminated, if possible.

7.2.6K Consistent with current construction practices, all food-related trash items such as wrappers, cans, bottles, and food scraps will be disposed of in a closed container or removed from the construction site.

7.2.6L Undisturbed areas (i.e., areas having minimal recent surface disturbance) that may be affected by proposed construction projects will be surveyed for dens of the San Joaquin kit fox no earlier than 60 days prior to the beginning of construction activities. The survey area will include a minimum 300-ft buffer zone around the proposed construction zone.

For new fire trails, linear trenching, or the redisking of the fire break in the northeastern corner of LLNL Site 300, the buffer zone will cover 50 ft on either side of the right-of-way. In addition, a 50-ft buffer zone will be established around monitor well installations.

Methods employed during these surveys will follow techniques acceptable to the U.S. Fish and Wildlife Service and the California Department of Fish and Game (U.S. Fish and Wildlife Service, 1989). Disturbed areas will not be surveyed because of the enhanced awareness program, however, personnel would be aware of the potential for kit fox at the site.

Depending upon the results of the survey outlined in mitigative measure 7.2.6L, the following measures may be implemented.

7.2.6M Consistent with U.S. Fish and Wildlife Service (1989) recommendations, protective exclusion zones will be established around kit fox dens (see Table F-14 in Appendix F for kit fox den classifications) observed in the 300- or 50-ft buffer zone. These exclusion zones will be the following distances:

- Known kit fox dens=200 ft
- Pupping kit fox dens (dens with sign of pupping activity)=300 ft
- Potential kit fox dens=25 ft

DOE and UC will restrict activities within these exclusion zones: only essential vehicle operation will be allowed, and construction, materials storage, or other types of surface-disturbing activity will be prohibited or minimized. New roads will be kept to a minimum and vehicle

		traffic will be restricted to roads that are necessary for construction. If it is impossible to maintain acceptable exclusion zones DOE and UC will consult the U.S. Fish and Wildlife Service and the California Department of Fish and Game to modify exclusion zone dimensions or time restrictions. Alternative courses of action may also be taken (e.g., mitigation measures 7.2.6Q and 7.2.6R below).
		7.2.6N Any known and pupping kit fox dens found will be posted with a sign near the den entrance stating the presence of the sensitive resource. To ensure protection of these dens, fencing will be installed around each one following the exclusion distances specified above. The exclusion fencing will consist of large stakes (4- to 5-ft metal or 1×1-inch wooden stakes) connected with a heavy rope or cord, and will be maintained for the duration of the construction project. The exclusion area can be modified as described in measure 7.2.6M.
		Potential kit fox dens found within a proposed construction site buffer zone will have 2-ft wooden stakes with flagging placed at the den's entrance and will be maintained for the duration of the construction project.
		7.2.6O Monthly checks of known and pupping dens will be conducted to ensure that the signs, stakes, and fencing are still intact. Monitoring will be done as unobtrusively as possible, staying outside the exclusion zones.
		7.2.6P To prevent the kit fox (and other species of concern) from being injured or trapped during the construction phase of a project, excavated steep-walled holes or trenches greater than 2 ft deep will be covered with plywood at the close of each working day, or provided with one or more escape ramps constructed of earth fill or wooden planks. Before such holes or trenches are filled, they will be thoroughly inspected for trapped animals.
		7.2.6Q If potential kit fox dens would be unavoidably destroyed by construction or other related activities, the following procedures will be initiated prior to disturbance. The dens will be monitored by a trained kit fox biologist for 2 to 3 days to determine if they are being used by kit fox. Activity at the dens can be monitored by placing tracking medium at the den's entrance and

		by night spotlighting. If there is sign of kit fox activity, the dens will be observed for 2 to 3 more days to allow the animal to move to another den during its normal activities. If there is no activity, the den will be destroyed.
		7.2.6R If known kit fox dens occur within the areas of proposed disturbance or development, and impact to these resources is unavoidable, the following procedures will be implemented. Prior to the onset of construction and den destruction, the U.S. Fish and Wildlife Service and the California Department of Fish and Game will be notified in writing of the intent to destroy dens, and reasons will be provided why alternative courses of action are not possible. The dens will not be impacted until the U.S. Fish and Wildlife Service and the California Department of Fish and Game are provided the opportunity to review and comment on the proposed action. These agencies may recommend alternative courses of action to avoid den destruction or reduce impacts.
		If given permission by these agencies, excavation of known kit fox dens may then proceed. When the den is thought to be unoccupied, the entrance can then be progressively plugged with loose dirt for several days to discourage the use of the den while still allowing resident animals to escape easily. When sign of activity at the den ceases and it is deemed safe to do so by a trained kit fox biologist, the den can be dug out with hand tools to a point where it is certain no kit fox is using the den. The den will be fully excavated and then filled with dirt and compacted to ensure that a kit fox cannot reenter the den during the construction period. If at any point a kit fox is thought to be using the den, the plugging or excavation activity will stop, and the U.S. Fish and Wildlife Service and the California Department of Fish and Game will be contacted. All plugging and excavation efforts will be conducted by a trained kit fox biologist.
		If excavation of a pupping den is unavoidable, the plugging and excavation activities will not take place during the breeding season (January through June). Den monitoring and plugging activities will be fully documented and reported in writing to the U.S. Fish and Wildlife Service and the California Department of Fish and Game as part of the Mitigation Monitoring and Reporting Program.

		7.2.6S If construction activities impact known kit fox dens, then artificial dens may be installed at an agreed-upon location. LLNL will consult with the U.S. Fish and Wildlife Service and the California Department of Fish and Game on the appropriate placement and design of artificial dens.	
		Because the burrowing owl and American badger are state species of special concern, occur on LLNL Site 300, and may be impacted by the proposed action, the following mitigation measures will be undertaken coincident with kit fox activities.	
		7.2.6T Undisturbed areas that might be affected by proposed construction projects will be surveyed (including a 300-ft buffer zone) for known burrows or dens of the burrowing owl and American badger no sooner than 60 days prior to the beginning of construction activities. For new fire trails, the buffer zone will cover 50 ft on either side of the right-of-way.	
		7.2.6U If known dens are identified within the survey area, exclusion zones of 50 ft will be established and delineated.	
		7.2.6V LLNL will restrict activities within these exclusion zones: only essential vehicle operation will be allowed, and construction materials storage, or other types of surface-disturbing activity, will be prohibited or minimized. New roads will be kept to a minimum and vehicle traffic will be restricted to roads that are necessary for construction. If it is impossible to maintain acceptable exclusion zones, LLNL will consult with the California Department of Fish and Game to modify exclusion zone dimensions.	
		7.2.6W If known dens will be unavoidably impacted, consultation with the California Department of Fish and Game will occur to determine acceptable procedures for destruction of the dens.	
7.2.7 The Contained Firing Facility would reduce potential noise-related impacts on sensitive species.	Beneficial	None warranted	Same
7.2.8 The Contained Firing Facility would eliminate the potential impact to wildlife	Beneficial	None warranted	Same

from flying debris.			
7.2.9 The Cheap Access to Orbit Facility would result in potential noise impacts to sensitive species.	Less than significant	None warranted	Same
7.2.10 The proposed action would result in the elimination of artificial wetlands as a result of a project designed to stop surface water runoff from onsite cooling towers.	Significant	7.2.10 The 0.5 acre of lost wetlands would be replaced pursuant to consultation with the California Department of Fish and Game. One potential measure would be to use the artificial wetland vegetation that would likely be created in Corral Hollow Creek as a result of the ground water restoration project at LLNL Site 300 as mitigation for these lost wetlands. The ground water restoration project is an ongoing project at LLNL Site 300 that is part of continuing operations. See Appendix G, section G.5 for additional details regarding this mitigation option.	Less than significant
Cumulative Impacts—Ecology			
7.4.1 Cumulative impacts to vegetation may result from regional development in the vicinity of the LLNL Livermore site and SNL, Livermore.	(Potentially) Significant and unavoidable	7.4.1 Impacts to vegetation within the cumulative impact study area cannot be mitigated by DOE or UC.	Same
7.4.2 Cumulative impacts to vegetation may result from regional development in the vicinity of LLNL Site 300.	Less than significant	None warranted	Same
7.4.3 Cumulative impacts to sensitive species may result from development in the vicinity of LLNL Site 300.	(Potentially) Significant and unavoidable	7.4.3 The impacts of the proposed action will be mitigated as set forth under Impact 7.2.6. Impacts to sensitive species by other projects within the cumulative impact study areas cannot be mitigated by DOE or UC.	Same
7.4.4 Cumulative impacts to wetlands may result from regional development in the vicinity of LLNL Site 300.	(Potentially) Significant and unavoidable	7.4.4 The impacts of the proposed action will be mitigated as set forth under Impact 7.2.10. Impacts to wetlands by other projects within the cumulative impact study area cannot be mitigated by DOE or UC.	Same
Air Quality			
LLNL Livermore site 8.1.1 Growth at the LLNL Livermore site would result in short-term impacts due to construction activities.	Significant and unavoidable	8.1.1 General construction practices at the LLNL Livermore site, including contract specifications, would require that fugitive emissions be reduced by means such as water spraying of roads and the wheels and lower portions of construction vehicles and covering exposed piles of excavated	Same

		material.	
8.1.2 Assumed growth at the LLNL Livermore site under the proposed action would result in an increase of criteria pollutant emissions.	Significant and unavoidable	8.1.2 On a project-specific basis, the LLNL Livermore site will evaluate the feasibility of designing buildings to minimize the contribution of criteria pollutants to the offsite ambient concentrations.	Same
8.1.3 Assumed growth at the LLNL Livermore site under the proposed action would result in an increase of beryllium emissions.	Less than significant	None warranted	Same
8.1.4 Assumed growth at the LLNL Livermore site under the proposed action would result in potential increases of toxic air contaminants.	Less than significant	None warranted	Same
8.1.5 Assumed growth at the LLNL Livermore site under the proposed action would result in an increase in carbon monoxide emissions from mobile sources.	Less than significant	None warranted	Same
8.1.6 Assumed growth at the LLNL Livermore site under the proposed action would result in an increase in nitrogen dioxide emissions from mobile sources.	Significant and unavoidable	8.1.6 Continue the existing LLNL programs to enhance, to the extent feasible, Transportation System Management programs that would revitalize and expand the vanpooling and ridesharing programs in an organized effort to reduce vehicle use and associated air emissions.	Same
8.1.7 The reduction in the administrative limit for tritium in Building 331 will be greater than the increase in the administrative limits for tritium in Buildings 298 and 391. The sum of the administrative limits for tritium in the three buildings will decrease from 300 g in Building 331 to a total of no more than 10 g in the three buildings (331, 298, 391). The reduction in the level of tritium operations would decrease releases of tritium into the environment.	Less than significant, may be beneficial	None warranted	Same
LLNL Site 300 8.2.1 Assumed growth at LLNL	Significant and	8.2.1 General construction practices at LLNL Site 300, including contract specifications, would	Same

Site 300 under the proposed action would result in short-term impacts due to construction activities.	unavoidable	require that fugitive emissions be reduced by means such as water spraying of roads and the wheels and lower portions of construction vehicles and covering exposed piles of excavated material.	
8.2.2 Construction of the Contained Firing Facility at LLNL Site 300 under the proposed action would result in decreased beryllium emissions from Building 801.	Beneficial	None warranted	Same
8.2.3 Growth at LLNL Site 300 would result in an increase in criteria pollutant emissions.	Significant and unavoidable	8.2.3 Mitigation measures for nitrogen dioxide, volatile organic compound, and PM10 emissions for the LLNL Livermore site identified in mitigation measure 8.1.2 would also be employed at LLNL Site 300.	Same
8.2.4 The Contained Firing Facility at LLNL Site 300 would essentially eliminate dispersion of uranium and any other constituent of explosive devices into the environment from Building 801.	Less than significant, may be beneficial	This is a beneficial impact and would require no mitigation	Same
8.2.5 Construction of the Explosives Waste Treatment Facility at LLNL Site 300 under the proposed action would result in the same or less air emissions.	Less than significant	None warranted	Same
8.2.6 Resumed use of a small amount of tritium at the LLNL Site 300 firing tables would increase the potential release of radioactivity into the atmosphere. The releases would be limited and would comply with NESHAP.	Less than significant	None warranted	Same
Cumulative Impacts—Air Quality			
8.4.1 Assumed growth under the proposed action at the Laboratory and surrounding communities would increase criteria pollutant emission.	Significant and unavoidable	None available. Mitigation measures to reduce the impacts to less than significant are beyond the authority of DOE and UC.	Same
8.4.2 Radiation exposures to the public from activities at	Less than significant,	None warranted	Same

LLNL and SNL, Livermore would decrease under the proposed action.	may be beneficial		
8.4.3 Assumed growth under the proposed action at the Laboratories and the surrounding communities would increase toxic air contaminants.	Less than significant	None warranted	Same
Water			
LLNL Livermore site 9.1.1 As a result of the proposed action, a 9 percent increase in gross square footage of developed space is assumed, which may result in impacts to surface water runoff and ground water recharge.	Less than significant	None warranted	Same
LLNL Site 300 9.2.1 As a result of the proposed action, a 9 percent increase in gross square footage of developed space is assumed, which may result in impacts to surface water runoff and ground water recharge.	Less than significant	None warranted	Same
Cumulative Impacts—Water			
LLNL Livermore site and SNL, Livermore 9.4.1 Cumulative impacts from the proposed action and other regional development may impact surface and ground water quality.	Less than significant	None warranted	Same
LLNL Site 300 9.4.2 Cumulative impacts from the proposed action and other regional development may impact surface and ground water quality.	Less than significant	None warranted	Same
Noise			
LLNL Livermore site 10.1.1 Increases in construction-related noise could occur intermittently near the LLNL	Less than significant	10.1.1 Construction equipment and vehicles at the LLNL Livermore site would be properly muffled to reduce noise impacts.	Same

Livermore site as a result of the proposed action.			
10.1.2 Long-term increases in traffic-related noise levels in the vicinity of the LLNL Livermore site would occur as a result of the proposed action.	Less than significant	None warranted	Same
LLNL Site 300 10.2.1 Short-term increases in construction-related noise could occur near LLNL Site 300 as a result of the proposed action.	Less than significant	10.2.1 Construction equipment and vehicles at LLNL Site 300 would be properly muffled to reduce noise impacts.	Same
10.2.2 Long-term increases in noise from operations at LLNL Site 300 could result from the Cheap Access to Orbit project of the proposed action.	Less than significant	10.2.2 LLNL's weather and noise monitoring program at LLNL Site 300 will continue to restrict operations when peak impulse noise levels are predicted to exceed 126 dB in populated areas. The results will be documented in LLNL's publicly available annual Environmental Report.	Same
10.2.3 Long-term traffic-related noise levels along Corral Hollow Road would increase as a result of the proposed action.	Less than significant	None warranted	Same
10.2.4 Noise-sensitive receptors surrounding LLNL Site 300 could experience a reduction in noise from high explosives testing.	Beneficial	None warranted	Same
Cumulative Impacts—Noise			
LLNL Livermore site 10.4.1 The proposed action would contribute a small increment to cumulatively significant roadway noise levels that are expected to occur in the future along some roads in the study area.	Significant and unavoidable	The contribution to noise levels by the proposed action will be reduced by LLNL Mitigation Measure 11.1.2. However, incremental noise impacts would not be completely eliminated. Measures to reduce cumulative roadway noise levels resulting from other projects are beyond the authority of DOE or UC to implement.	Same
LLNL Site 300 10.4.2 The proposed action would contribute a small increment to cumulative, but less than significant, roadway noise levels that are expected to occur in the future along	Less than significant	None warranted	Same

Corral Hollow Road.			
Traffic			
LLNL Livermore site 11.1.1 Short-term traffic impacts could result during construction activities on the Laboratory sites.	Less than significant	None warranted	Same
11.1.2 Implementation of the proposed action would result in increased congestion along local roadways and at intersections in the vicinity of the Laboratories.	Less than significant	11.1.2 While no mitigation is required, LLNL would implement an expanded Transportation Systems Management Program to aid in reducing traffic congestion.	Same
11.1.3 Acquisition of a portion of East Avenue, and subsequent alteration of the traffic flow along this roadway segment, could affect traffic conditions in the vicinity of the LLNL Livermore site and SNL, Livermore.	Less than significant	None warranted	Same
11.1.4 An increased demand on public transportation would occur.	Less than significant	None warranted	Same
11.1.5 An increase in demand for parking at the LLNL Livermore site would occur.	(Potentially) Significant	11.1.5 LLNL would continue to monitor the parking supply at the LLNL Livermore site and schedule capital improvements as necessary to alleviate any parking stall deficiencies. Implementation of Mitigation Measure 11.1.2 would also decrease the need for parking.	Less than significant
LLNL Site 300 11.2.1 Traffic volumes along Corral Hollow Road and at the Corral Hollow Road/I-580 interchange would increase.	Less than significant	None warranted	Same
11.2.2 An increase in demand for parking at LLNL Site 300 would occur.	Less than significant	None warranted	Same
Cumulative Impacts—Traffic			
LLNL Livermore Site 11.4.1 Cumulative development in the area would result in an increase in traffic congestion	Significant and unavoidable	No measures are implementable by DOE or UC.	Same

along roadways in the vicinity of the site.			
11.4.2 Planned and proposed development in the cumulative study area would result in a cumulative increase in traffic congestion at certain intersections in the vicinity of the Laboratories.	Significant and unavoidable	No measures are implementable by DOE or UC.	Same
LLNL Site 300 11.4.3 Cumulative development would result in an increase in traffic congestion on roadways in the vicinity of LLNL Site 300.	Less than significant	None warranted	Same
11.4.4 Traffic congestion at the Corral Hollow Road/I-580 interchange would increase significantly under cumulative buildout in the vicinity of LLNL Site 300.	Significant and unavoidable	No measures are implementable by DOE or UC.	Same
Utilities and Energy			
LLNL Livermore site 12.1.1 Growth at the LLNL Livermore site may result in increased water consumption.	Significant	12.1.1A LLNL would continue to reduce use of Hetch Hetchy and Zone 7 water for landscaping irrigation below 1989 levels.	Less than significant
		12.1.1B LLNL would continue to reduce blowdown in cooling towers to minimal operable levels.	
		12.1.1C LLNL would limit car washing to only that which is essential.	
		12.1.1D LLNL would use reclaimed ground water in place of potable water in cooling towers to the greatest extent feasible.	
		12.1.1E LLNL would reassess new contracts for additional water-intensive landscaping (i.e., lawn and groundcover) and implement feasible conservation measures, including native, drought-resistant plants and drip versus spray irrigation.	
		12.1.1F LLNL would monitor all water use to discourage waste or unnecessary use.	
		12.1.1G LLNL would use reclaimed ground water in place of potable water for irrigation to the greatest extent possible.	

		12.1.1H LLNL would continue the employee water conservation awareness program.	
12.1.2 Growth at the LLNL Livermore site would result in increased electricity consumption.	Less than significant	None warranted	Same
12.1.3 Total fuel consumption would increase at the LLNL Livermore Site as a result of the proposed action.	Less than significant	None warranted	Same
12.1.4 Retention tanks would reduce the potential for releases of radionuclides to the sewer.	Beneficial	None warranted	Same
12.1.5 An increase in the volume of sewage discharge would result from implementation of the proposed action at the LLNL Livermore site.	Significant	12.1.5 LLNL would evaluate and install, where feasible, process conservation devices or modifications to reduce water consumption. This would result in lower sewage discharges.	Less than significant
LLNL Site 300 12.2.1 Growth at LLNL Site 300 may result in increased water consumption.	Significant	12.2.1A LLNL would continue to reduce landscape irrigation below 1989 levels.	Less than significant
		12.2.1B LLNL would continue to reduce blowdown in cooling towers to minimal operable levels.	
		12.2.1C LLNL would limit car washing to only that which is essential.	
		12.2.1D LLNL would monitor all water use to discourage waste or unnecessary use.	
12.2.2 Growth at LLNL Site 300 would result in increased electricity consumption.	Less than significant	None warranted	Same
12.2.3 Total fuel consumption would increase at LLNL Site 300 as a result of the proposed action.	Less than significant	None warranted	Same
12.2.4 An increase in the volume of sewage discharge at LLNL Site 300 would result from the proposed action.	Less than significant	None warranted	Same

LLNL Livermore site 12.4.1 Cumulative development in the vicinity of the LLNL Livermore site would increase demand for and consumption of water.	Significant and unavoidable	Mitigation measures for the proposed action are set forth under Impact 12.1.1. No mitigation measures are available for other projects in the area.	Same
LLNL Site 300 12.4.2 Cumulative development in the vicinity of LLNL Site 300 would increase demand and consumption of water.	Significant and unavoidable	Mitigation measures for the proposed action are set forth under Impact 12.2.1. No mitigation measures are available for other projects in the area.	Same
LLNL Livermore site 12.4.4 Cumulative development at the LLNL Livermore site under the proposed action would increase electric power demand.	Less than significant	None warranted	Same
LLNL Site 300 12.4.5 Cumulative development at LLNL Site 300 under the proposed action would increase electric power demand.	Less than significant	None warranted	Same
LLNL Livermore site 12.4.7 The proposed action would impact sewage services together with other development in the service area.	Less than significant	None warranted	Same
Materials and Waste Management			
LLNL Livermore site 13.1.1 Increased use of hazardous and radioactive materials would result in an increased number of shipments of materials to and from LLNL.	Less than significant	None warranted	Same
13.1.2 Implementation of the proposed action may result in an increase in the generation of hazardous, radioactive, mixed, and medical waste at the LLNL Livermore site.	Less than significant	None warranted	Same
13.1.3 Mixed waste generation may require onsite storage beyond storage limits	(Potentially) Significant and	13.1.3A LLNL would continue to enhance its waste minimization policies and practices to reduce generation of mixed wastes at the source.	Less than significant

prescribed by RCRA and could result in a need for additional storage capacity.	unavoidable	13.1.3B When treatment, storage, and/or disposal options become available for these mixed wastes, LLNL would pursue those alternatives.	
		13.1.3C LLNL would treat increased quantities of treatable low-level liquid mixed wastes at the wastewater treatment tank farm to reduce total volumes. In addition, the planned Mixed Waste Treatment Facility would be used to reduce the volume of combustible mixed wastes.	
		13.1.3D If it appears that LLNL is approaching storage capacity limits, LLNL would apply for additional permitted capacity to accommodate storage until treatment, storage, and/or disposal become available.	
13.1.4 Increased radioactive waste storage capability may be required under the proposed action.	Less than significant	None warranted	Same
13.1.5 Increased waste generation would result in an increased number of waste shipments.	Less than significant	None warranted	Same
13.1.6 The Mixed Waste Treatment Facility is planned to provide treatment processes for mixed wastes with combustible organic constituents that are presently stored onsite and that have no disposal option.	Beneficial	None warranted	Same
13.1.7 The proposed Decontamination and Waste Treatment Facility would replace the current waste processing facility, improving waste management capability.	Beneficial	None warranted	Same
13.1.8 Retention tank upgrades would reduce the potential for releases of radionuclides to the sewer.	Beneficial	None warranted	Same
LLNL Site 300 13.2.1 Increased use of hazardous and radioactive materials would result in an increased	Less than significant	None warranted	Same

number of shipments or transfers of materials to and from LLNL Site 300.			
13.2.2 Implementation of the proposed action may result in an increase in the generation of radioactive, hazardous, mixed, and medical waste at LLNL Site 300.	Less than significant	None warranted	Same
13.2.3 Increased radioactive waste storage capability may be required under the proposed action.	Less than significant	None warranted	Same
13.2.4 Increased waste generation would result in an increased number of waste shipments.	Less than significant	None warranted	Same
Cumulative Impacts—Materials and Waste Management			
LLNL Livermore site, LLNL Site 300, and SNL, Livermore 13.4.1 The projected growth of LLNL and SNL, Livermore, together with increased development in regional industrial areas, would result in an increased number of shipments of radioactive and hazardous materials.	Less than significant	None warranted. No mitigation measures are available for other projects in the area.	Same
13.4.2 Assumed growth at the Laboratories and at other waste-generating facilities may result in increased waste generation, treatment, and disposal.	Significant and unavoidable	13.4.2 Mitigation measures to prevent or reduce these cumulative impacts are beyond the authority of UC. DOE is addressing the issue on a national scale as part of a Programmatic EIS.	Same
13.4.3 Assumed growth at the Laboratories and surrounding facilities may result in increased hazardous and radioactive waste shipments in the area.	Significant and unavoidable	13.4.3 Mitigation measures to prevent or reduce these cumulative impacts are beyond the authority of UC. DOE is addressing the issue on a national scale as part of a Programmatic EIS.	Same
Occupational Protection			
LLNL Livermore site 14.1.1 The planned upgrade of the Plutonium Facility would	Less than significant, may be	None warranted	Same

reduce external radiation exposures to workers by reducing the frequency and duration of exposures through design modifications that would provide additional shielding and ease of access to enhance the concept of "as low as reasonably achievable."	beneficial		
14.1.2 Reduction of the administrative limit for plutonium in Building 332, the Plutonium Facility, would reduce the radiation exposure of workers handling plutonium.	Beneficial	None warranted	Same
14.1.3 The combined administrative limit for tritium will be reduced from 300 g in one facility (Building 331) to 10 g total in three facilities (Buildings 298, 331, and 391).	Less than significant, may be beneficial	None warranted	Same
14.1.4 Decontamination and decommissioning of Buildings 212 and 292 would reduce long-term worker radiation exposure.	Less than significant, may be beneficial	None warranted	Same
14.1.5 Overall site usage of toxic substances and physical hazards is assumed to increase by 9 percent under the proposed action.	Less than significant	None warranted	Same
14.1.6 The proposed Hazards Control Fire Science Facility would add new laboratories and control rooms, which will reduce worker exposure.	Less than significant, may be beneficial	None warranted	Same
14.1.7 Upgrading the fire alarm system would improve the capability of responding to a fire.	Less than significant, may be beneficial	None warranted	Same
14.1.8 The proposed tightening of controls and enclosure of the system operations in the Building	Less than significant, may be beneficial	None warranted	Same

322 Plating Facility; renovation of Building 321, which houses all of the general and precision machining operations and the weld shop; and general upgrading of the electronic shop, including closed loop processing for the wire board facility, would decrease worker exposures to organic and inorganic toxic substances.			
14.1.9 Replacement of the fume hoods in Building 151 would decrease worker exposure to toxic substances.	Less than significant, may be beneficial	None warranted	Same
LLNL Site 300 14.2.1 Upgrade and operation of the Flash X-Ray accelerator (FXR) would add a potential source for external radiation exposure of workers, but the exposures would remain as low as reasonably achievable and within regulatory guidelines.	Less than significant	None warranted	Same
14.2.2 The high explosive waste open burning facility would be replaced with a new Explosive Waste Treatment Facility.	Less than significant, may be beneficial	None warranted	Same
Cumulative Impacts—Occupational Protection			
14.4.1 The collective radiation dose to workers at LLNL and SNL, Livermore would decrease from current levels.	Less than significant, may be beneficial	None warranted	Same
14.4.2 Workers at LLNL and SNL, Livermore would continue to be exposed to approximately the same level of risk from toxic substances in the workplace as under current conditions.	Less than significant	None warranted	Same
Site Contamination			

LLNL Livermore site 15.1.1 The proposed action may result in exposure of workers to site contaminants, or in the release of site contaminants to the air or surface water.	Less than significant	None warranted	Same
15.1.2 The proposed action may result in exposure of people to volatile organic compounds, or in the release of volatile organic compounds to the air.	Less than significant	None warranted	Same
15.1.3 The proposed action may result in exposure of people to chromium and tritium or the release of chromium and tritium to the air.	Less than significant	None warranted	Same
LLNL Site 300 15.2.1 The proposed action may result in exposure of people to site contaminants, or in the release of site contaminants to the air or surface water.	Less than significant	None warranted	Same
Cumulative Impacts—Site Contamination			
LLNL Livermore site 15.4.1 The cumulative site contamination setting may result in low concentrations of contaminants impacting the use of ground water.	Less than significant	None warranted	Same
LLNL Site 300 15.4.2 The proposed action may result in cumulative impacts through exposure of people to site contaminants, or in the release of site contaminants to the air or surface water.	Less than significant	None warranted	Same
15.4.3 The proposed action will have an overall beneficial impact on ground water resources and land use.	Beneficial	None warranted	Same

* In accordance with CEQA and the UC CEQA Guidelines, four descriptive categories are used in this EIS/EIR to discuss and analyze environmental impacts: less than significant, significant, significant and unavoidable, and beneficial. These determinations are used consistently throughout the EIS/EIR. Under NEPA, however, the

significance of environmental impacts determines the need for the NEPA document; once that decision has been made, specific impacts are not categorized according to level of impact in an EIS.

Table 5.1.16-2 Summary of Impacts and Mitigation Measures Sandia National Laboratories, Livermore

Issue Area and Impacts	Level of Significance*	Mitigation Measures	Level of Significance After Mitigation
Land Uses and Applicable Plans			
1.3.1 The proposed action would result in additional development at the site to be used for the same types of uses as existing facilities.	Less than significant	None warranted	Same
1.3.2 DOE acquisition of a portion of East Avenue would alter a segment of this road's use from a local government–owned, unrestricted access roadway to a federal government–owned, possibly restricted access roadway.	Less than significant	None warranted	Same
Socioeconomic Characteristics			
2.3.1 Total employment in Alameda County would increase with the implementation of the proposed action.	Beneficial	None warranted	Same
2.3.2 An increase in population level and housing demand within Alameda County would occur as a result of the proposed action.	Less than significant	None warranted	Same
2.3.3 An increase in population level and housing demand within the City of Livermore would occur as a result of the proposed action.	Less than significant	None warranted	Same
2.3.4 The proposed action would generate additional employment income and expenditures in the region.	Beneficial	None warranted	Same

Cumulative Impacts—Socioeconomic Characteristics			
2.4.1 The proposed action would contribute to cumulative housing demand in the region.	Significant and unavoidable	Mitigation measures to reduce impacts on housing availability in the region are beyond the authority of DOE or UC.	Same
Community Services			
3.3.1 The proposed action would potentially increase the demand for fire protection and emergency services at SNL, Livermore.	Less than significant	None warranted	Same
3.3.2 The proposed action would potentially increase the demand for security services to provide adequate protection at SNL, Livermore.	Less than significant	None warranted	Same
3.3.3 The proposed action would result in additional demand for school services in the region.	Less than significant	3.3.3 DOE will continue to participate in the federal government's Impact Aid Program, which contributes funds to the Livermore Valley Joint Unified School District to compensate for impacts to the district resulting from the provision of school services to pupils with at least one parent employed on federal lands.	Same
3.3.4 The proposed action would result in an increase in demand for nonhazardous solid waste disposal services at the Vasco Road Sanitary Landfill.	Less than significant	None warranted	Same
Cumulative Impacts—Community Services			
3.4.1 Cumulative development would increase demand for school services in the region.	Significant and unavoidable	None available to DOE and UC	Same
3.4.2 Cumulative development would increase the demand for nonhazardous solid waste disposal services at the Vasco Road Sanitary Landfill in Alameda County.	Less than significant	None warranted	Same
Prehistoric and Historic Resources			
4.3.1 Impacts to prehistoric or historic resources at SNL, Livermore are unlikely to result from the proposed action.	Less than significant	None warranted.	Same

Cumulative Impacts—Prehistoric and Historic Resources			
4.4.1 Cumulative impacts to prehistoric resources could result from regional development in the vicinity of the LLNL Livermore site and SNL, Livermore.	(Potentially) Significant	4.4.1 The impacts of the proposed action will be mitigated as described in Mitigation Measures 4.1.1. Impacts to prehistoric resources by other projects within the identified cumulative impact study area, but outside the boundaries of the LLNL, Livermore and SNL, Livermore sites, cannot be fully mitigated by DOE or UC.	Same
4.4.2 Cumulative impacts to historic resources could result from regional development in the vicinity of the LLNL Livermore site and SNL, Livermore.	(Potentially) Significant	4.4.2 The impacts of the proposed action will be mitigated as set forth in Mitigation Measures 4.1.2. Impacts to historic resources by other projects within the identified cumulative impact study area, but outside the boundaries of the LLNL Livermore and SNL, Livermore sites, cannot be mitigated by DOE or UC.	Same
Aesthetics and Scenic Resources			
5.3.1 New development under the proposed action would involve construction of new facilities and upgrade or replacement of buildings and infrastructure at SNL, Livermore, with possible impacts on the visual quality of the Laboratory.	Less than significant	None warranted	Same
5.3.2 The proposed action would alter views from roadways designated as scenic resources under plans and policies of the County of Alameda and the City of Livermore.	Less than significant	None warranted	Same
Cumulative Impacts—Aesthetics and Scenic Resources			
5.4.1 Buildout of approved and proposed developments in the vicinity of the Laboratories would potentially alter the visual quality of the region.	(Potentially) Significant	Measures to mitigate this impact are outside the authority of DOE or UC.	Same
Geologic Resources and Hazards			
6.3.1 Siting of facilities in areas subject to strong ground shaking at SNL, Livermore may result in structural damage and increased exposure of people to risks associated with ground shaking.	Significant	6.3.1A All new buildings and facilities would be built according to established seismic design criteria based upon their hazard ranking and location as stated in DOE Order 5481.1B (see Appendix I).	Less than significant

		6.3.1B Engineering and administrative measures would be taken to anticipate and prevent releases of hazardous substances resulting from strong ground shaking at any given facility. Discussions of these measures are included in Appendix D and Appendix I.	
		6.3.1C Site-specific geotechnical investigations by a California Certified Engineering Geologist or by a California Registered Geologist and a California Registered Civil Engineer specializing in geotechnical investigation would continue to be performed for proposed structures. The recommendations of the geotechnical investigation would include those regarding foundations and subterranean drainage and would be included in project design.	
6.3.2 The potential exists for surface faulting at SNL, Livermore, near the north branch of the Las Positas fault, which may result in structural failure or expose people to potential safety hazards.	Significant	6.3.2A All new buildings and facilities would be built according to established seismic design criteria based upon their hazard ranking and location as stated in DOE Order 5481.1B (see Appendix I).	Less than significant
		6.3.2B Site-specific geotechnical investigations by a California Certified Engineering Geologist or by a California Registered Geologist and a California Registered Civil Engineer specializing in geotechnical studies would continue to be performed for proposed structures. The recommendations of the geotechnical investigation would include those regarding foundations and seismicity and would be included in project design.	
6.3.3 Expansive or shrink-swell soils and soils with low permeability could adversely affect proposed action development projects at SNL, Livermore.	Significant	6.3.3. Site-specific geotechnical investigations by a California Certified Engineering Geologist or by a California Registered Geologist and a California Registered Civil Engineer specializing in geotechnical studies would continue to be performed for proposed structures. The recommendations of the geotechnical investigation would include those regarding foundations and subterranean drainage and would be included in project design.	Less than significant
Cumulative Impacts—Geologic Resources and Hazards			
6.4.1 Proposed development projects and population growth could expose people to geologic	Less than significant	None warranted	Same

hazards.			
Ecology			
7.3.1 The proposed action would affect vegetation principally by clearing land for building construction projects and infrastructure modernization (e.g., roof replacements, resurfacing paved areas, renovation of site fire water system).	Less than significant	None warranted	Same
7.3.2 The proposed action would affect wildlife principally by disrupting habitat from building construction and infrastructure modernization.	Less than significant	None warranted	Same
Cumulative Impacts—Ecology			
7.4.1 Cumulative impacts to vegetation may result from regional development in the vicinity of the LLNL site and SNL, Livermore.	Potentially significant and unavoidable	7.4.1 Impacts to vegetation within the cumulative impact study area cannot be mitigated by DOE.	Same
Air Quality			
8.3.1 The administrative limit for tritium at the Tritium Research Laboratory will be reduced from 50 g to zero over the next 10 years and the building will be converted to alternative uses.	Less than significant, may be beneficial	None required	Same
8.3.2 Assumed growth at SNL, Livermore under the proposed action would result in short-term impacts due to construction activities.	Less than significant	8.3.2 SNL, Livermore would require general construction practices to minimize generation of fugitive dust by water spray application.	Same
8.3.3 Assumed growth at SNL, Livermore under the proposed action would result in an increase in criteria pollutant emissions.	(Potentially) Significant and unavoidable	8.3.3 The mitigation measures discussed for nitrogen dioxide, volatile organic compound, and PM10 emissions from the LLNL Livermore site would also be employed at SNL, Livermore.	Same
8.3.4 Assumed growth at SNL, Livermore under the proposed action would result in an increase of toxic air contaminants.	Less than significant	None warranted	Same

8.3.5 Decontamination and decommissioning of the Tritium Research Laboratory will result in tritium air emissions during the decontamination activities.	Less than significant	None warranted	Same
Cumulative Impacts—Air Quality			
8.4.1 Assumed growth under the proposed action at the Laboratory and surrounding communities would increase criteria pollutant emissions.	Significant and unavoidable	None available. Mitigation measures to reduce the impacts to less than significant are beyond the authority of DOE and UC.	Same
8.4.2 Radiation exposures to the public from activities at LLNL and SNL, Livermore would decrease under the proposed action.	Less than significant, may be beneficial	None warranted	Same
8.4.3 Assumed growth under the proposed action at the Laboratories and the surrounding communities would increase toxic air contaminants.	Less than significant	None warranted	Same
Water			
9.3.1 As a result of the proposed action, a 6 percent increase in gross square footage of developed space is assumed, which may result in impacts to surface and ground water quality.	Less than significant	None warranted	Same
Cumulative Impacts—Water			
9.4.1 Cumulative impacts from the proposed action and other regional development may impact surface and ground water quality.	Less than significant	None warranted	Same
Noise			
10.3.1 Short-term increases in construction-related noise could occur near SNL, Livermore as a result of the proposed action.	Less than significant	10.3.1 Construction equipment and vehicles would be properly muffled to reduce noise impact.	Same
10.3.2 Long-term increases in traffic-related noise levels in the vicinity of SNL, Livermore would occur as a result of the proposed action.	Less than significant	None warranted	Same

Cumulative Impacts—Noise			
10.4.1 The proposed action would contribute a small increment to cumulatively significant roadway noise levels that are expected to occur in the future along some roads in the study area.	Significant and unavoidable	The contribution to noise levels by the proposed action will be reduced by LLNL Mitigation Measure 11.1.2. However, incremental noise impacts would not be completely eliminated. Measures to reduce cumulative roadway noise levels resulting from other projects are beyond the authority of DOE to implement.	Same
Traffic			
11.1.1 Short-term traffic impacts could result during construction activities on the Laboratory sites.	Less than significant	None warranted	Same
11.1.2 Implementation of the proposed action would result in increased congestion along local roadways and at intersections in the vicinity of the Laboratories.	Less than significant	11.1.2 While no mitigation is required, LLNL would implement an expanded Transportation Systems Management Program to aid in reducing traffic congestion.	Same
11.1.3 Acquisition of a portion of East Avenue, and subsequent alteration of the traffic flow along this roadway segment, could affect traffic conditions in the vicinity of the LLNL Livermore site and SNL, Livermore.	Less than significant	None warranted	Same
11.1.4 An increased demand on public transportation would occur.	Less than significant	None warranted	Same
11.1.6 An increase in demand for parking at SNL, Livermore would occur.	Less than significant	None warranted	Same
Cumulative Impacts—Traffic			
11.4.1 Cumulative development in the area would result in an increase in traffic congestion along roadways in the vicinity of the site.	Significant and unavoidable	No measures are implementable by DOE or UC.	Same
11.4.2 Planned and proposed development in the cumulative study area would result in a cumulative increase in traffic congestion at certain intersections	Significant and unavoidable	No measures are implementable by DOE or UC.	Same

in the vicinity of the Laboratories.			
Utilities and Energy			
12.3.1 Growth at SNL, Livermore may result in increased water consumption.	Significant	12.3.1A SNL, Livermore would continue to reduce landscape watering below 1989 levels.	Less than significant
		12.3.1B SNL, Livermore would continue to reduce blowdown in cooling towers to minimal operable levels.	
		12.3.1C SNL, Livermore would limit car washing to only that which is essential.	
		12.3.1D SNL, Livermore would reassess all new contracts for additional water-intensive landscaping (i.e., lawn and ground cover).	
		12.3.1E SNL, Livermore would monitor all water use to discourage waste or unnecessary use.	
12.3.2 Growth at SNL, Livermore may result in increased electricity consumption.	Less than significant	None warranted	Same
12.3.3 Total fuel consumption at SNL, Livermore would increase as a result of the proposed project.	Less than significant	None warranted	Same
12.3.4 An increase in the volume of sewage discharge at SNL, Livermore would result from the proposed action.	Less than significant	None warranted	Same
Cumulative Impacts—Utilities and Energy			
12.4.3 Cumulative development in the vicinity of SNL, Livermore would increase demand for and consumption of water.	Significant and unavoidable	12.4.3 Mitigation measures for the proposed action are set forth under Impact 12.3.1. No mitigation measures are available for other projects in the area.	Same
12.4.6 Cumulative development at SNL, Livermore under the proposed action would increase electric power demand.	Less than significant	None warranted	Same
12.4.7 The proposed action would impact sewage services together with other development in the service area.	Less than significant	None warranted	Same

Materials and Waste Management			
13.3.1 An increase in the quantity of hazardous or radioactive materials transported to and from SNL, Livermore would result under the proposed action.	Less than significant	None warranted	Same
13.3.2 The projected growth at SNL, Livermore may result in the increased generation of radioactive, hazardous, mixed, and medical wastes.	Less than significant	None warranted	Same
13.3.3 Mixed-waste generation would require onsite storage beyond storage limits prescribed by RCRA.	(Potentially) Significant and unavoidable	13.3.3A SNL, Livermore would continue to enhance its waste minimization policies and practices to reduce generation of mixed wastes at the source.	Same
		13.3.3B When treatment and disposal options become available for these mixed wastes, SNL, Livermore would pursue these alternatives.	
13.3.4 Increased waste generation may result in increased storage requirements for radioactive and mixed waste.	Less than significant	None warranted	Same
13.3.5 Increased waste generation would result in an increased number of waste shipments.	Less than significant	None warranted	Same
13.3.6 Decommissioning of the Tritium Research Laboratory would result in an increased generation of low-level radioactive wastes for the three years of the project.	Less than significant	None warranted	Same
13.3.7 Decommissioning of the Tritium Research Laboratory would result in increased mixed waste generation for the three years of the project.	Less than significant	None warranted	Same
Cumulative Impacts—Materials and Waste Management			
13.4.1 The projected growth of LLNL and SNL, Livermore, together with increased development in regional industrial areas, would result in an increased number of	Less than significant	None warranted. No mitigation measures are available for other projects in the area.	Same

shipments of radioactive and hazardous materials.			
13.4.2 Assumed growth at the Laboratories and at other waste-generating facilities may result in increased waste generation, treatment, and disposal.	Significant and unavoidable	Mitigation measures to prevent or reduce these cumulative impacts are beyond the authority of UC. DOE is addressing the issue on a national scale as part of a Programmatic EIS.	Same
13.4.3 Assumed growth at the Laboratories and surrounding facilities may result in increased hazardous and radioactive waste shipments in the area.	Significant and unavoidable	Mitigation measures to prevent or reduce these cumulative impacts are beyond the authority of UC. DOE is addressing the issue on a national scale as part of a Programmatic EIS.	Same
Occupational Protection and Public Health			
14.3.1 Over the next 10 years, SNL, Livermore will phase out tritium operations at the Tritium Research Laboratory and convert the building to other uses. This could reduce radiation exposure to workers.	Less than significant, may be beneficial	None warranted	Same
14.3.2 Decommissioning of the Tritium Research Laboratory would increase radiation exposure to decontamination workers.	Less than significant	None warranted	Same
14.3.3 Construction of a proposed Environmental Safety and Health facility at SNL, Livermore, with a new hazardous waste handling facility for temporary storage of toxic and mixed waste, would replace the current waste handling facility and would reduce worker exposure.	Less than significant, may be beneficial	None warranted	Same
Cumulative Impacts—Occupational Protection and Public Health			
14.4.1 The collective radiation dose to workers at LLNL and SNL, Livermore would decrease from current levels.	Less than significant, may be beneficial	None warranted	Same
14.4.2 Workers at LLNL and SNL, Livermore would continue to be exposed to approximately the same level of risk from toxic substances in the workplace as under current conditions.	Less than significant	None warranted	Same

Site Contamination–Cumulative Impacts			
15.4.4 The proposed action may result in exposure of people to site contaminants, or in the release of site contaminants to the air or surface water.	Less than significant	None warranted	Same

*In accordance with CEQA and the UC CEQA Guidelines, four descriptive categories are used in this EIS/EIR to discuss and analyze environmental impacts: less than significant, significant, significant and unavoidable, and beneficial. These determinations are used consistently throughout the EIS/EIR. Under NEPA, however, the significance of environmental impacts determines the need for the NEPA document; once that decision has been made, specific impacts are not categorized according to level of impact in an EIS. Although SNL, Livermore is not subject to CEQA, Levels of Significance are used in tables to provide consistency with LLNL discussions.

5.2 NO ACTION ALTERNATIVE

Summary of No Action

This alternative is the continued operation of LLNL and SNL, Livermore including those projects already funded through FY 1992. Programs and projects would continue at their present (FY 1992) level as described in section 3.2.1, but no proposed projects would be added except those funded, those required to maintain the existing infrastructure, and those required for compliance with statutes and regulations. Employment and funding levels, adjusted for inflation, would remain at FY 1992 levels.

The standards of significance for the no action alternative are the same as those applied to the proposed action.

5.2.1 LAND USES AND APPLICABLE PLANS

This section describes the impacts to land uses and applicable plans under the no action alternative.

LLNL Livermore Site

Under the no action alternative, programs and projects would continue at their present (FY 1992) level. No land acquisitions are included under the no action alternative.

The existing LLNL Livermore site facilities do not conflict with the surrounding land uses, given the 500-ft-wide perimeter areas. The no action alternative would be compatible with the surrounding land uses, since no new types of land uses would be introduced.

Implementation of this alternative would be consistent with the applicable land use plans and policies for the County of Alameda and the City of Livermore; no land use incompatibilities with planned and proposed projects in the vicinity are identified for this alternative.

LLNL Site 300

The types of land uses at LLNL Site 300 are not proposed to change. No land acquisitions are included as part of the no action alternative.

The no action alternative would be compatible with the surrounding land uses, since no new types of land uses would be introduced. Implementation of this alternative would also be consistent with the applicable land use plans and policies for the County of Alameda and the County of San Joaquin.

SNL, Livermore

Under the no action alternative, programs and projects at SNL, Livermore would continue at their present (FY 1992) level. No land acquisitions are included as part of the no action alternative. The types of land uses at SNL, Livermore would not change under the no action alternative.

The existing SNL, Livermore facilities do not conflict with the surrounding land uses. The no action alternative would be compatible with the surrounding land uses, since no new types of land uses would be introduced.

Implementation of this alternative would be consistent with the applicable land use plans and policies for the County of Alameda and the City of Livermore; no land use incompatibilities with planned and proposed projects in the vicinity are identified for this alternative.

IMPACTS—LLNL LIVERMORE SITE

No additional square footage at the site would result with this alternative.

As discussed in section 4.2, land uses surrounding the LLNL Livermore site include industrial, agricultural, and residential. The existing LLNL Livermore site facilities are compatible with the land uses surrounding the sites, recognizing the presence of the 500-ft-wide perimeter areas. The no action alternative would be compatible with existing and approved future land uses surrounding the site, since no new types of land uses are proposed.

IMPACTS—LLNL SITE 300

No additional square footage at the site would result with this alternative.

As discussed in section 4.2, land uses surrounding LLNL Site 300 include privately owned high explosives testing facilities, agricultural land, and the Carnegie State Vehicular Recreation Area. The uses at LLNL Site 300 are compatible with the existing land uses surrounding the site. The no action alternative would be compatible with existing and approved future land uses surrounding the site, since no new types of land uses would be introduced.

IMPACTS—SNL, LIVERMORE

No additional square footage at the site would result with this alternative.

Land uses surrounding the site include industrial, agricultural, and residential. The existing SNL, Livermore facilities are compatible with the land uses surrounding the site, recognizing the presence of the undeveloped perimeter areas. The no action alternative would be compatible with existing and approved future land uses surrounding the site, since no new types of land uses would be introduced.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

Development of the approved and proposed projects in the Livermore Valley (listed in Section 10) would contribute to the cumulative loss of agricultural land and open space; however, as under the proposed action, implementation of the no action alternative would not contribute to this cumulative effect because no loss of agricultural land or designated open space is proposed.

CUMULATIVE IMPACTS—LLNL SITE 300

Approved and proposed projects in the southwestern San Joaquin County hillsides (listed in Section 10) would contribute to a cumulative loss of open space; however, as under the proposed action, implementation of the no action alternative would not contribute to this cumulative loss of open space because no loss of agricultural land or open space is proposed.

5.2.2 SOCIOECONOMIC CHARACTERISTICS

This section describes the impacts to the socioeconomic characteristics of the region under the no action alternative.

LLNL Livermore Site

Project employment levels would remain similar to existing levels; therefore, the no action alternative would not change the employment base within Alameda County or San Joaquin County.

The no action alternative would not increase employment at the LLNL Livermore site; therefore, this alternative is not expected to alter the population within the region or to change the demand for housing.

Because employment levels and research and development activity would remain stable, the no action alternative would not result in impacts to the regional and local economy. The no action alternative would not provide additional employment opportunities or result in an increased level of expenditures for goods and services in the local and regional economy.

LLNL Site 300

As described for the LLNL Livermore site, implementing the no action alternative at LLNL Site 300 would result in no change to the current employment base or economy.

SNL, Livermore

Implementing the no action alternative at SNL, Livermore would result in no change to the current employment base or economy.

IMPACTS—LLNL LIVERMORE SITE

Employment Base

The no action alternative would not change the employment base of Alameda County because project employment levels are assumed to remain the same as current levels. Thus, no adverse employment impacts are anticipated.

Population and Demand for Housing

As stated above, the no action alternative would not increase employment at the LLNL Livermore site or SNL, Livermore. The no action alternative would not create an in-migration of persons into the region in search of employment opportunities. Therefore, the alternative is not anticipated to result in the alteration of population within the region or to change the demand for housing. Thus, no adverse housing impacts are anticipated.

Economic Factors

The no action alternative would not alter the existing economic contribution of the LLNL Livermore site to the region because employment levels and research and development activity are assumed to remain the same as current levels. Also, the no action alternative would have no effect on the amount of expenditures for goods and services in the local and regional economy. Thus, no adverse or beneficial economic impacts are anticipated.

IMPACTS—LLNL SITE 300

Employment Base

No adverse impacts to the employment base of San Joaquin County are anticipated as a result of the no action alternative because project employment levels are assumed to remain the same as current levels.

Population and Demand for Housing

No changes in population or in the demand for housing are anticipated within San Joaquin County as a result of the no action alternative because employment levels are assumed to remain the same as current levels. Thus, no adverse housing impacts are anticipated.

Economic Factors

The no action alternative would not alter the existing economic contribution of LLNL Site 300 to the region because employment levels and research and development activity are assumed to remain the same as current levels. Also, the no action alternative would have no effect on the amount of expenditures for goods and services in the local and regional economy. Thus, no adverse or beneficial economic impacts are anticipated.

IMPACTS—SNL, LIVERMORE

Employment Base

As described for the LLNL Livermore site, no adverse impacts to the employment base of Alameda County are anticipated as a result of the no action alternative for SNL, Livermore because employment levels under this alternative are assumed to remain the same as current levels.

Population and Demand for Housing

As described for the LLNL Livermore site, no changes in population or the demand for housing are anticipated within Alameda County as a result of the no action alternative for SNL, Livermore. Thus, no adverse population or housing impacts are anticipated.

Economic Factors

The no action alternative would not alter the existing level of economic contribution of SNL, Livermore to the region because employment levels and research and development activity are assumed to remain the same as current levels. Also, the no action alternative would have no effect on the amount of expenditures for goods and services in the local and regional economy. Thus, no adverse economic impacts are anticipated.

CUMULATIVE IMPACTS—LLNL AND SNL, LIVERMORE

Population and Demand for Housing

As discussed in section 5.1.2, development of the planned and proposed projects in the City of Livermore (listed in section 10) would contribute to an increase in population level and housing demand within the region. This is a potentially significant and unavoidable adverse impact. The no action alternative, however, would not contribute to this impact.

The evaluation of cumulative impacts on housing focuses on the City of Livermore since the highest proportion of LLNL and SNL, Livermore personnel live in that city. Population projections for the City of Livermore anticipate a 26.4 percent increase in population by the year 2000. This anticipated growth would result in a need for 25,426 housing units, based on the current person per household figure of 2.82. The projected increase in population associated with the planned and approved projects could not be accommodated in the current housing stock of 20,932 units.

5.2.3 COMMUNITY SERVICES

This section describes the impacts to community services from the no action alternative.

LLNL Livermore Site

The no action alternative would not result in any changes to existing fire protection and emergency services provided to the LLNL Livermore site, nor to existing police protection and security services.

Approximately 1700 students who have one or more parents employed at LLNL are currently enrolled in the Livermore Valley Joint Unified School District. The no action alternative is not expected to result in any changes to current enrollment or to school services in the Livermore Valley Joint Unified School District or other districts in the region.

The LLNL Livermore site currently disposes of approximately 24,000 cu yd of solid waste at the Vasco Road Sanitary Landfill each year and the landfill has an anticipated remaining capacity of 17 years. The no action alternative is not expected to result in any changes in solid waste generation or to solid waste disposal services in general.

LLNL Site 300

The no action alternative would not result in any changes to existing fire protection and emergency services, nor to existing police protection or security services.

The existing setting and impact analysis for school services is combined for the LLNL Livermore site and LLNL Site 300. Please see the above discussion of school services under the LLNL Livermore site.

LLNL Site 300 currently disposes of approximately 2200 cu yd of solid waste annually at the Corral Hollow Sanitary Landfill in San Joaquin County, which is scheduled to close in 1995.

SNL, Livermore

The no action alternative would not result in any changes to existing fire protection and emergency services provided to SNL, Livermore, nor to existing police protection or security services.

Approximately 205 students who have one or more parents employed at SNL, Livermore are currently enrolled in the Livermore Valley Joint Unified School District. The no action alternative would not result in a change in current enrollment or to school services at the Livermore Valley Joint Unified School District or other districts in the region.

SNL, Livermore currently disposes of approximately 3600 cu yd of solid waste at the Vasco Road Sanitary Landfill each year. The no action alternative would not result in a change in solid waste generation or solid waste disposal services.

IMPACTS—LLNL LIVERMORE SITE

Fire Protection and Emergency Services

The no action alternative would not have a significant impact on either onsite fire protection and emergency services or offsite fire protection agencies. The no action alternative would include infrastructure maintenance and upgrades; however, no increases in employment are anticipated. Demands for fire protection and emergency services as a result of the no action alternative are expected to be similar to those under present conditions. The LLNL Fire Department currently provides adequate onsite service. The adequacy of these services would continue to be evaluated on an annual basis, and it is anticipated that personnel, equipment, and facilities would be increased or upgraded as necessary.

LLNL interacts infrequently with offsite fire protection agencies. Interaction is expected to remain similar to the current level under the no action alternative. Current fire protection and emergency service needs of LLNL do not significantly affect offsite fire protection agencies' ability to provide adequate service within their respective jurisdictions or mutual aid network. Thus, no adverse impacts are anticipated.

Police Protection and Security Service

The no action alternative would not have a significant impact on onsite security services or offsite police protection agencies. Under the no action alternative, demands for security services are expected to remain similar to those under present conditions. The LLNL Protective Force Division currently provides adequate onsite security protection.

LLNL interacts infrequently with offsite police protection agencies. Under the no action alternative, interaction is expected to remain similar to the current levels. Current security needs of LLNL do not significantly affect the ability of offsite police protection agencies to provide adequate service within their respective jurisdictions or emergency response network. Thus, no adverse impacts are anticipated.

School Services

Employment at LLNL would not increase under this alternative; therefore, the number of students associated with the no action alternative would remain at the present levels. Thus, this alternative would not contribute further to existing capacity problems in the Livermore Valley Joint Unified School District or other districts in the region. No adverse impacts are anticipated.

Nonhazardous Solid Waste Disposal

Like the proposed action, the no action alternative would not result in an adverse impact on the ability of the County of Alameda to provide adequate solid waste disposal space. The amount of solid waste generated at the LLNL Livermore site under the no action alternative would be approximately the same as present levels. The Vasco Road Sanitary Landfill currently has an anticipated remaining capacity of 17 years, and Alameda County is planning to expand its solid waste disposal capacity. No adverse impacts are anticipated.

IMPACTS—LLNL SITE 300

Impacts discussed above under LLNL Livermore Site for fire protection and emergency services, police protection and security services, and school services are also applicable to LLNL Site 300. The rate of nonhazardous solid waste generated onsite as a result of the no action alternative is assumed to be approximately the same as the present rate. However, because the Corral Hollow Landfill is scheduled to close in 1995, and the County of San Joaquin has not completed plans for future nonhazardous solid waste disposal beyond that time, this alternative could contribute to a potentially significant impact on the disposal services at the landfill.

IMPACTS—SNL, LIVERMORE

Fire Protection and Emergency Services

The no action alternative would not have a significant impact on either onsite fire protection and emergency services or offsite fire protection agencies. Only a few additional structures and infrastructure upgrades would be included in the no action alternative (see Section 3). No increases in employment are anticipated. Demands for fire protection and emergency services as a result of the no action alternative are expected to be similar to those under present conditions. The LLNL Livermore site Fire Department and the SNL, Livermore fire protection and other site facility support currently provide adequate onsite service. The adequacy of these services would continue to be evaluated on an annual basis, and it is anticipated that personnel, equipment, and facilities would be increased or upgraded as necessary.

The LLNL Fire Department also serves SNL, Livermore. The department interacts infrequently with offsite fire protection agencies. Interaction is expected to remain similar to the current level under the no action alternative. Current fire protection and emergency service needs of SNL, Livermore do not significantly affect offsite fire protection agencies' ability to provide adequate service within their respective jurisdictions or mutual aid network. Therefore, no adverse impacts are anticipated as a result of the no action alternative.

Police Protection and Security Services

The no action alternative would not have a significant impact on onsite security services or offsite police protection agencies. Under the no action alternative, demands for security services are expected to remain similar to those under present conditions. The SNL, Livermore Protective Force currently provides adequate onsite security protection.

SNL, Livermore infrequently interacts with offsite police protection agencies. Under the no action alternative, interaction is expected to remain the same as the current levels. Current security needs of SNL, Livermore do not significantly affect the ability of offsite police protection agencies to provide adequate service within their respective jurisdictions or emergency response network.

School Services

Impacts discussed above under LLNL Livermore Site for school services are also applicable to SNL, Livermore.

Nonhazardous Solid Waste Disposal

Impacts discussed above under LLNL Livermore Site for solid waste disposal are also applicable to SNL, Livermore.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

Under the no action alternative, demands on fire protection and emergency services as well as police protection and security services are expected to remain similar to the current level. The LLNL Livermore site and SNL, Livermore fire protection and security staff currently provide adequate service onsite and current needs do not affect the ability of offsite agencies to provide adequate service within their respective jurisdictions. Therefore, the no action alternative would not result in a significant cumulative impact on either onsite or offsite fire protection and emergency services or police protection and security services.

Employment at LLNL and SNL, Livermore is not expected to increase; therefore, under this alternative the number of students associated with the no action alternative would remain at present levels and no additional demands on school services in the region would result.

The rate of nonhazardous solid waste generation at the LLNL Livermore site and SNL, Livermore under the no action alternative would be approximately the same as present levels. Thus, this alternative would not contribute to additional cumulative demand for nonhazardous landfill capacity at the Vasco Road Sanitary Landfill.

CUMULATIVE IMPACTS—LLNL SITE 300

Cumulative impacts discussed above for the LLNL Livermore site and SNL, Livermore for fire protection and emergency services, police protection and security services, and school services are also applicable to LLNL Site 300.

The rate of nonhazardous solid waste generation at LLNL Site 300 as a result of the no action alternative is expected to be approximately the same as present levels; however, because the Corral Hollow Sanitary Landfill is scheduled to close in 1995 and San Joaquin County has not completed plans for future nonhazardous solid waste disposal beyond that time, this alternative could contribute to a potentially significant cumulative impact on nonhazardous landfill capacity at the Corral Hollow Sanitary Landfill.

5.2.4 PREHISTORIC AND HISTORIC CULTURAL RESOURCES

This section describes the impacts to prehistoric and historic cultural resources under the no action alternative.

LLNL Livermore Site

No prehistoric resources have been identified on the LLNL Livermore site. A formal evaluation of the historic resources at the Laboratory has not yet been completed. If portions of the LLNL Livermore site are determined by the Section 106 process (of the National Historic Preservation Act) to be eligible for the National Register of Historic Places, implementation of the no action alternative could affect important historic resources through activities such as maintenance and experimental reconfigurations.

LLNL Site 300

Previous surveys at LLNL Site 300 have identified the presence of both prehistoric and historic resources on the site. Activities associated with the no action alternative could affect historic resources.

SNL, Livermore

No National Register listed or eligible properties are located at SNL, Livermore (State Historic Preservation Office, 1990); therefore, activities associated with the no action alternative would not affect any prehistoric or historic cultural resources at this facility.

IMPACTS—LLNL LIVERMORE SITE

The Area of Potential Effect would encompass the entire LLNL Livermore site.

Prehistoric Resources

There are no recorded prehistoric resources at the LLNL Livermore site that would be affected by this alternative. No impacts to prehistoric resources are identified. Continued DOE compliance with Section 106 of NHPA, as well as the provisions of 36 C.F.R. 800.11 (Properties Discovered During Implementation of an Undertaking), would lead to mitigation of impacts to National Register– listed or –eligible prehistoric resources, should any be discovered.

Historic Resources

Impacts to potentially important historic resources cannot be determined because the historic property identification phase of Section 106 is currently under way. Because of environmental restoration and other ongoing operations, historic resources could be affected. If portions of the Laboratory are determined to be eligible for the National Register of Historic Places, with concurrence from the State Historic Preservation Office, the Section 106 process would lead to preparation of an agreement document, outlining DOE's preservation responsibilities relating to the properties. Compliance with the National Historic Preservation Act would result in a less than significant impact to historic resources.

IMPACTS—LLNL SITE 300

The Area of Potential Effect would include all ongoing activity areas, including maintenance and environmental restoration activities.

Prehistoric Resources

No recorded prehistoric resources are anticipated to be affected under this alternative. Continued DOE compliance with Section 106 of NHPA, as well as the provisions of 36 C.F.R. 800.11 [Properties Discovered During Implementation of an Undertaking], would lead to mitigation of impacts to National Register listed or eligible prehistoric resources, should any be discovered.

Historic Resources

Impacts to potentially important historic resources at LLNL Site 300 cannot be determined because additional archival research and site investigation is currently underway to determine the presence of historically significant resources associated with the Carnegie townsite area in the southeastern portion of the site (William Self Associates, 1992). Because of environmental restoration and other ongoing activities, historic resources could be affected. Once the necessary data have been gathered, and the site(s) evaluated for eligibility to the National Register (and concurrence sought from the State Historic Preservation Office), the Section 106 process would lead to preparation of an agreement document, outlining DOE's preservation responsibilities relating to the properties. This is anticipated to reduce potential impacts to historic resources to a less than significant level.

IMPACTS—SNL, LIVERMORE

The Area of Potential Effect would encompass the entire SNL, Livermore site.

Prehistoric Resources

No impacts to prehistoric resources are anticipated at SNL, Livermore.

Historic Resources

No impacts to National Register listed on eligible historic properties are anticipated at SNL, Livermore.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

The cumulative impact study areas for prehistoric and historic resources at the three Laboratory sites under the no action alternative are the same as those described for the proposed action. As discussed under the proposed action, cumulative impacts to both prehistoric and historic resources within the identified cumulative impact study areas have not been delineated as part of this EIS/EIR; however, because cultural resources are known to occur within the areas, it is assumed that future development within the area could potentially impact these resources.

Prehistoric Resources

As no prehistoric resources were located either on the LLNL Livermore site or at SNL, Livermore and proposed activities at these facilities under the no action alternative are not expected to result in impacts to prehistoric resources, the Laboratories would not contribute to any potential cumulative impacts to prehistoric resources within the study area.

Historic Resources

No National Register–listed or –eligible historic properties were identified at SNL, Livermore. Important historic resources may be identified on the LLNL Livermore site, which would require compliance with Section 106 of the National Historic Preservation Act. The Laboratories could contribute to potential cumulative impacts to historic resources within the study area, although at this time it is too speculative to determine whether the potential cumulative impact is significant or not.

CUMULATIVE IMPACTS—LLNL SITE 300

Refer to the above discussion under LLNL Livermore site and SNL, Livermore regarding delineation of cumulative impact study areas and determination of cumulative cultural resources impacts within these areas.

Prehistoric Resources

No impacts to prehistoric resources are anticipated at LLNL Site 300 under the no action alternative; therefore, the Laboratory would not contribute to any potential cumulative impacts to prehistoric resources within the study area.

Historic Resources

Important historic resources may be identified on LLNL Site 300, which would require compliance with Section 106 of the National Historic Preservation Act. The Laboratory could contribute to potential cumulative impacts to historic resources within the study area, although at this time it is too speculative to determine whether the potential cumulative impact would be significant or not.

5.2.5 AESTHETIC AND SCENIC RESOURCES

This section describes the impacts to the aesthetic and scenic resources under the no action alternative.

LLNL Livermore Site

Under the no action alternative, programs and projects would continue at their present (FY 1992) level. The no action alternative includes facility upgrades and maintenance at the LLNL Livermore site. Views from surrounding scenic roadways and adjacent residences would not be adversely affected as a result of the no action alternative. Impacts upon the visual quality of the Laboratory would be less under the no action alternative than under the proposed action, due to fewer construction activities. The LLNL Livermore site would continue to be compatible with local and regional scenic resources plans and policies.

LLNL Site 300

The no action alternative includes upgrading of several existing facilities, roadways, and utilities. No land acquisitions are included as part of the no action alternative. The visual character of LLNL Site 300 would not change with the implementation of the no action alternative. LLNL Site 300 would continue to be compatible with local and regional scenic resource plans and policies.

SNL, Livermore

Under the no action alternative, programs and projects would continue at their FY 1992 level. The no action alternative includes facility upgrades and limited new construction at SNL, Livermore. Views from surrounding scenic roadways would not be adversely affected. Impacts upon the visual quality of the Laboratory would be less under the no action alternative than under the proposed action, due to less construction. SNL, Livermore operations would continue to be compatible with local and regional scenic resources plans and policies.

IMPACTS—LLNL LIVERMORE SITE

Short-Term Viewshed Impacts

The no action alternative includes upgrades and maintenance of existing facilities at the LLNL Livermore site. Construction activities may cause a short-term adverse impact on the views from some adjacent land uses and roadways. The discussion of viewshed impacts for the proposed action (see section 5.1.5) is also relevant for the no action alternative. The no action alternative involves less prominent construction activity at the LLNL Livermore site than the proposed action since no new buildings are included in this alternative. Therefore, the potential for short-term construction-related impacts on views from adjacent areas and scenic roadways would be less than significant under this alternative.

Conflict with Plans and Policies

The no action alternative would not conflict with adopted open space and scenic resources plans and policies of the County of Alameda or the City of Livermore. The discussion of consistency with scenic resource and open space policies for the proposed action (see section 5.1.5) is also relevant for the no action alternative.

IMPACTS—LLNL SITE 300

Short-Term Viewshed Impacts

The no action alternative includes upgrading and maintenance of roadways and utilities at LLNL Site 300. Construction activities may cause a short-term adverse impact on views from Corral Hollow Road. The discussion of viewshed impacts for the proposed action (see section 5.1.5) is also relevant for the no action alternative. The no action alternative involves less prominent construction at LLNL Site 300 than the proposed action since no major new buildings are included in this alternative. Therefore, the potential for short-term construction- related impacts on views from adjacent areas and scenic roadways would be less than significant.

Conflict with Plans and Policies

The no action alternative would not conflict with adopted open space and scenic resources plans and policies of the County of San Joaquin or the County of Alameda. The discussion of consistency with scenic resource and open space policies for the proposed action (see section 5.1.5) is also relevant for the no action alternative.

IMPACTS—SNL, LIVERMORE

Short-Term Viewshed Impacts

As described for the LLNL Livermore site, the no action alternative includes upgrades and maintenance of existing facilities at SNL, Livermore. Construction activities may cause a short-term adverse impact on the views from adjacent land uses and roadways.

Conflict with Plans and Policies

As described for the LLNL Livermore site, the no action alternative would not conflict with adopted open space and scenic resources plans and policies of the County of Alameda or the City of Livermore.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE, LLNL SITE 300, AND SNL, LIVERMORE

Development of approved and proposed projects in the vicinity of the sites could contribute to a cumulative effect on visual resources in the vicinity of the sites. At this time, however, it is too speculative to determine whether or not this impact would be significant. Implementation of the no action alternative would not contribute to the cumulative impact on scenic resources since this alternative would not have long-term impacts on views.

5.2.6 GEOLOGIC RESOURCES AND HAZARDS

This section includes an evaluation of potential geologic (or geotechnical) hazards, such as seismically induced hazards and nonseismic earth movements, and an evaluation of potential impacts to geologic resources such as minerals, construction materials, soils, and fossils under the no action alternative.

LLNL Livermore Site

Potential sources for future ground motion around the LLNL Livermore site include the Greenville, Las Positas, Vernon, Corral Hollow–Carnegie, and Williams faults. Buildings and structures under the no action alternative could be affected both by dynamic hazards, such as ground motion and fault rupture, and by static hazards such as differential settlement. This site is also located in an area of documented mineral and construction material resources, such as gravel.

LLNL Site 300

The active Corral Hollow–Carnegie fault zone crosses the southern portion of LLNL Site 300. Geologic outcrops are common, and exposures have been identified that contain both minerals and fossils.

SNL, Livermore

The hilly and flat terrains of SNL, Livermore are separated by the Las Positas fault, which crosses southeastern portions of the SNL, Livermore site.

IMPACTS—LLNL LIVERMORE SITE

Geologic Resources

None of the activities under the no action alternative would affect any known exploitable geologic resources, and therefore there would be no impacts on such resources from the no action alternative.

Geologic Hazards

Significant impacts to structures and related infrastructure under the no action alternative could result from seismic events. However, the impacts of a seismic event under this alternative would be similar to impacts under the proposed action.

IMPACTS—LLNL SITE 300

Geologic Resources

None of the activities under the no action alternative are on or near any known or exploitable geologic resources, and therefore no impacts on such resources would result from the no action alternative.

Geologic Hazards

Significant impacts to structures and related infrastructure, and surrounding communities, under the no action alternative could result from seismic events. However, the impacts of a seismic event under this alternative would be similar to impacts under the proposed action. A portion of the proposed 1.7-mile, 10-inch-diameter water supply line to LLNL Site 300 from the Hetch Hetchy Thomas Shaft is subject to surface faulting. Expansive or shrink-swell soils and soils with low permeability could adversely affect the no action alternative development projects. Construction of subterranean structures in poorly drained subsurface sediments could result in seepage problems.

IMPACTS—SNL, LIVERMORE

Geologic Resources

None of the no action alternative activities are near any known exploitable geologic resources, and therefore there would be no impacts on such resources from the no action alternative.

Geologic Hazards

Projects associated with the no action alternative are not located on or immediately near the known trace of the Las Positas fault.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE, LLNL SITE 300, AND SNL, LIVERMORE

People working in structures at the LLNL Livermore site and SNL, Livermore and those living in the vicinity of those facilities could be exposed to the impacts from landslides, ground shaking, and associated hazards that commonly occur in a seismically active area.

Facility upgrades, modifications, and maintenance activities associated with the no action alternative would include appropriate engineering and administrative measures to reduce or eliminate injuries or the release of hazardous substances resulting from ground shaking at the Laboratories.

5.2.7 ECOLOGY

This section focuses on the impacts to ecological resources under the no action alternative. Section 4.9 describes the existing ecological conditions and current operations that impact or may impact ecological resources. A more detailed description of the ecological resources and the impacts of current operations appears in Appendices F and G.

Vegetation and Wildlife

LLNL Livermore Site

The LLNL Livermore site vegetation has been greatly altered by human activity and consists of landscaped areas, fields dominated by early successional plant communities indicative of recent disturbance, annual grasslands in the security zone, and remnant wooded riparian vegetation along Arroyo Seco. The wildlife in these plant communities consists of species adapted to living in areas of high human activity or species adapted to living in grassland habitat.

LLNL Site 300

LLNL Site 300 vegetation and wildlife consist of a diverse interspersion of plant community types and a high level of wildlife species diversity.

SNL, Livermore

Vegetation at SNL, Livermore consists of highly altered plant communities in the built-up areas, annual grasslands in the security zone, and remnant riparian vegetation in Arroyo Seco. The wildlife in these areas consists of species adapted to living in areas with a high degree of human activity, species typical of grassland habitat, and species typical of wooded riparian areas.

IMPACTS—LLNL LIVERMORE SITE

The LLNL Livermore site has been built up for many years, and the current onsite vegetation and wildlife are adapted for life in areas that have a high degree of human activity. Therefore, the no action alternative would have less than significant impact on vegetation and wildlife.

IMPACTS—LLNL SITE 300

Operations impacting vegetation and wildlife at LLNL Site 300 are discussed in detail in sections F.1.1.3 and F.1.2.3 of Appendix F and sections 4.9.1 and 4.9.2 of this EIS/EIR. Overall, the operation of LLNL Site 300 has had a positive impact on vegetation and wildlife through the exclusion of livestock grazing and other agricultural practices and the annual controlled burns. These management practices have created an interspersion of unaltered plant communities including native perennial grasslands and wetlands that support a diverse assemblage of wildlife found in few grassland-dominated ecosystems in central California. Projects at LLNL Site 300 under the no action alternative, such as the site revitalization project plan, would have a minimal impact on vegetation and wildlife. Much of the 18.5 acres that would be cleared for road improvement (14.5 acres) represents marginal wildlife habitat because it is next to currently existing roadways. (See section 4.9 for more details.)

IMPACTS—SNL, LIVERMORE

The vegetation and wildlife that occur in built-up areas onsite have been adapted to such conditions for a long period of time. There would be no additional disturbance to vegetation and wildlife in the grasslands in the security zone or along Arroyo Seco. The vegetation and wildlife in these areas would remain in their relatively undisturbed state, and therefore the no action alternative would have a less than significant impact on vegetation and wildlife.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

While operated by separate contractors and managed by different DOE operational offices, for purposes of this discussion of cumulative impacts on vegetation wildlife, the LLNL Livermore site and SNL, Livermore are addressed together because of their proximity.

The cumulative impacts study area for vegetation and wildlife is defined as the Livermore Valley. The full extent of undeveloped plant communities and wildlife habitat within this study area cannot be delineated as part of this EIS/EIR; however, it is assumed that future development within the area could impact these resources. Because essentially no undeveloped plant communities or wildlife habitat would be impacted either at the LLNL Livermore site or at SNL, Livermore, activities associated with the no action alternative would not contribute to any potential cumulative impacts to undeveloped plant communities within the study area.

CUMULATIVE IMPACTS—LLNL SITE 300

The cumulative impacts study area for vegetation is the rolling terrain and steep canyon areas in the Diablo Range. The full extent of undeveloped plant communities and wildlife habitat within this study area cannot be delineated as part of this EIS/EIR. However, it is known that at least four developments totaling approximately 10,000 acres have the potential to be constructed in the area of LLNL Site 300 (see Section 10) and these projects would, if constructed, impact these resources. Because only 18.5 acres of undeveloped plant communities and wildlife habitat would be impacted at LLNL Site 300, activities associated with the no action alternative would not contribute to any potential cumulative impacts to undeveloped plant communities and wildlife habitat within the study area. The overall impact of operations at LLNL Site 300 has had a positive cumulative impact on vegetation and wildlife in that these operations (e.g., exclusion of grazing and the annual controlled burn) have promoted the development of a diverse mosaic of largely undisturbed plant communities, including a large stand of native perennial grasslands which are now rare in California. These plant communities support a highly diverse assemblage of wildlife species.

Threatened and Endangered Species

LLNL Livermore Site

Threatened, endangered, or other sensitive flora and fauna species of concern were not observed at the LLNL Livermore site.

LLNL Site 300

Threatened, endangered, and other sensitive flora and fauna species of concern reside at LLNL Site 300. Activities included in the no action alternative have the potential for significant impacts on these species.

SNL, Livermore

Threatened, endangered, or other sensitive species of concern were not observed at the SNL, Livermore site.

IMPACTS—LLNL LIVERMORE SITE

The no action alternative would have no impact on sensitive species at the LLNL Livermore site because no such species reside onsite.

IMPACTS—LLNL SITE 300

Surveys for threatened, endangered, and other species of concern resulted in the observation of eight species and the potential habitat of four additional species. Potential impacts of current operations on these and other species are summarized on Table 4.9-2. These impacts would be minimal on sensitive species especially. As indicated for vegetation and wildlife above, the management practices prohibiting agricultural practices onsite and conducting the annual controlled burns are beneficial to the biological resources, including the sensitive species that reside onsite.

IMPACTS—SNL, LIVERMORE

The no action alternative would have no impact on sensitive species at SNL, Livermore because no such species reside onsite.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

While operated by separate contractors and managed by different DOE operational offices, for purposes of this discussion of cumulative impacts on vegetation and wildlife, the LLNL Livermore site and SNL, Livermore are addressed together because of their proximity.

The cumulative impacts study area for sensitive species varies with each species. In general, this area is considered the occupied and/or historic range of the species in question. No sensitive species were recorded during the 1991 surveys at the LLNL Livermore site or at SNL, Livermore. The occurrence of sensitive species within their specific ranges is not fully known and cannot be delineated as part of this EIS/EIR; however, it is assumed that future development within these ranges would impact sensitive species. Since no sensitive species were recorded at either study site, activities associated with the no action alternative would not contribute to cumulative impacts on sensitive species.

CUMULATIVE IMPACTS—SITE 300

The cumulative impacts study area for sensitive species varies with each species. In general, this area is considered the occupied and/or historic range of the species. The cumulative impact study areas for sensitive species or sensitive species potential habitat recorded from LLNL Site 300 are listed in section 5.1.7.3 above.

The occurrence of the sensitive species within the cumulative study area is not fully known and cannot be delineated as part of this EIS/EIR. However, it is known that at least four developments totaling approximately 10,000 acres have the potential to be constructed in the area of LLNL Site 300 (see Section 10) and these projects would, if constructed, result in cumulative impacts to sensitive species. Because only 18.5 acres of potential sensitive species habitat would be impacted at LLNL Site 300 and because the Laboratory is committed to mitigation of its impacts on sensitive species, activities associated with no action would not contribute to any potential cumulative impacts to sensitive species. The overall impact of operations at LLNL Site 300 has had a positive cumulative impact on sensitive species in that these operations (e.g., exclusion of grazing, the annual controlled burn, and restricted access) have promoted the development of a largely undisturbed mosaic of habitats conducive to the occurrence of sensitive species.

Wetlands

LLNL Livermore Site

An estimated 0.36 acre of wetlands occurs along Arroyo Las Positas. The no action alternative activities would not occur in this area. Overflow from the retention basin may, however, impact these wetlands.

LLNL Site 300

An estimated 6.76 acres of natural and artificial wetlands occur at LLNL Site 300. Activities included in the no action alternative would not impact these wetlands.

SNL, Livermore

An estimated 1.44 acres of wetlands occur at SNL, Livermore. The no action alternative activities would not impact these wetlands.

IMPACTS—LLNL LIVERMORE SITE

The no action alternative activities would not adversely impact wetlands at the LLNL Livermore site. However, the retention basin designed to collect treated water from the ground water restoration project may result in additional runoff into Arroyo Las Positas, creating additional wetlands. In addition, wetlands may develop around the perimeter of the retention basin itself. This may be a beneficial impact.

IMPACTS—LLNL SITE 300

The no action alternative would not impact wetlands at LLNL Site 300. The ground water restoration project may result in the discharge of treated water into Corral Hollow Creek, which would likely create additional wetlands. This may be a beneficial impact.

IMPACTS—SNL, LIVERMORE

The no action alternative activities would not affect wetlands at SNL, Livermore.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

While operated by separate contractors and managed by different DOE operational offices, for purposes of this discussion of cumulative impacts on wetlands, the LLNL Livermore site and SNL, Livermore are addressed together because of their proximity.

The cumulative impacts study area for wetlands is defined as the Livermore Valley. The full extent of wetlands within this study area cannot be delineated as part of this EIS/EIR; however, it is assumed that future development within the area could impact this resource. As no wetlands would be impacted at the LLNL Livermore site or at SNL, Livermore under the no action alternative, activities at the LLNL Livermore site and SNL, Livermore would not contribute to any potential cumulative impacts to wetlands within the study area.

CUMULATIVE IMPACTS—LLNL SITE 300

The cumulative impacts study area for wetlands is the rolling terrains and steep canyon areas in the Diablo Range. The full extent of wetlands within this study area cannot be delineated as part of this EIS/EIR. However, it is known that at least four developments totaling approximately 10,000 acres have the potential to be constructed in the area of LLNL Site 300 (see Section 10) and these projects may, if constructed, impact this resource. Activities associated with no action would not impact wetlands at LLNL Site 300 and therefore would not contribute to any potential cumulative impacts to wetlands within the study area. The overall impact of operations at LLNL Site 300 has had a positive cumulative impact on wetlands in that these operations (e.g., exclusion of grazing) have promoted the development of unaltered wetlands, which are rare in California.

5.2.8 AIR QUALITY

This section discusses impacts to air quality under the no action alternative.

LLNL Livermore Site

Under the no action alternative, there would be no increases in criteria pollutant and toxic air contaminant emissions and, therefore, individually the site would have a less than significant impact. Existing emissions from the LLNL Livermore site would still be contributing to a nonattainment air basin for ozone and PM10, so the impact is considered a significant impact. Although mitigation measures such as those described under the proposed action would reduce offsite impacts, the mitigation measures would not reduce the impact to less than significant.

Under the no action alternative, the administrative limit for tritium at Building 331, the Hydrogen Research Facility, will be reduced from 300 g to 5 g. There are no reported releases of radionuclides other than tritium that affect the level of radiation exposure of members of the public. Therefore this impact is less than significant and may be beneficial.

LLNL Site 300

Under the no action alternative there would be no increases in criteria pollutant and toxic air contaminant emissions or radiation releases; therefore, individually the site would have a less than significant impact. Existing emissions from LLNL Site 300 would still be contributing to a nonattainment air basin for ozone and PM10, so the impact is considered a significant impact. Although mitigation measures would reduce the offsite impacts, they would not reduce the impacts to less than significant.

SNL, Livermore

Under the no action alternative there would be no increases in criteria pollutant and toxic air contaminant emissions or releases of radionuclides; therefore, individually the site would have a less than significant impact. Existing emissions from SNL, Livermore would still be contributing to a nonattainment air basin for ozone and PM10, so the impact is considered a significant impact. Although mitigation measures would reduce the offsite impacts, they could not reduce the impacts to less than significant.

IMPACTS—LLNL LIVERMORE SITE, LLNL SITE 300, AND SNL, LIVERMORE

Under the no action alternative there would be no new emission sources at the LLNL Livermore site, LLNL Site 300, or SNL, Livermore, but emissions from these sites due to stationary and mobile sources and from approved and proposed projects in the regional air districts would be contributing to a nonattainment area for ozone and PM10. These impacts are considered a significant and unavoidable impact.

Under the no action alternative the administrative limit for tritium at LLNL Livermore site Building 331 and SNL, Livermore Building 968 would be reduced from current levels and thus would lead to no increase in radiation releases from either LLNL Site 300 or SNL, Livermore. These impacts are considered less than significant and may be beneficial. Operations associated with the inventory reduction process would result in a short-term impact that is less than significant and a long-term impact that would be beneficial.

Decommissioning of Building 968, the Tritium Research Laboratory, would generate tritium emissions during the decontamination activities. These emissions would be within the same order of magnitude as the normal operating stack releases of this laboratory. This impact is discussed in Impact 8.3.5 for the proposed action alternative, and also applies to the no action alternative.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE, LLNL SITE 300, AND SNL, LIVERMORE

Under the no action alternative the development of approved and proposed projects near the LLNL Livermore site, LLNL Site 300, and SNL, Livermore, as identified in section 4.2.3, would result in increased criteria air pollutants due to stationary and mobile sources. While the carbon monoxide standards are not expected to be exceeded by the cumulative impacts, cumulative growth would result in the emission of primary pollutants, such as NOx and volatile organic compounds, that are precursors to ozone. Since the Livermore area exceeds federal and state ozone standards, any increase in pollutants that could lead to the formation of ozone is considered a potentially significant and unavoidable impact.

5.2.9 WATER

This section discusses impacts to surface water and ground water resources under the no action alternative. Impacts involving surface water and ground water quality are discussed in sections 4.11, 4.17, and 5.1.15. Hydrologic impacts relating to surface water and ground water bodies, including ground water recharge, declining water levels, and flooding, are presented below.

LLNL Livermore Site

Arroyo Las Positas is the only potential source of flooding onsite. An evaluation of hydrologic impacts from the no action alternative activities is presented below.

LLNL Site 300

Surface water bodies inventoried include intermittent streams that drain to Corral Hollow Creek, which in turn flows eastward into the San Joaquin Valley. The Altamont Hills represent a recharge area for the San Joaquin ground water basin. Three drainages, Oasis/Draney, Elk, and Middle, serve as pathways for storm water runoff and are the main drainages, along with Corral Hollow Creek, with potential for flooding. Potential impacts of the no action alternative activities are presented below.

SNL, Livermore

All drainages from SNL, Livermore flow into Arroyo Seco, a major source of recharge for the ground water basin. Various other sources of ground water recharge at SNL, Livermore include landscape irrigation and a recharge pond. Arroyo Seco is the only potential source for flooding at SNL, Livermore.

IMPACTS—LLNL LIVERMORE SITE

Seasonal rainfall, together with the additional paving included under the no action alternative, may increase runoff flows in local drainage channels. Although this could result in increased intermittent flow for some local streams, including Arroyo Seco and Arroyo Las Positas, such increased flows would likely be minor, and, therefore, would result in no adverse impacts.

IMPACTS—LLNL SITE 300

No adverse impacts to ground water or surface water bodies are anticipated under the no action alternative.

IMPACTS—SNL, LIVERMORE

No adverse impacts to ground water or surface water bodies are anticipated under the no action alternative. Use of the recharge basin would have an overall beneficial impact on the local ground water supply.

CUMULATIVE IMPACTS—LLNL LIVERMORE AND SNL, LIVERMORE

The cumulative impact study area includes the eastern Livermore Valley surface water bodies and ground water basin. The no action alternative includes maintenance and upgrade projects that still have some potential to reduce ground water recharge areas. Maintenance and upgrade activities could increase storm water runoff to Arroyo Las Positas and Arroyo Seco. The overall increase in stormwater runoff from regional development would depend on a variety of factors, including inherent soil permeability, the total amount of impervious surfacing (e.g., paving), intensity of development, slope, and other characteristics. Because of the high infiltration rates within the arroyos, however, and the abundant remaining surface area for ground water recharge, and because the projects under the no action alternative are maintenance and upgrades occurring on built-up space that already includes a substantial amount of impervious surface, no significant adverse cumulative impacts from the no action alternative at the LLNL Livermore site and SNL, Livermore are anticipated.

CUMULATIVE IMPACTS—LLNL SITE 300

The cumulative impacts study area is LLNL Site 300 and related drainages, and the San Joaquin Valley ground water basin. Cumulative impacts associated with the no action alternative and other offsite development or recharge programs are considered less than significant due to high infiltration rates of local soils and abundant remaining surface area for ground water recharge.

5.2.10 NOISE

This section describes the noise impacts under the no action alternative.

LLNL Livermore Site

A short-term increase in exterior noise levels from the LLNL Livermore site could affect the residences nearest to the site until the maintenance and upgrade projects associated with the no action alternative are complete.

LLNL Site 300

Noise-sensitive receptors could experience a short-term increase in exterior noise levels from LLNL Site 300 as a result of construction-related activities under the no action alternative.

SNL, Livermore

The residence between SNL, Livermore and Tesla Road could experience a short-term increase in exterior noise levels until the no action alternative construction and maintenance projects are complete.

IMPACTS—LLNL LIVERMORE SITE

Short-Term Construction Noise

As discussed for the proposed action, the no action alternative would result in increased noise levels generated by construction activities; however, these noise levels would not conflict with local noise standards or guidelines. In addition, it is assumed that the noise levels associated with the construction activity would be less under the no action alternative than under the proposed action since the no action alternative includes infrastructure improvements but does not include the construction of major new buildings or facilities that are part of the proposed action.

Long-Term Operational Noise

No increase in long-term operational noise levels would result from the no action alternative since it would not include any major alteration to noise-generating activities at the site, nor increase vehicular traffic associated with operation of the site.

IMPACTS—LLNL SITE 300

Short-Term Construction Noise

As discussed for the proposed action, the no action alternative would result in increased noise levels during construction phases of the infrastructure improvements and upgrades associated with this alternative. However, due to the remoteness of the site from noise-sensitive receptors, noise impacts would be less than significant.

Long-Term Operational Noise

No increase in operational noise levels at LLNL Site 300 would result from the no action alternative since it would not include any major alterations to noise-generating activities at the site, nor would it increase vehicular traffic associated with operation of the site. This is a less than significant impact.

IMPACTS—SNL, LIVERMORE

Short-Term Construction Noise

As discussed for the proposed action, the no action alternative would result in increased noise levels during construction phases of the infrastructure improvements and upgrades associated with this alternative. However, this would be considered a less than significant impact since it would not exceed local noise guidelines, nor would it conflict with a local noise ordinance.

Long-Term Operational Noise

No increase in operational noise levels at SNL, Livermore would result from the no action alternative since it would not include any major alterations to noise-generating activities at the site, nor would it increase vehicular traffic associated with operation of the site.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE, LLNL SITE 300, AND SNL, LIVERMORE

Cumulative traffic levels, and thus vehicular noise levels, would continue to increase on roadways in the vicinity of the three sites due to future developments proposed in the region. Table 5.2.10-1 presents noise conditions along a number of roadways in the vicinity of the sites, and is based on cumulative traffic conditions associated with future buildout of the area. As shown on the table, future noise levels along some roadways in the vicinity of the LLNL Livermore site and SNL, Livermore could increase significantly over existing levels. This is due to increased traffic from surrounding developments. Near LLNL Site 300 (along Corral Hollow Road) the increase in cumulative roadway noise levels would not be significant. Traffic associated with the Laboratories is assumed to stay at current levels under the no action alternative. Thus, under this alternative the operation of the Laboratories would not contribute to potentially significant cumulative roadway noise levels.

Table 5.2.10-1 Future Roadway Noise as a Result of Cumulative Development with the No Action Alternative Compared to Existing Conditions

Roadway Segment	Estimated Distance from Roadway Centerline to CNEL (in ft)			Estimated CNEL 50 ft from Centerline of the Near Travel Lane (dBA)	Increase Over Existing Level (dBA)
	70 CNEL	65 CNEL	60 CNEL		
First Street, N. Mines Road to Las Positas Road	63	135	290	70.8	2.2
Vasco Road, I-580 to Patterson Pass Road	69	141	301	69.5	0.5
Vasco Road, Patterson Pass Road to East Avenue	< 57	113	239	68.0	0.3
Vasco Road, East Avenue to Tesla Road	< 50	< 50	82	62.5	2.3
Greenville Road, I-580 to Patterson Pass Road (4 lanes)	62	125	265	68.7	4.7
Greenville Road, I-580 to Patterson Pass Road (2 lanes)	< 50	68	147	66.3	4.6
Greenville Road, Patterson Pass Road to East Avenue	< 50	56	119	65.0	3.8
Greenville Road, East Avenue to Tesla Road	< 50	< 50	< 50	56.8	0.2
East Avenue, West of Buena Vista Avenue	< 50	99	211	67.6	-0.8
East Avenue, Buena Vista Avenue to Vasco Road	< 50	95	201	67.3	0.2
East Avenue, Vasco Road	< 50	82	172	66.3	0.1

to Greenville Road (4 lanes)					
East Avenue, Vasco Road to Greenville Road (2 lanes)	< 50	53	114	64.7	0.2
North Mines Road, East Avenue to Patterson Pass Road	< 50	62	129	64.3	4.2
Patterson Pass Road, Vasco Road to Greenville Road	< 50	78	162	65.4	4.6
Tesla Road, Buena Vista Avenue to Vasco Road	< 50	< 50	94	63.4	1.3
Tesla Road, Vasco Road to Greenville Road	< 50	< 50	< 50	58.2	0.0
Corral Hollow Road, West of LLNL Site 300	< 50	< 50	< 50	54.6	2.0
Corral Hollow Road, East of LLNL Site 300	< 50	< 50	< 50	55.5	2.0

dBA = Decibel (A-weighted frequency).
CNEL = Community Noise Equivalent Level.

5.2.11 TRAFFIC

LLNL Livermore Site

The LLNL Livermore site currently generates approximately 23,960 vehicle trips per day and contributes a high proportion of the vicinity's daily traffic. The no action alternative is not anticipated to result in any increase in Laboratory-related traffic.

LLNL Site 300

LLNL Site 300 currently generates approximately 700 vehicle trips per day. The no action alternative would not result in any increase in traffic generation at the site.

SNL, Livermore

SNL, Livermore currently generates approximately 3100 vehicle trips per day. No increase in traffic generation is anticipated in conjunction with the no action alternative; therefore, SNL, Livermore is not anticipated to contribute any additional traffic to the local circulation network above present levels.

IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

Because the number of personnel at LLNL and SNL, Livermore is not anticipated to increase from present levels under the no action alternative, the Laboratories would not generate additional traffic beyond present levels and, therefore, would not contribute to projected traffic congestion in the vicinity of the Laboratory facilities. No traffic impacts are identified.

Since the number of personnel would not change with this alternative, public transportation usage would be the same as described under existing conditions. No impacts are identified.

IMPACTS—LLNL SITE 300

Because the number of employees at LLNL Site 300 is not anticipated to increase from present levels, the Laboratory would not generate additional traffic beyond present levels and would not contribute to increased traffic congestion. No traffic impacts are identified.

Although the amount of traffic related to LLNL Site 300 is not expected to increase along Corral Hollow Road roadway, employees are currently experiencing difficulty entering the site due to vehicles speeding along this roadway. To alleviate this situation, improvements are currently being planned by LLNL as part of the facilities revitalization, including reconfiguration of the internal gate structure and the parking area near the main entrance, and relocation of the main entrance slightly to the east of its present location along Corral Hollow Road. These improvements are in final design, and construction is anticipated to begin in April 1992.

CUMULATIVE IMPACTS—LLNL LIVERMORE SITE AND SNL, LIVERMORE

The cumulative traffic analysis for the no action alternative essentially represents an evaluation of the Laboratories at the present level of operations, but with the surrounding area developed to the buildout levels estimated in the general plans of the various city and county jurisdictions.

Projected future average daily traffic volumes at all key roadway segments in the vicinity of the project sites for the no action cumulative scenario are presented in Figure 5.2.11-1. Changes in traffic volumes in the immediate vicinity of the LLNL and SNL, Livermore sites can be determined by comparing the volumes in this figure with the existing traffic volumes presented in Figure 4.13-2. For example, on Vasco Road near the Laboratories, traffic would remain similar to current levels; however, on Vasco Road near I-580, daily traffic volumes are projected to increase from the current volume of approximately 21,000 vehicles per day to approximately 39,000 vehicles per day. This increase is largely due to the development of industrial uses in the area between the Laboratories and I-580. On Greenville Road, substantial traffic increases are also projected due to the development of these industrial land uses. In addition, it is anticipated that the projected congestion and lower travel speeds on Vasco Road would cause a diversion of traffic (primarily Laboratories-related) from the Vasco Road corridor to the Greenville Road corridor, particularly during peak periods. In the future general plan buildout scenario, approximately 40 percent more Laboratories-related traffic is projected to be on Greenville Road during peak hours. Section 5.1.11 and Appendix K include a description of the anticipated future traffic volumes on the Vasco Road and Greenville Road corridors (see Table 5.1.11-2 for a comparison of current and future peak-hour volumes of Laboratories-related traffic on these roadways). This shift in Laboratories-related traffic volumes is attributable to future development to the north of the Laboratories, not to an increase in traffic from the LLNL Livermore site and SNL, Livermore.

Cumulative levels of service and volume-to-capacity ratios at all study intersections under the no action alternative are shown in Table 5.1.11-1 in section 5.1.11. As shown in Table 5.1.11-1, the intersection of Greenville Road/East Avenue would change from the existing LOS A condition to an unacceptable LOS E. This increase would be caused by the diversion of traffic from Vasco Road to Greenville Road described above. Five intersections along First Street (at Las Positas Boulevard, North Mines Road, Southfront Road, I-580 westbound on/off ramps, and I-580 eastbound on/off ramps) would change from the existing LOS D to an unacceptable LOS F, primarily due to development of nearby land parcels. The Vasco Road interchange (at the l-580 westbound on/off ramps and at the l-580 eastbound on/off ramps) is projected to operate at unacceptable levels of service. Other intersections that are projected to operate at unacceptable levels of service include East Avenue/North Mines Road, Vasco Road/Preston Avenue, and the intersections of Greenville Road with Southfront Road and Altamont Pass Road. The four study intersections along Vasco Road nearest the Laboratories (at Patterson Pass Road, Mesquite Way, Westgate Drive, and East Avenue) are all projected to operate at acceptable levels of service A, B, or C in the cumulative no action scenario.

Various roadway and intersection improvement projects are underway or are anticipated in conjunction with future new development projects in the vicinity of the LLNL Livermore site and SNL, Livermore. These improvements, which are discussed in more detail in Appendix K, would alleviate the unacceptable traffic conditions discussed above and delineated in Table 5.1.11-1. The resulting projected traffic conditions following implementation of these improvements are delineated in Table 5.1.11-1 in the "Cumulative No Action Planned Roadway Network" column. It should be noted that these improvements would be the responsibility of the city or county jurisdiction in which the roadways are located. The no action alternative would not contribute to the significant cumulative traffic impacts of future growth described above.

CUMULATIVE IMPACTS—LLNL SITE 300

Under the future no action condition, it is projected that there would be approximately 1100 vehicles per day on Corral Hollow Road west of LLNL Site 300 and 1340 vehicles per day east of the site (see Figure 5.2.11-1), which is an increase of 400 and 490 vehicles per day, respectively, over the existing condition. None of this increase results from the no action alternative and the volumes are within the design capacity of the roadway. Therefore, no significant cumulative traffic impact is identified.

Traffic congestion at the interchange of Corral Hollow Road and the l-580 eastbound and westbound on/off ramps could increase to unacceptable levels from the present LOS A condition as a result of new development (including the proposed Tracy Hills development) in the vicinity of l-580 and LLNL Site 300. However, the amount of traffic at this intersection attributable to LLNL Site 300 is expected to remain unchanged from present conditions. The no action alternative would not contribute to projected significant cumulative traffic congestion.

5.2.12 UTILITIES AND ENERGY

This section focuses on impacts to utilities and energy under the no action alternative.

Water Consumption

LLNL Livermore Site

Based on projected 1992 estimates, the LLNL Livermore site consumes approximately 223 million gal of water annually (Parisotto, 1991b). For this EIS/EIR, this consumption is considered to be representative of future consumption rates for the no action alternative.

LLNL Site 300

Based on projected 1992 estimates, LLNL Site 300 consumes approximately 30 million gal of water annually (Parisotto, 1991b). For this EIS/EIR, this consumption is considered to be representative of future consumption rates for the no action alternative. LLNL is supplementing its water from onsite water wells with Hetch Hetchy water, and that supplier does not anticipate great difficulty in providing service.

SNL, Livermore

Based on projected 1992 estimates, the SNL, Livermore site consumes approximately 58 million gal of water annually (Parisotto, 1991b). For this EIS/EIR, this consumption is considered to be representative of future consumption rates for the no action alternative.

IMPACTS—LLNL LIVERMORE SITE

The no action alternative, as described in Section 3, would not change current water consumption rates, and therefore this is a less than significant impact.

IMPACTS—LLNL SITE 300

The no action alternative, as described in Section 3, would not change current water consumption rates, and therefore this is a less than significant impact.

IMPACTS—SNL, LIVERMORE

The no action alternative, as described in Section 3, would not change current water consumption rates. Consumption of water at current levels results in a less than significant impact because there is a water conservation program in effect and the supplier does not anticipate great difficulty in providing service.

Electricity Consumption

LLNL Livermore Site

Based on projected 1992 estimates, the LLNL Livermore site consumes approximately 321 million kilowatt-hours per year (Hale, 1991). For this EIS/EIR, this consumption is considered to be representative of future consumption rates for the no action alternative.

LLNL Site 300

Based on projected 1992 estimates, LLNL Site 300 consumes approximately 1.5 million kilowatt-hours per year (Hale, 1991). For this EIS/EIR, this consumption is considered to be representative of future consumption rates for the no action alternative.

SNL, Livermore

Based on projected 1992 estimates, SNL, Livermore consumes approximately 40.1 million kilowatt-hours per year (Hale, 1991). For this EIS/EIR, this consumption is considered to be representative of future consumption rates for the no action alternative.

IMPACTS—LLNL LIVERMORE SITE

The no action alternative, as described in Section 3, would not change current electrical consumption rates. Continued consumption of electricity at current levels results in a less than significant impact because there is an energy conservation program and the supplier does not anticipate great difficulty in providing service.

IMPACTS—LLNL SITE 300

The no action alternative, as described in Section 3, would not significantly impact electrical consumption rates. Continued consumption of electricity at current levels results in a less than significant impact because there is an energy conservation program and the supplier does not anticipate great difficulty in providing service.

IMPACTS—SNL, LIVERMORE

The no action alternative, as described in Section 3, would not significantly impact electrical consumption rates. Continued consumption of electricity at current levels results in a less than significant impact because there is an energy conservation program and the supplier does not anticipate great difficulty in providing service.

Fuel Consumption

LLNL Livermore Site and LLNL Site 300

Based on projected 1992 estimates, LLNL consumes a total of approximately 848,000 gal of various fuels per year (Holda, 1991; Frahm, 1991). For this EIS/EIR, this consumption rate is considered to be representative of future consumption rates for the no action alternative.

SNL, Livermore

Based on projected 1992 estimates, SNL, Livermore consumes a total of approximately 16,600 gal of various fuels per year (Allen, 1991). For this EIS/EIR, the consumption rate is considered to be representative of future consumption rates for the no action alternative.

IMPACTS—LLNL LIVERMORE SITE AND LLNL SITE 300

The no action alternative, as described in Section 3, would not significantly impact fuel consumption rates. Continued consumption of fuels at current levels results in a less than significant impact because there is an energy conservation program and the supplier does not anticipate great difficulty in providing service.

IMPACTS—SNL, LIVERMORE

The no action alternative, as described in Section 3, would not significantly impact fuel consumption rates. Continued consumption of fuel at current levels results in a less than significant impact because there is an energy conservation program and the supplier does not anticipate great difficulty in providing service.

Sewer Discharges

LLNL Livermore Site

Based on projected 1992 estimates, LLNL discharges approximately 107 million gal of sewage per year (Parisotto, 1991a). For this EIS/EIR, this rate is considered to be representative of future discharge rates for the no action alternative.

LLNL Site 300

Based on projected 1992 estimates, LLNL Site 300 discharges approximately 1.3 million gal of sewage per year. For this EIS/EIR, this rate is considered to be representative of future discharge rates under the no action alternative.

SNL, Livermore

Based on projected 1992 estimates, SNL, Livermore discharges approximately 27.7 million gal of sewage per year (Parisotto, 1991a). For this EIS/EIR, this rate is considered to be representative of future discharge rates for the no action alternative.

IMPACTS—LLNL LIVERMORE SITE

The no action alternative, as described in Section 3, would not significantly impact sewage discharge rates. Continued discharge of sewage at current levels results in a less than significant impact because there is a waste conservation program, the City of Livermore sewer system capacity is more than adequate to receive these flows, and the City does not anticipate great difficulty in providing service.

IMPACTS—LLNL SITE 300

Activities under the no action alternative, as described in Section 3, would not impact sewage discharge capacity in the area. Continued discharge of sewage at current levels results in a less than significant impact because there is a waste conservation program and the current infrastructure can withstand current rates.

IMPACTS—SNL, LIVERMORE

The no action alternative, as described in Section 3, would not significantly impact sewage discharge rates. Continued discharge of sewage at current levels results in a less than significant impact because there is a waste conservation program and the City of Livermore sewer system does not anticipate great difficulty in providing service.

CUMULATIVE IMPACTS

Under the no action alternative, the Laboratories would continue to consume utilities at rates equivalent to the projected 1992 estimates.

LLNL Livermore Site and SNL, Livermore

Water. Under the no action alternative, the LLNL Livermore site would consume an estimated 223 million gal of water annually, and SNL, Livermore would consume 58 million gal of water annually. The City of Livermore anticipates a 26.4 percent increase in population by the year 2000, and the City of Pleasanton projects a 43.4 percent increase by the year 2000. In conjunction with the no action water consumption at the Laboratories, this growth constitutes a significant adverse cumulative impact if the drought and other limiting factors continue. The steps necessary to mitigate this impact are not available to UC or DOE; therefore, it remains significant and unavoidable.

Electricity. Under the no action alternative, the LLNL Livermore site would consume 321 million kilowatt-hours per year, and SNL, Livermore would consume 40.1 million kilowatt-hours per year. The residential, commercial, and industrial electrical energy demand in the surrounding communities of Alameda County is anticipated to be about 12 percent. The Laboratories' electrical energy demands under the no action alternative represent about 3 percent of the total projected annual electricity demand for Alameda and San Joaquin counties. The Laboratories' contribution to the cumulative increase is less than significant. The utilities would increase their capacity to meet the anticipated energy demands.

Fuel. Under the no action alternative, the LLNL Livermore site would consume approximately 848,000 gal of various fuels per year, and SNL, Livermore would consume approximately 16,600 gal of various fuels per year. Because providers have indicated no shortage in available supplies, the Laboratories' contribution to the cumulative increase in fuel consumption in the area is less than significant.

Sewer Discharges. Under the no action alternative, the LLNL Livermore site would discharge 107 million gal of sewage per year, and SNL, Livermore would discharge 27.7 million gal of sewage per year. The Laboratories' contribution to the cumulative increase in sewage discharge in the area is less than significant.

LLNL Site 300

Water. Under the no action alternative, LLNL Site 300 water consumption would remain similar to the projected 1992 estimates of 30 million gal of water per year. Cumulative development in the vicinity of LLNL Site 300 (San Joaquin County is projected to increase by 47.7 percent by the year 2010) would increase demand for and consumption of water. The cumulative impact is significant and unavoidable. The LLNL Site 300 contribution to the cumulative increase is less than significant because the majority of its water is pumped from wells.

Electricity. Under the no action alternative, the LLNL Site 300 electricity consumption would remain similar to the projected 1992 consumption of 1.5 million kilowatt-hours per year. The LLNL Site 300 contribution to the cumulative increase (due to the increase in population) in the area is less than significant.

Fuel. Under the no action alternative, the LLNL Site 300 fuel consumption would remain similar to the projected 1992 consumption of approximately 78,000 gal per year. The LLNL Site 300 contribution to the cumulative increase in the area is less than significant.

Sewer Discharges. Under the no action alternative, the LLNL Site 300 sewer discharges would remain similar to the projected 1992 estimates of 1.3 million gal per year. Since the sewage discharges are within LLNL Site 300 (septic tanks, leach fields, cesspools, and an oxidation pond), the contribution to the cumulative increase in the area is less than significant.

5.2.13 MATERIALS AND WASTE MANAGEMENT

This section focuses on impacts to materials and waste management under the no action alternative.

Materials Management

LLNL Livermore Site

For this EIS/EIR, it is assumed that current rates of hazardous and radioactive materials use are representative rates for the no action alternative. Some Laboratory operations involve the use of various radionuclides, including, but not limited to, tritium, plutonium, and uranium. There are administrative limits for radionuclides within specific buildings (see Table 4.15-1 for additional details).

LLNL is currently reducing the plutonium administrative limit for the combined Buildings 332 and 334 from 700 kg to 200 kg with the inventory (actual inventory quantities are classified) being reduced accordingly. The reduction would be accomplished by shipping inventory to an offsite DOE facility and is targeted for completion during FY 1993.

Additionally, Laboratory research and development activities use a variety of hazardous materials. These include, but are not limited to, volatile organic compounds, fuel, and aromatic hydrocarbons (see Table A-25 in Appendix A for information on representative chemical inventories). The existing chemical inventory onsite is approximately 195,935 gal of liquids and 2,114,880 lb of solids and gases.

LLNL Site 300

For this EIS/EIR, it is assumed that current rates of hazardous and radioactive materials use are representative of rates for the no action alternative. The principal activity at LLNL Site 300 is testing with high explosives (HE). Present magazine storage limits for high explosives range up to 3000 lb. Present experiments in which high explosives are purposefully detonated use quantities up to several hundred pounds. The chemical inventory at LLNL Site 300 is approximately 84,404 gal of liquids, 100,000 lb of solids, and 1,895,400 cu ft of gases. Tritium use would continue at the firing tables with an administrative limit of 20 mg.

SNL, Livermore

For this EIS/EIR, it is assumed that current rates of hazardous and radioactive materials use are representative of rates for the no action alternative. The principal radionuclide used in SNL, Livermore's research and development facilities is tritium, used at Building 968, the Tritium Research Laboratory. The facility administrative limit is currently 50 g but would be reduced to 0 g under the no action alternative.

In addition, Laboratory research and development activities use a variety of hazardous materials. These include, but are not limited to, volatile organic compounds, fuel, and aromatic hydrocarbons. The representative chemical inventory onsite is approximately 3420 gal, 6320 lb, and 197,000 cu ft.

IMPACTS—LLNL LIVERMORE SITE

For the no action alternative, there would be no change in quantities of materials managed at the LLNL Livermore site, although procedures and organization for managing these materials would continue to be modified or revised as necessary to meet changes in DOE and LLNL guidelines and policies. This would be considered a less than significant impact.

IMPACTS—LLNL SITE 300

Since materials at LLNL Site 300 are managed by the materials management organization at the LLNL Livermore site, the impact analysis for LLNL Site 300 is the same as that discussed above for the LLNL Livermore site.

IMPACTS—SNL, LIVERMORE

Like LLNL, SNL, Livermore handles all hazardous and radioactive material in accordance with applicable laws and regulations designed to protect the health and safety of employees, the general public, and the environment. Because there would be no substantial changes in the types and quantities of hazardous materials managed at SNL, Livermore, the relative impacts of continued materials use would be less than significant. The quantities of radioactive waste generated at the Tritium Research Laboratory would be reduced in accordance with the reduction in the tritium inventory to 0 g.

CUMULATIVE IMPACTS—LLNL AND SNL, LIVERMORE

The cumulative impacts for materials used under the no action alternative would be equivalent to or less than those discussed under the proposed action (see section 5.1.13). These impacts were considered less than significant, unless an accident were to occur during transports (see section 5.6 for analysis of transport accidents).

Waste Management

LLNL Livermore Site

For this EIS/EIR, it was assumed that waste generation rates projected for 1992 are representative of waste generation rates under the no action alternative. These waste generation rates are summarized below.

Radioactive Waste. The LLNL Livermore site generates approximately 287,000 lb of solid and 22,000 gal of liquid low-level radioactive waste (LLW) annually. Also the site generates approximately 2700 cu ft of transuranic waste annually.

Hazardous Waste. The LLNL Livermore site generates approximately 567,000 lb and 309,000 gal of hazardous waste annually.

Mixed Wastes. The LLNL Livermore site generates approximately 45,000 lb and 23,000 gal of mixed waste annually.

Medical Waste. The LLNL Livermore site generates approximately 2600 lb of medical waste annually.

LLNL Site 300

For this EIS/EIR, it was assumed that waste generation rates projected for 1992 are representative of waste generation rates under the no action alternative. These waste generation rates are summarized below.

Radioactive Waste. LLNL Site 300 generates approximately 300,000 lb of solid low-level radioactive waste (LLW) annually.

Hazardous Waste. LLNL Site 300 generates approximately 37,000 lb and 41,000 gal of hazardous waste annually.

Mixed Wastes. LLNL Site 300 generates approximately 2000 lb of mixed waste annually.

Medical Waste. LLNL Site 300 generates approximately 12 lb of medical waste annually.

SNL, Livermore

For this EIS/EIR, it was assumed that waste generation rates projected for 1992 are representative of waste generation rates under the no action alternative. These waste generation rates are summarized below.

Radioactive Waste. SNL, Livermore generates approximately 8860 lb and 7670 gal of low-level radioactive waste (LLW) annually. This generation rate would be reduced in accordance with the reductions in tritium inventory. Decommissioning of the Tritium Research Laboratory would result in generation of low-level waste estimated at 100,000 lb over the 3 years of the project.

Hazardous Waste. SNL, Livermore generates approximately 6320 lb and 3940 gal of hazardous waste annually.

Mixed Wastes. SNL, Livermore generates approximately 73 lb of solid mixed waste and 250 lb of scintillation cocktails annually. Decommissioning of the Tritium Research Laboratory would result in generation of an additional quantity of liquid mixed wastes estimated at 310 gal over the 3 years of the project.

Medical Waste. SNL, Livermore generates approximately 124 lb of medical waste annually.

IMPACTS—LLNL LIVERMORE SITE

Under the no action alternative, the LLNL Livermore site would continue to generate radioactive, hazardous, mixed, and medical wastes, but there would be no increases in rates for these wastes. With the exception of mixed waste storage, impacts associated with the no action alternative would be less than significant. Because mixed waste generation would require onsite storage beyond storage limits prescribed by RCRA, the generation of any mixed waste is considered to have a significant and unavoidable impact on the environment. Even though waste generation rates (including U-AVLIS) are not projected to increase under the no action alternative, available capacity for mixed waste storage is expected to be exceeded within the next 10 years. Therefore, the discussion for Impact 13.1.3 also applies to the no action alternative.

IMPACTS—LLNL SITE 300

At LLNL Site 300, the no action alternative would impact waste management in the same manner as at the LLNL Livermore site because these two sites are operated under the same waste management program. LLNL Site 300 mixed waste is stored at the LLNL Livermore site.

IMPACTS—SNL, LIVERMORE

Under the no action alternative, SNL, Livermore will continue to generate radioactive, hazardous, mixed, and medical wastes, but there would be no increase in generation rates for these wastes. With the exception of mixed waste storage, impacts associated with the no action alternative would be less than significant. Because mixed waste generation would require storage beyond storage limits prescribed by RCRA, the generation of these wastes is considered to have a significant and unavoidable impact on the environment. Therefore, the discussion for Impact 13.3.3 also applies to the no action alternative.

The decommissioning of the Tritium Research Laboratory would result in low-level and mixed waste generation over the 3 years of the project. These generation rates are discussed in Impacts 13.3.6 and 13.3.7 for the proposed action alternative, and also apply to the no action alternative.

CUMULATIVE IMPACTS

Under the no action alternative, the Laboratories would continue to generate waste at the rates projected for 1992 (see above). These wastes are managed in accordance with applicable laws and regulations designed to protect workers, the public, and the environment. Since additional waste generation is not projected, the Laboratories' contribution to the cumulative impacts is less than significant.

5.2.14 OCCUPATIONAL PROTECTION

This section discusses the relative impact on occupational protection from implementation of the no action alternative.

Occupational Protection—Radiation Protection

LLNL Livermore Site

Radiation doses to workers at the LLNL Livermore site are well within DOE guidelines for protection of workers. Under the no action alternative the administrative limit for tritium at Building 331, the Hydrogen Research Facility, will be reduced from 300 g to 5 g. No additional tritium operations will be moved to Building 391, the Inertial Confinement Fusion Facility, or to Building 298, the Fusion Target Fabrication Facility.

LLNL is currently reducing the plutonium administrative limit for the combined Buildings 332 and 334 from 700 kg to 200 kg with the inventory (actual inventory quantities are classified) being reduced accordingly. The reduction would be accomplished by shipping inventory to an offsite DOE facility and is targeted for completion during FY 1993.

LLNL Site 300

There are currently no facilities at LLNL Site 300 that contribute significantly to the collective radiation dose to workers, and no changes will occur under the no action alternative that would affect radiation doses to workers.

SNL, Livermore

The radiation doses to workers at SNL, Livermore are well within DOE guidelines for protection of worker safety. Under the no action alternative the administrative limit for tritium would be reduced from 50 g to 0 g. There are no new facilities or modifications of existing facilities in the no action alternative that would affect these exposures.

IMPACTS—LLNL LIVERMORE SITE

Internal radiation doses from exposure to tritium would be reduced at Building 331, the Hydrogen Research Facility, by reducing the amount of tritium handled. This is a less than significant impact and may be beneficial.

IMPACTS—LLNL SITE 300

The site facility revitalization planned under the no action alternative, consisting primarily of building, equipment, and road improvements, would result in no additional radiation exposures. This is a less than significant impact.

IMPACTS—SNL, LIVERMORE

Exposure levels at SNL, Livermore would remain consistent with the reduction in tritium inventory under the no action alternative. This is a less than significant impact and may be beneficial.

The decommissioning of the Tritium Research Laboratory would increase radiation exposure of decontamination workers. This increase is discussed in Impact 14.3.2 under the proposed action alternative, and also applies to the no action alternative.

CUMULATIVE IMPACTS—LLNL AND SNL, LIVERMORE

Because radiation exposures at LLNL and SNL, Livermore are well below regulatory standards, the cumulative impacts to workers from radiation exposures associated with the no action alternative would depend on their receiving additional exposures offsite. Potential exposure to external radiation is highly regulated and the likelihood of individuals receiving exposures beyond accepted safety limits is very small, and is considered a less than significant impact.

Toxic Substances and Physical Hazards

LLNL Livermore Site

As under current conditions, exposures of workers to toxic chemicals would remain well within DOE safety guidelines under the no action alternative.

LLNL Site 300

There are no projects under the no action alternative that would impact worker exposure to toxic substances and physical hazards at LLNL Site 300.

SNL, Livermore

There are no new projects under the no action alternative that would increase exposure of workers to toxic substances at SNL, Livermore.

IMPACTS—LLNL LIVERMORE SITE

There are no projects at the LLNL Livermore site included in the no action alternative that would increase worker exposure to toxic substances. This is a less than significant impact.

IMPACTS—LLNL SITE 300

There are no projects at LLNL Site 300 included in the no action alternative that would increase worker exposure to toxic substances. This is a less than significant impact.

IMPACTS—SNL, LIVERMORE

There are no projects at SNL, Livermore under the no action alternative that would increase worker exposure to toxic substances. This is a less than significant impact.

CUMULATIVE IMPACTS

LLNL and SNL, Livermore

Because toxic materials exposures at LLNL and SNL, Livermore are well below regulatory standards, the cumulative impacts to workers would depend on their receiving additional exposures offsite. Potential exposure to these materials is highly regulated and the likelihood of cumulative impacts is very small and is considered a less than significant impact.

5.2.15 SITE CONTAMINATION

This section evaluates impacts upon soil and sediment, surface water, and ground water contamination at the LLNL Livermore site, LLNL Site 300, and SNL, Livermore under the no action alternative.

LLNL and SNL, Livermore

LLNL and SNL, Livermore are cleaning up affected soils and ground water that pose a threat to human health and the environment. As described in section 4.17, ongoing activities of the Environmental Restoration Program include identification and remediation efforts. These activities will continue under the no action alternative at both facilities.

IMPACTS—LLNL LIVERMORE SITE

Selection of the no action alternative would result in no increase in erosion and dispersion of excavated contaminated soils. The possibility of release of site contaminants to air or surface water would be minimized. Some worker exposure could result from remediation activities conducted in accordance with the Federal Facilities Agreement and regulatory requirements, but these impacts are minimal compared to those that would result if the restoration program were not implemented. The health risk assessments and associated health and safety plans that are prepared before any action that will disturb contaminated soils would specify measures to be implemented to minimize risks to worker health and to the environment. Minimal waste is expected to be generated as a result of the site restoration program.

IMPACTS—LLNL SITE 300

Under the no action alternative, environmental restoration activities would continue to address soil, sediment, surface water, and ground water contamination of LLNL Site 300. The remedial investigation/feasibility study process is still underway and no final decision has been made on potential alternatives. Once a final decision is made, appropriate NEPA documentation would follow. Risks of human exposure to site contaminants would not increase under this alternative. As at LLNL Livermore, health risk assessments and health and safety plans would be prepared prior to disruption of any contaminated area, and appropriate mitigation measures implemented.

IMPACTS—SNL, LIVERMORE

Environmental restoration activities currently underway would continue at SNL, Livermore under the no action alternative. As SNL, Livermore is not on the National Priorities List, the restoration activities are not being conducted pursuant to CERCLA. The wastes generated from the restoration activities have already been factored into the waste inventories specified in section 4.15.2.3. Potential impacts from historic contamination would continue to be addressed as part of the no action alternative. No activities under the no action alternative would result in impacts to contaminated areas at SNL, Livermore.

CUMULATIVE IMPACTS

LLNL and SNL, Livermore

Environmental restoration would continue at the same level of activity under the no action alternative as under the proposed action at LLNL and SNL, Livermore. The cumulative impacts for the no action alternative, therefore, would be equivalent to or less than those discussed in the proposed action (see section 5.1.5), which are less than significant.

5.3 MODIFICATION OF OPERATIONS

This alternative would modify LLNL and SNL, Livermore operations, including near-term (within 5 to 10 years) proposed projects, in order to reduce adverse environmental impacts. Modification of operations is broadly defined as the scale-down of operations and/or the application of alternative technologies and management strategies (formerly described as two alternatives in the Notice of Intent, 55 Fed. Reg. 41048).

The first step in assessing this alternative was to identify those operations at LLNL and SNL, Livermore where environmental impacts could be reduced through a modification of operations. The primary criteria for selection were:

- Operations with a history of, or a potential for, the greatest worker exposure to hazardous or radiological materials (see Appendix C).
- Operations, based on accident analyses, with the greatest potential impact to the public health and safety (see Appendix D).
- Operations that have historically generated the greatest quantities of transuranic waste, low-level waste, mixed waste, or waste restricted from land disposal (see Appendix B).

On the basis of the selection criteria and a review of facility operations, the following options for modification of operations were identified:

- Operations in LLNL's plating shop, Building 322, could be modified and the building structurally reinforced to prevent the accidental mixing of incompatible chemicals. This would minimize or eliminate offsite impacts during a severe earthquake.
- Waste management operations at the two Laboratories could be consolidated at LLNL's waste management complex. This might be accomplished if regulatory approval is obtained allowing LLNL and SNL, Livermore to apply for the same EPA identification number or by LLNL's modifying its RCRA Part B permit to accept SNL, Livermore wastes. This would allow transfer of wastes between sites for possible treatment and packaging in compliance with DOT regulatory requirements before wastes are shipped offsite. Under this alternative, more efficient methods of waste treatment could also be evaluated at a centralized waste management complex.
- At various facilities, notably LLNL's Building 332, plutonium and other Special Nuclear Materials are stored in excess of current needs. Removal of this material and storage elsewhere could reduce worker exposures. LLNL is currently reducing the plutonium administrative limit for the combined Buildings 332 and 334 from 700 kg to 200 kg, with the inventory (actual inventory quantities are classified) being reduced accordingly. The reduction would be accomplished by shipping inventory to an offsite DOE facility and is targeted for completion during FY 1993.
- Buffer zones to the east of the LLNL Livermore site and SNL, Livermore might be acquired to reduce fenceline exposures and to preclude the development of residential and/or industrial areas immediately downwind of the two Laboratories.

These examples are illustrative of possible modifications being considered. If this alternative were selected, however, more detailed engineering and environmental evaluations would be undertaken to select facilities and operations for modification. The implementation of any of these modifications is not precluded, however, if the proposed action is adopted.

5.3.1 LAND USES AND APPLICABLE PLANS

LLNL Livermore Site and SNL, Livermore

The modification of operations alternative would not alter the types of land uses at the LLNL Livermore site or SNL, Livermore. As discussed earlier, this alternative considers the acquisition of an unspecified amount of additional land east of the current boundaries of the LLNL Livermore site and SNL, Livermore as additional buffer area. The area is used for grazing and rural residential uses, and is zoned for agricultural uses. The area has an agricultural land use designation in the Alameda County General Plan and is included in the county's South Livermore Valley General Plan Amendment planning area.

If acquisition of additional buffer area were implemented, there would be the potential for a change to the existing residential and agricultural uses and a possible inconsistency with approved land use plans for the affected area.

LLNL Site 300

This alternative would neither alter the types of land uses at LLNL Site 300 nor require acquisition of any additional land. Thus, no impacts to land uses at or near LLNL Site 300 would result.

5.3.2 SOCIOECONOMIC CHARACTERISTICS

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

Impacts under the modification of operations alternative would be similar to those described for the proposed action. Consistent with the proposed action, this alternative assumes an increase in employment levels at LLNL and SNL, Livermore. Increased employment would result in population increases and an increased demand for housing in the region. The modification of operations alternative would also result in increases in the amount of goods and services purchased by the Laboratories at levels similar to those estimated for the proposed action.

5.3.3 COMMUNITY SERVICES

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

Impacts as a result of the modification of operations alternative would be similar to those described for the proposed action. Increases in the need for onsite fire protection and security services or in the interaction of these forces with offsite fire and police protection agencies would be required. It is also assumed that the employment increase associated with the modification of operations alternative would be the same as for the proposed action. Thus, increases in student enrollment and nonhazardous solid waste generation, based on the same increase in employment, are assumed to be the same as for the proposed action.

5.3.4 PREHISTORIC AND HISTORIC CULTURAL RESOURCES

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

The Area of Potential Effect for the LLNL Livermore site and SNL, Livermore under the modification of operations alternative would be expanded to encompass any newly acquired lands to the east of the sites. These lands would require an evaluation for the presence of cultural resources before impacts to prehistoric and historic resources could be determined. The Area of Potential Effect for LLNL Site 300 would be the same as for the proposed action. Impacts to prehistoric and historic resources at the LLNL Livermore site, LLNL Site 300, and SNL, Livermore would be similar to those described for the proposed action. Until structures and facilities have been evaluated as to their historic significance, the exact nature of impacts would remain unknown.

This evaluation would be done through the Section 106 process of the National Historic Preservation Act, which would be required regardless of whether or not the modification of operations alternative is chosen for implementation.

5.3.5 AESTHETIC AND SCENIC RESOURCES

LLNL Livermore Site and SNL, Livermore

The modification of operations alternative would have effects on visual resources at the LLNL Livermore site and SNL, Livermore consistent with the proposed action, with the exception of potential effects of the possible acquisition of land east of the LLNL Livermore site and SNL, Livermore as additional buffer area. Depending on the disposition of Greenville Road within this buffer zone, and the land use changes (if any) within the buffer zone, the County of Alameda scenic corridor status of the portion of Greenville Road between Patterson Pass Road and Tesla Road could be affected. The relative significance of this would depend on the accessibility of the roadway to the public and the possible changes to visual features (landscaping and vegetation) along the road. Until such an evaluation can be made, a potentially significant impact is identified.

LLNL Site 300

The modification of operations alternative would not substantially alter visual features at LLNL Site 300 nor would it affect scenic resources policies for roadways or land uses in the vicinity of the site. Thus, effects on aesthetics or scenic resources at or near LLNL Site 300 would be less than significant under this alternative.

5.3.6 GEOLOGIC RESOURCES AND HAZARDS

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

No known geologic resources are close enough to the LLNL Livermore site, LLNL Site 300, or SNL, Livermore to be affected by activities of the modification of operations alternative. Similarly, modification of operations would not initiate any geologic hazard (earthquake, landslide, or liquefaction). On the other hand, any construction needed for any particular modification of operations would have to adhere to the building codes that embody seismic-resistant design presented in section 5.1.6. The potential impacts of modification of operations on geologic resources and hazards would not be significant.

5.3.7 ECOLOGY (Vegetation, Wildlife, Sensitive Species, and Wetlands)

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

It is anticipated that the same land disturbance activities described for the no action alternative (e.g., the LLNL Site 300 revitalization plan) and for the proposed action (e.g., the Contained Firing Facility, the Cheap Access to Orbit Facility, and elimination of surface water runoff at LLNL Site 300) would occur under the modification of operations alternative. Therefore, the impacts of this alternative on vegetation, wildlife, sensitive species, and wetlands would be equivalent to the impacts of the proposed action on these biological resources.

5.3.8 AIR QUALITY

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

The modification of operations alternative may result in a small decrease in air emissions over those estimated for the proposed action. Given the changes in operations and facilities described above and in section 3.2.1, it is estimated that annual stationary source emissions could be reduced by up to 1 percent relative to the emissions contribution from the remainder of the facilities at LLNL and SNL, Livermore. A similar reduction would be expected for toxic air pollutants. Emissions from vehicular traffic and construction activities at the Laboratories would remain unchanged from those of the proposed action since growth in employment along with construction activity is estimated to be the same as for the proposed action. This reduction would be considered less than significant, except that any emissions into a nonattainment area are considered to be a significant impact.

If a buffer zone to the east of the LLNL Livermore site and SNL, Livermore were acquired, the radiation dose at the fenceline would be reduced by about 6 percent for each 100 m of distance from the existing boundary. This would result in a reduction in the radiation dose to the hypothetical maximum-exposed individual. However, because of the small number of persons living in this area, there would be no change in the calculated collective dose for the current population distribution. The acquisition would be of value for reducing collective radiation dose only if it prevented future development of the area for residential use. Even in this case, the contribution to the collective radiation dose would be less than significant.

5.3.9 WATER

The modification of operations alternative would not change the anticipated impacts on water resources from the proposed action.

5.3.10 NOISE

LLNL Livermore Site and SNL, Livermore

Noise characteristics at or in the vicinity of the LLNL Livermore site and SNL, Livermore would be the same as those under the proposed action.

LLNL Site 300

Noise characteristics at or near LLNL Site 300 would be the same as those identified for the proposed action.

5.3.11 TRAFFIC

LLNL Livermore Site and SNL, Livermore

Traffic conditions and levels of service at intersections studied would be essentially the same as those described for the proposed action. No project-specific traffic impacts are identified.

LLNL Site 300

Traffic conditions at or near LLNL Site 300 resulting from implementation of this alternative are assumed to be the same as those identified for the proposed action. No project-specific traffic impacts are identified.

5.3.12 UTILITIES AND ENERGY

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

The modification of operations alternative would not change the anticipated impacts on utility usage and energy resources from the proposed action.

5.3.13 MATERIALS AND WASTE MANAGEMENT

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

Because the modification of operations alternative aims to reduce the impacts of those activities with the largest potential exposures to workers and to the public, the amounts and uses of hazardous and radioactive materials are expected to be less than under the proposed action. The impacts associated with materials and waste management at LLNL and SNL, Livermore fall within those identified for the proposed action.

LLNL is currently reducing the plutonium administrative limit for the combined Buildings 332 and 334 from 700 kg to 200 kg, with the inventory (actual inventory quantities are classified) being reduced accordingly. The reduction would be accomplished by shipping inventory to an offsite DOE facility and is targeted for completion during FY 1993.

One potential modification option is the consolidation of SNL, Livermore waste management activities with the LLNL Livermore site waste management system. Consolidation of waste management activities in itself would not necessarily reduce the amount of wastes generated, but would provide for more efficient waste handling, treatment, packaging, and shipment. Consolidation of waste handling could potentially reduce the occupational exposure to waste management activities for SNL, Livermore workers. Other potential benefits that could be realized through consolidation include the need for fewer workers, less duplication of waste management equipment, reduced demands for emergency response capabilities, and fewer waste disposal shipments resulting from increased processing capabilities. However, this option would require a substantial regulatory approval process and result in the potential for increased liability to both site operators, increased exposure to LLNL workers, and increased demands on LLNL permitted capacities as a result of accepting SNL, Livermore waste.

Because the modification of operations alternative would reduce those activities at LLNL and SNL, Livermore with the greatest potential impacts, it is expected that the shipments of hazardous materials, particularly hazardous wastes, would fall within the range of transportation activity described for the proposed action. A possible exception could occur if LLNL and SNL, Livermore elected to consolidate some waste-handling facilities. This action might require the shipment of potentially contaminated waste-handling units from decommissioning of replaced waste-handling facilities to offsite treatment, storage, recycling, or disposal facilities. The transportation accident analysis and the level of transportation impacts identified for the proposed action, however, already encompass the hazardous waste transportation issues raised by consolidation.

5.3.14 OCCUPATIONAL PROTECTION

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

Modifications to the technical and management aspects of facilities and operations at LLNL and SNL, Livermore may reduce worker exposures under this alternative relative to the proposed action.

Consolidating SNL, Livermore waste management activities with LLNL waste management may result in an overall reduction in radiological and nonradiological exposures to workers over those of the proposed action, because of the need for fewer workers. The reduction in exposure of SNL, Livermore workers would be partially offset by an increase in exposure of LLNL workers.

LLNL is currently reducing the plutonium administrative limit for the combined Buildings 332 and 334 from 700 kg to 200 kg, with the inventory (actual inventory quantities are classified) being reduced accordingly. The reduction would be accomplished by shipping inventory to an offsite DOE facility and is targeted for completion during FY 1993.

5.3.15 SITE CONTAMINATION

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

The LLNL Livermore site has identified over 17 areas with known soil and sediment contamination. An additional 17 areas are currently under investigation for potential sources of contaminants. Contaminants in soils include volatile organic compounds, fuel hydrocarbons, pesticides, polychlorinated biphenyls, metals, and tritium.

LLNL Site 300 has identified 10 main areas of contaminated soil. Contaminants detected include volatile organic compounds, fuels, aromatic hydrocarbons, metals, radionuclides, and high explosive compounds.

SNL, Livermore has evaluated nine source areas for the presence of soil and sediment contamination. The contaminants detected include volatile organic compounds, fuel hydrocarbons, and metals. Regardless of whether the operations of the Laboratories are modified, the Environmental Restoration Programs will continue until remediation is completed. The net impacts are less than significant.

5.3.16 CUMULATIVE IMPACTS

The modification of operations alternative is a variation of the proposed action with additional emphasis on changing those operations at LLNL and SNL, Livermore with greatest impacts. The options for modification selected as examples in assessing this alternative were selected to reduce potential impacts to the environment, the public, and workers. Cumulative impacts, under this alternative, are therefore equivalent to or less than the cumulative impacts discussed under the proposed action.

5.4 SHUTDOWN AND DECOMMISSIONING

This alternative calls for the orderly phaseout of all programmatic research and development operations at LLNL and SNL, Livermore and the eventual shutdown and decommissioning of all facilities.

Phased shutdown is estimated to take 5 years. Decommissioning would involve the restoration or decontamination and disposal of contaminated facilities. Decommissioning and environmental compliance activities would start during shutdown and continue for at least another 5 years. The projects to be eliminated and the facilities to be shut down are those in existence at the end of FY 1992. Those projects and facilities required for compliance with statutes and regulations would continue. For additional discussion of this alternative, see section 3.2.3.

5.4.1 LAND USE

LLNL Livermore Site and SNL, Livermore

Implementation of the shutdown and decommissioning alternative would not result in land use changes other than the eventual shutdown of operations of the Laboratories. Determination of potential land use impacts for the period following shutdown and decommissioning is beyond the scope of this EIS/EIR. If the sites revert to private ownership, any land use or zoning approvals would be within the jurisdiction of the City of Livermore and/or the County of Alameda.

LLNL Site 300

Implementation of this alternative would not result in land use impacts other than the eventual shutdown of operations at LLNL Site 300. Determination of potential land use impacts for the period following shutdown and decommissioning is beyond the scope of this EIS/EIR. If the site reverts to private ownership, any land use and zoning approvals would be within the jurisdiction of the County of San Joaquin and/or the County of Alameda.

5.4.2 SOCIOECONOMIC CHARACTERISTICS

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

Under the shutdown and decommissioning alternative, there would be an estimated decrease in LLNL employment of about 11,400 people, including contractor personnel, 200 of whom are associated with LLNL Site 300. Shutdown would result in substantial economic losses to the local and regional economy through the loss of an estimated LLNL annual payroll of $432 million and $467 million per year spent on goods and services. At SNL, Livermore, the shutdown and decommissioning alternative would result in an estimated decrease in employment of 1500 people, as well as the loss of an estimated $52 million annual payroll and $92 million per year spent on goods and services.

The shutdown of LLNL and SNL, Livermore operations would result not only in the loss of the majority of employment opportunities associated with their operations, but also in a decline in sales tax revenues for area cities and counties. Job positions associated with current research projects would be eliminated at the completion of those projects. Significant unemployment and economic impacts to the local economy would occur in the short term, although long-term impacts cannot be determined.

By the end of the shutdown period, the majority of current positions would be eliminated. A smaller crew of decommissioning personnel, caretakers, and security staff would be employed to clean up and maintain the sites.

Although a precise estimate of the size of this work force is not available, it is estimated to be not more than a few hundred employees. Following decommissioning, the work force would approach zero (ultimately dependent upon future ownership and site use).

The relatively large employment loss from the shutdown would result in additional local and regional competition for jobs as LLNL and SNL, Livermore workers sought local work opportunities. Unemployment would increase. Furthermore, many of the workers would migrate out of the area in search of employment elsewhere because many are highly skilled and specialized. Job transferability within Alameda and San Joaquin counties would be extremely restricted (Szalay, 1990). This could reduce population growth and urban development in the surrounding area, where the majority of LLNL and SNL, Livermore personnel reside. These potential impacts are individually and collectively significant and unavoidable.

5.4.3 COMMUNITY SERVICES

LLNL and SNL, Livermore—Fire Protection and Emergency Services

The LLNL Fire Department would continue to provide fire protection and emergency response services, including mutual aid service to surrounding communities, during the shutdown and decommissioning process if this alternative were selected. Routine maintenance and upgrades of facilities and equipment would continue as needed until the Laboratories were closed, although the level of staff and equipment would be reduced to reflect reductions in facilities and staff. Eventually, following completion of decommissioning, the LLNL Fire Department would necessarily withdraw from its agreements with the City of Livermore Fire Department and from mutual aid agreements with other offsite agencies. Because this would not alter the ability of the City of Livermore Fire Department or other offsite agencies to provide adequate service within their respective jurisdictions, shutdown and decommissioning would result in a less than significant impact on local fire protection and emergency services.

SNL, Livermore does not maintain a separate fire protection force but relies on LLNL for help when needed; therefore, the impact of shutting down SNL, Livermore on fire and emergency protection community services would be less than significant.

LLNL and SNL, Livermore—Police and Security Services

The LLNL and SNL, Livermore protective forces would maintain a reduced level of operations to provide onsite security during the shutdown and decommissioning process. Because of the limited interaction with offsite law enforcement agencies, a reduction in the protective forces, and the ultimate discontinuance of onsite security services, the shutdown and decommissioning alternative would have a less than significant impact on offsite law enforcement agencies.

LLNL and SNL, Livermore—Schools

Because this alternative would involve a reduction in employment during the shutdown and decommissioning process, it could also result in a decrease in the number of students enrolled in the Livermore Valley Joint Unified School District and other school districts. Following complete shutdown and decommissioning, DOE would no longer be required to participate in the federal government's Impact Aid Program, which contributes funds to the Livermore Valley Joint Unified School District to compensate for impacts to the district resulting from the provision of school services to pupils with at least one parent employed on federal lands. This would represent a funding reduction to the school district, and would be a potentially significant impact.

LLNL Livermore Site and SNL, Livermore—Nonhazardous Solid Waste Disposal

This alternative could result in a short-term increase in the amount of nonhazardous solid waste transported to the Vasco Road Sanitary Landfill from disposal of demolition debris and other nonhazardous wastes from shutdown of the various facilities. Shutdown and decommissioning would gradually reduce and eventually eliminate solid waste generated at the sites. Implementation of this alternative would not have a significant impact on the ability of Alameda County to provide adequate landfill capacity.

LLNL Site 300—Nonhazardous Solid Waste Disposal

The shutdown and decommissioning alternative could result in a short-term increase in the amount of solid waste transported to the Corral Hollow Sanitary Landfill from disposal of demolition debris and other nonhazardous wastes. This increase would be considered potentially significant, even though shutdown and decommissioning would eventually eliminate solid waste generated at the site because the Corral Hollow landfill is scheduled to close before the shutdown and decommissioning process would be completed. Therefore, implementation of this alternative would have a significant impact on the ability of San Joaquin County to provide adequate landfill capacity.

5.4.4 PREHISTORIC AND HISTORIC CULTURAL RESOURCES

LLNL Livermore Site and LLNL Site 300

There are no recorded prehistoric resources at the LLNL Livermore site. The site's historic value has yet to be evaluated; the site may contain historic resources that are eligible for inclusion in the National Register of Historic Places. Under the shutdown and decommissioning alternative, the Area of Potential Effect for the LLNL Livermore site would encompass the entire site, since shutdown and decommissioning activities could affect structures throughout. This alternative could result in increased impacts to historic resources as the facility is decommissioned to allow for an undetermined future use. The exact nature of impacts would be unknown until a determination is made as to which structures or facilities are eligible for the National Register of Historic Places, and until DOE determines which structures would be dismantled under the shutdown and decommissioning program.

Of 24 cultural resource sites (3 prehistoric, 20 historic, and 1 with both a prehistoric and a historic component) recorded in a 1981 field and archival survey of LLNL Site 300, none has been formally evaluated for eligibility in the National Register of Historic Places. The Area of Potential Effect at LLNL Site 300 would be increased under this alternative to encompass the entire site. The exact nature of impacts is unknown until the shutdown and decommissioning program is clearly defined. Measures to protect all recorded prehistoric and historic sites, and any additional sites identified from the additional archival research of the town of Carnegie would need to be implemented. Protective measures might include flagging or fencing the site areas and/or recovering additional data from the sites.

Implementation of the shutdown and decommissioning alternative would not affect the need for compliance with Section 106 of the National Historic Preservation Act to determine if there are prehistoric and historic resources at LLNL Site 300 or at the LLNL Livermore site that should be included in the National Register.

SNL, Livermore

There are no National Register listed or eligible properties on SNL, Livermore to be affected by this alternative (State Historic Preservation Office, 1990).

5.4.5 AESTHETICS

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

Implementation of the shutdown and decommissioning alternative could result in short-term visual impacts if demolition of existing structures is required. In the long term, the visual character of the site following completion of the shutdown and decommissioning process cannot be determined until more is known regarding future land use.

Therefore, a potentially significant impact is identified. Evaluation of potential changes in the visual character of the sites as a result of possible new uses is not within the scope of this EIS/EIR.

5.4.6 GEOLOGIC RESOURCES AND HAZARDS

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

No known geologic resources are close enough to any of the three sites to be affected by activities of the shutdown and decommissioning alternative. Similarly, the shutdown and decommissioning alternative activities at LLNL and SNL, Livermore would not be impacted by a geologic hazard (earthquake, landslide, or liquefaction). It is assumed that as part of the shutdown and decommissioning process, steps would be taken to eliminate the potential for erosion due to loss of landscape vegetation and exposed soils from building demolition. These impacts are less than significant.

5.4.7 ECOLOGY (Vegetation, Wildlife, Sensitive Species, and Wetlands)

LLNL Livermore Site and SNL, Livermore

After shutdown and decommissioning, the long-term impacts on the ecology of the LLNL Livermore site and SNL, Livermore would depend on possible future uses that have not been identified or evaluated within the scope of this EIS/EIR. In the short term, any required demolition or decontamination could disrupt the already highly altered plant communities and associated wildlife; therefore, impacts of this alternative on biological resources at the LLNL Livermore site and SNL, Livermore would be less than significant.

LLNL Site 300

Biological resources at LLNL Site 300 could be substantially affected if shutdown and decommissioning were to alter the present land use controls, for example by allowing grazing or discontinuing the controlled burns. The native perennial grasslands could disappear and other plant community types, including wetlands, could be degraded, resulting in a reduction in wildlife species diversity. Negative impacts to threatened and endangered species and other sensitive species could occur, especially to species such as the red-legged frog and tiger salamander, which use aquatic habitats. In addition, all artificial wetlands would disappear.

Thus, impacts on biological resources at LLNL Site 300 could be significant. However, specific impacts cannot be determined until such time as new land uses are identified.

5.4.8 AIR QUALITY

LLNL Livermore Site

During shutdown there would be substantial reductions of emissions. However, during decommissioning there would be short-term impacts relating to particulate fugitive dust, volatile organic compounds, NOx, and resuspension contributing to a nonattainment area for ozone and PM10. These impacts would be temporary and localized to the areas of construction and are therefore less than significant. Overall, under the shutdown and decommissioning alternative, there would be an eventual reduction of emissions to near zero levels. These are beneficial impacts.

Although during shutdown and decommissioning some radiological releases would continue, these releases and the resulting public exposure would decrease to near zero. In the long run, the impact of this alternative on public exposures to radiation would be a beneficial impact.

LLNL Site 300

During decommissioning there would be short-term impacts relating to particulate fugitive dust, volatile organic compounds, and NOx emissions contributing to a nonattainment area for ozone and PM10. These impacts would be temporary and localized to the areas of construction and are therefore less than significant. Overall, under the shutdown and decommissioning alternative, there would be an eventual reduction of emissions to near zero levels at LLNL Site 300. These are beneficial impacts.

Although during shutdown and decommissioning some radiological releases would continue, these releases and the resulting public exposure would decrease to near zero. In the long run, the impact of this alternative on public exposures to radiation would be a beneficial impact.

SNL, Livermore

During decommissioning there would be short-term impacts relating to particulate fugitive dust, volatile organic compounds, and NOx emissions contributing to a nonattainment area for ozone and PM10. These impacts would be temporary and localized to the areas of construction and are therefore less than significant. Overall, under the shutdown and decommissioning alternative, there would be an eventual reduction of emissions to near zero levels at SNL, Livermore. These are beneficial impacts.

Although during shutdown and decommissioning some radiological releases would continue, these releases and the resulting public exposure would decrease to near zero. In the long run, the impact of this alternative on public exposures to radiation would be a beneficial impact.

5.4.9 WATER

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

Decommissioning activities under this alternative would produce some temporary but insignificant diversions of surface runoff at the LLNL Livermore site, LLNL Site 300, and SNL, Livermore. These activities are not expected to have long-term effects on ground water at any of the three sites. The impacts of shutdown and decommissioning on surface and ground water are, therefore, less than significant.

5.4.10 NOISE

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

A short-term increase in offsite noise levels might occur from possible demolition activities under this alternative. In the long term, implementation of the shutdown and decommissioning alternative would be expected to reduce traffic noise levels along roadways in the vicinity of the three sites. In addition, impulse noise levels would be eliminated at LLNL Site 300 because of the discontinuation of high explosives testing onsite. The net effect of these impacts is deemed to be less than significant or beneficial.

5.4.11 TRAFFIC

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

Without making assumptions regarding potential traffic from possible new land uses at the three Laboratory sites after shutdown and decommissioning, the reduced activity and employment levels resulting from the shutdown and decommissioning of the sites would result in reduced traffic and thus a beneficial effect compared to existing conditions. Levels of service on some of the major roadways near the sites would improve substantially from the reduction in peak-period traffic, resulting in decreased traffic impacts in the long term. In the short term there could be a temporary increase in truck traffic hauling construction debris; however, this is not considered to be a significant effect.

In some cases, depending on future land uses, street widening or other improvements planned to serve the combined traffic from the Laboratories and future development near the Laboratories would be unnecessary or could be reduced in scope.

5.4.12 UTILITIES AND ENERGY

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

Should the Laboratories be shut down and decommissioned, utility and energy consumption and production of sewerable waste would decrease to the level needed to maintain ongoing environmental compliance, restoration, and infrastructure maintenance, eventually reducing such consumption and production to near zero. Because water usage would be reduced, at least in the short term, this decrease in use of these resources could be a beneficial impact.

5.4.13 MATERIALS AND WASTE MANAGEMENT

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

Materials Management

Operations at LLNL and SNL, Livermore require the use of hazardous and radioactive materials. Under the shutdown and decommissioning alternative, the amounts of these materials used would decrease as individual facilities are phased out. Any such remaining materials would be sent to other facilities for their use, returned to vendors if possible, or disposed of or recycled in accordance with applicable regulations. Some of this material would become waste, as discussed below. The long-term impact of this alternative would be beneficial.

Waste Management

The shutdown and decommissioning of LLNL and SNL, Livermore facilities would generate hazardous and radioactive wastes from decontamination of structures and disposal of inventories of hazardous and radioactive wastes. To accurately estimate the hazardous, radioactive, and mixed wastes generated during decommissioning, a model would be developed to estimate the amount of contamination in individual facilities, the potential benefits of treating the wastes, and the permitted residual levels of contamination.

As a result of the decommissioning, the number of waste shipments would be expected to increase during the initial phases. However, shipments would gradually decline, reducing any potential long-term impacts to near zero. The number of initial waste shipments would be dependent upon disposal availability. Onsite storage of mixed waste would continue until approved treatment and disposal options become available. In addition, radioactive waste would not be shipped to the Nevada Test Site, or other approved disposal facilities, until waste certification plans are approved.

The ongoing environmental restoration activity would continue to produce wastes. This waste generation would, however, be offset in the long term by the elimination of hazardous and radioactive waste generated in current LLNL and SNL, Livermore operations.

The initial increased generation of wastes from shutdown and decommissioning would eventually be reduced to zero when the sites are completely decommissioned. The long-term impact of this alternative would be beneficial.

5.4.14 OCCUPATIONAL PROTECTION

LLNL Livermore Site, LLNL Site 300, and SNL, Livermore

Occupational Protection—Radiological

Although decommissioning activities would result in radiation doses to the workers involved in the removal of contaminated materials, these exposures would be less than DOE annual worker dose limit. It is estimated that each member of the work crews decommissioning radioactive materials handling areas would receive an annual radiation dose of approximately 0.5 rem, or about 10 percent of that limit for occupational exposure.

Decontamination of contaminated facilities would be conducted in secondary enclosures to mitigate the potential spread of radioactivity and other hazardous materials. Impacts would be similar to those of the proposed action and primarily restricted to the immediate area onsite. Exposures of workers to radiation would be kept below regulatory limits. This impact, therefore, is less than significant.

Occupational Exposure—Toxic Substances and Physical Hazards

Although the nonradiological consequences associated with LLNL and SNL, Livermore operations are below the occupational and public health threshold limits (see section 4.16), these impacts would eventually be eliminated altogether with shutdown and decommissioning. The number of potential occupational illnesses, injuries, and radiological and nonradiological exposures from current conditions would be reduced as employment gradually declined during decommissioning. Although there would be an influx of decommissioning personnel, the number of LLNL and SNL, Livermore program staff would decrease.

Although there may be an increase in exposures associated with initial decommissioning activities, with the cessation of research and the completion of decommissioning, there would be an eventual reduction to near zero of worker and public exposure to hazardous materials and wastes at the sites.

In the long term, shutdown and decommissioning would reduce worker exposure to toxic substances and physical hazards to near zero. Only the much smaller crew engaged in the long-term remediation of site contamination would remain, and the possibility of their continuing to be exposed to these hazards would be much reduced. During the decommissioning, however, any required demolition, some of it using heavy equipment, would be, essentially, construction activity. This activity could involve greater physical risks to the worker.

Although workers involved in decontamination and decommissioning would be at risk during these activities, health and safety plans and programs would be developed and implemented to reduce worker exposure and worker construction activity risks to the extent possible. The net effect would be a decreased risk to workers, since sources of exposure would be eliminated. The net impact is less than significant and may be beneficial.

5.4.15 SITE CONTAMINATION

It is assumed that, if the Laboratories were shut down and decommissioned, environmental restoration activities would continue until remediation is completed. It is likely that during shutdown and decommissioning, additional source areas of contamination would be found, particularly during building demolition activities. Under the shutdown and decommissioning alternative, the environmental restoration program would include characterization and remediation of these source areas, in addition to ongoing environmental restoration activities. The shutdown and decommissioning, therefore, would not affect present site contamination. In the long term, the impacts of site contamination are expected to decrease to near zero. As a consequence of shutdown and decommissioning, the potential for future releases of hazardous or radioactive materials would be eliminated; therefore, the net impact would be beneficial. Although the determination of the potential significance of possible land (and ground water) use changes at the Laboratories during and following shutdown and decommissioning is beyond the scope of this EIS/EIR, administrative controls on local ground water use would be required for areas impacted and potentially impacted by the contaminated plumes for the duration of the ground water remediation program.

5.4.16 CUMULATIVE IMPACTS

The influences of shutdown and decommissioning are not always limited to the boundaries of the LLNL Livermore site, LLNL Site 300, and SNL, Livermore. Offsite impacts are sometimes compounded by changes and influences taking place onsite.

CUMULATIVE IMPACTS—LAND USE

Planned and proposed development within the regions near the Laboratories would result in a cumulative loss of agricultural land and open space. However, shutdown and decommissioning activities would not contribute to this loss because no land acquisition or new facility construction is associated with this alternative. Evaluation of potential land use impacts related to future (as yet undefined) uses of the three sites or conflicts with land use plans of local jurisdictions is beyond the scope of this EIS/EIR.

CUMULATIVE IMPACTS—SOCIOECONOMICS

Planned and proposed development in the area would provide additional employment opportunities that might encourage a population increase and a subsequent increase in the demand for housing in the area. This cumulative demand for housing would be considered significant and unavoidable for those areas that have a limited supply of available housing (e.g., City of Livermore). However, the shutdown and decommissioning alternative would not contribute to this impact because this alternative could ultimately result in the loss of approximately 12,900 jobs at LLNL and SNL, Livermore. Many of these people are expected to leave the area to search for jobs elsewhere because of their highly trained and skilled professions (job transferability within Alameda and San Joaquin counties would be limited). Thus, this alternative would not contribute to a significant cumulative demand for housing in the area.

CUMULATIVE IMPACTS—COMMUNITY SERVICES

Planned and proposed development would contribute to a cumulative demand for community services in the area. This cumulative demand would be considered significant for those services which have existing capacity problems. For example, as discussed in section 5.1.3, there are potential cumulatively significant school and landfill capacity problems in the region. This alternative would not contribute further to potentially significant cumulative school capacity problems in the region since employment at the Laboratories would be reduced. However, during the shutdown and decommissioning process at the Laboratories could contribute to a cumulative significant impact on nonhazardous solid waste disposal services in San Joaquin County if activities at LLNL increase the rate of nonhazardous solid waste generation. Upon completion of the shutdown and decommissioning process, the Laboratories' demand for services would be reduced virtually to zero because this alternative would eventually lead to the elimination of the need for offsite community services required for the operation of the LLNL and SNL, Livermore sites. In the long term, this alternative would reduce the amount of nonhazardous solid waste generated at the sites and reduce the Laboratories' demand for landfill disposal services.

Because the Laboratories have independent security and fire protection services and rarely provide emergency response for offsite agencies, this alternative would not contribute to the increase in demand associated with development in the area. Though it would actually reduce impacts to school overcrowding by reducing local population attributable to the Laboratories, an additional impact to school services would occur under this alternative because the districts would lose Federal Impact Aid Funding that contributes money to the budgets of affected school districts.

CUMULATIVE IMPACTS—PREHISTORIC AND HISTORIC RESOURCES

As discussed in section 5.1.4, cumulative impacts to prehistoric and historic cultural resources within the cumulative impact study area cannot be delineated as part of this EIS/EIR; however, because cultural resources are known to occur in the study area, it is expected that future development within the area could potentially impact these resources. As discussed in section 5.4.4, the importance of historic resources at the LLNL Livermore site and LLNL Site 300 has yet to be determined and the exact nature of impacts to potentially important resources would not be known until DOE determines which structures (if any) would be dismantled under the shutdown and decommissioning program. Cumulative impacts, therefore, could occur under this alternative, although at this time it is too speculative to determine whether potential cumulative impacts would be significant or not.

CUMULATIVE IMPACTS—AESTHETICS

Planned and proposed development within the cumulative impact study areas would result in a cumulative alteration of existing scenic resources. Shutdown and decommissioning activities at LLNL and SNL, Livermore associated with this alternative, however, would not contribute to this alteration of scenic resources because no new construction is proposed. Visual impacts related to possible demolition activities could occur, but these impacts would be temporary and, therefore, less than significant. The evaluation of long-term visual impacts related to future uses on the sites is beyond the scope of this EIS/EIR.

CUMULATIVE IMPACTS—GEOLOGIC RESOURCES AND HAZARDS

No cumulative impacts to geologic resources are anticipated as a result of the shutdown and decommissioning alternative, since no known geologic resources are close enough to any of the three sites to be affected by shutdown and decommissioning activities. Shutdown and decommissioning of the Laboratories would remove structures and hazardous and radioactive materials from a seismically active area, thus lowering the risk for structural failure, fire, and hazardous materials releases to the community, resulting in a beneficial impact. No significant cumulative impacts from geologic hazards are anticipated in conjunction with shutdown and decommissioning.

CUMULATIVE IMPACTS—ECOLOGY

If shutdown and decommissioning results in changes in land use practices, such as allowing grazing and discontinuing controlled burns, then cumulative impacts could occur. A degradation of plant communities, including wetlands, and wildlife habitat would be expected if grazing is allowed and controlled burning no longer takes place. The destruction or degradation of 6.76 acres of wetlands would represent a cumulative impact when considered with potential wetland losses in the region. Because future land uses following shutdown and decommissioning are unknown, the full extent of long-term cumulative impacts of this alternative on ecology cannot be evaluated.

CUMULATIVE IMPACTS—AIR QUALITY

The shutdown and decommissioning of LLNL and SNL, Livermore would mean an eventual decrease of emissions to near zero levels. However, during shutdown and decommissioning the sources of air contamination at the three sites would contribute to a nonattainment area for PM10 (particulates) and ozone; this would be considered a significant and unavoidable impact.

The impacts of airborne emissions from shutdown and decommissioning at the sites would also be a decrease of these emissions to near zero. This would be considered a beneficial impact; however, it should be noted that radiological and other exposure levels offsite are already well below all regulatory standards.

CUMULATIVE IMPACTS—WATER

No significant cumulative impacts on surface and ground water are identified as a result of shutdown and decommissioning. The removal of paved and covered surfaces, resulting in increased recharge areas and decreased flood potential, would have a minor beneficial impact; however, future development at the Laboratories and in the vicinity would probably limit this benefit.

Shutdown and decommissioning would reduce ground water consumption both at the LLNL Livermore site and at LLNL Site 300. At the LLNL Livermore site, use of treated ground water in cooling towers and for landscape irrigation would cease. As a consequence, modifications to the ground water distribution and recharge system would be required and more treated ground water would be available for aquifer recharge. Under this alternative, at LLNL Site 300, existing water supply wells would be removed from service.

CUMULATIVE IMPACTS—NOISE

The shutdown and decommissioning alternative would eventually result in reduced cumulative traffic levels, and thus reduced roadway noise levels, in the vicinity of LLNL and SNL, Livermore. This would be a beneficial effect.

CUMULATIVE IMPACTS—TRAFFIC

It is possible that after shutdown and decommissioning of the Laboratories, the properties they now occupy could be converted to other high-employment uses. In addition, continued infill in the industrial development area north of the LLNL Livermore site would add to local traffic. Evaluation of the impacts associated with these subsequent uses of the Laboratories' properties or adjacent areas, however, is beyond the scope of this EIS/EIR. Shutdown and decommissioning of the Laboratories would result in a short-term increase in truck traffic hauling construction debris, which is not considered to be significant, and a long-term decrease in traffic levels nearby. Without considering traffic associated with possible new land uses at the sites, this alternative would result in a beneficial impact on cumulative traffic conditions near the sites.

CUMULATIVE IMPACTS—OCCUPATIONAL PROTECTION

Radiation workers accumulate exposures wherever they work. The reduction or elimination of worker exposures at LLNL and SNL, Livermore does not necessarily imply a net reduction of worker exposure throughout the industry. Under the present regulatory environment, these exposure records would follow these workers wherever they might work afterwards. Although the net impact of shutdown and decommissioning would potentially be a reduction in exposure to workers, it might be less than a complete cessation of exposure to these workers. The net cumulative impact of this alternative, however, would be less than significant.

CUMULATIVE IMPACTS—UTILITIES AND ENERGY

Decreased demands on utilities and energy resources as a result of shutdown and decommissioning would have a beneficial impact on available supply since increased utility and energy demand by Livermore and other surrounding growing communities is anticipated. Because future land use of the facilities following shutdown and decommissioning is unknown, it is not possible to estimate future utility and energy use requirements for the Laboratory properties, and, therefore, an evaluation of potential cumulative impacts cannot be made at this time.

CUMULATIVE IMPACTS—MATERIALS AND WASTE MANAGEMENT

The shutdown and decommissioning alternative would make it necessary to handle and dispose of any radioactive or hazardous materials, or radioactive, mixed, or hazardous waste presently stored at the LLNL Livermore site, LLNL Site 300, or SNL, Livermore. Radioactive or hazardous materials would be shipped offsite to other DOE facilities requiring these materials. Radioactive, mixed, or hazardous wastes would be shipped to disposal sites licensed to accept these wastes. All transportation would be in accordance with DOE, U.S. Department of Transportation, and California transportation requirements.

The existing industries to the north of the Laboratories and those that may be expected to be developed during the 5- to 10-year period of the shutdown and decommissioning would be expected to use some of the same hazardous materials used by LLNL and SNL, Livermore. Although this may result in a greater number of workers in the area being exposed to hazardous materials, the cumulative impacts would not affect the public unless an accident or spill occurs.

The overall cumulative impact from this alternative is considered less than significant.

CUMULATIVE IMPACTS—SITE CONTAMINATION

The present soils and ground water contamination underlying the LLNL Livermore site, LLNL Site 300, and SNL, Livermore stems from early uses of these sites (see section 4.17). DOE is responsible for their remediation and has instituted programs to evaluate the severity of this contamination and to assess means for its remediation. Regardless of whether or not the sites are shut down and decommissioned, this remediation effort will continue.

If the environmental restoration activities were to be discontinued or were found to be ineffective, in part or altogether, after nearly 270 years the contamination plume from the LLNL Livermore site would reach a municipal well field (see sections 4.17 and 4.19). Calculations indicate, however, that dispersion, dilution, and natural attenuation would have reduced contamination levels to below regulatory limits. Even in these circumstances, the impacts of site contamination would be less significant.

5.5 DISCONTINUE MANAGEMENT BY UC

5.5.1 DESCRIPTION

As discussed in section 3.2.4, this alternative would occur if UC and/or DOE chose to discontinue UC management of the LLNL Livermore site and LLNL Site 300. This alternative does not apply to SNL, Livermore, which is managed by a private company, Sandia Corporation.

Under this alternative, it is assumed that DOE would select another contractor to manage and operate LLNL at the same operational level described in the EIS/EIR proposed action or one of the alternatives.

5.5.2 IMPACT ANALYSIS

Impacts of this alternative cannot be fully assessed at this time because potential impacts depend upon the level of operations selected by DOE and its operating contractor. If the work force, level of operations, and future projects remain the same, for example, the environmental effects would remain largely as described in section 5.1 above.

Discontinuation of UC's management of LLNL could adversely impact the Laboratory's ability to fulfill its mission. In one instance, the increased difficulty of coordinating activities between LLNL and Lawrence Berkeley Laboratory would affect the cohesiveness needed to foster LLNL's national scientific leadership and technological innovation. Even though alternative management might promote continued cooperation between LLNL and UC, coordination of activities between the two institutions would become increasingly difficult as each alters future strategies and expectations.

In addition to a scientific staff made up in part of University professors and instructors, LLNL offers graduate education opportunities, most apparently in its cooperative program with the University of California, Davis, Department of Applied Science. Impaired coordination between UC and LLNL's alternative management could limit the availability of LLNL's advanced research and development facilities to students, affecting LLNL's ability to educate and train future generations of scientists and engineers.

Under alternative management, increasingly difficult coordination between UC's scientists, engineers, and professors and LLNL could reduce the quality of research and development produced at the Laboratory. Deterioration of the quality of research and development could, in turn, reduce opportunity and capacity for technology transfer.

Beyond these effects, UC would realize a loss in its management allowance from DOE. The present UC allowance is about $14 million, covering the Lawrence Berkeley Laboratory and the Los Alamos National Laboratory as well as LLNL; the share attributable to managing LLNL would be somewhat less than half this amount. Additionally, arrangements would have to be made for transferring the benefit programs of some 12,000 employees to the new contractor.

5.6 BOUNDING ACCIDENT SCENARIOS

NEPA requires the inclusion of hypothetical accident scenarios in the EIS/EIR discussion. An accident is considered bounding if no reasonably foreseeable accident can be found with greater consequences. An accident is reasonably foreseeable if the analysis of occurrence is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason (40 C.F.R. 1502.22(b)(4)). Consequence criteria are discussed in detail below.

Many research activities at LLNL and SNL, Livermore require the use of radioactive materials, hazardous chemicals, and high explosives, all of which have the potential, under certain circumstances, to be involved in an accident. These materials are received at the sites, transferred onsite, and often shipped offsite. Activities using these materials onsite involve specialized facilities with appropriate safety equipment and procedures to reduce the possibility or the severity of accidents.

A number of specific accident scenarios within an accident category were developed and analyzed to formulate the potential consequences that set the upper limit for all similar accidents at both LLNL and SNL, Livermore. An example of an accident category is Transportation Accidents Involving Radioactive Materials. Accident scenarios were developed for specific facilities or operations to estimate the consequences of releases of radioactive materials, releases of hazardous chemicals, and detonation of high explosives. Additionally, transportation accident scenarios involving radioactive materials, hazardous chemicals, and high explosives were also considered. The analysis also postulated a multiple-building accident initiated by a severe earthquake. The various accident scenarios developed are summarized in Table 5.6-1. The methods used in the analysis and descriptions of each accident scenario are discussed in detail in Appendix D.

CEDE	=	Committed Effective Dose Equivalent
U-AVLIS	=	Uranium Atomic Vapor Laser Isotope Separation
Ci	=	Curie
HTO	=	Tritium oxide
HEPA	=	High Efficiency Particulate Airfilter
Am^{241}	=	Americium-241
TRU	=	Transuranic materials
LSA	=	Low-specific-activity
TRUPACT-11	=	Container designed to transport TRU waste
RADTRAN	=	Computer code to analyze transportation of radioactive material
ERPG-3	=	Emergency Response Planning Guidelines level-3
ICF	=	Inertial Confinement Fusion
AIRDOS	=	Computer code to analyze airborne radioactive contamination
IDLH	=	Immediately-Dangerous-to-Life-or-Health
HE	=	High explosive
NH_3	=	Ammonia gas
HCl	=	Hydrogen chloride gas
Octol	=	A form of high explosive

Cl_2	=	Chlorine gas
H_2O_4	=	Sulfuric acid
LX-10	=	A form of high explosive

In performing the accident analysis, specific source terms were determined for accidents involving radioactive materials or hazardous chemicals. Onsite and offsite exposures were calculated as appropriate, and health effects or risks were predicted using risk estimators recommended by the International Commission on Radiation Protection (ICRP) (Table 5.6-2).

For chemical exposures, predicted concentrations were compared to human toxicity data. The analysis used conservative assumptions to prevent underestimating possible releases and their consequences. For example, the calculations do not account for the extensive safety training, procedures, and administrative controls implemented at LLNL and SNL, Livermore, or any existing mitigating design features. Additionally, the analysis did not account for any mitigating measures likely to be taken in response to a serious accident, such as emergency response activities that would normally provide an effective safety factor.

Land in the path of the plumes resulting from accidents would be evaluated for contamination. It is anticipated that residential, commercial, and industrial uses could continue without unacceptable exposures. This is because the majority of the predicted exposures are from inhalation during plume passage immediately after the event and not from activities that cause particles to be resuspended. Agricultural land use could be curtailed until it was demonstrated that agricultural products would meet FDA standards (FDA, 1982) because of biological transfer. No long-term restrictions on land use would be anticipated after remediation or damage repair is completed (if required).

Table 5.6-1 Chemical, High Explosive, and Radiological Accident Scenario Summary

Building	Name	Scenario Description	Source Term	Assumptions	Results
332[a]	Plutonium Facility	Inadvertent plutonium criticality	1018 fissions results in 7913 Ci of noble gases and iodines	Building ventilation operable (2 HEPA filters in series); ground-level release	**Exposure:** 400 rem CEDE out to 15 m; 37 rem CEDE onsite (100 m); 2.0 rem CEDE at southern site boundary (400 m); 0.38 rem CEDE at western site boundary (900 m); 440 person-rem to the general public **Effects:** Fatalities likely in the affected laboratory; 1 in 40 chance of an individual onsite, 1 in 700 chance of an individual at the southern site boundary, and 1 in $5×10^6$ of a member of the general public incurring a health effect[c]
968[b]	Tritium Research Lab	Tritium release during earthquake	50 g (500,000 Ci) tritium gas	1 percent of total release is converted to HTO (re-emission)	**Exposure:** 4.2 rem CEDE onsite (100 m); 0.37 rem CEDE at site eastern site boundary (400 m); 0.92 rem CEDE at western site boundary (850 m);

					4220 person-rem to the general public **Effects:** 1 in 300 chance of an individual onsite, 1 in 4000 chance of an individual at the eastern site boundary, and 1 in 5×10^{5} of a member of the general public incurring a health effect[c]
332	Plutonium Facility	Release of plutonium into laboratory	2.1×10^{-4} Ci of fuel grade plutonium mixture	Building ventilation operable (2 HEPA filters in series); ground-level release	**Exposure:** 0.078 rem CEDE onsite (100m); 6.6×10^{-3} rem CEDE at southern site boundary (400m); 1.6×10^{-3} rem CEDE at western site boundary (900m); 10 person-rem to the general public **Effects:** 1 in 20,000 chance of an individual onsite, 1 in 2×10^{5} chance of an individual at the southern site boundary, and 1 in 2×10^{8} of a member of the general public incurring a health effect[c]
331[b]	Hydrogen Research Facility	Tritium release during earthquake	3.5 g (35,000 Ci) tritium gas	1 percent of total release is converted to HTO (re-emission)	**Exposure:** 0.28 rem CEDE onsite (100 m); 2.6×10^{-2} rem CEDE at southern site boundary (400 m); 0.060 rem CEDE at western site boundary (900 m); 290 person-rem to the general public **Effects:** 1 in 5000 chance of an individual onsite, 1 in 50,000 chance of an individual at the southern site boundary, and 1 in 6×10^{6} of a member of the general public incurring a health effect[c]
251[b]	Diagnostic Chemistry	Am241 release during earthquake	7.5×10^{-4} Ci Am^{241}	All 5 curies at risk are Am^{241}; unhardened building shell fails completely; ground-level release	**Exposure:** 3.1 rem CEDE onsite (100 m); 0.14 rem CEDE at the western site boundary (600 m); 430 person-rem to the general public **Effects:** 1 in 400 chance of an individual onsite, 1 in 10,000 chance of an individual at the western site boundary, and 1 in

					5×10^{6} of a member of the general public incurring a health effect[c]
612 Area	Waste Storage	TRU fire after spill	3.0×10^{-3} Ci Am^{241}	TRU container at maximum limit of 6 Ci Am^{241}; 10-meter-high homogeneous release	**Exposure:** 3.7 rem CEDE onsite (100 m); 2.0 rem CEDE at southern site boundary (200 m); 0.12 rem CEDE at western site boundary (1.6 km); 1670 person-rem to the general public **Effects:** 1 in 400 chance of an individual onsite, 1 in 700 chance of an individual at the southern site boundary, and 1 in 10^{6} of a member of the general public incurring a health effect[c]
493	Separation Support Facility for U-AVLIS	Uranium fire	5 kg of natural uranium (3.5×10^{-3} Ci)	0.1 percent of 5000 kg released during fire; 30-meter-high homogeneous release	**Exposure:** 0.41 rem CEDE onsite (100 m); 0.15 rem CEDE at northern site boundary (300 m); 3.9×10^{-2} rem CEDE at western site boundary (1300 m); 560 person-rem to the general public **Effects:** 1 in 3000 chance of an individual onsite, 1 in 9000 chance of an individual at the northern site boundary, and 1 in 3×10^{6} of a member of the general public incurring a health effect[c]
625[b]	Waste Storage and Shipping	Multiple-building earthquake	7.2×10^{-3} Ci Am^{241}	8 drums each containing 6 Ci Am^{241}; all crushed by falling crane; ground-level release	**Exposure:** 30 rem CEDE onsite (100 m); 4.2 rem CEDE at eastern site boundary (300 m); 0.27 rem CEDE at western site boundary (1600 m); 4030 person-rem to the general public **Effects:** 1 in 50 chance of an individual onsite, 1 in 300 chance of an individual at the eastern site boundary, and 1 in 5×10^{5} of a member of the general public incurring a health effect[c]
Offsite	Transportation of LSA Waste, Scenario 1 (mixed	Truck accident carrying a Low Specific Activity (LSA) waste shipment offsite, involved in a	1.4×10^{-2} Ci Pu^{239} 3.4×10^{-1} Ci U^{238}	Category 6 (NRC, 1977) or above accident, H3 as HTO and other nuclides; 10-	**Exposure:** 109 person-rem **Effects:** 1 in 10^{6} chance of a member of the general public [c]

	nuclides)	category 6 (NRC, 1977) class accident with at least a 30-minute fire	3000 Ci H^3 8.0×10^{-3} Ci Am^{241} 6.0×10^{-3} Ci TB^{32} 2.0×10^{-1} Ci U^{235} 1.0×10^{-1} Ci U^{233} 40 Ci P^{32}	meter-high homogeneous release (Fire)	incurring a health effect
Offsite	Transportation of LSA waste, Scenario 2 (tritium oxide)	Truck accident carrying a Low Specific Activity (LSA) waste shipment offsite, involved in a category 6 (NRC, 1977) class accident with at least a 30-minute fire	30,000 Ci H^3 (HTO)	Category 6 (NRC, 1977) or above accident, H3 as HTO; 10-meter-high homogeneous release (fire)	**Exposure:** 843 person-rem **Effects:** 1 in 2×10^6chance of a member of the general public incurring a health effect[c]
Offsite	Transportation of TRU	Truck accident carrying three fully loaded TRUPACT-II containers offsite, involved in a category 8 (NRC, 1977) class accident with at least a 2-hour fire	1100 plutonium equivalent curies	Category 8 (NRC, 1977) accident, three fully loaded TRUPACT-II containers, population density of 10,000 persons per square mile	**Exposure:** RADTRAN 4.93×10^4 person-rem AIRDOS 3.52×10^4 person-rem **Effects:** 1 in 3×10^4 chance of a member of the general public incurring a health effect[c]
298[b]	Fusion Target Fabrication Facility	Tritium release during earthquake	5 g (50,000 Ci) tritium gas	1 percent of total release is converted to HTO (re-emission)	**Exposure:** 0.40 rem CEDE onsite (100 m); 0.20 rem CEDE at northern site boundary (150 m); 0.11 rem CEDE at western site boundary (750 m); 420 person-rem to the general public **Effects:** 1 in 3000 chance of an individual onsite, 1 in 7000 chance of an individual at the northern site boundary, and 1 in 5×10^6 chance of a member of the general public incurring a health effect[c]
514 Area	Waste Treatment	Sulfuric acid spill	21 g H_2O_4 as mist	Released over 45 minutes at maximum possible rate	**Exposure:** 2.4 mg/m^3 at southern site boundary (90 m) [NOTE: ERPG-3 is 30 mg/m^3] **Effects:** Serious injury to

					operators, mild transient effects offsite
518	Gas Cylinder Dock	One 100 lb chlorine container release	100 lb Cl_2 gas	Inventory since 1989 representative of future gas usage	**Exposure:** 14,000 mg/m^3 at southern site boundary (10 m) [NOTE: ERPG-3 is 60 mg/m^3] **Effects:** Lethal concentrations are likely near point of release and potential for death or serious health effects across southern site boundary to 750 m from point of release
Tracy Municipal Airport[a]	Transportation of HE by Air	Aircraft crashes	2200 lb LX-10 and 300 lb of aircraft fuel	Aircraft fuel fire detonates LX-10	**Exposure:** 200 psi overpressure out to 31 ft; 1 psi overpressure out to 490 ft Effects: Crew is killed; unshielded personnel would be killed out to 31 ft; property is damaged out to 490 ft
Site 300	Firing Table	Bounding explosion during HE test	1000 lb Octol	Delayed or inadvertent ignition occurs while personnel are unshielded	**Exposure:** 200 psi overpressure out to 24 ft; 1 psi overpressure out to 370 ft **Effects:** Unshielded personnel would be killed or seriously injured; no offsite impact
Interstate 580	Transportation of HE by truck	Truck accident	22 lb of LX-10	Fuel fire detonates LX-10	**Exposure:** 200 psi overpressure out to 6 ft; 1 psi overpressure out to 15 ft **Effects:** Unshielded personnel would be killed out to 6 ft
131[b]	Engineering Building	Multiple-building earthquake	150 lb NH_3 gas	One 120 lb container plus 30 lb	**Exposure:** 580 mg/m^3 at western site boundary (335 m) [NOTE: ERPG-3 is 710 mg/m^3] **Effects:** Serious health effects onsite out to 600 m beyond western site boundary
151[b]	Nuclear Chemistry	Multiple-building earthquake	5 lb HCl gas	Inventory since 1989 representative of future gas usage	**Exposure:** 52 mg/m^3 at western site boundary (550 m) [NOTE: ERPG-^{3} is 152 mg/m^3] **Effects:** Mild transient health effects out to 600 m beyond western site boundary
166	ICF Facility	Handling accident	2 lbs	Operator drops	**Exposure:** 0.14 mg/m^3 at 27 m

			arsine gas	cylinder during installation	from point of release [NOTE: OSHA PEL is 0.2 mg/m^3] **Effects:** Workers exposed; no offsite impact
322[b]	Plating Shop	Multiple-building earthquake	10.3 kg hydrogen cyanide	Contents of plating tanks mix over 45 minutes	**Exposure:** 125 mg/m^3 at western site boundary (275 m) [NOTE: IDLH is 54 mg/m^3] **Effects:** Potential for serious health effects (including death) near the point of release; slight symptoms out to 600 m beyond western site boundary

[a] Bounding event

[b] Multiple-building event

[c] Includes fatal cancers, and severe genetic effects occurring at an estimated rate of 7.3×10^{-4} effects per rem (ICRP, 1991).

Table 5.6-2 Risk Estimators for Health Effects from Exposure to Ionizing Radiation

Effect	Risk Factor* (probability per rem per 70 years)
Fatal cancer	5.0×10^{-4}
Fatal, nonfatal, and severe genetic effects	7.3×10^{-4}

* Source: ICRP, 1991.

5.6.1 RADIOLOGICAL ACCIDENT SCENARIOS

Selection Process

The selection process for radiological scenarios divided the hypothetical accidents into those associated with a specific location and those associated with transportation, and then applied a multistep screening process to determine bounding events.

For accidents associated with specific locations, the screening process reviewed the building hazard classifications, the inventories, and the physical properties of radionuclides such as type, quantity, physical form, and storage conditions. Nine scenarios at eight locations were identified in this process and are listed in Table 5.6-1 and described in full in Appendix D. The bounding accident is the Inadvertent Criticality at Building 332.

Radiological transportation scenarios were divided into two categories: materials and waste. The accident scenario for waste shipments bounds accidents for material shipments. Two accidents were identified involving waste shipment.

Two low-specific-activity shipments were modeled and are listed in Table 5.6-1 and presented in Appendix D. Additionally, an accident involving the shipment of transuranic waste was identified. This accident was analyzed in the Final Supplemental Environmental Impact Statement of the Waste Isolation Pilot Plant and summarized in Appendix D.

Additionally, DOE and the Laboratories' staffs reviewed the accident scenarios to identify new scenarios for inclusion and to verify the accuracy of the selection process.

Exposure Limits and Protective Action Thresholds

The radiation exposure limit for workers is set by DOE Order 5480.11 at 5 rem per year. Exposures are, however, required to be kept As Low As Reasonably Achievable (ALARA). The similar limit for the general public is set at a factor of 10 lower because the public is a diverse group including children and the elderly, as well as healthy men and women in their young and middle years. These limits are readily met by controlling the operations involving potential radiation exposure so that workers and the public are protected.

In the case of accidents, however, regulations allow emergency workers to receive higher doses for short periods of time. This exception allows these workers to take necessary actions to rescue injured persons and to protect the surrounding population. Even so, precautions are taken to minimize exposures to emergency workers. The general limit for emergency team workers is 25 rem whole body or 75 rem to the thyroid. In cases where a lifesaving mission must be undertaken, one-time exposures up to 75 rem whole body may be acceptable.

The need for any protective action for the offsite public from radiation exposure from an onsite accident is based on predicted and measured radiation dose rates. Emergency response actions are based on the guidance provided in a series of Protective Action Guides (PAGs) developed by the EPA. For example, the Protective Action Guides require no protective action when the projected doses are less than 1 rem to the whole body or less than 5 rem to the thyroid. Radiation levels, however, should be monitored, and an advisory to seek shelter may be issued.

The Protective Action Guides suggest that for whole-body doses of 1 rem and thyroid doses of 5 rem, the responsible officials should consider initiating protective action, particularly for the more sensitive populations (children and women of childbearing age). For whole-body and thyroid doses higher than 5 rem and 25 rem, respectively, the Protective Action Guides require mandatory evacuation, control of access to the contaminated area, and monitoring of radiation levels, unless these actions would have greater risk than the projected dose.

For this analysis, the radiation doses estimated for the various accident scenarios are those that would be received by the population if no protective actions were taken. Both LLNL and SNL, Livermore personnel are trained in the protective actions to be taken after a release of radioactive or other hazardous material. These response activities would also be closely coordinated with those of Alameda County (see Appendix J for more discussion of emergency response).

Bounding Case Accident Involving Radioactive Releases and Impacts

The bounding radiological accident scenario for individual LLNL and SNL, Livermore facilities is an inadvertent nuclear criticality yielding 10^{18} fissions within Building 332 (Plutonium Facility). In a review of 41 recorded inadvertent criticalities that have occurred nationally, only 10 have had estimated yields of 1018 fissions or greater (Stratton and Smith, 1989). Of these 10, 3 occurred in aqueous processing plants, 2 occurred in heavy-water-natural-uranium systems, 4 occurred in water-moderated reactors or reactor prototypes, and 1 occurred in an aircraft engine prototype reactor. All involved a combination of physical parameters and/or processes that are found in reactor or nuclear materials processing facilities, but are not present in the research and plutonium metals fabrication activities in Building 332. No criticality accidents have occurred in DOE plutonium metals fabrication facilities. Previous safety analyses have analyzed the consequences of an inadvertent criticality yielding 10^{18} fissions without postulating a method of initiation. The estimated frequency of occurrence is less than 1×10^{-6}/year and, in fact, such an event may not be possible under the operational conditions and procedures existing in Building 332. However, despite the extremely low probability of occurrence, the consequences of this accident have been analyzed with the initiator left undefined.

The acute radiological consequences onsite and at the site boundary are calculated to be higher than those of any other radiological accident that could occur on the sites. For onsite personnel, the radiation dose would be 37 rem at a distance of 100 m, and the immediate exposure ("prompt dose") for unshielded personnel would be greater than 450 rem out to 13 m, possibly causing death. Using the risk estimators presented in Appendix C and shown in Table 5.6-2, the 100-m dose has a probability of 20 chances in 1000 of causing the development of a fatal cancer.

The effective dose equivalents at the site boundary nearest to the release (East Avenue at 400 m) and the western boundary (Vasco Road at 900 m) would be 2.0 and 0.38 rem, respectively. The 2.0-rem dose is in the lower range of the levels at which the EPA begins to recommend protective actions, including seeking shelter, controlling access to the contaminated area, monitoring radiation levels, and initiating evacuation unless local authorities judge it impractical. However, it is noted that the computer modeling used to estimate this 2.0-rem dose level is less refined and significantly more conservative than those used to calculate the lower values reported in the Safety Analysis Report (LLNL, 1990c) for the facility.

The collective population dose was also estimated. The population around the Laboratories was divided into 16 sectors (each 22.5 degrees wide), which radiate 50 miles out in pie-shaped wedges from a central point at the LLNL Livermore site and SNL, Livermore. From 1990 census data (Educational Data Systems, 1991), the sector with the highest population (the western sector) contained 1.4 million people. The wind was therefore assumed to blow to the west (towards the highest population sector). In reality, the wind blows in that direction only 5 percent of the time per year. The wind direction of the highest probability is to the northeast, which occurs 22 percent of the time per year. Plume concentration is inversely proportional to wind speed. Therefore, a very low wind speed of 1 m/second was selected. In reality, the lowest wind speed that is thought to occur for very stable conditions is about 2 to 3 m/second. However, using this higher wind speed would reduce the plume concentration, so conservatively it was not used. A very short release time of less than 15 minutes (which implies no wind meander) was also assumed. If the wind changes direction during the period of release (meanders), the entire centerline of the plume cannot pass over a single point, and, therefore, average air concentrations for that point can be lower by a factor of 3.

These meteorological conditions maximize estimated dose for an individual exposed to the densest part of the plume, and mathematically this results in a linear plume with a width of about 5 degrees. However, a plume this narrow may not conservatively estimate population dose. Additionally, census data could not be divided into 72 sectors to match plume width with sector width. Therefore, it was conservatively assumed that everyone in the western sector resided within 2.5 degrees of the plume centerline. Population dose then equals the individual's dose evaluated at 10 discrete distances times the population at those same distances (see Appendix D for the population data). Using this method, the inadvertent criticality would result in a conservative population dose (first-year and 70-year collective effective dose equivalent) of 440 person-rem. This is estimated to result in less than one additional case of fatal cancer over 70 years for the population of 1.4 million people. The population dose resulting from a release that occurred under average meteorological conditions and applied to actual lower population density could be 100 times less severe.

Natural background radiation to the same population is expected to deliver a 70-year collective effective dose equivalent to 29.8 million person-rem, with 10,000 cases of fatal cancer expected over 70 years. The inadvertent criticality accident would have a significant impact on onsite workers; however, the 440 person-rem exposure is not considered a significant offsite impact with respect to health effects.

An assessment was performed for this accident to estimate the maximum number of health effects associated with the postulated event and hence to bound the number of severe health effects from any other postulated radiological accident at LLNL or SNL, Livermore. Three wind directions were chosen for analysis. The first direction was toward the nearest site boundary, the second in the direction that maximized both onsite and offsite effects, and the third in the direction that would have the potential for the greatest number of severe health effects.

For this assessment one receptor point was modeled at the plume centerline at 775 m, corresponding to the maximum distance from Building 332 where personnel exposed to the plume would receive doses that exceed 0.5 rem. The plume width at 775 m was assumed to be 60 m (~2óy). It was conservatively assumed that the resulting doses at these receptors would be the same in any direction without regard to protection or dispersion from obstacles such as buildings and trees. Additionally, the entire population in the path of the plume was assumed to be outdoors and exposed to the plume for the entire duration of plume passage. Two receptor arcs at 40 m (prompt dose >= 50 rem corresponding to elevated health effect risks) and at 250 m (prompt dose >= 0.5 rem) were also modeled. Shielding provided by Building 332's concrete walls, which would normally attenuate the prompt dose, was not considered. An estimate of potential fatalities in Building 332 was computed using the average expected population in the building (19), an estimate of personnel in the Radioactive Materials Area (RMA) based on square footage ratio ((20,800)/30,647×19 » 13), and an estimate of the "LD50" zone or area exposed to >= 450 rem (Turner, 1986). In this estimate, the attenuation by the concrete walls was considered. About 2100 square feet of laboratory would be exposed to >= LD50, which predicts that one person would be exposed to potential lethality. However, since procedures require two people to perform most operations (this requirement mitigates the likelihood of personnel error causing this accident), up to four people would be exposed to >= LD50. The consequences are summarized in Table 5.6-3.

Note that if a different criterion for the radiological consequences were used, then the bounding accident scenario would be different. For example, if total acute population dose were the criterion, the bounding accident would then become the multiple-building event initiated by a severe earthquake. This accident is discussed in section 5.6.4.

Preventative Measures

The prevention of nuclear criticality is one of the principal safety considerations at LLNL. In addition to engineered safety features such as workstation separation and the use of safe geometric configurations, administrative controls and safety procedures are strictly enforced. These controls and procedures include limits on the quantity of fissile material that is present at any workstation, verification that a critical mass is not likely to occur, and glovebox cleanup procedures. The Criticality Safety Group of the Health and Safety Division of the Hazards Control Department advises Laboratory personnel on fissile materials that may present a criticality concern. Mitigating features such as criticality alarms, emergency-response procedures and drills, emergency exits, the building ventilation system, and the shielding provided by building construction would all help reduce doses to personnel outside the room and the building.

Table 5.6-3 Estimation of Fatalities and Exposure to Elevated Health Effects Risks from the Postulated Inadvertent Criticality (Building 332)

Distance from Point of Postulated Accident (m)	Health Effect	Direction of Plume Travel/Number of People Affected		
		270^{o} (worst-case direction offsite)	180^{o} (nearest site boundary)	180^{o} (worst-case direction onsite)
13	50% chance of fatality in the absence of medical care (>= 450 rem)	4	4	4
40	Elevated Risk of incurring a health effect* (>= 50 rem)	30	30	30
250	Nominal Risk proportional to exposure of 7.3×10^{-4} health effects* per rem (>= 0.5 rem from prompt dose)	964	964	964
775	Nominal Risk proportional to exposure of 7.3×10^{-4} health effects* per rem (>= 0.5 rem	853	910	910

	from passage of the plume)			

* Defined as fatal and nonfatal latent cancers, and genetic defects.

5.6.2 CHEMICAL ACCIDENT SCENARIOS

Selection Process

The selection process for chemical scenarios divided the hypothetical accidents into two categories, those associated with a specific location and those associated with transportation, and applied a multi-part screening process to determine bounding events.

For accidents associated with specific locations, the screening process began with a document review to develop a list of chemicals that could be screened. The chemicals were screened based on hazard, quantity, physical characteristics, dispersion potential, and special factors such as the potential for causing cancer. Six scenarios were identified in this process and are listed in Table 5.6-1 and described in full in Appendix D. The bounding accident (chlorine handling accident, Building 518) is also discussed in that appendix.

Chemical transportation scenarios were divided into two categories: material and waste. No accidents were identified for either case, given the regulations and existing procedures and policies.

Additionally, DOE and the Laboratories' staffs reviewed the accident scenarios to identify new scenarios for inclusion and to verify the accuracy of the selection process.

Protective and Emergency Response Planning Guidelines

The adverse effects of exposure vary greatly among chemicals. They range from physical discomfort and skin irritation to respiratory tract tissue damage and, at the extreme, death. For this reason, allowable exposure levels differ from substance to substance. Occupational exposure limits intended to protect average, healthy workers are established for 10- to 15-minute exposures, at concentrations that should not be exceeded at any time; and for 1- or 8-hour time-weighted averages. These occupational exposure limits do not apply to the general population, which may contain more sensitive subpopulations, such as children, the elderly, and the infirm.

The standards used to determine bounding case scenarios are the Immediately-Dangerous-to- Life-or-Health (IDLH) concentrations of the National Institute for Occupational Safety and Health. The IDLH limits are exposure guidelines established for selecting respirators to protect workers from chemical exposure. An IDLH condition is a situation that poses an immediate threat, but one from which an individual could escape within 30 minutes without escape-impairing or irreversible health effects.

The Emergency Response Planning Guidelines (ERPGs) of the American Industrial Hygiene Association (American Industrial Hygiene Association, 1989) are used as the standard of comparison for exposure to the public. The ERPGs (described in Figure 5.6-1) provide emergency response planners with estimates of the potential hazards associated with accidental releases of various toxic chemicals. The comparison to ERPGs is made when possible to provide estimates of the area where health effects would be the greatest.

Human toxicity data are used in evaluation of health effects. These include:

- LC_{low} - The lowest concentration of a chemical in air reported to have caused death.
- TC_{low} - The lowest concentration of a chemical in air reported to have caused toxic effects.

Data such as these were used to determine consequences of public exposures due to accidental releases. For the bounding chemical accident (chlorine handling accident, B-518), an overlay showing gradients of concentration with distance was used to estimate the number of deaths (when compared to toxicity data) and determine the zone of concern.

Bounding Case Accident Involving Chemical Releases and Impacts

The bounding chemical accident was determined to be a handling accident involving one 100-lb cylinder of liquefied chlorine gas (Appendix D, section D.3.3.1). In this scenario the operator is assumed to have uncapped the container to inspect the valving and then dropped the container, damaging the valve and releasing the entire 100 lb of chlorine gas over a 30-minute period. A release of this type is estimated to have a probability of 1×10^{-7} per year. A chemical accident of this magnitude has not previously been analyzed at LLNL or SNL, Livermore. Although the estimated probability of occurrence is extremely low, analysis of the consequences would provide an upper bound for chemical releases from LLNL Livermore and SNL, Livermore.

For this scenario, the number of fatalities was estimated in three wind directions. The three wind directions are (1) the direction that maximized the estimated fatalities (315^o), (2) the direction toward the nearest site boundary (toward East Avenue, 180^o), and (3) the direction that maximized onsite and offsite consequences (toward Greenville Road, 90^o·).

The first wind direction is towards the onsite craft shops (315^o). It was estimated that 270 workers in this direction would receive an exposure significant enough to be lethal if not given immediate medical attention. No offsite fatalities would be expected.

The nearest site boundary (East Avenue, 10 m) is at a wind direction of 180^o. The chemical plume would pass across East Avenue and into the SNL, Livermore buffer. The number of onsite fatalities in this direction was estimated at six, with an unknown number of fatalities offsite. Although there is the potential for offsite fatalities in this wind direction, no number could be determined because the estimate would be based purely on conjecture.

The wind direction that maximizes onsite and offsite consequences is 90·. It was estimated that 74 fatalities would occur onsite, with an unknown number of fatalities offsite. However, due to the presence of a private dwelling near where the chemical plume would cross Greenville Road, it was assumed that at least one offsite fatality would occur. No fatalities would be expected farther than 750 m from the point of release, where the plume falls below ERPG-3.

Currently, the use of chlorine in greater than 20-lb cylinders at the LLNL Livermore site is rare. LLNL is developing administrative and safety procedures for the use of chlorine in greater than 20-lb cylinders. The use of 100-lb chlorine cylinders is analyzed at the LLNL Livermore site as an upper bound of consequences. The maximum consequences of a chlorine accident involving a 20-lb cylinder are one-half those for the 100-lb cylinder.

Concentrations of chlorine above the ERPG-2 level would exist as far out as 4.1 km from the site boundary. Persons at this location would be expected to experience irreversible or other serious health effects that could impair their ability to take protective action. At locations further out, effects to persons would likely include mucous membrane irritation.

The ERPG-1 concentration level is exceeded out to a distance of 9.1 km from the site boundary. This suggests that persons exposed at distances greater than 9.1 km from the site boundary would experience only mild, transient adverse health effects such as slight irritation of mucous membranes.

Preventative Measures

Chlorine is stored in standard containers approved by the DOT. The condition of the container is controlled by the shipper, who is responsible for inspecting the containers for corrosion of the pressure-relief plugs. It is the operator's responsibility to ensure that the container cap is in place. Containers are also inspected on arrival at Building 518. LLNL operators are trained in the safe handling and storage of chemicals. The special service unit of the LLNL Fire Department has cylinder overpacks (called "bottle buggies") to provide emergency containment for leaking gas cylinders. The special service unit can respond in a short time period (a few minutes) to contain a release from a leaking gas cylinder.

5.6.3 HIGH EXPLOSIVE ACCIDENT SCENARIOS

Selection Process

The selection process for high explosive scenarios divided the hypothetical accidents into two categories—those associated with a specific location and those associated with transportation—and applied a multistep screening process to determine bounding events.

For scenarios associated with specific locations, building hazard classifications were reviewed to identify buildings that use high explosives. Inventories and the potential for impact on personnel were compared to determine the bounding event. This process looked at large and small quantities of high explosives to ensure that small quantities did not pose a threat to more personnel than did larger quantities. One accident was identified and is listed in Table 5.6 and described in full in Appendix D.

Accidents involving the transportation of high explosives were identified for both truck and air shipments. These two scenarios are listed in Table 5.6-2 and described in full in Appendix D. The shipment of high explosives by air is the bounding scenario for high explosives.

Additionally, DOE and the Laboratories' staffs reviewed the accident scenarios to identify new scenarios for inclusion and to verify the accuracy of the selection process.

Protective Actions and Emergency Response

No Emergency Response Planning Guidelines have been established for accidents involving detonation of high explosives; however, Health and Safety Manual (LLNL, 1988b), U.S. Department of Transportation regulations (49 C.F.R.), California Highway Patrol Regulations, and DOE 5400 series orders all provide guidance and restrictions on the handling and transportation of high explosives on and offsite.

The standards used in this EIS/EIR analysis are overpressures that characterize the shock waves associated with detonation of energetic materials and the consequential effect on property and individuals. Typically, 1.0 psi (pounds per square inch) overpressure will damage the average wooden structure to the point of rendering it uninhabitable, 10 psi will destroy the average structure, and 200 psi is lethal to an exposed individual.

Bounding Case Accident Involving High Explosives and Impacts

The bounding accident for high explosives is the crash of an aircraft carrying 2200 lb of the explosive LX-10 and 300 lb of aviation fuel. If a fuel fire causes the detonation of the explosives, the resulting blast force would be 1 psi or more out to a distance of 490 ft in all directions, with a 1-psi overpressure causing enough damage to a standard dwelling to render it uninhabitable. The crash would result in the death of the aircraft crew and property damage within 490 ft of the point of impact. It was assumed that this accident happened on final approach to the Tracy Municipal Airport.

The aircraft accident rate per departure for large commercial jets is 3.1×10^{-6} and the associated probability that a crash-caused fire exceeds 1-hour duration is 1×10^{-2}. The probability of a detonation with respect to burn time was not determined, but is estimated not to exceed that of a fire with 1-hour duration. Although the transporting aircraft in this scenario is a turboprop, the increased probability associated with the lighter aircraft is estimated to be no more than 10 times higher. Finally, two shipments per year double the probability of a single departure. The overall probability of occurrence is therefore $(3.1\times10^{-6}) \times (1\times10^{-2}) \times 10\times2 = 6.2 \times 10^{-7}$ per year.

Based on a fatal blast radius of 31 ft for 200 psi overpressure, the area of lethality would be 0.0003 km2. Assuming a rural population density of 6 persons/km2 (the glide path into Tracy Municipal Airport is currently over farmland), only the onboard crew would likely be subjected to a lethal blast force. Emergency response personnel would potentially be at risk, but the actual number would depend on the timing of their activities and the number of response personnel within the 0.0003-km^2 area at the time of the detonation. No number is assigned as it would be too speculative.

Preventative Measures

High explosives are transported by approved carriers in cargo aircraft. The aircraft is flown by a qualified pilot, who must file an approved flight plan. The glide paths into the Tracy Municipal Airport are currently over farmland versus the developed areas of Tracy. High explosives are packaged for transport in accordance with the requirements of the Department of Transportation, and while this does not eliminate the possibility of an explosion, the packaging offers some protection from thermal and pressure stresses. Finally, air transportation is less accident prone than ground transportation (Nuclear Regulatory Commission, 1977).

5.6.4 MULTIPLE-BUILDING ACCIDENT SCENARIO

Selection Process

The accidents analyzed in this section were selected using the processes described for radiological and chemical accidents. The multiple-building initiating event assumed to occur is a large earthquake. The buildings identified in these processes were examined to determine their susceptibility to damage during a 0.8g earthquake (see Appendix I). Additionally, buildings found to survive the 0.8g earthquake were examined under 0.9g earthquake conditions. The accidents identified for the multiple-building event are identified in Table 5.6, fully described in Appendix D, and discussed below. Definition of the 0.8g and 0.9g earthquake events is provided in Appendix I. As a comparison, the January 24 and January 27, 1980, Livermore earthquakes, recorded as 5.4 and 5.6 Richter magnitude events, generated maximum measured peak ground accelerations of 0.26g. The October 17, 1989 Loma Prieta earthquake, recorded as a 7.1 Richter magnitude event, generated maximum measured peak ground accelerations of 0.68g. The multiple-building scenario involves releases of radioactive materials and wastes from the Tritium Research Laboratory (B-968), the Hydrogen Research Facility (B-331), Diagnostic Chemistry (B-251), and the Waste Storage and Shipping Facility (B-625). Additionally, the scenario involves toxic chemical releases from the Engineering Building (B-131), the Nuclear Chemistry Laboratory (B-151), and the Plating Shop (B-322).

Protective Action and Emergency Response

The Protective and Emergency Response Planning Guidelines for these scenarios are the same as those discussed for radiological and chemical scenarios in sections 5.6.1 and 5.6.2, respectively.

Bounding Case Accident for the Multiple-Building Scenario and Impacts

The multiple-building accident scenario releases described in this section (and in more detail in Appendix D) are those that bound all other releases from the sites as a result of the multiple-building event. It is acknowledged that some smaller additional releases of similar materials from other buildings or areas may occur as a result of this event; however, the additional contribution to health effects risks from the smaller releases would be insignificant. In addition, the method used for combining the individual bounding scenario releases is extremely conservative. Each individual scenario assumes that on the day of the earthquake the maximum allowable quantity of material is in the building and in the worst at-risk position. The probability of this occurring for even one scenario is extremely low. The probability of this occurring for all scenarios is clearly much lower. Consequently, the elimination of additional smaller releases from consideration in the multiple-building accident scenario is more than offset by the conservatism of assuming that the bounding scenario releases occur concurrently.

The bounding facility-wide seismic accident scenario at the LLNL Livermore site and SNL, Livermore (Appendix D, section D.5) would have the highest offsite impacts if it occurred under existing conditions. Under the proposed action, no action, modification of operations, and shutdown and decommissioning alternatives, the offsite impacts are less. Increased quantities of at-risk tritium in Buildings 298 and 391 are more than offset by decreased quantities in

Buildings 968 and 331.

Radioactive Materials. Should the severe seismic event occur under the worst-case existing conditions, this could result in the release of 50 g of tritium from Building 968, 3.5 g of tritium from Building 331, 7.5×10-4 Ci of americium-241 from Building 251, and 7.2×10^{-3} Ci of americium-241 from Building 625 as described in Appendix D, section D.2. The collective radiation dose that would result from this postulated release in the sector west of the site would be 4700 person-rem for the first-year effective dose equivalent and 9000 person-rem for the 70-year committed effective dose equivalent. The tritium contribution to these cumulative doses occurs during the first year only, because tritium has a short biological half-life (on the order of weeks). The transuranic contribution (from americium-241) to these cumulative doses occurs mostly during the first year and also continues for the life of the affected individual (but at lower subsequent levels). This dose contribution accumulates over the life of the individual because transuranic nuclides are generally bone-seekers (deposited in the bone or on the bone surface) and have long biological half-lives.

A dose of 9000 person-rem to a population of 1.4 million people could result in an additional 5 cases of fatal cancer over 70 years. This can be compared to the 70-year collective radiation dose from background radiation of 29.8 million person-rem with 10,000 cases of fatal cancer over 70 years.

Hazardous Chemicals. Additionally, the bounding facility-wide seismic accident scenario at LLNL and SNL, Livermore (Appendix D, section D.5) may release toxic chemicals under the worst-case existing conditions. These releases may occur at Buildings 131, 151, and 322 as described in Appendix D, section D.3, as well as lesser releases at other locations.

Toxic effects from the ammonia, hydrogen chloride, and hydrogen cyanide releases may result. The release of ammonia at Building 131 would result in a maximum concentration of 580 mg/m^3 at 0.34 km (site boundary) from the point of release. The predicted average concentration at this location is 451 mg/m^3 for 41 minutes. This average level of exposure to ammonia might produce symptoms ranging from eye, nose, and throat irritation to decreased blood pressure. Deaths are not expected as a result of this release.

The release of hydrogen chloride at Building 151 would result in a maximum concentration of 52 mg/m^3 at 0.55 km (site boundary) from the point of release. The predicted average concentration at this location is 11 mg/m^3 for 19 minutes. This average level of exposure to hydrogen chloride would not impair a person's ability to take protective action. Deaths are not expected as a result of this release.

The release of hydrogen cyanide at Building 322 would result in a maximum concentration of 125 mg/m3 at 0.28 km (site boundary) from the point of release. The predicted average concentration at this location is 54 mg/m^3 for 51 minutes, with higher concentrations near the point of release. Lethal concentrations may be expected near the point of release; however, the average level of exposure to hydrogen cyanide at the site boundary may be tolerated without immediate or latent effects.

The combined health effects of exposure to these three chemicals may be worse than the effects due to the exposure to any single chemical.

5.6.5 COMPARISON SUMMARY OF POSTULATED ACCIDENTS

Under the existing conditions, the potential exists for the accidental release of radioactive materials and hazardous chemicals, and the accidental detonation of high explosives at several facilities during ordinary operations, during transportation, and as a result of an event affecting more than one facility. These accidents are summarized in sections 5.6.1, 5.6.2, 5.6.3, and 5.6.4 (listed in Table 5.6-1) and described in detail in Appendix D. Below is a discussion of how the alternative actions affect the postulated accident scenarios; this information is summarized in Table 5.6-4.

Under all alternatives, the administrative limit for tritium at SNL, Livermore Building 968 would be reduced from 50 g to 0 g.

Currently LLNL's Building 331, the Hydrogen Research Facility, has an *administrative limit* for tritium of 300 g and an *inventory* of less than 20 g. Under the proposed action, the administrative limit would be reduced from 300 g to 5 g with the inventory reduced accordingly. A portion of the tritium operations in Building 331 may be moved to Building 298, the Fusion Target Fabrication Facility, and to Building 391, the Inertial Confinement Fusion Facility, known as the NOVA-Upgrade/National Ignition Facility. The three buildings would have a combined administrative limit of 10 g with no more than 5 g in any one building and no more than 5 g combined in Buildings 298 and 391. For these facilities, the administrative limit would therefore be reduced from 300 g in one facility (Building 331) to a total of 10 g among three facilities (Buildings 298, 331, and 391).

Under the modifications of operations alternative, LLNL's Building 322 would be reinforced to withstand the postulated earthquake, and/or the use of all cyanides in Building 322 would be eliminated. These actions would eliminate the release of hydrogen cyanide from Building 322 as a result of the postulated earthquake.

Under the no action alternative, the administrative limit for tritium would decrease from 300 g to 5 g and the tritium inventory from less than 20 g to 5 g at LLNL's Building 331. The maximum at-risk quantity of tritium would be 2 g. No other accidents are affected by the no action alternative.

Under the shutdown and decommissioning alternative, the maximum consequences are those postulated under the proposed action. As inventory reductions for radioactive and toxic materials are effected, the consequences would be reduced accordingly.

Table 5.6-4 Comparison of Postulated Accidents Under the Proposed Action and the Alternatives

Postulated Accident[a]	Proposed Action	No Action	Modification of Operations	Shutdown and Decommissioning
Inadvertent plutonium criticality (B-332)	Applies[b]	Applies	Applies	Applies initially, not applicable after inventory reduced to zero.
Tritium release during severe earthquake (B-968)[c]	Applies initially, not applicable after inventory reduced to zero.	Applies initially, not applicable after inventory reduced to zero.	Applies initially, not applicable after inventory reduced to zero.	Applies initially, not applicable after inventory reduced to zero.
Release of plutonium into Laboratory (B-332)	Applies	Applies	Applies	Applies initially, not applicable after inventory reduced to zero.
Tritium release during severe earthquake (B-331)	Applies	Applies	Applies	Applies initially, not applicable after inventory reduced to zero.
Americium-241 release during severe earthquake (B-251)	Applies	Applies	Applies	Applies initially, not applicable after inventory reduced to zero.

Transuranic waste involved in fire after spill (B-612 area)	Applies	Applies	Applies	Applies initially, not applicable after inventory reduced to zero.
Uranium fire (B-493)	Applies	Applies	Applies	Applies initially, not applicable after inventory reduced to zero.
Transuranic waste (Americium-241) release during severe earthquake (B-625)	Applies	Applies	Applies	Applies initially, not applicable after inventory reduced to zero.
Truck accidents, trucks carrying low specific activity waste (2 scenarios)	Applies	Applies	Applies	Applies initially, not applicable after inventory reduced to zero.
Truck accident, truck carrying transuranic waste	Applies	Applies	Applies	Applies initially, not applicable after inventory reduced to zero.
Tritium release during severe earthquake (B-298)	Applies	Not applicable (currently, no inventory)	Not applicable (currently, no inventory)	Not applicable (currently, no inventory)
Sulfuric acid spill (B-514)	Applies	Applies	Applies	Applies initially, not applicable after inventory reduced to zero.
Chlorine gas release (B-518)	Applies	Applies	Applies	Applies initially, not applicable after inventory reduced to zero.
Aircraft high explosive accident (Tracy Municipal Airport)	Applies	Applies	Applies	Applies initially, not applicable after inventory reduced to zero.
Site 300 high explosive accident (firing table)	Applies	Applies	Applies	Applies initially, not applicable after inventory reduced to zero.
Truck accident, truck carrying high explosive (Interstate 580)	Applies	Applies	Applies	Applies initially, not applicable after inventory reduced to zero.
Ammonia gas release during severe earthquake (B-131)	Applies	Applies	Applies	Applies initially, not applicable after inventory reduced to zero.

Hydrogen chloride gas release during severe earthquake (B-151)	Applies	Applies	Applies	Applies initially, not applicable after inventory reduced to zero.
Arsine gas release (B-166)	Applies	Applies	Applies	Applies initially, not applicable after inventory reduced to zero.
Hydrogen cyanide release during severe earthquake (B-322)	Applies	Applies	Applies initially, not applicable after inventory reduced to zero or building reinforced.	Applies initially, not applicable after inventory reduced to zero.

[a] details.

[b] the postulated accident as described in Appendix D apply to the alternative.

[c] all other buildings listed in this table are at the LLNL Livermore site or LLNL Site 300. While they are distinct operations managed and operated by different contractors, for the purposes of this multiple-facility accident the three sites are addressed together.

SECTION 5 REFERENCES

40 C.F.R. pt. 60, Washington, D.C. 1990, Code of Federal Regulations, U.S. Government Printing Office, Washington, D.C.

42 U.S.C. section 7401, Federal Clean Air Act of 1990.

AB 2588, 1987, California Assembly Bill AB 2588, Air Toxic "Hot Spots" Information and Assessment Act.

Allen, John, 1991, Sandia National Laboratories, Livermore, interoffice memorandum, April 1991.

American Industrial Hygiene Association, 1989, *Emergency Response Planning Guidelines*, AIHA Emergency Response Planning Guideline Committee, Akron, OH, March 30, 1989.

Anthony Guzzardo and Associates, Inc., 1990, *Preliminary Zoning Map for Tracy Hills*, blueline, December 21, 1990.

Association of Bay Area Governments, 1989, *Projections 90*, Oakland, CA.

Bell, Allen, 1991, City of Tracy, personal communication, May 8, 1991.

Brown, George W., 1991, Deputy Chief, City of Livermore Fire Department, personal communication, May 31, 1991.

Busby, C. I., and D. M. Garaventa, 1990, *A Cultural Resources Overview and Historic Preservation Regulatory Analysis of Sandia National Laboratories Livermore Facility, Alameda County, California*, report by Basin Research Associates, San Leandro, CA.

Busby, C. I., D. M. Garaventa, and R. M. Harmon, 1990, *A Cultural Resources Assessment of Sandia National Laboratories Livermore Facility, Alameda County, California*, report by Basin Research Associates, San Leandro, CA.

Busby, C. I., D. M. Garaventa, and L. S. Kobori, 1981, *A Cultural Resource Inventory of Lawrence Livermore National Laboratory's Site 300, Alameda and San Joaquin Counties, California*, report on file, Northwest Information

Center, Sonoma State University (S-2675) and Central California Information Center, California State University Stanislaus.

California Department of Finance, 1990a, "Alameda County Population and Housing Estimates," (computer printout report E-5).

California Department of Finance, 1990b, "San Joaquin County Population and Housing Estimates," (computer printout report E-5).

California Department of Transportation, 1991, *California Traffic Volumes, Truck Annual Average Daily Traffic Annual Reports 1985–1989.*

California Employment Development Department, 1990a, *Annual Planning Information for Alameda County*, Sacramento, CA.

California Employment Development Department, 1990b, *Annual Planning Information for Stockton MSA (San Joaquin County)*, Sacramento, CA.

CARB, 1987, *Air Quality Analysis Tools (AQAT-2),* California Air Resources Board, Technical Support Division, Sacramento, CA.

City of Livermore, 1977, *Scenic Route Element of the City of Livermore General Plan 1976–2000*, Livermore, CA.

City of Pleasanton, 1990, *Growth Management Plan*, Pleasanton, CA.

Clemens, David, 1991, Assistant Planning Director, City of Livermore, personal communication, September 11, 1991.

Conant, Bob, 1991, City of Tracy Planning Department, personal communication, March 20, 1991.

County of Alameda, 1966, *Scenic Route Element of the County of Alameda General Plan*, Hayward, CA.

County of San Joaquin, 1978, *Scenic Highways Element of the San Joaquin County General Plan*, Stockton, CA.

County of San Joaquin, 1987, *Housing Element of the San Joaquin County General Plan*, Stockton CA.

DOE, 1991, *Predecisional Draft, Brief Environmental Assessment for the Cheap Access to Orbit (CATO) Experimental Tests (Formerly SHARP) at Lawrence Livermore National Laboratory*, (DOE/EA-OOOO), July 1991.

Dresen, M. D., W. F. Isherwood, and J. P. Ziagos, 1991, *Proposed Remedial Action Plan for the LLNL Livermore Site, Livermore, CA,* UCRL-AR-105577, Lawrence Livermore National Laboratory, Livermore, CA.

Edminster, Dick, 1991, Planning Manager, Alameda County Waste Management Authority, personal communication, June 25, 1991.

Educational Data Systems, 1991, *Baseline 1990 Census, Lawrence Livermore Laboratories.*

EPA, 1982, *Compilation of Emission Factors for Stationary Sources*, AP-42, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1987, *Industrial Source Complex Dispersion Model Users Guide*, Second Edition, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, December 1987.

EPA, 1990, *Users Guide to Cal3qhc, a Modeling Methodology for Predicting Pollutant Concentrations Near Roadway Intersections*, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1990.

FDA, 1982, *Accidental Radioactive Contamination of Human Food and Animal Feeds; Recommendations for State and Local Agencies*, Food and Drug Administration, October 22, 1982.

Frahm, Eric, 1991, Lawrence Livermore National Laboratory, interoffice memorandum, February 1991.

Grandfield, C. H., 1989, *Guidelines for Discharges to the Sanitary Sewer System*, Lawrence Livermore National Laboratory, Livermore, CA, August 1989.

Hale, Kathy, 1991, Lawrence Livermore National Laboratory, interoffice memorandum, March 1991.

Holda, Mike, 1991, Lawrence Livermore National Laboratory, interoffice memorandum, March 1991.

Huston, Sheryl, 1992, San Ramon Unified School District, personal communication, January 10, 1992.

ICRP, 1991, *1990 Recommendations of the ICRP*, Publication 60, International Commission on Radiological Protection, Pergamon Press, New York.

Isherwood, W. F., C. H. Hall, and M. D. Dresen, 1990, *CERCLA Feasibility Study for the LLNL Livermore Site*, UCRL-AR-104040, Lawrence Livermore National Laboratory, Livermore, CA, December 1990.

Karam, Gabriel, 1991, Solid Waste Engineer, County of San Joaquin, Department of Public Works, correspondence, May 8, 1991.

Livermore Valley Joint Unified School District, 1991a, *Monthly Enrollment Analysis* (computer printout), April 19, 1991.

Livermore Valley Joint Unified School District, 1991b, *Short-Term School Facilities Status Report*, February 1991.

LLNL, 1988a, *Parking Master Plan*, Lawrence Livermore National Laboratory, Livermore, CA, May 1988.

LLNL, 1988b, *Shipping, Transferring, and Transporting Explosives*, Health & Safety Manual Supplement 24.05, Revised April 1988, Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1990a, *Action Description Memorandum for Infrastructure Modernization at Lawrence Livermore National Laboratory*, MISC-4854-90-19, Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1990b, *AB2588 Air Toxics Inventory Report for Site 300*, Lawrence Livermore National Laboratory, Livermore, CA, June 1990.

LLNL, 1990c, *Review Draft Safety Analysis Report B322, Plutonium Facility*, UCAR-10211, Rev. 1, Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1991a, *AB2588 Air Toxics Risk Screening Document*, Lawrence Livermore National Laboratory, Livermore, CA, February 1991.

LLNL, 1991b, *Employee Residence Analysis*, (computer printout), Lawrence Livermore National Laboratory, Livermore, CA.

LLNL, 1991c, *Lawrence Livermore National Laboratory Site Development Plan*, Lawrence Livermore National Laboratory, Livermore, CA, April 1991.

Lydick, John, 1991, Vasco Road Sanitary Landfill, correspondence, May 10, 1991.

Martinson, Tom, 1991, Alameda County Waste Management Authority, personal communication, May 22, 1991.

Parisotto, Rudy, 1991a, Lawrence Livermore National Laboratory, interoffice memorandum, March 1991.

Parisotto, Rudy, 1991b, Lawrence Livermore National Laboratory, interoffice memorandum, April 1991.

SNL, Livermore, 1990, *News Release*, Sandia National Laboratories, Livermore, Livermore, CA.

SNL, Livermore, 1991, *On-Roll Counts by City*, (computer printout), Sandia National Laboratories, Livermore, Livermore, CA.

Sonanberg, Dave, 1991, Livermore Valley Joint Unified School District, personal communication, June 5, 1991.

State Historic Preservation Office, 1990, *Cultural Resources Inventory*, Letter to R.H. Johnsen at Sandia National Laboratories, Livermore, October 24, 1990.

Stratton, W. R. and D. R. Smith, 1989, *A Review of Criticality Accidents*, Lawrence Livermore National Laboratory, Livermore, CA, March 1989.

Szalay, Steven C., 1990, *Economic Impact of the Nuclear Free Initiative (Measure A) on Alameda County,* County of Alameda, Hayward, CA, May 1990.

Thorpe, R. K., W. F. Isherwood, M. D. Dresen, and C. P. Webster-Scholten, 1990, *CERCLA Remedial Investigations Report for the LLNL Livermore Site*, UCAR 10299, Lawrence Livermore National Laboratory, Livermore, CA.

TJKM Transportation Consultants, 1989, *Traffic Impact Study, Proposed Closure of East Avenue in the City of Livermore and the County of Alameda*, Pleasanton, CA, June 23, 1989.

TJKM Transportation Consultants, 1992, *Traffic Study for the Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore, Environmental Impact Statement/Environmental Impact Report*, Pleasanton, CA.

Turner, J. E., 1986, *Atoms, Radiation, and Radiation Protection*, Pergamon Press, NY.

U.S. Fish and Wildlife Service, 1989, *Standardized Recommendations For Protection of the San Joaquin Kit Fox,* U.S. Fish and Wildlife Service, Sacramento, CA.

William Self Associates, 1992, *Documentation and Assessment of the History of Lawrence Livermore National Laboratory, Livermore Facility, and Site CA-SJo-173H, the Carnegie Townsite, at Lawrence Livermore National Laboratory's Site 300*, Alameda and San Joaquin Counties, CA, August 1992.

Williams, Peter, 1991, San Joaquin County Council of Governments, personal communication, May 3, 1991.

SECTION 6 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

Significant and unavoidable impacts constitute a substantial adverse change to existing environmental conditions that cannot be fully mitigated by implementing mitigation measures. The potential significant and unavoidable adverse impacts that could arise from implementation of the proposed action discussed in section 5.1 are summarized below. Where appropriate, significant and unavoidable impacts are identified by site (i.e., LLNL Livermore site, LLNL Site 300, or SNL, Livermore). Although CEQA does not apply to SNL, Livermore, discussions in this EIS/EIR, where appropriate because of their proximity, include activities and impacts at both LLNL and SNL, Livermore. To provide consistency in this section, both LLNL and SNL, Livermore are included in the following discussion.

LLNL Livermore Site and SNL, Livermore

- The increase in housing demand in the region created by the proposed action in the near term (5 to 10 years) would result in a potentially significant and unavoidable impact. Projected demand due to an increase in employees cannot be accommodated by the existing Livermore housing market and other markets in the region. This impact is made more severe by increased demand due to cumulative growth in addition to the Laboratories' growth. Mitigation measures impacting housing availability are beyond the authority of DOE and UC.
- The increase in employees under the proposed action could impact school services provided by the Livermore Valley Joint Unified School District and other districts in the region. The addition of an estimated 800 students to the existing facilities would result in a potentially significant and unavoidable adverse impact due to an existing shortage of school capacity at the Livermore Valley Joint Unified School District and some other school districts in the region. To partially mitigate this impact, DOE will continue to participate in the federal government's Impact Aid Program, which provides funds to the district.
- The increase in nitrogen dioxide, volatile organic compounds, and fugitive dust emissions from Laboratory facilities and vehicles under the proposed action contribute to an existing nonattainment condition for ozone and particulate standards. The Laboratories' emissions of these pollutants are in addition to those from other area sources. Although the individual contributions are low, because the area is in nonattainment for ozone and particulate standards these emissions constitute a significant and unavoidable adverse impact.
- As a result of LLNL and SNL, Livermore and surrounding future development, cumulative roadway noise will increase substantially in the future along a number of roads near the Livermore sites, resulting in a significant and unavoidable adverse impact. Mitigation measures in the surrounding area that might reduce this impact to less than significant are beyond the control of DOE and UC.
- The proposed action, along with planned and proposed development near the LLNL Livermore site and SNL, Livermore, would result in a cumulative increase in traffic congestion at certain intersections. This increase is primarily due to the development of surrounding future land uses. Mitigation measures would be needed in the surrounding area to reduce this impact to less than significant; such measures are beyond the control of DOE and UC.
- Water usage by the Laboratories can be mitigated to a less than significant impact. However, cumulative development would increase demand for and consumption of water at a time of continuing drought in the state, and thus would be a significant and unavoidable adverse impact. Mitigation measures, beyond those proposed by DOE and UC, would be necessary to reduce this cumulative impact to less than significant.
- Both LLNL and SNL, Livermore generate mixed waste, almost all of which is prohibited from land disposal under RCRA without first being treated to meet defined standards. Currently, no treatment or disposal options are available for most of these wastes. Extended storage of these wastes may violate RCRA storage regulations (42 U.S.C. section 3004 (j)). The EPA recognizes that "generators and storers of these wastes may find it impossible to comply with the . . . storage prohibition if there are no available options for treatment or disposal of the wastes." The EPA suggests that "responsible management practices should minimize the environmental risks from these section 3004 (j) storage violations" (56 Fed. Reg. 42731).
- Assumed growth at LLNL and SNL, Livermore may contribute to significant and unavoidable cumulative

impacts resulting from increased waste generation and waste shipments in the region. Measures to fully mitigate these impacts are beyond the control of DOE and UC.

LLNL Site 300

- The proposed action, along with planned and proposed development in the vicinity of LLNL Site 300, would result in a cumulative increase in traffic congestion at the Corral Hollow Road/I-580 interchange. Measures that would reduce this impact to a less than significant level are beyond the control of DOE and UC.
- Currently, solid waste from LLNL Site 300 is sent to the Corral Hollow Sanitary Landfill for disposal. This landfill is slated to close in 1995 and, as yet, the county has not identified an alternative landfill location. Under the proposed action, the anticipated increase in solid waste generation from LLNL Site 300 is approximately 500 cu yd per year. This increase, plus the cumulative contributions from other sources in the region, would constitute a significant and unavoidable impact until another landfill location is identified.
- The proposed action in conjunction with anticipated cumulative regional development could result in significant and unavoidable cumulative impacts to wetlands in the vicinity of LLNL Site 300. The full extent of wetlands within this study area is not known. Identifying these resources is also beyond the scope of this EIS/EIR. It is known, however, that at least four developments, totaling approximately 10,000 acres, could be constructed in the area of LLNL Site 300. The impacts to wetlands by other projects within the study area cannot be mitigated by DOE or UC.
- Increases in criteria pollutant emissions associated with stationary and mobile sources at LLNL Site 300 in addition from other regional sources of emissions would contribute to cumulative impacts on regional air quality. Although LLNL Site 300 contribution to area emissions is small, because the area is in nonattainment for ozone and particulate standards these emissions constitute a significant and unavoidable impact.
- The demand for and consumption of water at LLNL Site 300 together with cumulative demand from other users in the vicinity could contribute to a potentially significant and unavoidable impact on available water supplies. Population in San Joaquin County is projected to increase by 47.7 percent by the year 2010. Added to the assumed 9 percent increase in water usage at LLNL Site 300, this could constitute a significant and unavoidable cumulative impact if drought and other limiting factors continue. Despite LLNL conservation measures, all steps to mitigate this impact are not available to DOE or UC.

National

- The projected increase in waste generation at the Laboratories under the proposed action implies an increased need for treatment and disposal facilities for these wastes. A similar need may exist for waste generators elsewhere in the country. In order to evaluate the cumulative impact of this widespread waste generation, the problem must be addressed on a national scale. DOE is evaluating the national capacity for and cumulative impact on waste treatment and disposal facilities as part of the Programmatic Environmental Impact Statement for Environmental Restoration and Management. The Laboratories can and will minimize their rate of waste generation and treat what wastes they can to reduce waste quantities requiring offsite treatment and disposal; however, the general problem is beyond the scope of this EIS/EIR.

SECTION 7 SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

In accordance with NEPA and CEQA requirements, this section discusses the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity. It also examines long-term adverse cumulative impacts, with a focus on impacts that may narrow the range of options for future use. Impacts of the proposed action at LLNL and SNL, Livermore are discussed in section 5.1; unavoidable adverse environmental impacts are identified in Section 6.

Return of the LLNL Livermore site and SNL, Livermore to agricultural or other nonindustrial use may be precluded by the presence of the existing structures, roads, and utilities, and the existing soil contamination problems. Based on the general plans of the City of Livermore and the County of Alameda, both jurisdictions have designated these sites, as well as much of the surrounding area, for industrial uses. The long-term productivity of the Laboratories would be optimized by their continued use for research and design or as industrial facilities.

Because much of the land at LLNL Site 300 is undeveloped, it is conceivable that the site could be used for wind energy development or returned to an agricultural use, such as livestock grazing. These uses of the site would be compatible with existing Alameda and San Joaquin counties land use and applicable land use plans. However, it is possible that the remediation of contaminated areas and the protection of sensitive habitats would be required before such uses could take place.

Long-term cumulative impacts described above would be mitigated somewhat by a change to agricultural use. LLNL and SNL, Livermore contributions to future noise levels, traffic, and water consumption would be reduced.

The long-term benefits of continuing to operate LLNL and SNL, Livermore must include fulfilling national defense missions, together with laser, biomedical, energy, education, and other research and development, and also including technology transfer to academia and industry. If the Laboratories were shut down and the properties were to return to other uses, for example agriculture or urban development, the short-term benefits of such a transfer would be substantially outweighed by the long-term loss to the nation of a major technical research facility with diversified research, particularly in the fields of biomedicine, energy development, and national defense.

Environmental remediation activities currently occurring and scheduled to continue under the proposed action will, in the long term, improve the options for alternative uses of the LLNL and SNL, Livermore sites. Cleanup of the sites increases the options for future use of the property rather than narrowing it.

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Section 8 Irreversible and Irretrievable Commitment of Resources

For purposes of this EIS/EIR, impacts are considered significant and irreversible where:

- Uses of nonrenewable resources by implementing the proposed action are of sufficient magnitude that removal or nonuse thereafter is unlikely, and
- Primary and secondary impacts generally commit future generations to similar uses.

On this basis, the proposed action, including continuing operation of LLNL and SNL, Livermore, would result in the irreversible and irretrievable commitment of resources needed for construction of new facilities, and for maintenance, repair, and operation of existing facilities. The projected use of water, fuel, and electricity for the proposed action reflects gross square footage increases of 9 percent at the LLNL Livermore site, 9 percent at LLNL Site 300, and 6 percent at SNL, Livermore (Table 8-1). Resources committed to implement the proposed action are discussed in section 5.1.12.

Table 8-1 Annual Expenditure of Resources, Proposed Action[a]

Resource		LLNL Livermore Site[b]	LLNL Site 300	SNL, Livermore	Total
Water	(106 gal)	261	33	62	356
Fuel[c]	(103 gal)	888	85	18	991
Electricity	(106 kWh)	377	2	43	422

[a] Without mitigation.

[b] Includes offsite leased properties.

[c] Fuel includes gasoline, jet fuel, diesel, and LPG.

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SECTION 9 GROWTH-INDUCING IMPACTS

SECTION 10 LOCAL PROJECTS CONTRIBUTING TO CUMULATIVE IMPACTS

CEQA requires consideration of the incremental effects of a project that are "cumulatively considerable" when viewed in connection with "the effects of past projects, the effects of other current projects, and the effects of probable future projects." (Pub. Res. Code sections 21083(b), 21000.) The CEQA Guidelines provide that a discussion of "cumulative impacts" may be based either on a list of "past, present, and reasonably anticipated future projects," or on a "summary of projections contained in an adopted general plan or related regional planning document." (CEQA Guidelines section 15130(b).) The "list-based" approach relies upon lists of recently approved and proposed projects compiled by local agencies as the basis for estimating future regional growth. The "programmatic approach" uses population, employment, and housing projections or buildout of general and community plans as a basis for estimating future growth in the region.

The Laboratory activities proposed and analyzed in this EIS/EIR are in the vicinity of several local governments, each with its own general plan or general plan equivalent and each having its own projected planning horizon. Therefore, this EIS/EIR uses the list-based approach in defining cumulative development in the surrounding area that may compound the Laboratories' impacts on land use, traffic, visual/aesthetic, community services, and so on.

Where the resource subject to impact is clearly larger in scope, cumulative impact analyses, discussed in Section 5, address the appropriate resource area. The cumulative analysis for air, for example, accounts for projected impacts to the region regulated by the Bay Area Air Quality Management District.

Although CEQA does not apply to SNL, Livermore, discussions in this EIS/EIR, where appropriate because of their proximity, include activities and impacts at both LLNL and SNL, Livermore. To provide consistency in this section, both LLNL and SNL, Livermore are included in the following discussion. Approved and proposed projects in the vicinity of the LLNL Livermore site, LLNL Site 300, and SNL, Livermore are identified below.

LLNL Livermore Site and SNL, Livermore

Both the County of Alameda and the City of Livermore have approved or proposed projects in the vicinity of the LLNL Livermore site and SNL, Livermore.

County of Alameda

The only major land use planning activity currently proposed within the County of Alameda in the vicinity of the LLNL Livermore site and SNL, Livermore is the proposed South Livermore Valley General Plan Amendment (Stein, 1991). As an amendment to the Alameda County General Plan for the Livermore-Amador Valley Planning Unit, it would revise land classifications for the area and establish boundary areas, densities, and development conditions in order to protect viticultural uses (cultivation of grapes) and to promote the area as a wine region (County of Alameda, 1991). A preliminary draft of the South Livermore Valley General Plan Amendment was submitted to the County of Alameda Board of Supervisors for review on March 6, 1991. The location of the South Livermore Valley Plan Area is shown in Figure 10-1. No other specific development applications or approved (but unbuilt) projects had occurred near the LLNL Livermore site or SNL, Livermore within the County of Alameda as of March 1991.

City of Livermore

As of March 1991, the City of Livermore had approved several new commercial and industrial projects for construction in the vicinity of the LLNL Livermore site and SNL, Livermore. These projects, shown collectively as O1 on Figure 10-1, are located south of I-580 and north of Patterson Pass Road (Environmental Science Associates, Inc., 1991). Briefly described, these projects include:

- Orchard Properties. Project approval has been granted for a 55,800-sq-ft distribution factory on 5.3 acres along Vaughn Avenue and a 242,200-sq-ft industrial building on 11.3 acres along Lawrence Drive. In addition, the city has approved a factory outlet center as an addition to the Orchard Properties development. It would include approximately 515,000 sq ft of factory outlet, service retail, and general commercial uses on 53.5 acres between I-580 and Vaughn Avenue at Greenville Road.
- Kraft Foods. Construction has been approved for a 125,900-sq-ft distribution facility on 18.9 acres along Lawrence Drive.
- Signature Properties. Project approval has been granted for 19,000 sq ft of light industrial uses on 2.8 acres along Preston Avenue.
- Santa Fe. Approximately 175,000 sq ft of warehouse uses have been approved for 9.4 acres along Vaughn Avenue.
- Discovery Toys. Construction has been approved for a 175,000-sq-ft manufacturing and distribution facility on 9.1 acres east of Vasco Road.
- Pacific Gas and Electric. Project approval has been granted for a 50,000-sq-ft building on 35 acres south of Lavender Avenue for training and storage facilities.

In addition, the City has adopted the North Livermore Area "A" General Plan Amendment. This general plan amendment, adopted in 1988, allowed for another 3000 dwelling units, and approximately 170 more commercial acres to be built in the Springtown Community (City of Livermore, 1991). The approximate location of Area "A" is shown on Figure 10-1.

The City of Livermore is currently evaluating a proposal to establish the amount, mix, and pattern of future land uses and major circulation systems for a 15,500-acre area north and west of the North Livermore Area "A" planning area (see Figure 10-1). Most of this area is within unincorporated Alameda County. The city would bring this area into its sphere of influence and annex substantial portions prior to approval of specific development projects. The alternatives being evaluated include a range of densities for a mixed-use community of between 10,000 and 45,000 people; including open space/recreational, residential, commercial, business park, community center, and public facilities uses. To date, no specific development proposals are associated with this planning area (Brown, 1992).

LLNL Site 300

Planning efforts of the County of San Joaquin and the City of Tracy in the vicinity of LLNL Site 300 are described below.

County of San Joaquin

New planned communities and a major commercial and industrial complex are being proposed or are in the initial phases of consideration in the vicinity of LLNL Site 300 in San Joaquin County. The new planned communities will be considered in the update of the county's general plan, scheduled for completion in April 1992 (Islas, 1992a). These proposed projects are briefly described below, and their approximate locations are shown on Figure 10-1.

- Tracy Hills. A new community is proposed for development on approximately 5900 acres immediately northeast of LLNL Site 300. Tracy Hills would include 10,212 residential units and 479 acres of commercial and industrial uses (County of San Joaquin, 1991). The number of dwelling units proposed is a preliminary figure and may change as the project is further defined. The application for development of the Tracy Hills community will be processed through the City of Tracy since the applicant is seeking annexation to the city; however, no formal application had been made as of January 1992 (Conant, 1992).
- Tracy Highlands. A new community is being considered (no formal applications have been made as of January 1992) on approximately 1400 acres immediately north of LLNL Site 300 (Conant, 1992). Tracy Highlands proposes approximately 3500 residential units, 156 acres of commercial uses, and 267 acres of industrial uses (County of San Joaquin, 1991). These land use figures are preliminary and are subject to change as the project is further defined.
- New Jerusalem. A new community called "New Jerusalem" is being considered on 3024 acres approximately 11 miles east of LLNL Site 300 (Islas, 1992b). Preliminary plans for this community include 7566 residential units

and approximately 478 acres of commercial and industrial uses (County of San Joaquin, 1991).

- Gateway Commercial Complex. A commercial and industrial center has been formally proposed on 687 acres between I-580 and I-205, approximately 7 miles north of LLNL Site 300. A Safeway grocery store is proposed on 171 acres of the site and is scheduled to be completed in 1992. A Bay Cities truck stop is proposed on 52 acres and is scheduled to be completed in 1995 (County of San Joaquin, 1991).

City of Tracy

According to the City of Tracy Planning Department, there are no approved or proposed projects within the City of Tracy in the vicinity of LLNL Site 300 (Conant, 1991). The project proponents of the Tracy Hills community, however, are considering requesting an annexation to the City of Tracy, which would be considered in the update of the City of Tracy General Plan scheduled for completion in June 1992 (Bell, 1991).

SECTION 10 REFERENCES

Bell, Allen, 1991, City of Tracy, personal communication, May 13, 1991.

Brown, Eric, 1992, City of Livermore Planning Department, personal communication, January 13, 1992.

City of Livermore, 1991, *North Livermore General Plan Amendment*, Livermore, CA.

Conant, Bob, 1991, City of Tracy Planning Department, personal communication, March 20, 1991.

Conant, Bob, 1992, City of Tracy Planning Department, personal communication, January 17, 1992.

County of Alameda, 1991, *South Livermore Valley General Plan Amendment*, Hayward, CA.

County of San Joaquin, 1991, *San Joaquin County New Communities Descriptions*, Stockton, CA.

Environmental Science Associates, Inc., 1991, *Orchard Properties Draft Supplemental Environmental Impact Report*, San Francisco, CA.

Islas, Lorre, 1992a, County of San Joaquin, personal communication, January 2, 1992.

Islas, Lorre, 1992b, County of San Joaquin, personal communication, February 4, 1992.

Stein, Deborah, 1991, County of Alameda Planning Department, personal communication,

March 20, 1991.

ABBREVIATIONS AND ACRONYMS

ABAG Association of Bay Area Governments

ADT Average daily traffic

AIHA American Industrial Hygiene Association

APE Area of Potential Effect

AQS Air Quality Standard

ARAC Atmospheric Release Advisory Capability

ARAR Applicable or Relevant and Appropriate Requirement

ATA Advanced Test Accelerator

AVLIS Atomic Vapor Laser Isotope Separation

BAAQMD Bay Area Air Quality Management District

BART Bay Area Rapid Transit District

BEIR-V Biological Effects of Ionizing Radiation, report V

(See references for Section 4)

BLM U.S. Bureau of Land Management

CAPCOA California Air Pollution Control Officers Association

CARB California Air Resources Board

CDF California Department of Forestry

CDFG California Department of Fish and Game

CEDE Committed effective dose equivalent

CEQ Council on Environmental Quality

CEQA California Environmental Quality Act

CERCLA Comprehensive Environmental Response, Compensation and

Liability Act of 1980

CFA Cognizant federal agency

CHARM™ Complex Hazardous Air Release Model, Version 6.1

CHP California Highway Patrol

Ci Curies

CM Crisis manager

CMT Crisis management team

CNEL Community Noise Equivalent Level

CPR Cardiopulmonary resuscitation

dB decibel (a measure of noise level)

dBA A-weighted decibel

DBE Design basis earthquake

DBF Design basis fire

DBW/DBT Design basis wind/design basis tornado

DHS California Department of Health Services

DOD U.S. Department of Defense

DOE U.S. Department of Energy

DOT U.S. Department of Transportation

DTSC Department of Toxic Substances Control

EDC Emergency dispatch center

EDE Effective dose equivalent

EHM Extremely hazardous material

EIR Environmental Impact Report

EIS Environmental Impact Statement

EIS/EIR Environmental Impact Statement/Environmental Impact Report

EKG Electrocardiograph

EOC Emergency operations center

EPA U.S. Environmental Protection Agency

EPIP Emergency plan implementing procedure

ERPG Emergency Response Planning Guidelines

ES&H Environment, safety, and health

FAH Fuel aromatic hydrocarbon

FBI Federal Bureau of Investigation

FDA U.S. Food and Drug Administration

FEMA Federal Emergency Management Agency

FHC Fuel hydrocarbon

FHWA Federal Highway Administration

FSP Facility safety procedure

HE High explosive

HEAF High Explosives Application Facility

HEPA High efficiency particulate air (filter)

HI Hazard Index

HM Hazardous material

HRF Hydrogen Research Facility

HVAC Heating, ventilation, and air conditioning

HWM Hazardous waste management

IC Incident commander

ICRP International Commission on Radiation Protection

ICU Intersection capability utilization

IDLH Immediately-Dangerous-to-Life-and-Health

IHSG Industrial Hygiene Service Group

ISC-ST EPA Industrial Source Complex Short Term air dispersion model

JTA Joint test assembly

LAP Livermore Atmospheric Propagation (code)

Ldn Day-night average noise level

LEDO Laboratory emergency duty officer

Leq Equivalent noise level

LLNL Lawrence Livermore National Laboratory

LOS Level of service

LPG Liquified petroleum gas

LVJUSD Livermore Valley Joint Unified School District

MAP Mitigation Action Plan

MCL Maximum contaminant level

MCLG Maximum contaminant level goals

MEI Maximally exposed individual

MMP Mitigation Monitoring Plan

MSL Mean sea level

NAI Non-proliferation, Arms Control, and International Security

NCRP National Council on Radiation Protection and Measurements

NEPA National Environmental Policy Act

NIOSH National Institute for Occupational Safety and Health

NOA Notice of Availability

NOAA National Oceanic and Atmospheric Administration

NOC Notice of Completion

NOD Notice of Determination

NOI Notice of Intent

NOP Notice of Preparation

NPDES National Pollutant Discharge Elimination System

NPR-EIS New Production Reactor Environmental Impact Statement

NRC U.S. Nuclear Regulatory Commission

OIC Officer in Charge

OSHA Occupational Safety and Health Agency

PAG Protective Action Guide

PAH Polycyclic aromatic hydrocarbons

PCBs Polychlorinated biphenyls

PCE Perchloroethylene

PEIS Programmatic Environmental Impact Statement

PEL Permissible exposure limit

PM10 Suspended particulate material less than 10 mm in diameter

ppb Parts per billion

ppm Parts per million

PRAP Proposed Remedial Action Plan

psi pounds per square inch (pressure)

RACES Radio Amateur Communication Emergency System

rad A unit of absorbed dose

RAM Radioactive material

RCRA Resource Conservation and Recovery Act

rem A unit of dose equivalent

RMG Radiation Measurement Group

RMS Radioactive material spill

ROD Record of Decision

RWQCB Regional Water Quality Control Board, California

SA Specific activity

SAR Safety analysis report

SARA Superfund Amendments and Reauthorization Act

SCC Satellite command center

SDI U.S. Strategic Defense Initiative (Star Wars)

SIS Special Isotope Separation

SMTD Stockton Metropolitan Transit District

SNL, Livermore Sandia National Laboratories, Livermore

State OES California State Office of Emergency Services

STP Standard Temperature and Pressure

TAC Toxic air contaminant

TCE Trichloroethylene

THM Trihalomethane, especially chloroform

TLD Thermoluminescent dosimeter

TLV/TWA Threshold Limit Value/Time-Weighted Average

TRCFPD Tracy Rural County Fire Protection District

TRL Tritium Research Laboratory

TRU Transuranic (waste)

TSP Total suspended particulates

U-AVLIS At LLNL, Atomic Vapor Laser Isotope Separation applied to

uranium

UC University of California

UCLA University of California at Los Angeles

UOR Unusual occurrence report

V/C Volume to capacity ratio

VISTA Verification, Intelligence, and Special Technology Analysis (Center)

VMH Valley Memorial Hospital

WIPP Waste Isolation Pilot Plant, Carlsbad, NM

COMPLETE GLOSSARY

A-weighted decibel (dBA)	*See* Decibel, A-weighted.
Absolute risk	An expression of excess risk based on the assumption that the excess risk from radiation exposure *adds* to the underlying (baseline) risk by an increment dependent on dose but independent of the underlying natural risk. *See* Relative risk.
Absorbed dose	The mean energy imparted to matter by ionizing radiation per unit mass. The unit of absorbed dose is the rad, which is equal to 100 erg/g.
Accelerator	An apparatus for imparting high velocities to charged particles.
Active fault	In this EIS/EIR, a fault known to be recent because it has displaced materials 35,000 years old or younger. Alquist-Priolo Special Studies Zones Act of 1972 defines an active fault as one that has had surface displacement during Holocene time (the last 11,000 years).
Activity	The number of nuclear transformations occurring in a given quantity of material per unit time. *See* Curie; Radioactivity.
Acute	With respect to dose or toxicity, one that occurs in a short time.
Administrative limit	A limit imposed administratively on the quantity of a radionuclide permitted in a building or part of a building.
AIRDOS	A computer code endorsed by the EPA for predicting radiological doses to members of the public due to airborne releases of radioactive material. It accounts for inhalation, external exposure to direct radiation, and food ingestion pathways.
Air stripper	A ground water treatment system in which volatile organic compounds are removed from soil by aeration.
Alluvial	Referring to alluvium, which is any stream-laid sediment deposit found in a stream channel and in low parts of a stream valley subject to flooding.
Alpha, alpha particle	A heavy particle consisting of two neutrons and two protons and thus having a charge of +2; the nucleus of a helium-4 atom.
Ambient noise	The residual (background) sound in the absence of specific identifiable noise sources.
Americium	An artificial radioactive element of atomic number 95. Am-241 is produced by the beta decay of Pu-241.
Anticline	A fold in rocks in which the strata dip outward from both sides of the axis, where the oldest strata are in the core of the fold. The opposite of a syncline.
Aquifer	A water-bearing stratum of permeable rock or sediments capable of producing economically significant quantities of water to wells and springs.
Archaeological resources	*See* Cultural resources (prehistoric).
Archival research	Examination of records at the regional offices of the State Historic Preservation Office for evidence of recorded historic and/or prehistoric sites; the use of other archival sources (libraries, private collections, museums) to gather information on historic and prehistoric sites that have not been formally recorded or that have not been completely documented.
Arcuate	Curved like a bow, curved or bowed.

Area of Potential Effect (APE)	In the context of Section 106 of the National Historic Preservation Act, the area in which planned development may directly or indirectly affect a cultural resource. The area is determined by the federal lead agency in the Section 106 process.
Aromatic hydrocarbons	Volatile organic compounds characterized by unsaturated ring structures; in this EIS/EIR, benzene, toluene, ethylbenzene, and xylenes.
As low as reasonably achievable (ALARA)	A philosophy of protection that controls and maintains exposures to individuals and to the work force and general public as low as technically and economically feasible below the established limits.
Aseismic slip	A slip along an underground fault consisting of many small movements so that very little seismic energy is emitted.
Assignable space	That part of the building space that is not taken up by halls, stairs, elevators, restrooms and so on, and that can be occupied by Laboratory personnel carrying out the Laboratory mission.
Atmospheric dispersion, dilution	The greater the spread downwind of airborne material, the greater the spread of dilution, and the smaller the concentration along the hotline.
Atmospheric stability	The tendency of the atmosphere to slow the rise of a contaminant plume; the more stable the atmosphere, the smaller the cloud rise and the greater the concentration of the contaminant along the hotline.
Augering	Use of a hand or power auger to investigate areas for evidence of archaeological midden deposits.
Autoclave	An apparatus for sterilizing that uses superheated steam under pressure.
Background radiation	Radiation arising from radioactive material other than that directly under consideration. Background radiation due to cosmic rays and natural radioactivity is always present. There may also be external background radiation from the presence of radioactive substances in building material itself and internal radiation from natural radioactive substances such as potassium-40 in the body.
Bedrock mortar	Depression worn in the floors of rock shelters or on the flat portions of exposed bedrock where prehistoric peoples ground grass seeds and acorns into meal. The depression is created by the continual grinding motion of a stone pestle, which is alternately used to pound and grind from side to side.
Beryllium	A toxic metal of atomic number 4. Natural beryllium consists entirely of Be-9.
Best estimate	An estimate made with the numerical inputs that are believed to be representative of the real situation, not biased conservatively.
Beta particle	Charged particle emitted from the nucleus of an atom, with a mass and charge equal in magnitude to that of the electron.
Bioassay	Urinalysis used to monitor the intake of tritium and plutonium in an individual. Blood, breath, feces, sperm, and sputum are also sometimes used in bioassays.
Bioremediation	Cleanup of contaminated ground water by bacteria.
Bioturbation	Disturbance of the surface layer of the soil by worms, rodents, and so on.
Blind thrust fault	A thrust fault that does not intersect the surface of the earth; a buried thrust fault.
Bounding	An accident is bounding if no reasonably foreseeable, equally probable accident can be found with greater consequences. A bounding envelope consists of a set of individual bounding accidents that cover the range of probabilities and possible consequences.
Budgeted construction	Construction for which Congress has not yet appropriated the necessary funds but that

	appears in the proposed FY 1992 DOE budget.
Candidate species	Species being reviewed by the U.S. Fish and Wildlife Service for possible listing as endangered or threatened, but for which substantial biological information to support a listing is lacking.
Carcinogen	A substance that directly or indirectly causes cancer.
Catalytical oxidation	A ground water treatment system in which volatile compounds are destroyed by oxidation mediated by a material such as a noble metal that increases the rate of the oxidation but emerges from the process unchanged.
Centroid	A point within a traffic zone that represents the assumed focal point of the land use activity. For modeling purposes, a centroid is a point in the zone from which traffic generated by the zone can be connected to the surrounding roadway system.
CHARM™	A Gaussian puff model of atmospheric dispersion of gases.
Chromosome	One of the bodies within a cell nucleus that contains most or all of the DNA or RNA comprising the genes of the individual.
Clastic	Pertaining to a rock or sediment composed principally of broken fragments that are derived from preexisting rocks or minerals and that have been transported some distance from their places of origin.
Collective (effective) dose equivalent	The sum of the doses to all exposed groups of people times the number of individuals receiving each dose. For example, if 20 persons receive a dose of 5 rem, 10 a dose of 10 rem, and 5 a dose of 20 rem, the collective dose is (20×5)+(10×10)+(5×20)=100+100+100=300 person-rem.
Colluvium	A general term applied to loose and incoherent deposits, usually at the foot of a slope or cliff and brought there chiefly by gravity. Talus and cliff debris are included in such deposits.
Committed dose	The time integral of the dose equivalent rate for a specified time period.
Committed Effective Dose Equivalent (CEDE)	"The sum of the committed dose equivalents to various tissues in the body, each multiplied by its weighting factor. It does not include contributions from external dose. Committed dose equivalent is expressed in units of rem (or sievert)" (DOE Order 5480.11, section 8e(8)).
Community Noise Equivalent Level (CNEL)	A time-weighted 24-hour average noise level based on the A-weighted decibel. The CNEL scale includes an additional 5-dB adjustment to sounds occurring in the evening (7:00 p.m. to 10:00 p.m.) and a 10-dB adjustment to sounds occurring in the late evening and early morning hours (10:00 p.m. to 7:00 a.m.).
Confined aquifer	An aquifer bounded above and below by impermeable beds, or beds of distinctly lower permeability than that of the aquifer itself.
Conjugate fault	A fault or set of faults that are of the same age and deformation episode.
Conservative	Having consequences that are greater than the most likely consequences; using assumptions that tend to overestimate consequences, that err on the safe side.
Controlled material	Materials designated by DOE, LLNL, or SNL, Livermore for special control because they are classified, hazardous, of national interest, or of high monetary value.
Coseismic slip	A slip directly associated with a particular earthquake, as opposed to a later slip.
Criteria air pollutant	An air quality pollutant for which the EPA has established criteria documents and for which concentration standards exist. These pollutants are sulfur dioxide (SO_2), particulates, carbon monoxide (CO), ozone (O_3), hydrocarbons, nitrogen dioxide (NO_2), and lead.

Critical habitat	"Specific areas within the geographical area occupied by [an endangered or threatened] species . . . , essential to the conservation of the species and which may require special management considerations or protection; and specific areas outside the geographical area occupied by the species . . . that are essential for the conservation of the species" (Endangered Species Act section 3).
Criticality	The state of a mass of fissionable material when it is sustaining a chain reaction.
Cultural resources (historic)	Material remains, such as trash dumps and architectural features, including structures, foundations, basements, and wells; any other physical alteration of the landscape, such as ponds, roads, landscaping, and fences.
Cultural resources (prehistoric)	Any material remains of items used or modified by people, such as artifacts of stone, bone, shellfish, or wood. Animal bone, fish remains, bird bone, or shellfish remains used for food are included. Physical alteration of the landscape, such as hunting blinds, remains of structures, excavated house pits, and caches of artifacts or concentrations of stones (such as cooking stones) are also prehistoric cultural resources.
Cumulative impacts	As defined by CEQA, ". . . two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts. "(a) The individual effects may be changes resulting from a single project or a number of separate projects.
	"(b) The cumulative impact from several projects is the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time."
Curie (Ci)	A special unit of activity. One curie equals 37 billion nuclear transformations per second.
Day-night average level (LDN)	The average noise level in dBA over a 24-hour period with a 10 dB adjustment for events occurring during the night (10:00 p.m. to 7:00 a.m.), and ignoring an evening-hour adjustment.
Decibel (dB)	A unit measure of a sound pressure ratio. The reference sound pressure is 0.0002 dynes per square centimeter, or the equivalent of 200 micro-bar or 20 Pascal (Pa). This is the smallest sound a human can hear.
Decibel, A-weighted (dBA)	A frequency correction that correlates overall sound pressure levels with the frequency response of the human ear.
Decollement	A low-angle fault that forms the base of an overlapping series of thrust faults.
Decommissioning	The process of removing a facility from operation. The facility is then mothballed, entombed, or decontaminated, after which it is dismantled or converted to another use.
Decontamination	The removal of unwanted material, especially radioactive material, from the surface or from within another material.
Default parameters	Inputs to a computer code that are supplied by the code if the operator fails to supply them.
Demand criteria	Values of maximum ground acceleration that buildings should be able to withstand and remain operational.
Department of Health Services, Toxic Substances Control Program (DHS)	The state agency with responsibility for administering the California Hazardous Waste Control Law. Effective July 17, 1991 this program became the Department of Toxic Substances Control within the newly formed California Environmental Protection Agency.
Depleted uranium	Uranium from which most of the uranium-235 isotope has been removed.

Depletion of the plume	Removal of contaminants from the plume by rain or deposition on the ground.
Design basis accident	A postulated abnormal event that is used to establish the performance requirements of structures, systems, and components necessary to maintain a safe shutdown condition indefinitely, so that the general public and operating staff are not exposed to hazards in excess of appropriate guidelines.
Design capacity	The capacity at which a street, water distribution pipe, pump, reservoir, wastewater pipe, or treatment plant is intended to operate.
Deterministic	With results determined by input assumptions and data, but without the probability of occurrence.
Detonation table	*See* Firing table.
Detonators	A device used to initiate detonation in a high explosive. Typically these are much more sensitive to shock than the high explosives they initiate.
Deuterium	The hydrogen isotope that is twice the mass of ordinary hydrogen and that occurs in water; also called heavy hydrogen.
Dextral motion	Right-lateral motion on a strike-slip fault. If one stands on one side of the slip facing it, the other side is displaced to the right.
Diffusion	The process whereby particles of liquids, gases, or solids intermingle as a result of spontaneous movement caused by thermal agitation; in dissolved substances, diffusion is from a region of higher to a region of lower concentration.
Dip	The angle at which a stratum or other planar feature is inclined from the horizontal.
Disconformity	An unconformity in which the bedding planes above and below the break are essentially parallel, indicating a significant interruption in the orderly sequence of sedimentary rocks, generally by a considerable interval of erosion (or sometimes of nondeposition), and usually marked by a visible and irregular or uneven erosion surface of appreciable relief. (An unconformity is a substantial break or gap in the geologic record where one rock unit is overlaid by another not next in the stratigraphic succession.)
DOE Orders	Rules indicating the procedures and responsibilities of the various units of DOE. DOE orders give details on how overall federal rules and regulations apply to DOE operations and indicate who shares responsibilities for administering them.
Doppler	Relating to the change in frequency with which radar or sound waves from a given source reach an observer when they are in rapid motion with respect to each other. Doppler radars measure velocity, not range and distance.
Dose	A general term denoting the quantity of radiation or energy absorbed. For special purposes, it must be appropriately qualified.
Dose equivalent	"The product of absorbed dose in rads (or gray) in tissue, a quality factor, and other modifying factors. Dose equivalent is expressed in units of rem (or sievert)" (DOE Order 5480.11, section 83(2)). The relative biological effectiveness of different kinds of radiation is expressed in the quality factor. (Note: The International Commission on Radiological Protection (ICRP) now uses the term *radiation weighting factor* to replace the term *quality factor*.)
Dosimeter	An instrument or device used to detect and measure accumulated radiation exposure.
Edaphic characteristics	Soil factors.
	The dose equivalent from irradiation of an organ or part of the whole body that bears the

Effective Dose Equivalent (EDE)	same risk of cancer as uniform irradiation of the whole body. "The sum over specified tissues of the products of the dose equivalent in a tissue and the weighting factor for that tissue. The effective dose equivalent is expressed in units of rem (or sievert)" (DOE Order 5480.11, section 8e(5)). *(Note: The International Commission on Radiological Protection (ICRP) decided in ICRP Publication 60 to use the term* effective dose *to replace the term* effective dose equivalent.)
Emergency Response Planning Guidelines	Estimates of concentration ranges at which adverse effects can be expected if exposure to a specific chemical lasts more than 1 hour.
En echelon	Parallel structural features that are offset like the edges of shingles on a roof when viewed from the side.
Endangered species	Species of plants and animals that are threatened with either extinction or serious depletion in their range and that are formally listed as such by the U.S. Fish and Wildlife Service.
Engineered barrier	In the context of a high-level waste repository, a barrier to release of radioactivity made by man, such as a corrosion- resistant container.
Enriched uranium	Uranium enriched in the fissile nuclide U-235.
Epicenter	The point on the earth's surface directly over the point at which earthquake motion starts.
Equivalent noise level (Leq)	A single-number representation of the fluctuating sound level in decibels over a specified period of time. It is an average of the fluctuating level of sound energy.
Ergonomic factors	Environmental stresses such as repetitive motion and mental or physical fatigue that can create health concerns when uncontrolled. Ergonomics is also known as human engineering.
Eutrophic	Rich in dissolved nutrients.
Evapotranspiration	Loss of soil water by evaporation and transpiration.
Explosives	*See* High explosives.
Exponential notation	A means of expressing large or small numbers in powers of ten. For instance, 4.3×10^{6} = 4,300,000 and 4.3×10^{-5} = 0.000043. This relationship is also sometimes expressed in the form $4.3E^{+6}$ = 4,300,000, and $4.3E^{-5}$ = 0.000043.
Exposure assessment	The determination of the magnitude, frequency, duration, and route of exposure.
External exposure	Radiation exposure from sources outside the body: cloud passage, material deposited on the ground, and nearby surfaces.
Facultative plant species Facultative-upland plant species Facultative-wet plant species Fault	Species that are equally likely to occur in wetlands and nonwetlands. Species that occur in nonwetlands 67 to 99 percent of the time. Species that occur in wetlands 67 to 99 percent of the time. A fracture in the earth's crust accompanied by displacement of one side of the fracture with respect to the other and in a direction parallel to the fracture.
Fault creep	Slow ground displacement usually occurring without accompanying earthquakes. It may be of tectonic origin or result from oil or groundwater withdrawal.
Fault plane solution	A determination of the underground plane on which a slip occurs in an earthquake; a determination of the focal plane. The distribution of first-motion compressional and dilatational waves from an earthquake calculated from many seismological stations.
Fault zone	The region of rock failure along a fault.
Feral FHWA Highway Noise Model	Escaped from domestication and became wild. A highway noise prediction model developed for the Federal Highway Administration. Model input data include average daily traffic levels; day/night percentages of autos and medium and heavy trucks; vehicle speeds;

	ground attenuation factors; and roadway widths (FHWA-RD-77-108, December 1978).
Firing table	A table placed on a gravel or concrete pad on which experiments with explosives are set up and, when ready, fired. The term is also used to refer to the pad on which the test is conducted.
Fissile	Capable of being fissioned by slow neutrons. The principal fissile isotopes are U-233, U-235, and Pu-239.
Fission	The splitting of a heavy atomic nucleus into two nuclei of lighter elements, accompanied by the release of energy and generally one or more neutrons. Fission can occur spontaneously or be induced by neutron bombardment.
Flash x-ray	An x-ray apparatus that emits short pulses of x rays useful for examining the behavior of rapidly changing mechanical systems.
Floodplain	The valley floor adjacent to the incised channel of a stream, which may be inundated during high water.
Focal depth	The depth from the earth's surface to the point of initial rupture of an earthquake.
Focal plane	The plane on which the initial rupture of an earthquake occurs.
Fold	A bend in strata or any other planar structure.
Forbs	Herbs other than grasses.
Frequency	Number of complete oscillation cycles per unit of time. The unit of frequency is the hertz (Hz).
Fuel-grade plutonium	Plutonium-239 with enough admixture of other plutonium isotopes (such as plutonium-240) that it cannot be used in weapons although it can be used in reactors.
Funded construction	Construction for which Congress has already appropriated the necessary funds.
Fusion	The energy-releasing process in which atoms of very light elements such as deuterium and tritium combine to produce heavier elements.
g notation	Accelerations measured relative to the acceleration of gravity at the earth's surface. Thus, 0.1g = 3.2 ft/sec^2 or 98.3 cm/sec^2.
Gamma radiation	Shortwave-length electromagnetic radiation emitted from the nucleus with typical energies ranging from 10 keV to 9 MeV. Individual gammas considered as particles are also called photons.
Gamma spectroscopy	Analysis of the radionuclides in a sample by measurement of the intensities of the various gammas given off.
Gaussian plume	A plume of contaminants is said to be Gaussian when the contaminant concentrations are greatest at the centerline and decrease to either side as exp[-(x/s)2/2], where x is the distance from the centerline and s is the distance to the point where the concentration is down to 37 percent of the centerline concentration. *See* Standard deviation.
General Plan	A compendium of city or county policies regarding long-term development in the form of maps and accompanying text. The General Plan is a legal document required of each local agency by California Government Code section 65301 and adopted by the City Council or Board of Supervisors. The General Plan may also be called "City Plan," "Comprehensive Plan," or "Master Plan."
Geodetic	Of, relating to, or determined by geodesy, which is a branch of applied mathematics that determines the exact positions of points and the figures and areas of large portions of the earth's surface, the shape and size of the earth, and the variations of terrestrial gravity and magnetism.

Geologic ages	The ages of rocks, formations, and so on. The present age is the Holocene or Recent Age.
Geometric center	A centroid is located in the geometric center of a zone, which is another way of describing the focal point of land use activity. Locating the geometric center is important because the model assigns proportionally more traffic to that part of the surrounding roadway system. As such, the location tends to be a compromise between the point in the zone where activity is most dense and the need to place the centroid closer to the section of the roadway system where the most traffic use is expected. (Traffic may not use the nearest main roadway section if it does not lie along the direction of travel.)
Geometrics	In traffic studies, the features of roadway design, roadway alignment, grade, cross-section, access control, intersections, and interchanges.
Glovebox	A sealed box in which workers, while remaining outside and using gloves attached to and passing through openings in the box, can safely handle and work with radioactive materials, other hazardous materials, and nonhazardous air-sensitive compounds.
Gray Gross alpha	A unit of absorbed dose equal to 100 rad. The concentration of all alpha-emitting radionuclides in a sample.
Gross beta	The concentration of all beta-emitting radionuclides in a sample.
Gross gamma	The concentration of all gamma-emitting radionuclides in a sample.
Ground acceleration	The intensity of the strong phase of ground shaking in units of g (earth's gravitational attraction).
Half-life, Biological	The time required for the body to eliminate one-half of an administered dosage of any substance by regular processes of elimination.
Half-life, Ecological	The time required for removal of one-half of the amount of a material deposited in the local environment
Half-life, Radioactive	Time required for a radioactive substance to lose 50 percent of its activity by decay.
Hazard Index (HI)	The ratio between the intake of a chemical and an acceptable health-based reference level. A hazard index of less than 1 indicates a safe level of intake.
Hazardous waste	Any solid, semisolid, liquid, or gaseous waste that is ignitable, corrosive, toxic, or reactive as defined by RCRA and identified or listed in 40 C.F.R. part 261.
Health-conservative scenario	Refers to a scenario in which the highest possible source parameters are used to predict the highest offsite concentrations. Also called the worst-case scenario.
Health physics	The science and practice of radiation protection and management.
HEPA (High Efficiency Particulate Air) filter	Filter material that captures entrained particles from an air stream, usually with efficiencies in the range of 99.95 percent and above for particle sizes of 0.3 micron. Filter material is usually a paper or fiber sheet that is pleated to increase its surface area.
High explosives (HE)	Chemically energetic materials with the potential to react explosively; nuclear explosives are not included.
High-level waste (HLW)	Radioactive waste resulting from the reprocessing of spent nuclear fuel. Discarded, unreprocessed spent fuel is also high-level waste. It is characterized by intense penetrating radiation and by high heat-generation rates.
Hispanic era	The period in California history from the arrival of the Spanish missions in central California, circa 1776, to the start of the Gold Rush era in 1849.
Historic resources	The sites, districts, structures, and objects considered limited and nonrenewable because of their association with historic events or persons, or social or historic movements.

Holocene	A standard epoch of geological time, from 10,000 years ago until the present.
Hood	An enclosure or canopy provided with a draft to carry off toxic or otherwise noxious vapors.
Hotline	The line of maximum intensity in a downwind radiation pattern.
Human genome	A set of chromosomes with the genes they contain.
Hydraulic head	Ground water pressure, measured as the height of a column of fresh water in equilibrium with the water.
Hydric soils	Soils that are saturated, flooded, or ponded long enough (7 days or longer) during the growing season to develop anaerobic conditions in their upper layer.
Hydrodynamic testing	Testing the properties of solid materials or the behavior of components made of such materials by subjecting them to strong shock from explosives or high-velocity impact.
Hydrograph, rainfall	A graph of water level versus time.
Hydrophytic vegetation	Vegetation that grows in water, soil, or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content.
Hyetograph	A graph of rainfall versus time.
Immediately-Dangerous-to-Life-or-Health (IDLH)	Immediately dangerous to life or health concentrations (IDLHs) represent the maximum concentration from which, in the event of respirator failure, one could escape within 30 minutes without a respirator and without experiencing any escape-impairing (e.g., severe eye irritation) or irreversible health effects.
Impact	The effect, influence, or imprint of an activity on the environment. Impacts include direct or primary effects, which are caused by the project and occur at the same time and place, and indirect or secondary effects, which are caused by the project and are later in time or farther removed in distance, but still reasonably foreseeable. Indirect or secondary effects may include growth-inducing and other effects related to induced changes in the pattern of land use, population density, or growth rate, and related effects on air and water and other natural systems, including ecosystems.
Infrastructure	Utilities and other physical support systems needed to operate a laboratory or test facility. Included are electric distribution systems, water supply systems, sewage disposal systems, roads, and so on.
Internal exposure	Radiation exposure from sources inside the body: from materials ingested, inhaled, or (in the case of tritium) absorbed through the skin.
Intersection Capacity Utilization method	In traffic studies, a method for analyzing intersection operating conditions by calculating a volume-to-capacity (V/C) ratio for each governing "critical" movement during a traffic signal phase. The V/C ratio for each phase is summed with the others at the intersection to produce an overall V/C ratio for the intersection as a whole. The V/C ratio represents the percentage of intersection capacity utilized. For example, a V/C ratio of 0.85 indicates that 85 percent of the capacity is being used.
Inventory	The amount of a radioactive or hazardous material present in a building or laboratory.
Isoconcentration map	A map showing contours of equal concentration of the contaminant.
Isotopic uranium analysis	Determination of the relative amounts of uranium present by gamma spectroscopy.
Jurassic	A standard period of geologic time, from about 181 million to 135 million years ago.
Kit fox biologist	*See* Trained kit fox biologist.
	Laboratories characterized by high-bay construction, overhead cranes, and, in some cases,

Laboratories, heavy	shielding. Heavy laboratories are typically used for large research apparatus or large mechanical test equipment.
Laboratories, light	Laboratories characterized by small equipment and apparatus. Light laboratories are typically used for direct bench-scale research.
Lagomorphs	Rabbits, conies, and hares.
Land use	The purpose or activity for which a piece of land or its buildings is designed, arranged, or intended, or for which it is occupied or maintained.
Left-lateral motion	On a strike-slip fault, if one stands on one side of the slip facing it, the other side is displaced to the left.
Level of Service (LOS)	In traffic studies, the different operating conditions that occur in a lane or roadway when accommodating various traffic volumes. A qualitative measure of the effect of traffic flow factors such as special travel time, interruptions, freedom to maneuver, driver comfort, convenience, and (indirectly) safety and operating cost. In this study, levels of service are described by a letter rating system of A through F, with LOS A indicating stable traffic flow with little or no delays and LOS F indicating excessive delays and jammed traffic conditions.
Liquefaction	A type of soil failure in which a mass of saturated soil is transformed from a solid to a liquid state.
Lithic scatter	Concentrations of stone once used for the manufacture of artifacts. The stone includes finished artifacts, roughly formed artifacts, the cores of the stone from which they were made, and the waste flakes from the manufacturing process.
Livermore Atmospheric Propagation Model (LAP)	A computer code developed by LLNL to compute the trajectories of rays (waves) that radiate from a point source following a detonation. The code includes the weather conditions both at the source and downstream.
Low-level waste (LLW)	Waste that contains radioactivity and is not classified as high-level waste, transuranic waste, or spent nuclear fuel or byproduct material.
Low specific activity	"'Low Specific Activity material (LSA)' means any of the following: "(1) Uranium or thorium ores and physical or chemical concentrates of those ores. "(2) Unirradiated natural or depleted uranium or unirradiated natural thorium. "(3) Tritium oxide in aqueous solutions provided the concentration does not exceed 5.0 millicuries per milliliter. "(4) Material in which the radioactivity is essentially uniformly distributed and in which the estimated average concentration of contents does not exceed: "(i) 0.0001 millicurie per gram of radionuclides for which the A2 quantity* is not more than .05 curie; "(ii) 0.005 millicurie per gram of radionuclides for which the A2 quantity* is more than .05 curie, but not more than 1 curie; or "(iii) 0.3 millicurie per gram of radionuclides for which the A2 quantity* is more than 1 curie. "(5) Objects of nonradioactive materials externally contaminated with radioactive material, provided that the radioactive material is not readily dispersible and the surface contamination, when averaged over an area of 1 square meter, does not exceed 0.0001 millicurie (220,000 disintegrations per minute) per square centimeter of radionuclides for which the A2 quantity* is not more than .05 curie, or 0.001 millicurie (2,200,000 disintegrations per minute) per square centimeter for other radionuclides" (49 C.F.R. section 173.403(n)). * "`A2 quantities' are the maximum activities of radioactive material permitted in the package being transported. These quantities are listed in 49 C.F.R. 173.435; they depend on the isotopes included(49 C.F.R. 173)."
Machine count	A traffic count made using an automatic counting machine that tallies vehicles as they pass over a pressurized hose laid across a vehicle path.
Magazine	An approved structure designed for the storage of explosives, excluding operating buildings.

Magnitude	A measure of the strength of an earthquake or the strain energy released by it; the logarithm of the amplitude of motion recorded on a seismograph.
Major emergency	To the fire department, an emergency requiring more than a one-company response. Such situations include big fires, medical emergencies with multiple casualties, and other special situations.
Maximum credible accident	An accident that has the greatest offsite consequence from hazardous material release and that has a frequency of occurrence greater than 10-6 per year, when credit for mitigation is allowed. Such an accident is one of the set of reasonably foreseeable accidents.
Melanoma	A skin cancer characterized by black pigmentation, given to metastasis.
Metamorphic rock	Any rock derived from preexisting rocks by mineralogical, chemical, and/or structural changes, essentially in the solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment, generally at depth in the earth's crust.
MeV	A unit of energy equal to 1.6×10^{-6} ergs or 1.6×10^{-13} joules. Short for "million electron volts," an electron volt being the energy acquired by an electron when it is accelerated through a potential drop of one volt.
Microearthquakes	Very small earthquakes that can only be detected by seismometers.
Microseismicity	Weak seismic signals in an earthquake region that are too small to notice but that indicate continued slow slip.
Midden	Characteristic soils containing cultural resources and other evidence of use of an area, such as the decomposed organic remains of vegetal foods, animals, and evidence of fires (e.g., ash, carbon, charcoal). Because of the organic content, midden soils tend to differ from surrounding soils in texture and color.
Miocene	A standard epoch of geologic time between the Pliocene and Oligocene, from about 28 million to 5.3 million years ago.
Misfire	Failure of an explosive to detonate (completely) when the firing signal is given. Also called a hang-fire.
Mitigation	NEPA and CEQA define mitigation identically: "'Mitigation' includes: "(a) Avoiding the impact altogether by not taking a certain action or parts of an action. "(b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation. "(c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment. "(d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action. "(e) Compensating for the impact by replacing or providing substitute resources or environments" (40 C.F.R. 1508.20; CEQA Guidelines 15370). NEPA also says regarding alternatives: ". . . Include appropriate mitigation measures not already included in the proposed action or alternatives" (40 C.F.R. 1502.14(f)).
Mitigation measure	An action taken to reduce or eliminate environmental impacts. Mitigation includes avoiding the impact altogether by not taking a certain action or parts of an action; minimizing impacts by limiting the degree or magnitude of the action and its implementation; rectifying the impact by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by preservation and maintenance during the life of the action; and compensating for the impact by replacing or providing substitute resources or environments.
Mixed fission products	The ensemble of fission products resulting from the fission of a heavy element such as uranium. *See* Fission.
Mixed waste	Radioactive waste also containing RCRA-designated hazardous constituents.

ML	Local magnitude. Logarithm of the maximum amplitude of ground motion from an earthquake measured on a seismogram at a distance of 100 km from the epicenter.
Mode choice	A choice of means of travel (e.g., car, public transit, walking, cycling).
Modified Mercalli Scale	An earthquake intensity scale, with 12 divisions ranging from I (not felt by people) to XII (damage nearly total).
mrem, millirem	1/1000 rem.
MS	Surface-wave magnitude; magnitude determined from measurements of the amplitude of seismic surface waves.
Mutagen	A substance that causes genetic or inheritable defects.
National Register of Historic Places	A register of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, engineering, and culture. It is in the Department of the Interior and was established pursuant to the National Historic Preservation Act of 1966, as amended (16 U.S.C. section 470a).
Natural uranium	Uranium as it occurs in nature. The natural substance is 99.28 percent uranium-238, 0.72 percent uranium-235, and 0.0055 percent uranium-234. Only the uranium-235 isotope is fissionable by slow neutrons.
Negligible individual risk level	A level of average excess risk of fatal health effects attributed to irradiation below which further effort to reduce radiation exposure is unwarranted. The value recommended by the National Council on Radiation Protection (NCRP) is 1 mrem.
Network building	In traffic studies, redrawing the roadway system in a format that can be understood by the model program. The extent of the network developed to accurately study an area must take into account traffic expected to be generated locally and from the surrounding region. A network looks like a simplified and stylized version of a roadway map, with a series of straight lines (links) used instead of curves. Links are coded with data such as their distance, speed of travel, roadway capacity, and number of travel lanes.
Noble gas	In this EIS/EIR, neon, argon, krypton, or xenon. With rare exceptions, these gases do not enter into chemical reactions.
Noncriteria air pollutants	Air pollutants other than criteria air pollutants. Pollutants for which the EPA has not yet produced criteria documents. Only initial limits have been established for these.
Nonionizing radiation	Electromagnetic radiation of wavelengths greater than 10-7 m (1000Å), such as laser, thermal, or radio-frequency radiation.
Normal fault	A fault in which the block above appears to have moved downward relative to the block below.
Obligate plant species	Species that occur in wetlands most of the time (99 percent) .
Open space	Any area of land or body of water set aside and left essentially unimproved that is dedicated, designated, or reserved for public or private use or enjoyment, or for the use and enjoyment of owners and occupants of land adjoining or neighboring such open space.
Oralloy	Enriched uranium.
Order of magnitude	A factor of ten. When a measurement is made with a result such as 3×107, the exponent of 10 (here 7) is the order of magnitude of that measurement. To say that this result is known to within an order of magnitude is to say that the true value lies (in this example) between 3×10^6 and 3×10^8.
Overpressure	In a blast wave, the pressure above ambient. The pressure in the wave rises sharply to the peak overpressure, then falls more slowly to and below ambient.

Packaging	In the NRC regulations governing the transportation of radioactive materials (10 C.F.R. part 71), the term "packaging" is used to mean the shipping container together with its radioactive contents.
Paleontological resources	Fossils.
Paleosol	A buried soil; a soil of the past.
Path building	The development of travel paths for traffic. The model determines the minimum impedance path from a selected origin to its destination. This would depend on the variables related to the various possible routes, such as distance and travel time or speed.
Perched aquifer	An aquifer containing unconfined ground water separated from an underlying main body of ground water by an unsaturated zone.
Permissible Exposure Limit (PEL)	Occupational exposure limits endorsed by OSHA. May be for short term or 8-hour duration exposure.
Person-rem	A unit of collective dose.
Petroglyph	Art that was carved or inscribed into bedrock by historic or prehistoric people.
pH	The negative logarithm of the concentration of hydrogen ions in a liquid measured in gram equivalents per liter. A pH of 7 is neutral; smaller numbers indicate an acid condition, larger ones a basic condition.
Phenologic period	Period during the year when characteristic activities take place, such as (for vegetation) flowering and fruiting.
Piercing point	A point at which an underlying structure penetrates to the earth's surface.
Plasma	A cloud of charged particles containing about equal numbers of positive ions and electrons and exhibiting some properties of a gas but differing from a gas in being a good conductor of electricity and being affected by magnetic fields.
Plate tectonics	A theory of global-scale dynamics involving the movement of rigid plates of the earth's crust.
Pleistocene	A standard epoch of geological time, from about 1.6 million to 10,000 years ago.
Pliocene	A standard epoch of geological time, from about 5.3 million to 1.6 million years ago.
Plunge	The inclination of a linear geologic structure measured as the angle it makes with the horizontal.
Plutonium	An artificial fissile metal of atomic number 94.
Plutonium-239–equivalent activity	A radioactive hazard index factor that relates the radiotoxicity of transuranic nuclides to that of plutonium-239.
Population exposure	The collective radiation dose received by a population group. *See* Collective dose equivalent.
ppb	Parts per billion; equivalent to mg/kg when referring to contaminant concentrations in soils; equivalent to mg/L when referring to contaminant levels in ground water.
ppm	Parts per million.
Prehistoric resources	*See* Cultural resources (prehistoric).
Primary and secondary containment	Primary containment is that set of engineered safety features immediately around a radioactive or hazardous material designed to prevent its release; secondary containment is the set of backup features outside the primary containment.

Probabilistic	With results taking into account the probability of occurrence. Probabilistic calculations sometimes combine the results of several deterministic calculations, weighting their results by their probabilities. *See* Deterministic.
Programmatic EIS	An EIS that, when complete, will examine a nationwide issue. The two that are related to the present decisions are the Programmatic Environmental Impact Statement for the Integrated Restoration and Waste Management Program (55 FR 42633, October 22, 1990) and the Programmatic Environmental Impact Statement for Reconfiguration of DOE Nuclear Weapons Complex (56 FR 5590, February 11, 1991).
Prompt radiation	Gamma or neutron radiation emitted during the fission process is said to be prompt (within microseconds) or delayed (as much as seconds).
Protective (Preventive) Action Guide	FDA-recommended levels of radiation exposure above which actions should be taken to prevent or reduce the radioactive contamination of human food or animal feeds.
Pyrotechnic material	A combustible substance such as gunpowder that gives off a display of sparks when burning.
Quaternary	The period of geologic time since the end of the Pliocene, comprising the Pleistocene and Holocene, from about 1.6 million years ago to the present.
Rad	A unit of absorbed dose equal to 100 erg/g. The equivalent 51 unit is the gray, abbreviated Gy; 1 Gy=100 rad.
Radiation source	In context, a small sealed source of ionizing radiation. Sealed sources are generally used to supply a material that has a known radiation intensity or a specific type of radiation and are not easily dispersed or altered chemically under normal use.
Radioactive material	Any material having a specific activity greater than 0.002 microcuries per gram, as defined by 49 C.F.R. part 173.4-3(y).
Radioactive waste	Material that contains radionuclides regulated under the Atomic Energy Act of 1954, as amended, and is of negligible economic value given the cost of recovery.
Radioactivity	The properties that certain nuclides have of spontaneously emitting particles, gamma radiation, or x radiation.
Radionuclide	An unstable nuclide of an element that decays or disintegrates spontaneously, emitting radiation.
Radius of impact	The distance to which a specified peak overpressure will extend. In this EIS/EIR, the level at which it is calculated is 1 psi.
RADTRAN	An NRC-approved code for estimating the radiological impacts of transportation of radioactive materials.
Ray-trajectory method	A method of following the propagation of individual acoustic rays through the atmosphere as they are refracted by changes in sound speed with height above the ground.
RCRA Part B permit	A permit issued by the EPA under the Resource Conservation and Recovery Act that would have allowed LLNL to operate landfills at LLNL Site 300 for the disposal of debris from high explosives tests.
Reasonably foreseeable	An accident whose impacts "have catastrophic accident consequences, even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason" (10 C.F.R. part 1502.22(b)(4)).
Refraction	The change in direction of propagation of a sound upon passage into a medium with different sound speed.

Relative risk	An expression of excess risk based on the assumption that the excess risk from radiation exposure depends on the underlying natural risk.
Release fraction	The fraction of the amount of a substance present that is released in an accident.
Relevé	A descriptive technique for sampling vegetation.
Rem	The special unit of dose equivalent that expresses the effective dose calculated for all radiation on a common scale. It is the absorbed dose in rads multiplied by certain modifying factors (e.g., the quality factor). The equivalent SI unit is the sievert, abbreviated Sv; 1 Sv=100 rem.
Reserve capacity	The unused capacity of a vehicle travel lane. The number of additional vehicles that could make a particular turning movement before that movement reaches capacity.
Response spectra	Spectral content of earthquake accelerations for specified peak accelerations and damping factors.
Resuspension	The process by which material deposited on the ground is again made airborne, such as by wind or vehicle disturbance.
Retention tanks	Tanks in which liquid wastes and other effluents are held pending determination of what, if any, treatment they require before disposal.
Reserve capacity	The unused capacity of a vehicle travel lane. The number of additional vehicles that could make a particular turning movement before that movement reaches capacity.
Reverse fault	A fault dipping steeper than 45·, in which the block above appears to have moved upward relative to the block below.
Right-lateral motion	On a strike-slip fault, if one stands on one side of the slip facing it, the other side is displaced to the right.
Riparian	Located along the banks of streams, rivers, lakes, and other bodies of water.
Risk assessment or analysis	Integration of the toxicity and exposure assessment into qualitative and quantitative expressions of risk.
Risk estimator	A number used to convert the measured or calculated effective dose equivalent to estimates of latent fatal cancers that can be attributed to the exposure.
Rock shelter	An opening in exposed rock of sufficient size to allow people to be sheltered from the weather. Used by both historic and prehistoric people, rock shelters contain midden deposits, grinding holes, evidence of fires, artifacts, and sometimes artwork carved or inscribed onto the walls of the shelters.
Run card	A fire department folder that contains information on a building that would be useful on a call, such as a response plan, building layout, location and nature of special hazards, and names of key people.
Satellite waste accumulation area	The initial point of waste accumulation at waste-generating facilities. Waste is held here for later transfer to the waste management organization.
Saturated zone	The zone of soil and rock below the water table.
Scat	Animal droppings, feces.
Scenario	A particular chain of hypothetical circumstances that could, in principle, release radioactivity or hazardous chemicals from a storage and handling site, or during a transportation accident.
Screening-level assessment	An assessment of potential health effects used to determine relative risks of various procedures and/or hazards.

Sealed source	In context, a small source of ionizing radiation. Sealed sources are generally used to supply a material that has a known radiation intensity or a specific type of radiation and are not easily dispersed or altered chemically under normal use.
Section 106 process	A process under the National Historic Preservation Act for identifying, evaluating, and nominating historic properties for inclusion in the National Register.
Sedimentary rock	A rock resulting from the consolidation of loose sediment that has accumulated in layers.
Seeps	A spot where water or petroleum oozes from the earth, often forming the source of a small trickling stream.
Seiche	A wave oscillation of the surface of water in an enclosed basin (such as lake or bay) initiated by an earthquake or changes in atmospheric pressure.
Seismogenic source	A fault capable of producing earthquakes.
Shear	Force or motion tangential to the section on which it acts.
Sievert (Sv)	A unit of dose equivalent equal to 100 rem.
Significant effect	As defined by CEQA, a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project, including land, air, water, minerals, flora, fauna, ambient noise, and objects of historic or aesthetic significance. An economic or social change by itself shall not be considered a significant effect on the environment. A social or economic change related to physical change may be considered in determining whether the physical change is significant.
Sitewide EIS	An EIS that examines the environmental impacts of the operation of a complete site, not just of a particular activity within it.
Slickensides	A smoothly striated surface that results from friction along a fault plane.
Slip	To move or displace; a movement dislocating adjacent blocks of crust separated by a fault.
Sludge	Precipitated solid matter produced by water and sewage treatment processes. In the context of this EIS/EIR, also the moist precipitate resulting from the dewatering of hazardous waste.
Solid waste	Any nonhazardous garbage, refuse, or sludge that is primarily solid; but may also include liquid, semisolid, or contained gaseous material resulting from residential, industrial, commercial, agricultural, or mining operations, and community activities.
Sound level	The quantity in decibels measured by a sound level meter satisfying requirements of the American National Standard Specifications for Sound Level Meters SI.4-1971. Sound level is the frequency-weighted sound pressure level obtained with the standardized dynamic characteristic "fast" or "slow" and weighting A or C.
Sound pressure level (SPL)	The level of the A-weighted sound pressure referenced to 20 level micropascal (for air).
Source term	In a calculation of contaminant dispersion, the amount of that contaminant assumed available to be dispersed.
Special Isotope Separation (SIS)	At LLNL, the process of Atomic Vapor Laser Isotope Separation applied to plutonium.
Special nuclear material	Plutonium, uranium enriched in the isotope U-233 or in the isotope U-235, and any other material that, pursuant to the provisions of section 51 of the Atomic Energy Act of 1954, as amended, has been determined to be special nuclear material, but does not include source material, or any other material enriched by any of the foregoing.
Specific activity	The amount of radioactivity per unit volume or mass.

Splays	Divergent small faults that comprise a fault zone.
Standard deviation	A description used in statistical theory for the average variation of a random quantity. The root-mean-square deviation from an average value.
Standard of significance	The limit of acceptable performance of the traffic network. Exceeding this limit would constitute a significant adverse effect in terms of traffic conditions.
Strata	Plural of stratum which is a single sedimentary bed or layer.
Stratigraphic offset	Displacement of a formerly continuous stratigraphic horizon.
Strike (of a stratum or fault)	The direction of the line of intersection of a horizontal plan with an uptilted geologic stratum or fault plane.
Strike-slip fault	A fault in which the net slip is horizontal, parallel to the strike of the fault.
Surface faulting	As opposed to a thrust fault, a fault that does intersect the surface of the earth; the displacement of ground along the surface trace of a fault.
Syncline	A fold in rocks in which the strata dip inward from both sides of the axis, where the youngest strata are in the core of the fold.
Taxon (pl: taxa)	The name applied to a plant or animal group in a formal system of nomenclature.
Terraces	Relatively horizontal or gently inclined surfaces or deposit sometimes long and narrow, which are bounded by a steeper ascending slope on one side and by a steeper descending slope on the opposite side.
Tertiary	The period of geologic time between the Cretaceous and the Pleistocene, comprising the Pliocene, Miocene, Oligocene, Eocene, and Paleocene, from about 65 million to 1.6 million years ago.
Thermoluminescent detector (TLD)	A dosimeter that operates on the principle that energy absorbed from ionizing radiation raises the molecules of the detector material to a metastable state until they are heated to a temperature high enough to cause the material to return to its normal state accompanied by the emission of light. The amount of light emitted is proportional to the energy absorbed.
Thermonuclear	Related to the fusion process.
Threatened species	A species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
Threshold limit concentration, total or soluble (TTLC or STLC)	California standards for determining whether a waste is hazardous. A solid waste is considered hazardous if any of the extractable concentrations of its toxic constituents (in mg/L) equals or exceeds the STLS and/or any of the total concentrations of its toxic components equals or exceeds the TTLC. The so-called Waste Extraction Test is used to determine extractable concentrations. A liquid waste is hazardous if any of the total concentrations of its toxic constituents exceeds the STLC.
Threshold Limit Values/Time-Weighted Average (TLV/TWA)	Guidelines or recommendations that refer to airborne concentrations of potentially hazardous substances. A time-weighted average TLV is an average for a normal 8-hour workday or 40-hour workweek, to which all workers may be repeatedly exposed, day after day, without adverse effect.
Threshold of feeling	The intensity of a 120-dB sound produces a tickling sensation to human ears. This level of sound is called the threshold of feeling.
Threshold of pain	As the noise level is increased from the threshold of feeling, the tickling sensation gives way to one of pain at about 140 dB, and this level is called the threshold of pain.
Thrust fault	A fault dipping less than 45·, in which the block above appears to have moved upward relative to the block below.

Tiger Team	A team set up by the Secretary of Energy in 1989 to assess the environment, safety, and health operations at all DOE facilities to determine whether changes were needed to improve the protection of the environment, safety, and health.
Tonal contrast	A contrast in color value or hue in a photograph. Often referred to a change or contrast in color along a linear trend in aerial photographs of the earth's surface, suggesting the presence of a fault or structural boundary.
Total detriment	The total number of deleterious effects (fatal and nonfatal cancers, severe hereditary effects, other deleterious effects, and the associated morbidity) that would eventually be experienced by persons exposed to ionizing radiation and by their descendants.
Toxicity assessment	Identification of the types of adverse health effects associated with exposures and the relationship between the magnitude of the exposure and of the adverse effects.
Trace	A line on one plane representing the intersection of another plane with the first one (e.g., a fault trace).
Trained kit fox biologist	A trained kit fox biologist must have at least 4 years of college or university training in wildlife biology or a related field, and have demonstrated field expertise in the identification and life history of the San Joaquin kit fox.
Transect	A sample area (as of vegetation), usually in the form of a long continuous strip.
Transuranic (TRU) waste	Waste containing 100 nCi/g or more of alpha-emitting isotopes of elements above uranium in the periodic table with half-lives of over 20 years.
Trend (of a fault)	If the fault intersects the surface, the general direction of that intersection.
Trinomial designation	A numeric site designation assigned by the regional offices of the State Historic Preservation Office for recording a prehistoric or historic site.
Trip assignment	The allocation of vehicle trip ends to available routes between locations in a traffic study area.
Trip distribution	The allocation of vehicle trip ends to available routes between locations in a traffic study area.
Trip generation	The number of vehicle trip ends associated with (produced by) a particular land use of a traffic study site.
Trip matrix adjustment	This process factors the person trips generated to vehicle trips. The vehicle occupancy factor is typically 1.5.
Trip matrix balancing	This process converts a production-attraction matrix to an origin-destination trip table.
Tritiated water	Water in which one of the hydrogen atoms has been replaced by a tritium atom; sometimes shown as HTO.
Tritium	A radioactive isotope of the element hydrogen, with two neutrons and one proton in its nucleus. Common symbols for the isotope are, 3H, and T.
TRU	*See* Transuranic waste.
TRUPACT-II	The package designed to transport contact-handled transuranic waste to the WIPP site. (TRUPACT=Transuranic Package Transporter)
Tuff	A rock formed of compacted volcanic fragments, generally smaller than 4mm in diameter.
Type A packaging	"A packaging designed to retain the integrity of containment and shielding . . . under normal conditions of transport as demonstrated by" a water spray test, a free-drop test, a compression test, and a penetration test (40 C.F.R. parts 173.403(gg), 173.465).
	An NRC-certified container that must be used for the transport of transuranic waste

Type B packaging	containing more than 20 curies of plutonium per package. Type B packaging must be able to withstand both normal and accident conditions without releasing its radioactive contents. These containers are tested under severe, hypothetical-accident conditions that demonstrate resistance to impact, puncture, fire, and submersion in water (49 C.F.R. part 173).
U-AVLIS	At LLNL, the process of Atomic Vapor Laser Isotope Separation applied to uranium.
Uranium	*See* Natural uranium.
Uranium hydride	A bed of the porous form of the material used to transport and store tritium.
Vacuum-induced stripping or venting	A ground water treatment system in which a vacuum soil draws off volatile organic contaminants for treatment and/or disposal.
Vadose zone	The zone of unsaturated material in soil or rock above the water table.
Valley fever (coccidioidomyocosis)	A fungal disease of the lungs endemic to the southwest United States characterized in severe cases by high fever and extreme fatigue.
Vascular plants	Plants characterized by channels or ducts for the transfer of sap upward from the roots to their above-ground growing portions.
V/C ratio	Volume-to-capacity ratio.
Vehicle trip ends	A single or one-directional vehicle movement with either the origin or destination inside a traffic study site.
Vernal pool	A wetland created from standing water, typically in the spring, hence its name.
View corridor	A long, axial vista formed by regularly placed buildings or landscaping.
Viewpoint	A location from which a site is visible.
Viewshed	The geographic area from which a site is visible; a collection of viewpoints.
Volatile organic compound (VOC)	A compound containing carbon and hydrogen in combination with any other element that has a vapor pressure of 1.5 psi absolute (77.6 mm Hg) or greater under storage conditions.
Volcanic rock	A generally finely crystalline or glassy igneous rock resulting from volcanic action at or near the Earth's surface, either ejected explosively or extruded as lava (e.g., basalt). The term also includes near-surface intrusions that form a part of the volcanic structure.
Waste Accumulation Area	An area specifically designed for temporary storage of wastes until they are picked up by the waste management staff. Hazardous and mixed waste may only be stored in these areas for up to 90 days. Radioactive waste may also be stored in these areas prior to being transferred to Waste Management storage facilities or being shipped offsite.
Waste Generator	Any individual or group of individuals that generate radioactive, mixed, or hazardous wastes at LLNL or SNL, Livermore. Waste generator responsibilities are discussed in section B.3.1.1.
Waste Isolation Pilot Plant (WIPP)	A facility in southeastern New Mexico being developed as the disposal site for transuranic and transuranic mixed waste, not yet approved for operation.
Waste Management Facilities	One or more of the waste management units for LLNL Livermore site, LLNL Site 300, and SNL, Livermore respectively.
Waste Management Staff	Group of individuals whose sole responsibility is to manage wastes generated at the Laboratories (including offsite leased properties) and perform tasks associated with the management of those wastes.
Wetland	Land or areas with abundant moisture, saturated or inundated during some portion of the year, or plant species tolerant of such conditions.
Wetland hydrology	Permanent or periodic inundation for at least 7 days during the growing season.

Whole-body radiation	Radiation to the whole body, as opposed to individual organs or parts of the body.
Wind rose	Diagram showing wind speeds and directions from which they blow.
Work station waste management unit	*See* Satellite waste accumulation area.
Zoning	The division of a city or county by legislative regulations into areas, or zones, that specify allowable uses for real property and size restrictions for buildings within these areas; a program that implements the policies of the General Plan.
Zoning District	A designated section of a city or county wherein prescribed land use requirements and building and development standards are uniform.

Conversion Factors

To Convert:	To:	Multiply By:
LENGTH		
1 mile (U.S. statute)	km	1.609 344
1 yd	m	0.9144
1 ft	m	0.3048
	mm	304.8
1 in	mm	25.4
AREA		
1 mile^2 (U.S. statute)	km^2	2.589 99
1 acre (U.S. survey)	ha	0.404 687
	m^2	4046.87
1 yd^2	m^2	0.836 127
1 ft^2	m^2	0.092 903
1 in^2	mm^2	645.16
VOLUME, MODULUS OF SECTION		
1 acre ft	m^3	1233.49
1 yd^3	m^3	0.764 555
100 board ft	m^3	0.235 974
1 ft^3	m^3	0.028 316 8
	L (dm^3)	28.3168
1 in^3	mm^3	16 387.1
	mL (cm^3)	16.3871
1 barrel (42 U.S. gallons)	m^3	.158 987
(FLUID) CAPACITY		
1 gal (U.S. liquid)*	L**	3.785 41

1 qt (U.S. liquid)	mL	946.353
1 pt (U.S. liquid)	mL	473.177
1 fl oz (U.S.)	mL	29.5735
1 gal (U.S. liquid)	m^3	0.003 785
* 1 gallon (UK) approx. 1.2 gal (U.S.)		
** 1 liter approx. 0.001 cubic meters		
SECOND MOMENT OF AREA		
1 in^4	mm^4	416 231
	m^4	0.416 231×10^{-6}
PLANE ANGLE		
1· (degree)	rad	0.017 453 3
	mrad	17.4533
1' (minute)	µrad	290.888
1" (second)	µrad	4.848 14
VELOCITY, SPEED		
1 ft/s	m/s	0.3048
1 mile/h	km/h	1.609 344
	m/s	0.447 04
VOLUME RATE OF FLOW		
1 ft^3/s	m^3/s	0.028 316 8
1 ft^3/min	L/s	0.471 947
1 gal/min	L/s	0.063 090 2
	m^3/min	0.0038
1 gal/h	mL/s	1.051 50
1 million gal/d	L/s	43.8126
1 acre ft/s	m^3/s	1233.49
TEMPERATURE INTERVAL		
1·F	·C or K	0.555 556
		5/9·C=5/9 K
EQUIVALENT TEMPERATURE (toc=Tk-273.15)		
t_{oF}		9/5toc+32
MASS		
1 ton short (2000 lb)	metric ton	0.907 185
	kg	907.185
1 ton long (2240 lb)	kg	1016.05
1 lb	kg	0.453 592
1 oz	g	28.3495

MASS PER UNIT AREA		
1 lb/ft^2	kg/m^2	4.882 43
1 oz/yd^2	g/m^2	33.9057
1 oz/ft^2	g/m^2	305.152
DENSITY (MASS PER UNIT VOLUME)		
1 lb/ft^3	kg/m^3	16.0185
1 lb/yd^3	kg/m^3	0.593 276
1 ton/yd^3	t/m^3	1.186 55

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The overall effort for this EIS/EIR was directed by LLNL through Charles W. Meier and his deputy, Constance E. DeGrange. SNL, Livermore involvement was directed by Donald A. Nissen and his assistant Sheryl L. Buck. Assistance for the preparation of this document was provided to LLNL and SNL, Livermore by Roy F. Weston, Inc. (WESTON) under the direction of David J. Lechel and his assistant, William N. Taber. The WESTON team included subcontractors Michael Brandman Associates, ABB Government Services, Inc.(formerly ABB Impell Corporation), Holman & Associates, and William Self Associates. Mr. Anthony J. Adduci provided the DOE overview for the entire project.

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Section 1	Purpose and Need for the Proposed Action	D. Lechel, J. Guerrero, M. Merritt
Section 2	Overview	D. Lechel, J. Guerrero, M. Merritt
Section 3	Proposed Action and Alternatives	D. Lechel, J. Guerrero, M. Merritt
Section 4	Description of the Existing Environment	B. Bruesch, C. Burt, T. Chung, K. Curtis, E. Fiering, B. Grimsted, D. Jacobs, M. Koch, M. Lafferty, J. Markoff, C. McEnany, D. Miller, L. Militana, W. Taber
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Section 6	Unavoidable Adverse Environmental Impacts	M. Merritt
Section 7	Short-Term Uses and Long-Term Productivity	M. Merritt
Section 8	Irreversible and Irretrievable Commitment of Resources	M. Merritt
Section 9	Growth-Inducing Impacts	C. Alling
Section 10	Local Projects Contributing to Cumulative Impacts	B. Bruesch
Appendix A	Description of Major Programs and Facilities	H. Khan
Appendix B	Waste Management	G. Daloisio

Appendix C	Environment, Safety, and Health	D. Jacobs
Appendix D	Accident Analysis	R. Philbrick, H. McGee, R. Mertogul, T. Parnell, D. Petroff, T. Simpson
Appendix E	[Reserved for Future Use]	
Appendix F	Ecology and Biological Assessment	C. Burt
Appendix G	Floodplain and Wetlands Assessment	L. Mazur, C. Burt
Appendix H	Prehistoric and Historic Cultural Resources	M. Holman, M. Clark, K. Curtis, C. Alling
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Appendix J	Emergency Planning and Response	R. Philbrick, C. Frank, D. Petroff
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B.S. Wildlife Science, Cornell University, 1975
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Mr. Alling is an environmental impact assessment and documentation expert with 17 years of experience in multidisciplinary environmental analysis, natural resources management, community planning, and regulatory compliance. He has prepared or managed the preparation of over 250 Environmental Impact Statements, Environmental Impact Reports, and other documents pursuant to NEPA and CEQA.

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B.A. Business Management, University of Puget Sound, 1973
B.S. Civil Engineering, University of Colorado, 1975
M.S. Civil Engineering, University of New Mexico, 1992

Mr. Bone has over 17 years of experience in civil and environmental engineering. He has been involved in the site characterization, feasibility, design, and remediation/construction of landfills, solid and hazardous waste sites, and heavy industrial facilities. His fields of competence include surface water hydrology and hydraulics, erosion and sediment control, and site development and design.

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B.A. Social Ecology, University of California, Irvine, 1979

Ms. Bruesch has an interdisciplinary background in the environmental planning field, having prepared or managed numerous environmental assessments and impact reports to meet NEPA and CEQA requirements. In her 13 years of experience, she has focused on water resources and water quality issues, water treatment facilities, and residential, commercial, and industrial developments.

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B.S. Biology, Hope College, 1968
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Mr. Burt has 19 years of experience in the environmental impact assessment field, including the preparation of NEPA documents and conducting field investigations in upland and wetland ecosystems. He has worked on pumped storage hydroelectric projects, transmission lines, gas pipelines, high-level nuclear waste repository siting processes, and uranium mill tailings remedial action plans.

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Ph.D.Mechanical Engineering, University of California, Los Angeles, 1991

Dr. Chung has over 12 years of experience as an acoustical engineer, especially in environmental and architectural acoustics. This experience includes mitigation of community and transportation noises, mechanical equipment noises, exterior and interior sound and vibration control, and room acoustics.

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B.A. Anthropology, San Francisco State University, 1976
M.A. Anthropology, San Francisco State University, 1985

Mr. Clark is a Society of Professional Archaeologists (SOPA) certified archaeologist with 15 years of field and laboratory experience in conducting archaeological research in central and northern California. His focus has been on prehistoric Bay Area cultures.

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B.S. Fisheries Ecology, Texas A&M University, 1977
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Ms. Curtis has 5 years of experience in the preparation of Environmental Impact Reports and related environmental documents. She has managed the preparation of these documents in California for a number of residential, industrial, commercial, and recreational developments. Ms. Curtis also has a background in fisheries research, with an emphasis in fisheries management and genetics.

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Mr. Daloisio has 10 years of experience in the nuclear industry with emphasis on low-level waste management. His responsibilities have included development and implementation of radioactive and mixed waste minimization programs, computer applications to track waste generation and assess economic impacts of waste options, and assessing radioactive and mixed waste management performance relative to regulatory requirements and industry experience.

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B.S. Mathematical Sciences, University of California, Santa Barbara, 1989
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Ms. Fiering has over 3 years of experience in planning, environmental document preparation, and environmental analysis for a variety of projects, including major regional transportation corridors, solid waste landfills, and residential, commercial, and industrial development.

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M.A. Urban Affairs/Public Administration, University of Colorado, 1979

Mr. Guerrero has more than 20 years of experience in environmental regulatory compliance. He has been a staff member to a U.S. Senator, working on environmental issues; has spent 7 years in DOE's transuranic waste management program; and more recently has worked on transportation regulatory issues.

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B.A. Anthropology, San Francisco State University, 1971
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Mr. Holman has 27 years of experience in conducting archaeological research in central and northern California.

Donald G. Jacobs, Vice President and Senior Health Physicist, Roy F. Weston, Inc.

B.S. Agricultural Science, University of Illinois, 1954
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Dr. Jacobs has over 35 years of experience in all phases of radiological environmental protection programs, divided among government laboratories, international organizations, and industrial consulting firms. He served for 2 years at the International Atomic Energy Agency as head of the waste management section and 20 years at the Oak Ridge National Laboratory, finally as manager of its Office of Environmental Policy Analysis. He is a member of the National Council on Radiation Protection and Measurements and since 1987 has been on its Board of Directors.

Jennifer L. Kauffman, Community Relations Specialist, Roy F. Weston, Inc.

B.S. Land Use and Regional Planning, Bowling Green State University, 1977
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Ms. Kauffman has over 12 years of experience in environmental planning. She has planned and directed diverse projects in areas of solid waste management, public participation in regulatory compliance, impact assessment, and environmental planning. She has developed and implemented public participation and community relations programs, conducted regulatory compliance audits for military and industrial clients, and developed regulatory compliance manuals and training programs.

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B.S. Chemical Engineering, University of California, Berkeley, 1979

Mr. Khan has over 12 years of experience in environmental air quality regulation, compliance, and remediation. He has experience in budgeting, cost controls, and scheduling; and with the design and management of construction of facilities for emission controls and chemical recovery.

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B.A. Environmental Health and Planning, University of California, Irvine, 1990

Mr. Koch's experience is in planning and environmental impact assessment; his work has ranged from major regional transportation corridors, residential and marine development, and state correctional facilities to site-specific hazardous materials investigations.

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B.S. Nuclear Medicine Technology, University of Wisconsin-LaCrosse, 1983
M.S. Radiological Health Physics, San Diego State University, 1991

Mr. Kraus has 9 years of experience in nuclear medicine and health physics. As a nuclear medicine technologist, he provided health physics support, including receipt and waste management of radiopharmaceuticals, instrument calibration, internal and external dosimetry, and diagnostic procedures. He has also performed radiological risk assessments for workers and the public.

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B.S. Geology, Lehigh University, 1976
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Mr. Lafferty has over 12 years of experience in hydrogeology, environmental chemistry, engineering geology, and water resources management. The range of his work includes preparation and technical reviews of HARs, EIRs, Groundwater Monitoring/Sampling and Analysis Plans, Closure Plans, Reports of Waste Discharge, Remedial Action Plans, and monitoring variance documents for RCRA, CERCLA, Title 23, and Katz Bill Compliance.

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Mr. Lechel has over 18 years of experience in project management of multidisciplinary environmental studies, regulatory analyses, environmental site monitoring, and EISs. He has been responsible for the design, conduct, management, and report preparation for extensive environmental assessments of radioactive and mixed-waste disposal sites, hazardous and toxic waste sites, proposed coal mines, power plants, and waste water treatment facilities.

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Ms. Markoff has 3 years of experience in environmental analysis and has participated in CEQA- and NEPA-related studies for a variety of projects throughout Southern California.

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Ms. Mazur has 7 years of experience in civil and environmental engineering. She has been involved in the planning, design, and construction phases of a variety of projects including subdivision planning, storm and sanitary sewer design, drainage channel analysis and design, and a uranium mine reclamation.

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B.S. Environmental Science, Washington State University, 1976
M.S. Environmental Engineering, Washington State University, 1984

Mr. McEnany has over 10 years of experience in air pollution analysis and regulatory assessment. He has reviewed air pollution discharge permit applications, done field surveillance and enforcement of air pollution regulations, compiled extensive point and area source emissions inventories, designed and enforced air pollution compliance plans, and provided expert testimony in air pollution compliance disputes.

H. Shel McGee, Principal Engineer, ABB Impell Corporation

Various U.S. Navy schools, 1976–1982
B.S. Chemical Engineering, University of California, Berkeley, 1990

Mr. McGee has 9 years of nuclear power experience, including 6 years with the U.S. Navy involved with the management of operations concerning plant chemistry and radiological controls. He has also had experience in pesticide studies and in the handling and preparation of organic residue samples.

Remzi Mertogul, Staff Engineer, ABB Impell Corporation

B.S. Nuclear Engineering, University of Illinois, 1977
M.S. Nuclear Engineering, University of Illinois, 1979

Mr. Mertogul has over 13 years of experience in the nuclear power industry. He holds a Senior Reactor Operating License and has been a Control Room Supervisor and Shift Foreman.

Melvin L. Merritt, Principal Scientist, Roy F. Weston, Inc.

B.S. Physics, California Institute of Technology, 1943
Ph.D.Physics, California Institute of Technology, 1950

Dr. Merritt has over 40 years of experience in nuclear weapons effects, weapons test safety, and environmental impact assessment. He has prepared four EAs and EISs involved with operating a national laboratory, identifying sites for conducting nuclear tests, the Waste Isolation Pilot Plant, and uranium mill tailings remediation. He was chairman of an NAS subcommittee on fallout and has co-edited and authored numerous technical and scientific articles.

Peter K. Middlebrooks, Hydrogeologist, Roy F. Weston, Inc.

B.S., Geology, Duke University, 1985
M.S., Geology, Wright State University, 1987

Mr. Middlebrooks has 7 years experience as a hydrogeologist and geophysicist, including supervision of oil field drilling programs field analysis of geological samples and geophysical logs, interpreting seismic refraction data, and developing a conceptual model of ground water flow at a CERCLA site.

Louis M. Militana, Senior Section Manager, Roy F. Weston, Inc.

B.S. Meteorology, Rutgers University, 1977
M.S. Meteorology, University of Maryland, 1980

Mr. Militana has over 11 years of experience in air-quality modeling and impact analysis for the nuclear power industry. He has prepared air-quality sections of a number of environmental impact statements and safety-analysis reports, as well as air-quality permits for numerous industrial facilities.

David R. Miller, Project Manager, Roy F. Weston, Inc.

B.S. Agronomy, West Virginia University, 1979
M.S. Soil Chemistry, New Mexico State University, 1984

Mr. Miller has 8 years of experience in the characterization and remediation of contaminated soils. He has been involved in the preparation of a number of remedial investigation plans, reports, and feasibility studies for technically sound and cost-effective cleanups of contaminated sites.

Timothy E. Parnell, Senior Scientist, ABB Government Services, Inc.

B.S. Nuclear and Electrical Engineering, University of California, Berkeley, 1980

Mr. Parnell has 12 years of nuclear power experience including 10 years in the U.S. Navy. There he was involved in the management of maintenance and operations of Navy nuclear power plants. He also has experience in a wide range of computer modeling and analysis of airborne dispersion of radiological and other contaminants.

Dale M. Petroff, Supervising Engineer, ABB Impell Corporation

B.S. Science, Math, and Engineering Curriculum, U.S. Military Academy, 1975
A.S. Radiation Protection Technology, Central Florida Community College, 1982

Mr. Petroff has over 8 years of experience in radiation protection, emergency preparedness, and training as well as 7 years of experience as an Army officer. He is on the National Registry of Radiation Protection Technologists and has a working knowledge of ALARA and regulatory agency requirements.

Richard T. Petrus, C.P.G., Senior Project Manager, Roy F. Weston, Inc.

B.A. Geology, Slippery Rock University, Pennsylvania, 1974
M.A. Geology, University of Missouri, 1976

Mr. Petrus has over 15 years experience in the waste management industry including hydrogeological investigations at CERCLA (Superfund), RCRA, and DOE sites. He has 9 years of experience in the managment of Superfund investigations for the U.S. Environmental Protection Agency. He has been involved in the preparation of monitoring-well specifications, contractor procurement, well installation and testing, and aquifer characterization studies for remedial investigation and feasibility studies.

Robert A. Philbrick, C.E., Section Manager, ABB Government Services, Inc.

B.S. Civil/Environmental Engineering, Cornell University, 1975
M.S. Structural Engineering, University of California, Berkeley, 1976

Mr. Philbrick has 15 years of experience in project management, structural and mechanical engineering design and analysis, structural mechanics, and technical supervision on facilities such as nuclear power plants, research laboratories, industrial facilities, and hospitals. He also has managerial experience in Quality Assurance.

William D. Self, Principal, William Self Associates

B.A. Anthropology, UCLA, 1973
M.A. Anthropology, University of Nevada, Reno, 1980

Mr. Self has 18 years of experince investigating historical and prehistorical resources throughout the western United States for private and government clients. He has served as State Archaeologist in the Nevada State Historical Preservation Office.

Terry R. Simpson, Technical Manager, ABB Government Services, Inc.

B.S. Physics, California Institute of Technology, 1965
Sc.D.Nuclear Engineering, Massachusetts Institute of Technology, 1970

Dr. Simpson has over 20 years of experience in the areas of radiation dose assessments, dose mapping, prediction of radiation environments, and the effects of such environments on biological and electrical components. He has participated in a number of projects for both DOE and DOD dealing with high-level nuclear waste management, radioactive waste containment, radioactive protection standards, and probabilistic risk assessment.

William N. Taber, Deputy Project Manager, Roy F. Weston, Inc.

B.S. Ecology, California State University, Northridge, 1969

Mr. Taber has over 15 years of experience in the management of environmental studies, regulatory analysis, and project licensing in support of energy and precious metal development, crude oil storage and transportation systems, and remedial action in the cleanup of oil spills and radioactive waste.

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