APPENDIX I: SUMMARY

I-S.1 Introduction

The U.S. Department of Energy (DOE) proposes to construct and operate the National Ignition Facility (NIF). The goals of NIF are to achieve fusion ignition in the laboratory for the first time by using inertial confinement fusion (ICF) technology based on an advanced design solid-state laser and to conduct high-energy-density experiments in support of national security and civilian applications.

The purpose of this project-specific analysis is to assess the environmental impacts of construction and operation of NIF. This document describes the project and its purpose and need, considers site alternatives and project design options, delineates the affected environments, assesses potential environmental impacts, and suggests mitigation measures. This analysis, as an appendix to the Final *Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*, is equivalent to a stand-alone environmental impact statement on the proposed NIF.

I-S.2 Purpose and Need

NIF would provide a unique capability for DOE's science-based stewardship of the nuclear weapons stockpile. The goal of obtaining fusion ignition and burn would attract and challenge top scientific and engineering talent with a problem containing many of the same elements of physical understanding as those necessary for stewardship of the nuclear stockpile. Planned experiments with NIF, at temperatures and pressures near those that occur in nuclear weapon detonations, would provide the data needed to verify certain aspects of sophisticated computer models. These models are needed to simulate weapons physics and to provide insights on the reliability of the Nation's nuclear weapons stockpile. Specially designed NIF experiments could also address specific issues of modeling or physics that are of concern because of changes in weapons due to aging or remanufacture. Finally, NIF experiments could provide a unique source of radiation for studies on nuclear weapon effects.

NIF experiments could address, to various degrees, certain weapons issues connected with fusion ignition and boosting; weapon effects; radiation transport; and secondary implosion, ignition, and output. Most of these processes occur at very high energy density (i.e., at high temperatures and pressures) and are relevant to a weapon's reliability. NIF would achieve higher temperatures and pressures, albeit in a very small volume, than any other existing or proposed stockpile stewardship facility. It is also the only facility that would achieve fusion ignition. Safety issues principally connected with the high explosive and fissile material implosion in a weapon would not be addressed by NIF.

Present computer codes are not adequate to calculate all the high-energy-density phenomena that occur in an exploding nuclear weapon. The high temperatures and pressures achievable with NIF would be used to measure properties of matter at the extreme conditions expected and, thus, verify aspects of advanced computer models. If an unanticipated change relevant to the high-energy-density phase of weapon operation is observed in the weapon surveillance program, specially designed NIF experiments could aid weapons scientists in validating aspects of their integrated computer models to assess whether that change would adversely impact the weapon's reliability. It is important to have NIF operating well before the period 2005 to 2010, as weapons age beyond their original design lifetime.

As a multipurpose facility, NIF would also be important to the Nation's energy, basic science, and technology missions. Its data would determine whether ICF can be a viable source of electric power in the future. Achieving ignition, optimizing the various target gain curves, and providing initial data on fusion reactor materials would allow sound decisions to be made concerning inertial fusion energy development.

NIF experiments would also achieve the same temperatures and pressures that exist in the sun and other stars, providing new laboratory capabilities for exploring basic high-energy-density sciences such as astrophysics and plasma physics. As the world's largest optical instrument, NIF could spur high technology industries in such areas as optics, lasers, materials, high-speed instrumentation, semiconductors, and precision manufacturing.

Achievement of fusion ignition at NIF would fulfill a major goal of the ICF program. Both the National Academy of Sciences in 1990 and the Inertial Confinement Fusion Advisory Committee have recommended proceeding with an ignition facility based upon solid-state laser technology.

I-S.3 Project Description

Conventional construction techniques would be used to build NIF. The extent and exact nature of such activities as site clearing, infrastructure improvements, and support facility construction required would depend on the specific location selected for NIF. Construction of NIF would be organized in the following sequential phases: (1) initial building construction, (2) special equipment structures installation, (3) final building construction, (4) final installation preparation, (5) clean component installation, and (6) final laser/target systems installation.

Once operational, NIF would provide the capability to perform the full range of target physics experiments leading up to and including ignition and burn. It would also allow researchers to design experiments studying weapons effects, weapons physics, fusion energy, and the basic sciences. NIF would consist of two main components: a collection of 192 laser generation and transport systems and a target area including a target chamber and associated equipment. An advanced, integrated sensor and computer system would control the lasers and collect data from diagnostic equipment. These elements would all be housed in one central facility. Required support facilities, such as assembly areas, maintenance areas, machine and mechanical shops, and offices would be located nearby. General site requirements would include control by DOE Office of the Assistant Secretary for Defense Programs (DP), significant ICF infrastructure, protection of the public and the environment, hazardous and radioactive waste management capability, and transportation services. The total land area requirement for NIF, including direct-support buildings, would be about 20 hectares (ha) (50 acres). Depending on the site selected, many of the NIF needs may be served by existing facilities, reducing the requirements of new land area to 3.2 to 18.2 ha (7.9 to 45 acres.)

I-S.4 Alternatives

The alternatives considered in this analysis consist of 5 candidate locations at four DP sites. (LLNL, LANL, NTS-Area 22 main site location, NLVF, location near NTS, and SNL), the No Action alternative, and two design capabilities. The designs under consideration consist of two operational capabilities, the Conceptual Design Option, and the Enhanced Option.

I.S.4.1 Alternative Sites

DOE has selected one preferred (LLNL) and three alternative (LANL, NTS, and SNL) NIF sites that meet most of the following site criteria: BP-controlled Federal site, significant ICF infrastructure, adequate protection of the public and the environment, hazardous and radioactive waste management capabilities, and adequate transportation services for transport of targets. While the two NTS locations currently do not have ICF infrastructure, they have been included to ensure that DOE examines any potential lost efficiencies that might arise by taking advantage of the infrastructure that must be maintained at these sites in accordance with the presidential mandate to maintain a test-readiness posture.

Lawrence Livermore National Laboratory. LLNL is located about 64 kilometers (km) (40 miles [mi]) east of San Francisco in southern Alameda county. LLNL occupies 332 ha (821 acres). NIF would be situated on 8.1-ha (20-acre) disturbed grassland area in the NE quadrant of LLNL, adjacent to existing ICF facilities.

Los Alamos National Laboratory LANL is located in Los Alamos County in north central New Mexico, approximately 97 km (60 mi) north northeast of Albaquerque. LANL occupies 11,300 ha (28,000 acres). NIF will be located on a 4-ha (10 acre) area in Technical Area (TA) 58, an underdeveloped forested area adjacent to TA-3, the hub for LANL administration and support activities.

Nevada Test Site Area 22 at NTS is located in southern Nye county in southern Nevada, about 105 km (65 miles) northwest of Las Vegas. NTS occupies about 350,000 ha (867,000 acres). NIF will be located on an 18.2 ha (45 acres) area within area 22 in an undeveloped creosote bush habitat, southwest of Mercury Base Camp in the southeastern portion of NTS. NLVF is located in the city of North Las Vegas, Nevada, and occupies 32 ha (80 acres) zoned for general industry within the city. NIF will be lcoated within a 3.2 ha (8 acre) previously disturbed, sparsely vegetated area in the northwestern portion of NLVF.

Sandia National Laboratories, NM DOE SNL site is located 11 km (6.5 mi) east of downtown Albaquerque and Benalillo County, New Mexico. DOE owns 1150 ha (2842 acres) within the boundaries of the Kirtland Air Force Base military reservation and uses additional property through land withdrawals and land-use permits from Kirtland Air Force Base, the State of New Mexico, and the Isleta Pueblo. NIF would be located in an 11-ha (28-acre) disturbed grassland portion of the southern side of Technical Area II. The site is near SNL facilities that would be required for NIF support.

I-S.4.2 No Action

Under the No Action alternative, DOE would not construct and operate NIF. Without the facility, the Stockpile Stewardship and Management Program mission and the Nation's sustainable energy policy mission, as defined in the *National Energy Policy Act* of 1992, would be adversely affected. Key support elements of Stockpile Stewardship and Management, such as the goals of producing ignition and energy gain in ICF targets and performing fusion and high-energy-density physics or weapons-effects experiments in support of the Stockpile Stewardship and Management Program, would not be achieved.

The Stockpile Stewardship and Management Program would continue to use Nova and other facilities for a time, but fusion ignition and the much higher temperatures and pressures of NIF would not be available. Alternatives to achieve higher temperatures and pressures than are presently available may eventually be proposed, but they would not be available when several of the remaining types of nuclear weapons age beyond their original design lifetime, between 2005 and 2010. Thus, issues may arise that decrease confidence in the reliability of these weapons and increase the probability that the United States may need to invoke "supreme National interest" and withdraw from any Comprehensive Test Ban Treaty in effect (based on *Statement by the President on Goal for a Comprehensive Test Ban Treaty* , White House Office of the Press Secretary, August 11, 1995).

Without NIF, efforts to obtain the critical data needed to determine if the ICF approach, based on the neodymium glass solid-state laser design, would be a viable and practical energy source for electric power production would be delayed or abandoned. Other ICF-based methods proposed for achieving ignition (such as heavy ion acceleration, light ion diodes, krypton-fluoride lasers) are not developed to the point of being able to propose an ignition facility. As a result, these potential alternatives for ICF energy source demonstrations would have longer lead times and a higher integrated cost to achieve the mission proposed for NIF.

I-S.4.3 Operational Capability Options

Two operational capability options (Conceptual Design and Enhanced) have been proposed for NIF. The Conceptual Design Option would use an ICF approach called "indirect drive." In indirect drive, laser beams would illuminate and heat the interior surfaces of a small metal case (hohlraum) containing a deuterium-tritium-filled capsule. The beams would cause the case to emit x rays that would strike the fusion target capsule, resulting in compression and heating of the capsule to conditions igniting the fusion reaction. This option also includes basic experiments for weapons physics, nuclear weapons effects on other systems, and other user community needs.

The Enhanced Option would include the indirect drive operations of the Conceptual Design Option and a second approach called "direct drive." The Enhanced Option would provide the capability to perform an increased number of both yield and non-yield experiments to accommodate greater user needs. No hohlraum would be used in the direct drive approach. Instead, a large number of laser beams would be employed to ensure good uniformity of the driving force (laser light) over the face of the target. The laser beams would impinge directly on the deuterium-tritium-filled capsule to drive the fusion reaction. Because it is possible that NIF would be used for direct-drive experiments in its lifetime, operating conditions for both indirect- and direct-drive experiments have been developed and are being assessed.

I-S.5 Environmental Consequences

Table I-S.5-1 compares the potential environmental consequences of the No Action alternative with those of construction and operation of NIF at the alternative candidate sites. The comparison is based on the assessments in section I.4 of this analysis. Factors analyzed include land use and visual resources; air quality and noise; water resources; biotic resources; cultural and paleontological resources; socioeconomics; and radiological and chemical health, safety, and risk. Where they would differ, the potential impacts of the two operational scenarios (Conceptual Design Option and Enhanced Option), are also compared in table I-S.5-1. Table I-S.5-2 compares waste management issues for each candidate site.

The analyses in this appendix indicate that there would be few significant differences in the adverse environmental impacts among the candidate sites analyzed. The maximum 24-hour particulate matter

10 microns or smaller (PM [10]) concentration in the air during site clearing would exceed applicable standards at LLNL and NLVF (table I-S.5-1). However, the ambient air quality impacts would be localized and of short duration. Uncommitted land requirements would be greatest at NTS (18.2grassland (LLNL and SNL) or to an area of sparse vegetation (NLVF) (table I-S.5-1). The risk of cancer to members of the public from a facility accident involving the release of radioactive material would be greatest at NLVF and SNL (table I-S.5-1), although the potential for the actual occurrence of such an accident would be extremely low.

NIF will comply with all applicable Federal, state, and local environmental regulatory requirements, including the *California Environmental Quality Act* if NIF is sited in the State of California. The candidate sites have also enacted several mitigative measures for construction actions that would also be applicable to NIF construction. While each of these mitigative measures may be minor, in combination they could significantly reduce impacts to the environmental resources of the selected site. The evaluations of environmental consequences of NIF construction and operation summarized in tables I-S.5-1 and I-S.5-2 are based on the assumption that the mitigative measures would be carried out if the proposed action were undertaken.

Even with mitigation, construction and operation of NIF could result in unavoidable residual adverse effects. These effects would include the disturbance of up to 18.2 regions. Readable adverse socioeconomic impacts would occur in any of the regions of influence for NIF candidate sites. No adverse disproportionate environmental justice concerns would be expected at any of the candidate sites, except for a minor potential to disproportionately impact minority populations in the region of influence for NLVF.

Table I-S.5-1.-- ***Comparison of Alternatives for the Proposed National Ignition Facility***

Environmental Resource Parameter	No Action	LLNL[1]	LANL[1]	NTS[1]	NLVF[1]	SNL[1]
Land Resources						
Uncommitted land requirements[2] (hectares)	None	8.1	4.0	18.2	3.2	10.5
Uncommitted land requirements (%)	None	11	1	<1	56	7
Number of buildings to be constructed	None	2	3	5	5	7
Conflicts with site development or land-use plans	No	No	No	No	No	No
Air Quality and Noise						
Predicted maximum 24-hour particulate matter 10 microns or smaller concentration during site clearing	124/150	175/150	183/150	52/150		
Baseline emissions (t/yr)/baseline emissions plus NIF emissions (t/yr) during operation[5]						

irretrievable.

Adequate land exists at each of the five candidate location sites to support ongoing programs and other foreseeable short-term uses of undeveloped areas. The use of land for NIF would enhance the long-term productivity of the selected site in two ways. First, NIF represents long-term research and development functions compatible with historic nuclear weapons support and would require a technically competent, skilled, and stable workforce. Second, in light of current reductions in the nuclear weapons stockpile, the lack of new weapons development or production, the moratorium on nuclear testing, and concerns about safety and reliability in the aging stockpile, DOE plans to downsize or consolidate existing facilities and provide upgraded or new experimental and computational capabilities that would enhance the long-term productivity of the selected sites.

Land clearing and construction activities for NIF would eliminate habitat and destroy or displace wildlife. Construction of new facilities could result in short-term disturbances of previously undisturbed biological habitats. These disturbances could cause long-term reductions in the biological productivity of an area.

Cumulative impacts would result from the addition of the incremental effects of the construction and operation of NIF to the effects of other past, present, and reasonably foreseeable future actions at the selected site. PM_{10} emissions from construction of NIF would be an incremental addition to the already existing environmental impact of dust emissions to the atmosphere. Minor changes in stormwater runoff are expected due to removal of grass cover during NIF construction and increased runoff from pavement during facility operations. Construction of NIF would replace natural habitat with areas of pavement and buildings. Depending upon the candidate site selected, this conversion could extend the influence of urbanized/industrial habitats into natural areas, increase fragmentation of natural habitat, and cause minor loss of habitat used by rare species. However, no critical habitat for federally threatened or endangered species would be affected. Radiological doses to the general public from NIF operations would be no more than 20 normal background radiation. The risk of a NIF accident-related cancer fatality occurring to a member of the public over the 30-year lifetime of the facility would be less than 1 in 700,000. NIF would be considered a low-hazard, radiological facility. Such a facility uses radionuclides (for nonreactor purposes) and has other hazards (such as chemicals needed at the facility). Low hazard implies that there are minor onsite and negligible offsite consequences.

I-S.6 U.S. Department of Energy's Preferred Alternative

Council on Environmental Quality regulations require that an agency identify the preferred alternative for a proposed Federal action in a final environmental impact statement (40 *Code of Federal Regulation* s 1502.14[e]). The preferred alternative is the alternative that DOE believes would best fulfill its statutory mission, giving consideration to environmental, economic, technical, and other factors. The preferred operational option for NIF is the Enhanced Option (indirect and direct drive). The preferred NIF siting alternative is at LLNL. The Record of Decision will describe DOE's decision on the operational capability and siting of NIF.

1 Value for Enhanced Option is given in parentheses only for parameters that differ from the Conceptual Design Option.

2 Uncommitted land, as defined by each of the sites, is land that is currently open and available for NIF development. An additional 2 hectares would be temporarily required for a construction laydown

area at LLNL. Construction laydown areas for the other sites would be located within the area designated for NIF.

3 Estimated by combining baseline concentrations and NIF contributions based on dust control measures using water spray twice a day (with continuous water spraying and/or chemical dust suppressants for LLNL and NLVF sites).

4 The 24-hour California state standards for particulate matter (50site yielding the largest risks.

5 Collective population fatalities were calculated for 145 shipments (Conceptual Design Option) and 335 shipments (Enhanced Design). For example, a reported value of 4x10-3 fatalities suggests that no fatalities are expected for the proposed action. However, one single fatality out of the entire affected population might be expected over the course of 250 years if the same number of shipments were to continue for that length of time.
ND - No data available; NA - Not applicable.
Derived from tables and text contained in appendix I.

6 Shipped offsite.

7 Varies depending on the waste stream.
Source: Andrews and Tobin 1995; Bowers 1995; NTS 1996.

APPENDIX I: NATIONAL IGNITION FACILITY PROJECT-SPECIFIC ANALYSIS

I.1 Introduction

I.1.1 The National Ignition Facility Proposal

As part of its Stockpile Stewardship and Management Program, the U.S. Department of Energy (DOE) proposes to construct and operate the National Ignition Facility (NIF) (DOE 1995b). NIF would contain the world's largest solid-state laser system, which would be used to achieve ignition of nuclear fusion in the laboratory for the first time. NIF would perform fusion, high-energy-density, and radiation-effects experiments in support of stewardship of the Nation's stockpile of nuclear weapons and other basic and applied science objectives.

NIF would consist of 192 laser beams that would be focused into a small target containing a spherical capsule of fusion fuel, positioned in the center of a large spherical target chamber. The energy of the lasers would be deposited into the target in a few billionths of a second, causing the fuel capsule inside the target to implode, thereby compressing and heating the fuel. This process would force atomic nuclei sufficiently close together so that the rate of fusion reactions would become very large. This reaction rate would, in fact, be so rapid that a significant fraction of the fuel would burn up before the target flew apart in a miniature explosion; that is, while the target was held together only by its own inertia. This method for achieving fusion ignition and energy gain is called inertial confinement fusion (ICF). Ignition occurs when the fusion reactions become self sustained; i.e., a significant portion of the fusion reactions result from self heating of the fuel beyond that achievable by the lasers alone. Energy gain occurs when the amount of fusion energy produced by the target exceeds the amount of laser energy supplied to ignite the target. The NIF capsule's fusion yield is expected to be up to 10 times the laser driver energy required to produce fusion ignition.

In January 1993, the Secretary of Energy confirmed the need for NIF and authorized a collaborative effort by the three DOE defense laboratories and the University of Rochester's Laboratory for Laser Energetics to produce the Conceptual Design Report for NIF. The Conceptual Design Report was completed in April 1994. In October 1994, the Secretary of Energy approved initiation of the next phase of the NIF Project, including preliminary design, safety analysis, cost and schedule validation, and *National Environmental Policy Act* (NEPA) analysis preparation that would include public involvement. This NIF Project-Specific Analysis (PSA), prepared as part of the *Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (PEIS), represents that NEPA analysis. This PSA is equivalent to a project-specific EIS. However, it is referred to as a PSA to avoid confusion with the term PEIS. As a part of the Stockpile Stewardship and Management PEIS, this PSA shares certain elements (such as data) common to the main document. However, some of the data described in this PSA are necessarily more detailed than some of the data cited in the Stockpile Stewardship and Management PEIS analysis.

I.1.2 History and Background

Three decades of research and development by U.S. laboratories and private industry has led to the design of NIF. Soon after the invention of the laser in the early 1960s, scientists recognized that the laser might be used to drive an ICF capsule to ignition and that this technology could be used to achieve some of the high-energy-density conditions (such as high temperatures and pressures) that occur in the detonation of nuclear weapons. It was also recognized that if more energy could be produced than that required to ignite a target, such fusion technology might one day also be used to generate electrical power.

Since then, a series of laser systems, each several times more powerful than its predecessor, have been constructed and operated. The first of these laser systems, a single beam system called Longpath, was completed in 1970 and was used experimentally for 5 years, until a two-beam system called Janus was completed in 1974. Janus demonstrated laser-driven compression, heating, and thermonuclear burn of fusion fuel for the first time. Although neither Janus nor any of the subsequent lasers were large enough to produce target ignition, each advanced the state of the art in solid-state laser technology, and each contributed significantly to a sounder understanding of how ICF targets work.

Experimentation on the most recent of these systems, the 10-beam Nova laser, has led to an even greater understanding of ICF targets. Nova has been used not only for target physics experiments, but also for weapons physics experiments of the type that would be done at NIF, although the NIF experiments would be done at much larger energies (a factor of 40 to 50 times more energy available). Thus, the Nova experiments have established the principles and measurement techniques that would be used at NIF. More than 10,000 experiments have been conducted with Nova during its 10 years of operation. DOE is also now conducting target physics research at the Omega Upgrade Facility located at the University of Rochester. This new laser system is similar in energy to Nova but has a larger number of beams and can better address issues of directly driven laser targets than can Nova, which specializes in indirectly driven targets (see chapter 3). In its Enhanced Option mode, NIF would be capable of performing experiments with both types of targets.

During the 1980s, a program to study the physics of ICF capsules with the much larger energies available from underground nuclear explosions was successfully conducted. The very positive results of the Nova program, combined with the positive results from underground nuclear tests in the Halite/Centurion program, have led to the development of specifications for a future system to create target ignition and energy gain, i.e., for NIF. A 1990 study by the National Academy of Sciences (NAS 1990), which reviewed both the laboratory and the underground nuclear test data, recommended proceeding with an ignition facility based on a solid-state laser as the next step in the ICF program. NIF is proposed as that next step.

Achievement of fusion ignition at NIF would fulfill a major goal of the ICF program. The ICF program was initiated in 1971 to develop capabilities that would support the Nation's nuclear weapons deterrent and that have longer-term potential for commercial energy. Confidence in ignition at NIF is based on 24 years of ICF research and major program reviews, most recently the continuous monitoring of ICF progress by the ICF Advisory Committee. That panel of independent experts tracked the successful accomplishment of the objectives set out by the National Academy of Sciences recommendations in 1990 and advised DOE that the program was technologically ready to proceed with NIF, both from the standpoint of the understanding of target physics and from the standpoint of the readiness of the laser technology (DOE 1990). In 1994, the Beamlet laser, a full-scale prototype NIF beamline, demonstrated that the laser technology selected for NIF would perform as specified.

The ability to predict the performance of ignition capsules is based on similar calculations of physics that predict some aspects of nuclear weapons performance. Ignition is a "first-level" test of our weapons analysis capability. Achieving laboratory ignition with laser-driven inertial fusion is widely recognized as a major scientific challenge that will attract and stimulate highly capable scientists. While much of the science is useful to nuclear weapons analyses, NIF is not a weapon, and the ICF approach cannot be directly extended to become a weapon. Much of the research at NIF can be open to the broad scientific community. Thus, NIF experiments can advance both our weapons analysis capability and civilian science and energy interests.

I.1.3 Environmental Review Process

DOE's NEPA compliance for the Stockpile Stewardship and Management Program includes preparation of the Stockpile Stewardship and Management PEIS. Because NIF would be an integral part of a science-based Stockpile Stewardship and Management Program, the NEPA process for NIF is being conducted as part of the NEPA process for Stockpile Stewardship and Management. This NIF PSA is, therefore, included as an appendix to the Stockpile Stewardship and Management PEIS. The PSA was prepared according to the Council on Environmental Quality's "Regulations for Implementing the Procedural Provisions of the *National Environmental Policy Act* " (40 CFR 1500-1508) and DOE's NEPA implementing procedures and guidelines (10 CFR 1021). The purpose of this NIF PSA is to provide an environmental evaluation of the impacts of construction and operation of NIF as a basis for DOE's decision on whether or not to proceed with such a facility. As discussed in section I.1.1, this document is in the strictest sense a project-specific EIS, but it is referred to as a PSA to avoid confusion with the term PEIS.

The first step in the Stockpile Stewardship and Management PEIS process was to publish a Notice of Intent to prepare an EIS in the *Federal Register* (60 FR 31291, June 14, 1995). The Notice of Intent described the project and solicited comments on preliminary plans for the scope of the Stockpile Stewardship and Management PEIS. The Notice of Intent also announced DOE's plan for gathering scoping comments on the significant issues and concerns related to the proposed action and alternatives that should be addressed in the PEIS. To ensure public input to the planning and preparation of the PEIS, public scoping meetings were held during July and August 1995. At each meeting, representatives of DOE explained the purpose of the meeting, the role of the Federal Government, and the PEIS process. During the remainder of each meeting, DOE received comments from agencies, groups, and individuals and invited interested parties to submit any additional comments by August 11, 1995, the close of the PEIS scoping period. Concerns and suggestions resulting from the scoping process are summarized and evaluated in the Stockpile Stewardship and Management PEIS Implementation Plan, which states how the comments are to be incorporated into the scope of the Stockpile Stewardship and Management PEIS. The Implementation Plan also summarizes the proposed action and alternatives (designs, sitings, and No Action), outlines issues to be addressed in the PEIS, and discusses the subsequent procedures for the PEIS preparation. The Stockpile Stewardship and Management Draft PEIS was subsequently prepared and published in February 1996.

The publication of, and call for comments on, the Stockpile Stewardship and Management Draft PEIS were announced in the Notice of Availability published in the *Federal Register* . DOE invited comments from all interested parties to correct factual errors or to provide insights on any matter related to this environmental analysis. The 60-day public comment period for the Draft PEIS began on March 8, 1996 and ended on May 7, 1996. However, late comments were accepted to the extent practicable.

After considering the comments received, DOE revised the Stockpile Stewardship and Management Draft PEIS, as appropriate. This Final PEIS was distributed to those who received the Stockpile

Stewardship and Management Draft PEIS, those who commented on the Draft PEIS, and any other interested parties.

Following completion of the Stockpile Stewardship and Management Final PEIS, but at least 30 days after it is issued, DOE will issue a Record of Decision (ROD). The ROD will explain all factors, including environmental impacts, that DOE considered in reaching its decisions regarding Stockpile Stewardship and Management, including NIF. The ROD will specify the alternatives that are considered to be environmentally preferable. This NIF PSA is a critical element in the ROD and the basis for the environmental comparison of alternatives related to NIF. DOE anticipates that, in addition to considering the environmental impacts as presented in the PEIS, the ROD will be based on cost, national security, and infrastructure considerations. If mitigation measures, monitoring, or other conditions are adopted as part of the agency's decision, they will be summarized in the ROD as applicable and included in a Mitigation Action Plan that would accompany the ROD. The Mitigation Action Plan would explain how and when mitigation measures would be implemented and how DOE would monitor the mitigation measures to judge their effectiveness.

I.1.4 Organization of the National Ignition Facility Project-Specific Analysis

This NIF PSA consists of eight chapters. Chapter I.1 (Introduction) describes the NIF background and the environmental review process. Chapter I.2 (Purpose and Need for the National Ignition Facility) describes mission-related reasons why DOE needs to construct and operate NIF. Chapter I.3 (Proposed Action and Alternatives) describes the facilities required for NIF and the operations that would be associated with NIF. Chapter I.3 also includes a discussion of the No Action alternative and an overview of the four DOE sites, providing five alternate locations for NIF.

Chapter I.4 (Affected Environment and Environmental Impacts) describes the natural and human resources at the alternate NIF locations and identifies the impacts that could occur to these resources from construction and operation of NIF and from the No Action alternative. This chapter also addresses mitigation commitments and recommendations, adverse effects that cannot be avoided, irreversible and irretrievable commitments of resources, the relationship between short-term uses and long-term productivity, and cumulative impacts. Chapter I.5 (Environmental, Occupational Safety and Health Permits, and Compliance Requirements) discusses environmental regulations, Executive Orders, permits, and laws applicable to NIF construction and operation.

Chapter I.6 (List of Preparers) includes a list (including credentials) of the technical staff who prepared the NIF PSA. Chapter I.7 (Glossary) defines selected technical terms used within this PSA. Chapter I.8 includes a list of references.

I.2 Purpose and Need for the National Ignition Facility

I.2.1 General Background

Under the *Atomic Energy Act* of 1954, as amended (42 United States Code 2011 et seq.), the U.S. Department of Energy (DOE) is charged with providing nuclear weapons to support the Nation's nuclear deterrent policy. Thus, DOE must maintain a Complex with sufficient capabilities and capacity to meet current and future weapons requirements. This mission is accomplished in a way that protects the environment and the health and safety of workers and the public.

Recent changes in the global political situation and in national security needs have necessitated corresponding changes in the way DOE must meet its responsibilities regarding the Nation's nuclear weapons. As a result of international arms control agreements (the Strategic Arms Reduction Talks [START I] Treaty and the START II protocol and unilateral decisions by the U.S. Government), the Nation's stockpile will be significantly reduced by 2003. Consequently, the Nation has halted the development of new nuclear weapons, begun closing portions of the DOE weapons complex, and is considering further consolidation and downsizing of the remaining elements in the Complex. In addition, the Nation is observing a moratorium on nuclear testing and is pursuing a Comprehensive Test Ban Treaty (CTBT). However, international nuclear dangers remain and, as the President has emphasized, nuclear deterrence will continue to be an important element of the U.S. national security posture. Thus, DOE's responsibilities for ensuring the safety and reliability of the Nation's nuclear stockpile and for maintaining expertise in nuclear weapons generally will continue for the foreseeable future.

In announcing the indefinite extension of the nuclear test moratorium in July 1993, President Clinton reaffirmed the importance of maintaining confidence in the enduring U.S. stockpile by alternative means and the need to ensure that the Nation's nuclear deterrent remains safe, secure, and reliable during a test ban. In 1994, by Presidential Decision Directive and Act of Congress (Public Law 103-160), DOE was directed to establish a Stockpile Stewardship and Management Program to ensure the continued safety and reliability of the remaining weapons and the preservation of the core intellectual and technical competencies of the United States in nuclear weapons in the absence of nuclear testing. Subsequent Presidential decisions established that the United States would seek a "zero-yield" CTBT (August 1995) and that all three of the Nation's nuclear weapons laboratories would be required to ensure the highest continued confidence in the stockpile.

Thus, DOE was required to develop a Stockpile Stewardship and Management Program that would not include any level of nuclear testing but would support the following objectives:

- Full support at all times of the Nation's nuclear deterrent with safe and reliable nuclear weapons while transforming the current Complex (laboratories and production facilities) to one that is more appropriate for a smaller stockpile
- Preservation of the core of intellectual and technical competencies of the weapons laboratories. Without nuclear testing, confidence in the Nation's nuclear stockpile will depend largely on the continued availability of competent people who must make the scientific and technical judgments related to the safety and reliability of nuclear weapons
- Ensurance that the activities needed to maintain the Nation's nuclear deterrent are consistent with the Nation's arms-control and nonproliferation objectives

The purpose and need section that follows (section I.2.2) discusses the National Ignition Facility's (NIF) role in supporting objectives 1 and 2 above. Objective 3 (nonproliferation) was evaluated for NIF in a recent DOE study--The National Ignition Facility and the Issue of Nonproliferation (DOE 1995a). That study, prepared by the Office of Arms Control and Nonproliferation of DOE, has been the subject of extensive public involvement, interagency review, and review by outside experts. The study concludes that (1) the technical proliferation concerns at NIF are manageable and therefore can be made acceptable, and (2) NIF can contribute positively to U.S. arms control and nonproliferation policy goals.

To ensure the continued safety and reliability of the enduring stockpile while achieving a CTBT, the President and the Department of Defense have emphasized the importance of a strong science-based stockpile stewardship program, including NIF. It is important to establish a firm commitment to this program before the issue of ratification of a CTBT arises.

I.2.2 Purpose and Need

I.2.2.1 Stockpile Stewardship and Management Program

Although DOE is confident today that the Nation's nuclear weapons stockpile is safe and reliable, it is expected that problems could develop in the future. A recent interlaboratory study, *Stockpile Surveillance: Past and Future* (Johnson et al. 1995), documents the historical evidence. Nuclear weapons, of necessity, contain materials that react with one another slowly even when the weapon is simply being stored. These slow interactions can and have, over time, caused defects in weapons that adversely affect safety and/or reliability. These processes are called "aging." Also, design or manufacturing defects have been found after a weapon enters the stockpile or is remanufactured. The DOE historical database on such incidents shows that there have been hundreds of cases that have necessitated some kind of corrective action because of safety or reliability concerns. Because nuclear weapons in the future will be expected to remain in the stockpile beyond their designed lifetimes, it is to be expected that such incidents will increase.

The *Stockpile Stewardship and Management Program* (DOE 1995b) defines a science-based program intended to satisfy the three program objectives stated in section I.2.1. Science-based stockpile stewardship would provide the expert judgment, underpinned by scientific understanding, advanced calculations, and modern experimental facilities, to predict, identify, evaluate, and render solutions to problems that affect safety and reliability of the remaining stockpile in the absence of underground testing. The stockpile stewardship program would not replace nuclear testing completely because complex interactions between processes cannot be experimentally simulated. However, for weapons that have been tested before (and all the weapons expected to remain in the stockpile have been tested), the previous nuclear test database will provide a benchmark that can be used to evaluate future problems with the stockpile.

Building upon existing capabilities, the DOE science-based stockpile stewardship program includes an accelerated strategic computing initiative and several new experimental facilities that are required to provide the data needed to verify the models and help assess specific problems that arise. The stewardship program consists of three major components that are used to evaluate stockpile surveillance data: (1) experimental capabilities and facilities, (2) scientific evaluation by competent scientists of the information from the experimental capabilities and facilities, and (3) validation of the computer models using the accelerated strategic computing initiative. These three components lead to the development of a corrective action to resolve the identified problem.

I.2.2.2 Physical Processes in Nuclear Weapons

Because nuclear tests would not be available, more sophisticated and comprehensive computer models would be needed to conduct essential evaluations. For confidence to be established in these new models, experimental facilities must be able to provide data on all processes in the relevant physical regimes that occur in weapons. The relevant physical regimes may be divided into the following groups:

1. Detonation of high explosive and implosion of fissile material
2. Conditions for criticality of fissile material
3. Fusion ignition and boosting
4. Radiation transport
5. Secondary implosion
6. Secondary ignition, burn, and output
7. Nuclear weapon effects on other systems

The DOE program proposes a set of experimental facilities, each designed to address one or more of these areas in a complementary fashion.

A general understanding of a nuclear weapon would be helpful to better understand these seven categories and their relationship to stockpile stewardship and management and NIF. Modern thermonuclear weapons consist of two stages: a primary stage (fission trigger) and a secondary stage (fusion). The purpose of the primary is to produce x rays to implode the secondary, thereby causing ignition. The secondary is the stage that produces high yields for modern U.S. strategic weapons-typically hundreds of kilotons. The primary contains a subcritical pit of fissile material, generally plutonium, surrounded by a layer of chemical high explosive. The high explosive is detonated, burns rapidly, and compresses the pit. The implosion of the pit increases the density of the fissile material to super criticality, leading to a fission chain reaction and rapid heating. X rays from the hot exploding primary are then channeled by a radiation case to the secondary, where they implode the secondary, creating temperatures and pressures great enough to ignite a fusion reaction in the secondary.

To increase their efficiency, modern primaries can employ a process called boosting. In boosted primaries, the pit contains the hydrogen isotopes deuterium and tritium gas that is compressed and heated. The deuterium and tritium gas undergoes fusion, producing copious quantities of energetic neutrons that flood the compressed pit. The extra burst of neutrons causes significant additional fission reactions that "boost" the primary yield to a much higher value. If the primary fails to boost properly, its yield may be inadequate to drive the secondary, resulting in weapon failure.

I.2.2.3 The National Ignition Facility as Part of the Stockpile Stewardship and Management Program

NIF would provide an essential capability for the DOE's science-based stewardship of the nuclear weapons stockpile. The basic goal of NIF is to achieve ignition of thermonuclear fusion in the laboratory by imploding and igniting a small capsule containing a mixture of deuterium and tritium. The goal of obtaining fusion ignition and burn at NIF would attract and challenge top scientific and engineering talent with a problem containing many of the same elements of physical understanding as those necessary for stewardship of the nuclear stockpile. Achieving fusion ignition and conducting experiments at such high temperatures and densities in NIF would make it possible to study the properties of material under conditions close to those they would be subjected to in a nuclear weapon detonation. Thus, specific experiments can be conducted with weapons materials to measure relevant equations of state (what pressures are created at high temperature), opacity (how a material absorbs and emits radiation), and hydrodynamics (how a material moves in response to forces applied). These experiments apply to several of the regimes of interest listed in section I.2.2.2. The following discussion focuses on how NIF can be used to evaluate weapons concerns relevant to the physical regimes in that list.

NIF experiments could examine the growth and control of hydrodynamic instabilities, which are important both in making inertial confinement fusion (ICF) targets ignite and burn and in making nuclear weapons perform reliably. Hydrodynamic instabilities ultimately lead to mixing of some quantity of one material with another. This mix can affect both ignition and burn processes (regimes 3 and 6). NIF experiments can determine how fusion fuels ignite and what helps and what hinders the ignition process (such as how much mix is tolerable).

High-temperature transport of radiation in complex geometries and materials (regime 4) can be examined to test the ability of computer models to predict this transport. Deposition and re-emission of radiation and the general transport problem constitute a very complex process. This process must be understood in order to predict the transport of radiation necessary to ignite ICF targets. In addition, radiation transport experiments can be designed to simulate weapons radiation transport conditions more closely than those in the basic ICF ignition target.

Output calculations must be done on the ICF ignition targets so that the performance of the target can be properly measured. Again, however, specific targets can be designed to alter the output radiation. These experiments can be used to test the computer codes used to calculate the output of weapons.

NIF targets, either the basic type for ignition or specially altered ones, would produce copious x rays, neutrons, gamma rays, and other radiation. These emissions can be used to assess the consequences of nuclear effects (regime 7) in electronic systems or other hardware intentionally exposed to these radiations. The survivability of military hardware subjected to various nuclear effects is an important factor in assuring reliability of that hardware.

In addition to its role in attracting and maintaining core scientific and engineering capability and in helping to verify the calculational capability of the more sophisticated computer models, NIF would also play a role in evaluating specific problems that arise in the stockpile, as mentioned in section I.2.2.2. As the stockpile surveillance program reveals an unanticipated change due to aging or remanufacture, a weapons expert will estimate which of the weapons physics processes listed in section I.2.2.3 could be affected. If any of the high-energy-density process (regimes 3 through 7) could be affected, then a NIF experiment may be designed to measure the physical properties of the change. For example, if the chemical composition of a material (such as a glue joint) has changed for some reason, it may be necessary to determine the opacity (how a material absorbs and emits radiation) of the changed material. Computer models are not able to predict the opacity of all materials under all temperatures and pressures. Thus, it may be necessary to put some of the changed material into a NIF target, raise its temperature and pressure to near those that would occur when the weapon is exploded, and measure its opacity (regime 4). These measurements would then be compared with the computer model predictions, and the physics model would be refined until an agreement was reached. The computer model could then be used to evaluate whether the given change in properties causes an integrated change in performance that adversely affects the reliability of the weapon. This evaluation would determine whether the altered weapon could remain in the stockpile (or be placed in the stockpile in the case of a remanufactured weapon).

In conclusion, NIF would address, to some degree, weapons processes that occur in physical regimes 3 through 7 in the list in section I.2.2.2. These processes are the ones that occur at very high energy density (high temperatures and pressures). These processes are very important in assessing a weapon's reliability. NIF would achieve higher temperatures and pressures, albeit in a very small volume, than any other proposed stockpile stewardship facility. It would also be the only facility that would achieve fusion ignition. The principal safety issues for a nuclear weapon that involve the high explosive and fissile material implosion, relevant physical regimes 1 and 2, could not be addressed in NIF.

The nuclear weapons expected to remain in the stockpile will age beyond their original design lifetime between the years 2005 and 2010. It is important to have NIF in place and operating successfully well before this period so that the facility can be used to help verify the new computer models before problems may begin arising more rapidly. The goals of completing construction of NIF in 2002 and achieving ignition by 2005 would allow this to happen, first with nonignition target experiments and later with ignition experiments.

I.2.3 Other Benefits of the National Ignition Facility

NIF would be a multipurpose facility used for both national security and civilian applications. The most significant potential long-term civilian application of ICF is the generation of electric power. DOE is pursuing two distinct approaches to fusion energy: magnetic fusion energy and inertial fusion energy. Development of inertial fusion as a source of electrical power depends upon achieving ignition in NIF. This approach to inertial fusion energy is consistent with the recommendations of the National Academy of Science's *Second Review of the Department of Energy's Inertial Confinement Fusion Program* (NAS 1990) and the *Fusion Policy Advisory Committee Report* (DOE 1990). Many studies (such as Meier 1994; Moir 1994) have described viable power plant designs that could be developed once high-gain targets are understood. Furthermore, the International Atomic Energy Agency report, *Energy from Inertial Fusion* (IAEA 1995), describes possible engineering development paths to a demonstration fusion power plant once ignition is established on NIF. These development paths are most efficiently accomplished if NIF can first be used to (1) determine the beam energy required for ignition, (2) map out the target gain curves, and (3) understand the post-ignition dynamics of the environment inside a reaction chamber. Thus, early achievement of ignition in NIF is needed to allow the pursuit of an efficient, timely, inertial fusion energy development program.

NIF would also establish new capabilities for the basic sciences. Because fusion targets would provide temperatures and pressures similar to those found in the sun and other stars, data from NIF high-energy-density experiments would interest scientists working in such fields as astrophysics, material sciences, nonlinear optics, x-ray sources, plasma physics, and computational physics. For example, astrophysicists could do experiments that study some of the processes that occur during primordial nucleosynthesis (the original formation of all elements), stellar evolution, and spectacular events such as a supernova explosion.

As the world's largest optical instrument, NIF could spur high-technology industries in the areas of optics, lasers, materials, high-speed instrumentation, semiconductors, and precision manufacturing.

Past ICF developments, for example, have led to manufacturing capabilities for precision optics that enabled the development of correcting optics to fix the initial problem of the Hubble space telescope. The ICF need for high-speed target diagnostics led to the development of a low-cost micro-impulse radar that has many commercial applications (12 industrial licenses have already been granted). Commercial applications derived from NIF could include flexible, low-cost, laser-based manufacturing; advanced x-ray lithography for integrated circuit manufacturing; high-density information storage; improved flat-panel display technology; advanced health care technologies; new materials; and new scientific instrumentation.

NIF would play a major role in U.S. science and technology early in the next century. Its civilian and defense missions would maintain weapons technology and expertise for continuing national security objectives, assess a new energy option, contribute to the basic high-energy-density sciences, and enhance industrial competitiveness through numerous technology advances.

I.2.4 Relationship of the National Ignition Facility to Other Department of Energy Environmental Impact Statements

DOE prepared this Programmatic Environmental Impact Statement (PEIS) to assess the alternatives for conducting the Stockpile Stewardship and Management Program, including the action described in this NIF Project-Specific Analysis (PSA). The PEIS also evaluates the No Action alternative and provide an assessment of environmental impacts to support programmatic and siting decisions.

However, for NIF and certain other facilities, the PEIS includes both a programmatic assessment and site-specific assessments of the construction and operation impacts at the reasonable candidate sites. The site-specific assessments consider the environmental impacts associated with siting of these facilities and provide a basis for deciding whether or not to proceed with construction.

DOE is currently preparing site-wide EISs for two of the five sites proposed as alternative locations for NIF: the Nevada Test Site (NTS) and the Los Alamos National Laboratory (LANL). The projected completion dates for these EISs are late 1996 for LANL and NTS. A site-wide EIS for the Lawrence Livermore National Laboratory, the preferred NIF location, was issued in 1992. The site-wide EISs address the continued operation of the sites, including near-term (within 5 to 10 years) proposed projects. The sitewide EIS's probide an opportunity to address the cumulative impacts of all reasonably foreseeable activities and provide a mechanism for coordinating site and agency planning for complex facilities by provideing an opportunity for review of the potential collective environmental effects associated with lafge, diverse facilities. The EIS's evaluate a range of different alternatives, including the alternative of continuing current operations.

DOE's *Draft Waste Mangement Programmatic Environmental Impact Statement*, issued in August 1995, addresses the long-term management and safe treatment, storage, and disposal of radioactive, hazardous, and mixed wastes. NIF would generate these types of wastes, and the treatment, disposal, and storage of NIF wastes would be compatible with any decisions resulting from the waste management PEIS. DOE is proceeding with two other actions related to the Stockpile Stewardship and Management Program: the Dual-Axis Radiographic Hydrodynamic Test Facility EIS (DOE 1995c) and the Tritium Supply and Recycling PEIS (DOE 1995d). DOE determined that implementing the ROD on these two facilities will not prejudice any decisions in the Stockpile Stewardship and Management Program.

I.3 Proposed Action and Alternatives

I.3.1 Overview

This chapter describes the alternatives analyzed in this Project-Specific Analysis (PSA) for the construction and operation of the National Ignition Facility (NIF) at one of five candidate locations at four alternate sites: Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL), Nevada Test Site (NTS) Area 22 main site location and North Las Vegas Facility (NLVF) location near NTS, or Sandia National Laboratories (SNL). The NIF Conceptual Design Report (LLNL 1994b) describes the proposed action in detail and establishes the technical feasibility of the project. Section I.3.2 describes the proposed action and includes a description of NIF and its operations. Section I.3.3 describes the No Action alternative. Section I.3.4 describes the five locations at the four alternative sites, including their selection, location, infrastructure requirements, and site-specific aspects of NIF construction and operations. Section I.3.5 discusses other alternatives not considered in detail. Section I.3.6 summarizes and compares the impacts of construction and operation of NIF at the four alternative sites.

I.3.2 Proposed Action

The proposed action is to construct and operate NIF, which would be capable of achieving fusion ignition by the inertial confinement fusion (ICF) process. Two options for NIF operations have been proposed. The Conceptual Design Option would use an ICF approach called *indirect drive* . The current research program on ICF has emphasized development of the indirect drive approach, and the experimental program currently planned for NIF uses that approach. In indirect drive, laser beams would illuminate and heat the interior surfaces of a metal case (hohlraum) containing a deuterium-tritium-filled capsule. The beams would cause the case to emit x rays that would in turn strike the fusion target capsule and drive the fusion reaction (figure I.3.2-1). Targets used for indirect drive would contain sub-milligram levels of tritium.

An Enhanced Option would include the above indirect drive operations and a second approach called *direct drive* . The Enhanced Option would also include the ability to perform an increased number of experiments to accommodate greater user needs. No hohlraum would be used in the direct drive ICF method. Instead, a large number of laser beams would impinge directly on the outer surface of the capsule containing the tritium and deuterium (figure I.3.2-1). Targets for direct drive would contain milligram levels of tritium. Achieving ICF by direct drive is theoretically possible, and an experimental feasibility program is currently underway at the Omega Upgrade Facility at the University of Rochester Laboratory for Laser Energetics in New York and at the Naval Research Laboratory in Washington, D.C. Because it is possible that NIF would be used for direct-drive experiments in its lifetime, operating conditions for both indirect- and direct-drive experiments have been developed and are assessed in this PSA.

I.3.2.1 National Ignition Facility Components

NIF would consist of three main elements: a laser system and optical components, a target chamber placed within a target area, and an advanced integrated computer system to control the lasers and diagnostic equipment. These three elements would be housed in a single environmentally controlled building called the Laser and Target Area Building (figure I.3.2.1-1). The entire NIF complex (figure I.3.2.1-2) would require a maximum area of about 20 hectares (ha) (50 acres). Depending on the site selected, many of the NIF needs may be served by existing facilities (see section I.3.4), reducing the requirements for a full 20 ha (50 acres) of new land area.

I.3.2.1.1 *Laser and Target Area Building*

The Laser and Target Area Building would be an environmentally controlled facility housing the laser and target area systems and the integrated computer system. The majority of the building would contain laser optics. This reinforced concrete and structural steel building would be constructed to be vibration isolated, provide radiation confinement and control, and include all necessary machine control and diagnostic systems. It would consist of two laser bays, two optical switchyards, a target chamber in a target area, target diagnostic facilities, capacitor areas, control rooms, and operations support areas (figure I.3.2.1-1). The floor plan would have a U-shaped layout, with the laser bays forming the legs of the "U" and the optical switchyards and target room forming the connection (LLNL 1994b).

I.3.2.1.1.1 *Laser System*

A laser is a device that produces a beam of monochromatic (single-color) "light" in which the waves of light are all in phase. This condition creates a beam that has relatively little divergence (scattering) and has a high concentration of energy per unit area of the beam. The NIF laser system would generate and deliver high-power optical pulses to a target suspended in the target chamber. Multiple laser beams would be used to uniformly irradiate the required target surface area.

The NIF laser would contain 192 independent laser beams, or beamlets. Each beamlet would have a square aperture of slightly less than 40-centimeter (cm) (16-inch [in]) beam width. Beamlets, each of which would have a unique beam path, or beamline, to the chamber, would be grouped in 48 2x2 groupings at the target chamber. The 192 beamlines would require more than 10,000 discrete optical components. Figure I.3.2.1.1.1-1 illustrates a schematic diagram of the path of one beamlet from origin to the target.

I.3.2.1.1.2 *Target Area*

The NIF target area (figure I.3.2.1.1.2-1) would provide confinement of tritium and activation products by providing physical barriers and by controlling air flow. In addition shielding would provide protection from neutron and gamma radiation. The target area would consist of the following major subsystems: target chamber, target emplacement positioner, target diagnostics, target diagnostic control room, support structures, environmental protection, and vacuum and other auxiliary systems (LLNL 1994b). The primary tritium confinement would be provided by the target (vacuum) chamber and tritium collection system, which would be designed to capture tritium exhausted from the test chamber. The secondary tritium confinement would be the Target Area Building structure, which would be provided with a heating, ventilation, and air conditioning system capable of operating at a negative pressure during and immediately after shots of greater than 1 megajoule (MJ). The building structure would act as the confinement for air activation products. The final exhaust release point from the heating, ventilation, and air conditioning system would be elevated. The airborne radiation releases at the building release points would be measured and the target area would have monitors to allow detection of conditions requiring corrective or protective actions.

Environmental protection systems, including tritium-handling systems, target storage, and decontamination equipment used to clean the target chamber components, would be located adjacent to the target chamber and target chamber room. X-ray, optical, and neutron measurement instruments would be arranged around the chamber to help evaluate the success of each target experiment. Structural support of the target diagnostics, as well as of the target positioner, final optic assemblies, and turning mirrors, would be provided by target area structures. The target area would also provide the following subsystems: the target area auxiliary systems, material handlers, the chamber personnel transporter, and the diagnostics and classified control rooms.

I.3.2.1.1.3 *Target Chamber*

The NIF target chamber would be a 10-meter (m) (33-feet [ft]) internal-diameter spherical aluminum shell with walls 10 cm (4 in) thick (figure I.3.2.1.1.3-1), and the exterior of the chamber would be encased in 40 cm (16 in) of concrete to provide neutron shielding. The target chamber would be supported vertically by a hollow concrete pedestal and horizontally by radial joints connected to the cantilevered floors. The aluminum wall of the chamber would provide a vacuum barrier and mounting surface for the first wall panels, which protect the aluminum from soft x rays and shrapnel. The vacuum system would provide a 10^{-6} torr vacuum level for target experiments (LLNL 1994b). The laser beams would enter the chamber in two conical arrays from the top and two conical arrays from the bottom. At the poles and in the equatorial regions of the chamber, diagnostic equipment would be inserted through the chamber wall. Unconverted laser light that hit the opposite wall would be absorbed by the light-absorbing panels located adjacent to and slightly smaller than the opposing beam port. The target chamber would also include the target emplacement and positioning/alignment systems and planned diagnostics.

I.3.2.1.1.4 *Integrated Computer Control System*

The computer control system would be an integrated network of conventional computer systems providing the hardware and software needed to support full operational activities. The system would include the computer controls to manage the complex laser optical system and would have to meet security requirements to handle classified information.

I.3.2.1.1.5 Sequence of Events During an Ignition Shot

A shot would begin as weak laser pulses at four separate frequencies (or colors of light) in the master oscillator room (figure I.3.2.1-1). Each pulse is launched into an optical fiber system that amplifies and splits the pulse into 192 separate fibers, 48 of each color. The four colors are used to smooth the intensity (power per unit area) of the laser spot on the target. The power in the laser pulse at this point is a little less than a watt. Typical pulses are a few nanoseconds long, so the energy is a few nanojoules. The optical fibers carrying the pulses then spread out to 192 preamplifiers. The preamplifiers are located beneath the focal plane at the center of the large transport spatial filters, which are located between the laser components and the target chamber (figure I.3.2.1.1.1-1). Within the preamplifier, the pulse is amplified by a factor of about one million, to about a millijoule. The laser pulse then enters spatial beam-shaping optics and a flashlamp-pumped, four-pass rod amplifier, which converts it to about a 1-joule pulse with the spatial intensity profile needed for injection into the main laser cavity.

The pulse of laser light from the preamplifier reflects from a small mirror (labeled LM0, figure I.3.2.1.1.1-1). The laser light comes to a focus at the focal plane of the transport spatial filter, and passes through booster amplifier 3, reflects from the polarizer, is amplified further in cavity amplifier

2, goes through a second spatial filter (the cavity spatial filter), then passes through cavity amplifier 1, and reflects from the deformable mirror (mirror LM1, figure I.3.2.1.1.1-1). The beam then reflects back through cavity amplifier 1, the cavity spatial filter, and cavity amplifier 2.

In the interim, the Pockels cell (figure I.3.2.1.1.1-1) is energized. This component rotates the plane of polarization of the laser light from horizontal to vertical. Therefore, the laser light pulse passes through the polarizer and strikes cavity mirror LM2, which redirects the pulse back to the Pockels cell, which rotates the polarization back to horizontal. The pulse then continues towards the deformable mirror LM1. It then reflects back from LM1, through cavity amplifier 1, the cavity spatial filter, and cavity amplifier 2 again. By this time the Pockels cell has been de-energized so that it no longer rotates the polarization of the pulse. Thus, the laser pulse reflects from the polarizer and is further amplified by booster amplifier 3 to an energy of about 17 kilojoules for a typical ignition target pulse shape. The pulse then passes through the transport spatial filter on a path slightly displaced from the input path, thus just missing the injection mirror LM0.

The laser pulse then travels through a long beam path reflecting from several transport mirrors (LM 4 through 8) until it reaches the target chamber. (For simplicity, figure I.3.2.1.1.1-1 does not show all of these mirrors.) Mounted on the target chamber is a frequency converter that changes the infrared laser pulses to ultraviolet light. The focusing lens then brings the four color pulses (192 separate fibers or 48 for each color pulse) to a focus at a single spot at the center of the target chamber. The debris shield/phases plate (figure I.3.2.1.1.1-1) protects the focusing lens from any target fragments, and it may also have a pattern etched into its surface to reshape the distribution of laser intensity in the focal spot on the target.

The target would be a small spherical capsule whose hollow interior would contain a thin annular layer of liquid or solid DT fuel (a mixture of deuterium and tritium isotopes of hydrogen). The outer surface of the capsule is rapidly heated and evaporated, either by the absorption of soft x rays under indirect drive or by direct heating by lasers under direct drive (see figure I.3.2-1). The rocket effect caused by the evaporated outer capsule creates an inward pressure causing the capsule to implode in about 4 nanoseconds. The implosion heats the DT fuel in the core of the capsule to about 50 million degrees Celsius (90 million degrees Fahrenheit), sufficient to cause the innermost core of the DT fuel to undergo fusion. The fusion reaction products deposit energy in the capsule, further increasing the fuel temperature and the fusion reaction rate. Core fuel ignition occurs when the self-heating of the core DT fuel due to the fusion reaction product deposition becomes faster than the heating due to compression. The ignition of the core would then propagate the fusion burn into the compressed fuel layer around the core. This will result in the release of much more fusion energy than the energy required to compress and implode the core.

The energy in one pulse would be about equal to the caloric energy in one candy bar (1.8 MJ, or 400 food calories). However, the peak power for a few nanoseconds would be equal to about 500 terawatts (500×10^{12} watts), instantaneously exceeding the steady-state power capacity in the entire United States by about a factor of 1,000 (LLNL 1994a).

I.3.2.1.2 Target Receiving/Inspection Area

NIF would require a facility at which to receive and inspect targets fabricated at another site (LLNL 1995b). This area would require several Class 100 (Airborne Particulate Cleanliness Class) clean rooms and inspection laboratories in a vibration-free environment. This facility would also include cryogenic laboratories and a central chemical waste system. The facility would have to meet security requirements to handle classified equipment.

I.3.2.1.3 *Other Areas*

Optics Assembly Area/Clean Room. The optics assembly area/clean room would be used to clean, coat (for example, with Sol-gel as an optics dielectric), inspect, and assemble the NIF's optics and crystals (LLNL 1995b).

General Assembly Area. The general assembly area would be used to assemble mechanical and electrical components not requiring a clean-room environment (LLNL 1995b). The facility would be equipped to handle large and heavy assemblies. This area would also be used for assembly welding.

Optics Maintenance Area. The optics maintenance area would be used for refurbishing, cleaning, and coating of both laser glass and optical components (LLNL 1995b). This specialized area would require vibration isolation, temperature and humidity controls, and Class 100 clean rooms.

Optics Storage Area. During the NIF operational phase, spare parts would be stored in the optics storage area. Because of the size and mass of many of these components the storage area would provide for truck and forklift access (LLNL 1995b).

Radioactive Storage Area . The radioactive storage area would be an intermediate storage area used to store components that come out of the target area before they can be decontaminated.

Electrical and Mechanical Shops. The electrical and mechanical shops would house the machine tools to be used for repairs, maintenance, and special fabrication required for daily operations of the NIF laser and its auxiliary systems (LLNL 1995b).

Support Facilities. NIF would require the following additional support facilities (LLNL 1995b): (1) shipping, receiving, and central stores; (2) medical building; (3) cafeteria; (4) garage and gas station; (5) fire station; and (6) security and badging. All of these services currently exist within the infrastructures of the candidate sites and could be used by NIF.

I.3.2.1.4 Facility Construction

Conventional construction techniques would be used to build NIF. The extent and exact nature of such activities as site clearing, infrastructure improvements, and support facility construction required would depend on the specific location selected for NIF. Construction of NIF would be organized in the following sequential phases: (1) initial building construction, (2) special equipment structures installation, (3) final building construction, (4) final installation preparation, (5) clean component installation, and (6) final laser/target systems installation.

As conceptually designed, about 20 ha (50 acres) of land area would be required for NIF. Figure I.3.2.1-2 shows an overall conceptual plan of a generic NIF site, including all required buildings and improvements. Within this area, all direct and support buildings for NIF would require 4.7 ha (11.6 acres). There would also be 4.1 ha (10.1 acres) of access roads and 1.9 ha (4.7 acres) of parking space (LLNL 1995b). The remaining 9.3 ha (23.0 acres) would consist of open space (e.g., landscaped lawns). The actual amount of land required at the selected host site would be less, as all of the candidate sites have existing facilities that could meet some of the infrastructure requirements for NIF (see section I.3.4). During construction, about 2.0 ha (4.9 acres) of land would be required for a construction laydown area. The laydown area would be located within or near the location designated for the NIF (see section I.3.4). Following construction, the laydown area would be restored to its preconstruction condition or incorporated into the landscaping design selected for the site.

I.3.2.2 Facility Operations

The NIF experimental plan comprises several stages:

- Start-up experiments to activate core diagnostics and to validate laser performance
- Hohlraum tuning experiments to attain minimum asymmetry in x-ray drive (indirect-drive approach only, laser symmetry experiments for direct drive)
- Cryogenic pre-ignition experiments for detailed study of capsule implosions
- User experiments for weapons physics, weapons effects, and other user groups
- Ignition experiments
- Ignited burn experiments to obtain basic data for inertial confinement energy development, basic scientific research on high-density plasmas, and research relative to various military-related applications

When the laser "fires" on a target, all 192 laser beams are synchronized such that after grouping in 48 2x2 groupings at the chamber, they simultaneously "hit" the target. The target is compressed and heated, creating intense fusion reactions. Ignition is defined as occurring when heating of the compressed target by fusion products is just adequate to create an advancing front, or wave, of fusion reactions across the target, heating or "igniting" the entire fuel in the target to reaction conditions.

The numbers and types of "shots" needed to achieve ignition have been estimated on the basis of experience with other large laser systems-such as Nova (many of the activities for NIF would have parallels with Nova, such as hohlraum symmetry and plasma diagnostic activation) and the NIF Beamlet Demonstration Project. Relatively low laser energies would be required for most of the early shots; shaped pulses greater than 1 MJ would be required for very few shots before the demonstration of ignition. It is estimated that approximately 1,600 target shots, in addition to approximately three months of downtime for installation of a cryogenic target positioner, would be required to attain ignition (LLNL 1994b). Concurrently, other target experiments would be carried out for various user communities.

I.3.2.2.1 *Conceptual Design Operations*

It is expected that once ignition is achieved, NIF would be operated within the constraints specified for an operational baseline in the Conceptual Design. This baseline, or Conceptual Design Option, is the 192-beam, indirect drive operation mode for NIF. The estimated parameters for the Conceptual Design Option are as follows:

- Maximum design yield: 20 MJ
- Annual total yield: 385 MJ/year (yr)
- Tritium throughput: 600 Curies (Ci)/yr
- Maximum tritium inventory: 300 Ci
- Tritium effluent: 10 Ci/yr

I.3.2.2.2 *Enhanced Option Operations*

The enhanced NIF operational capabilities, or Enhanced Option, would include the indirect drive and user capabilities described above plus direct-drive capabilities and additional test-specific capabilities that might be desired by the user communities. In addition, the Enhanced Option would include the ability to perform an increased number of yield experiments per year to accommodate greater user needs. Enhanced capability operations would involve some design changes to the Conceptual Design Option Facility. By diverting the 24 beamlines (96 beamlets) from the indirect-drive configuration for direct drive, an additional 24 beam ports would be placed evenly spaced half above and half below the chamber equator. Final optics assemblies already modified for direct drive would be placed permanently at these ports. The final turning mirrors that direct the laser beams to their final optics assemblies would be adjusted with motors to direct the selected beams away from their usual final optics assemblies and toward another final mirror that would send the beams through the new final optics assemblies in a direct-drive mode. A different target positioner would be required for direct-drive target insertion and positioning. A new target shroud that could be removed much more quickly than that for indirect drive would also be required. Equipment decontamination systems would also be upgraded for the Enhanced Option. The Enhanced Option Facility would use the same utilities and consumables (for example, electricity, water, fuel, and oil) as the Conceptual Design Option Facility.

Under the Enhanced Option, NIF would have the capability to do both direct and indirect drive target experiments (although several days would be necessary to switch from one mode to another). The facility would also have the capacity to handle more experiments per year (both yield and no-yield types) to accommodate greater user needs than permitted by the Conceptual Design Option operations. The estimated operating parameters for the Enhanced Option are as follows:

- Maximum design yield: 20 MJ[1]
- Annual total yield: 1,200 MJ/yr
- Tritium throughput: 1,750 Ci/yr
- Maximum tritium inventory: 500 Ci
- Tritium effluent: 30 Ci/yr

I.3.2.2.3 *Security*

Both classified and unclassified activities would be conducted at NIF, and appropriate security and badging requirements would be implemented. Because many uncleared visitors are expected to use the facility, security features would be designed to allow easy access for visitors while at the same time maintaining effective physical and technical security where necessary.

Security requirements would include those for physical protection of classified matter; physical protection of Department of Energy (DOE) property and unclassified facilities; protective program operations; and personnel security, including issuance, control, and use of badges, passes, and credentials. In addition, telecommunication services would be designed to be capable of handling both classified and unclassified information.

I.3.3 No Action Alternative

Under the No Action alternative, NIF would not be constructed or operated. NIF's experiments related to science-based stockpile stewardship (see section I.2.2) would not be realized. If NIF were not built, the ability of the Stockpile Stewardship and Management Program to obtain the fusion and high-temperature/density data that would have been available with NIF would be hampered or delayed. The Stockpile Stewardship and Management Program would continue to use Nova and other facilities for as long as they produced useful data, but the existing facilities are not capable of reaching the temperatures and pressures that are anticipated for NIF. If other technologies were proposed to obtain higher temperatures and pressures than those available from existing facilities, such technologies would not be operational by the period 2005 to 2010. When enduring stockpile weapons age beyond their original design lifetimes, confidence in the reliability of such weapons may decrease significantly, and the probability would increase that the United States might have to invoke "supreme National interest" and withdraw from any test moratorium or Comprehensive Test Ban Treaty.

Under the No Action alternative, many operations at LLNL, LANL, SNL, and NTS would continue as described in the existing environment subsections of chapter I.4. However, all existing NIF-dependent functions of the ICF program would be discontinued at LLNL, LANL, and SNL. The number of employees at each of these sites would decrease somewhat as a result. For the purposes of the socioeconomic analysis in this PSA, it is assumed that employment at LLNL would decrease by 100, employment at LANL would decrease by 20, and employment at SNL would decrease by 20. There would be no change in employment at NTS or NLVF related to the No Action alternative.

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1 Maximum credible yield is 45 MJ for bounding accident evaluation.

I.4 Affected Environment and Environmental Impacts

I.4.1 Lawrence Livermore National Laboratory

I.4.1.1 Affected Environment

The following sections describe the affected environment associated with the construction and operation of the National Ignition Facility (NIF) at Lawrence Livermore National Laboratory (LLNL). Land use, air quality and acoustics, water resources, biotic resources, cultural and paleontological resources, socioeconomics, radiation and hazardous chemicals, and waste management are described.

I.4.1.1.1 Location and Land Use

The LLNL 332-hectare (ha) (821-acre) site is east of the city of Livermore, California; immediately to the south is Sandia National Laboratories (SNL), Livermore (figure I.3.4.1.1-1). Although their primary missions are similar, LLNL and SNL are separate facilities. Also located south of LLNL are agricultural areas devoted to grazing, orchards and vineyards, some low-density residential areas, and a business park to the southwest. A very small amount of low-density residential development lies east of LLNL, and a business park is located to the north. A parcel of open space to the northeast has been rezoned to allow development of a center for heavy industry (LLNL 1994d). A high-density residential area lies west of the site. I.4.1.1.1-1 shows generalized land use at LLNL and vicinity.

The majority of the LLNL site is designated "industrial," and the perimeter areas on the western and northern portions of the site are designated "industrial" or "agricultural." The southwestern and southeastern quadrants of the site are the most crowded. The proposed location for NIF at LLNL is in the northeastern quadrant of the site adjacent to existing inertial confinement fusion (ICF) facilities (figure I.3.4.1.1-2).

Slopes at the LLNL site are nearly level. Soils are loamy textured, shallow to very deep soils occur on older fans and floodplains. The erosion potential is slight to moderate. No prime or unique farmland soils are located at LLNL.

I.4.1.1.2 Air Quality and Acoustics

This discussion of existing air quality and acoustics includes a review of the meteorology, climatology, and atmospheric dispersion characteristics near LLNL. No meteorological data were available for the proposed NIF location, so the nearest local and regional monitoring information was used to describe expected site conditions.

I.4.1.1.2.1 Meteorology and Climatology

The climate at LLNL and the surrounding region is characterized by mild, rainy winters and warm, dry summers. The annual average temperature at LLNL is 15.0 degrees Celsius (°C) (59.0 degrees Fahrenheit [°F]); average daily temperatures range from 7.9 °C (46.2 °F) in January to 21.0 °C (69.8 ° F) in July. The average annual precipitation is 37.8 centimeters (cm) (14.9 inches [in]) (LLNL 1995a). The prevailing winds are from the southwest to west at an annual average wind speed of 3.3 meters per second (m/s) (7.4 miles [mi] per hour [hr] [mph]) (LLNL 1992). The 1994 annual wind rose for LLNL is shown in figure I.4.1.1.2.1-1. During 1994, unstable conditions occurred approximately 29 percent of the year, neutral conditions occurred about 35 percent of the year, and stable conditions occurred the remaining 36 percent (LLNL 1995d). Atmospheric dispersion improves as the wind speed increases and atmospheric conditions become more unstable.

I.4.1.1.2.2 Ambient Air Quality

National Ambient Air Quality Standards (NAAQS) exist for the criteria air pollutants ozone, carbon monoxide, nitrogen dioxide, sulfur oxides (measured as sulfur dioxide), particulate matter with a diameter of less than microns (PM 10), and lead (40 Code of Federal Regulations [CFR] 50). California has established state ambient air quality standards for these pollutants, as well as standards for suspended sulfates, hydrogen sulfide, vinyl chloride (chloro-ethene), and visibility reducing particles. In addition, the Bay Area Air Quality Management District (BAAQMD) has established a monthly ambient concentration limit for beryllium 1994d), which is the same as the National Emission Standard for Hazardous Air Pollutants for beryllium (40 CFR 61.32). Applicable NAAQS and California state and BAAQMD ambient air quality standards are presented in I.4.1.1.2.2-1.

Table I.4.1.1.2.2-1.-- Comparison of Baseline Ambient Air Concentrations with Most Stringent Applicable Regulations and Guidelines at Lawrence Livermore National Laboratory

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Pollutant	Averaging Time	Most Stringent Regulation or Guideline g/m^3)	1993 Baseline Concentration [1] g/m^3)
Criteria Pollutant			
Carbon monoxide	8-hour	10,000 [2, 3]	4,600
	1 hour	23,000 [3]	7,000
Lead	Calendar quarter	1.5 [2]	0.01
	30-day	1.5 [3]	0.01
Nitrogen dioxide	Annual	100 [2]	36
	1 hour	470 [3]	210
Ozone	1 hour	180 [3]	250 [4]
Particulate matter 10 microns or smaller	Annual arithmetic mean	50 [3]	24.3
	Annual geometric mean	30 [3]	20.9
	24-hour	50 [3]	84 [4]

Sulfur dioxide	Annual	80[2]	ND [5]
	24-hour	105[3]	ND
	3-hour	1,300[2]	ND
	1 hour	655[3]	ND
Mandated by State			
Hydrogen sulfide	1 hour	42	ND
Suspended sulfates	24-hour	25	6.9
Vinyl chloride (chloroethene)	24-hour	26	ND
Visibility-reducing particles	8-hour (10 a.m.-6 p.m. PST)	[6]	ND
Mandated by BAAQMD			
Beryllium	30-day	0.01	0.000137
Other Air Pollutants			
Particulate ammonium-10mm	24-hour	NS [7]	1.50
Particulate chloride-10mm	24-hour	NS	3.61
Particulate nitrate-10mm	24-hour	NS	20.8
Particulate sulfate-10mm	24-hour	NS	4.7
Suspended nitrates	24-hour	NS	22.5
Total suspended particulates	24-hour	NS	93.0

LLNL is located within the San Francisco Bay Area Basin, designated by the Federal Government as the San Francisco Bay Intrastate Air Quality Control Region (AQCR 30). The Bay Area Basin is in attainment for all national ambient air quality standards except carbon monoxide in an urban area that includes the northern tip of Alameda County (40 CFR 81.305). This nonattainment area does not include LLNL. The Bay Area Basin is designated nonattainment for the state ozone and PM 10 and has an unclassified state designation for hydrogen sulfide and visibility reduction (CARB 1994). (With the exception of one county designated as attainment and four counties and part of a fifth county designated as unclassified, all of California is designated as nonattainment for the state 24-hour PM 10 .) In general, pollutant emission increases in an area designated nonattainment for a specific pollutant are subject to more stringent permitting requirements than if the area is designated as attainment.

The BAAQMD is responsible for air pollution control from stationary sources and attainment of air quality standards in the San Francisco Bay Area, including Alameda County. The district operates ambient air monitors throughout the San Francisco Bay Area Air Basin to determine compliance with national and state ambient air quality standards. The BAAQMD monitor closest to LLNL is the Livermore Old First Street Station located in downtown Livermore. In addition, LLNL maintains onsite and 11 offsite particulate monitors that measure airborne beryllium concentrations. The most recently published data show violations in calendar year 1993 of the state and national ozone standards and the state 24-hour PM 10 standard (see table I.4.1.1.2.2-1 and Lazaro et al. 1996).

Federal Prevention of Significant Deterioration (PSD) regulations limit increases in criteria pollutant concentrations resulting from emissions from new sources above a baseline concentration. The allowable concentration increases (called increments and presented in Lazaro et al. 1996), depend on the PSD classification of the area. Class I areas allow the smallest increases. The area surrounding LLNL contains several PSD Class I areas. The closest such areas are Point Reyes National Wilderness Area, approximately kilometers (km) (55 miles) to the west-northwest; Desolation National Wilderness Area and Mokelumme National Wilderness Areas (160 to km [100 to 110 mi]) to the northeast; and Emigrant National Wilderness Area, Hoover National Wilderness Area, and Yosemite National Park (215 to km [135 to 145 mi]) to the east-northeast and east.

The primary emission sources of criteria pollutants at LLNL are numerous boilers, solvent cleaning operations, stand-by electric generators, and various experimental, testing, and process sources. Emissions estimates for these sources are presented in section I.4.1.2.2.

I.4.1.1.2.3 Acoustic Conditions

Major noise emission sources within LLNL include various experimental facilities, equipment, and machines. LLNL is bordered by highways along its entire boundary. In the vicinity of a highway, traffic contributes to ambient noise levels, especially during peak hours. Across the highways bordering the site, the main land uses are light industrial to the north and south, urban residential to the west, agricultural to the southwest, and open rangeland to the east. The acoustic environment along the LLNL boundary is generally assumed to be that of an urban location, with typical average daytime sound levels of 55 to 65 decibel A-weighted (dBA).

I.4.1.1.3 Water Resources

The LLNL site is in the eastern Livermore Valley. Only intermittent streams flow into the eastern Livermore Valley from the surrounding uplands and low hills. Two intermittent streams flow through the LLNL site: Arroyo Las Positas and Arroyo Seco (figure I.4.1.1.3.-1). The proposed NIF location is in the drainage of Arroyo Las Positas. Arroyo Las Positas drains an area of 13.3 square kilometers (km2) (5.16 square miles [mi2]) east of the LLNL site. The channel is not well defined and usually carries only storm runoff. The channel enters the site from the east, is diverted along a ditch around the northern edge of the site, and exits the site at the northwestern corner. Arroyo Seco has a drainage area of 36.3 km2 (14.0 mi2) upstream of Sandia National Laboratories, Livermore. The headwaters of the arroyo are in the hills southeast of the LLNL site. The channel is well defined in the LLNL area and is dry for at least six months of the year.

Surface drainage and infiltration at LLNL are generally good, but infiltration decreases locally with increasing clay content in soils (U.S. Department of Energy [DOE] and University of California [UC] 1992). About one-fourth of stormwater runoff within the LLNL site drains into the Central Drainage Basin (figure I.4.1.1.3.-1), which collects runoff from the southeastern quadrant of the LLNL site. During extreme wet weather, the basin can overflow through culverts into storm drains that discharge into Arroyo Las Positas. The remainder of the site drains either directly or indirectly into the two arroyos through storm sewers and ditches (DOE and UC 1992; LLNL 1994d).

Groundwater at the LLNL site occurs in an unconfined zone overlying a series of semiconfined aquifers. The two geologic units containing the most important aquifers are the surface valley-fill deposits and the Livermore Formation. The aquifers in the Livermore Valley are locally recharged by precipitation, irrigation, stream runoff from precipitation, and controlled releases from the South Bay Aqueduct and gravel pits west of the city of Livermore. Groundwater withdrawal from the Livermore Valley is mainly for agricultural use, municipal use, and gravel quarrying. In the vicinity of the LLNL site, agricultural withdrawal is still a major source of groundwater drawdown. Depth to groundwater at the LLNL site varies from about m (110 feet [ft]) in the southeast corner to m (30 ft) in the northwest corner (DOE and UC 1992).

Water used at LLNL (including Sandia National Laboratories, Livermore) is primarily surface water purchased from the city of San Francisco Hetch Hetchy Aqueduct and from the Alameda County Flood and Water Conservation District, 7. A small amount of treated groundwater is used for irrigation and cooling tower makeup. In 1990, 983 million liters (L) (260 million gallons [gal]) and 74.1 L (19.6 million gal) of water were obtained from the two sources, respectively. The water is primarily used for industrial cooling processes, the sanitary system, and irrigation. The LLNL site (excluding Sandia National Laboratories, Livermore) currently uses 970 liters per year (MLY) (256 million gallons per year [MGY]) annually (LLNL 1995c) and used an average of 990 MLY (262 MGY) from 1986 through 1990 (DOE and UC 1992).

Beginning in 1988, LLNL started implementing water conservation measures such as reducing landscape watering by 35 percent below the projected 1989 level, reducing blowdown from cooling towers to minimal operable levels, limiting use of water for car washes, and eliminating the washing of sidewalks and driveways (DOE and UC 1992).

The city of Livermore Water Reclamation Plant handles sewage from the LLNL site and Sandia National Laboratories, Livermore. The plant currently receives an average of 6.205 MLY (1.643 MGY). The facility is being expanded to treat 11.753 MLY (3.103 MGY) (DOE and UC 1992). LLNL discharges about 402 MLY (110 MGY) of wastewater to the city of Livermore sewer system. This volume includes wastewater from Sandia National Laboratories, Livermore, which is discharged into the LLNL sewer system. LLNL tests and pretreats all wastewater before it leaves the site.

I.4.1.1.4 Biotic Resources

LLNL is within the Southern and Central California Plains and Hills Ecoregion (Omernik 1986). This ecoregion is dominated by annual grasslands. A generalized overview of the habitats and biota that occur at LLNL are provided by DOE and UC (1992). Agricultural, industrial, and residential developments have limited the diversity of wildlife in the area of LLNL. About 259 ha (640 acres) percent) of the 332-ha (821-acre) LLNL site is developed. The developed portions of LLNL are planted with ornamental vegetation and lawns; the undeveloped lands in the security areas (including the proposed NIF and laydown locations) are primarily dominated by non-native grasses and forbs. Common plant species include ripgut brome, slender oat, star thistle, Russian thistle, turkey mullein, sweet fennel, and Italian ryegrass (DOE and UC 1992). Relatively small areas of other habitats at LLNL hold a special significance, either because of their uniqueness or because of their importance as habitat to biota. These areas are primarily limited to remnant riparian habitats in Arroyo Seco along the southwestern corner of LLNL. These areas contain native tree species such as red willow and California walnut and introduced species such as black locust and almond (DOE and UC 1992). No wildlife refuges or sanctuaries occur at LLNL.

The wildlife of LLNL consists primarily of species adapted to habitats that have been disturbed by humans and that are tolerant of human presence (DOE and UC 1992). Common species at LLNL include the western fence lizard, western meadowlark, American crow, American robin, Anna's hummingbird, white-throated swift, California quail, house sparrow, scrub jay, European starling, house finch, house sparrow, desert cottontail, black-tailed jackrabbit, feral house cat, and California ground squirrel. Raptors that have been observed at LLNL include the red-tailed hawk, Cooper's hawk, sharp-shinned hawk, ferruginous hawk, red-shouldered hawk, black-shouldered kite, American kestrel, burrowing owl, turkey vulture, and golden eagle. Red and gray foxes, coyotes, and raccoons are also known to exist throughout LLNL (DOE and UC 1992).

Wetlands at LLNL are limited to three small areas totaling 0.15 ha (0.36 acre) located at, and downstream from, culverts (DOE and UC 1992). Saltgrass and sedge dominate the two wetlands that exist along Arroyo Las Positas; the other wetland is dominated by cattails, with saltgrass and sedge also existing. Other plant species existing in these wetlands include willow, curly dock, ryegrass, and Hooker's evening primrose. These wetlands are located m (1,000 ft) and more from the proposed NIF construction area.

Aquatic habitats are limited to intermittent drainages (in the two arroyos that cross the site), ditches, and a 1.6-ha (4-acre) water retention basin at LLNL. The water retention basin, located southwest of the proposed NIF location near the center of LLNL, is the only water body that contains fish (mosquito fish). It also could provide habitat suitable for waterfowl, tricolored blackbirds, sensitive amphibians, and sensitive aquatic invertebrates. Runoff from this basin could eventually increase riparian habitat within Arroyo Las Positas (DOE and UC 1992). Kingfishers and pied-billed grebes have been observed at the basin (LLNL 1994d).

A list of rare, threatened, and endangered Federal and state species that could exist at LLNL is provided in Lazaro et al. (1996). Most of the listed species would be more likely to exist in the less disturbed habitats of LLNL, although several of the species could forage or inhabit the grassland habitat identified for NIF and/or laydown locations (such as western burrowing owls). During detailed surveys conducted in 1991, no sensitive species were encountered at LLNL (DOE and UC 1992). During the summer of 1994, a nesting pair of white-tailed kites, a state-protected species, was noted in a stand of eucalyptus trees near the East Gate (LLNL 1994a). No designated critical habitats for federally listed species exist at LLNL.

I.4.1.1.5 Cultural and Paleontological Resources

No prehistoric or historic archaeological sites or historic structures exist on the proposed locations for NIF at LLNL. The uppermost 0.6 to m (2 to 4 ft) of sediment at the proposed site is composed of redeposited fill that would not contain any undisturbed archaeological remains. Results of an intensive pedestrian survey (employing 15 m [50 ft] transects) conducted in July 1990 noted the disturbed character of the surficial sediment and absence of archaeological remains (Bennett 1994). The fill unit overlies alluvium of Pleistocene age that was deposited at least 15,000 years ago (Dresen and Weiss 1985) and thus antedates the earliest documented human settlement in the region (therefore, has little or no probability of containing archaeological remains). Paleontological remains (which would represent late Quaternary fauna) have not been recovered from the alluvium (Dresen and Weiss 1985). Consultation is in progress with Native American groups to identify any important cultural resources on LLNL.

I.4.1.1.6 Socioeconomics

Socioeconomic characteristics discussed here include the regional economy, population and housing, public finance and public service infrastructure, and local transportation. Regional economic statistics are based on a regional economic study area that encompasses counties around LLNL, as defined by the U.S. Bureau of Economic Analysis (BEA). The economic study area is a broad labor and product market-based region linked by trade among economic sectors within the region. Statistics for population and housing, public finance, and public service infrastructure are based on the region of influence (ROI), a three-county area (Alameda, Contra Costa, and San Joaquin counties) in which nearly percent of all LLNL employees reside. Lazaro et al. (1996) lists counties included in the economic study region and the counties included in the ROI. Assumptions, assessment methodologies, and supporting data for each technical area are also presented in Lazaro et al. (1996).

I.4.1.1.6.1 Regional Economy

The regional economic study area for LLNL includes the San Francisco-Oakland-San Jose Consolidated Metropolitan Statistical Area, consisting of the following Primary Metropolitan Statistical Areas: Oakland, San Francisco, San Jose, Santa Cruz, Santa Rosa-Petaluma, and Vallejo-Fairfield-Napa. Between 1988 and 1995, employment in the economic study area was projected to increase from 4,555,600 to 5,117,400. BEA projects a compounded average annual rate of growth of percent from 1995 to 2003 jobs) (BEA 1990). The unemployment rate in the area is expected to decrease from 6.5 percent in 1995 to 4.4 percent in 2010 (Association of Bay Area Governments 1993).

In 1995, LLNL employed approximately 8,300 people, accounting for percent of employment in the regional economic study area. The distribution of LLNL employees by place of residence in the ROI is presented in Lazaro et al. (1996).

I.4.1.1.6.2 Population and Housing

The ROI has experienced significant population growth between 1980 and 1990, with an average annual increase of about percent, bringing the 1990 total to about 2.5 million. By the year 2000, population in the ROI is expected to grow to approximately 2.9 million Department of Commerce 1994; BEA 1990).

Between 1980 and 1990, the number of housing units in the ROI increased approximately 19 percent, from 832,559 to 986,553 (see I.4.1.1.6.2-1). The number of housing units in Alameda County increased from 444,607 units in 1980 to 504,109 units in 1990 (13.4 percent). Housing units in Contra Costa County increased from 251,917 units in 1980 to 316,170 units in 1990 (25.5 percent). Housing units in San Joaquin County increased from 136,001 units in 1980 to more than 166,274 units in 1990 percent). The number of housing units in the ROI is expected to increase about percent over the period 1990 to 2000. The rental vacancy rate in the ROI is approximately percent Department of Commerce 1994; Urban Land Institute [ULI] 1995).

The residential building permit volume within the ROI remained strong between the mid- to late-1980s; however, with the national and local recession and a slowing of new household formation, permit volume in the region dropped between 1990 and 1993. The market rebounded somewhat in 1994. The largest percent of new construction within the ROI since 1989 has been within Contra Costa County, where most NIF employees would reside (ULI 1995).

Contra Costa County has historically been the Bay Area's strongest market for residential development, followed by Alameda County. Most new construction has been within southern Alameda County and eastern Contra Costa County, a trend that is likely to continue. Substantial new construction is also planned within central Contra Costa County east of San Roman and north of Dublin (ULI

The rental apartment market, which experienced some overbuilding in the 1980s, has improved in the 1990s. Production has declined sharply since 1989, reflecting a market adjustment to overbuilding and changes in the Federal tax code. Because of the public construction volume during the 1980s and the subsequent slow economy, rental rate increases since 1985 have generally been lower than the rate of inflation. With high land and construction costs, rental rates do not justify new construction. Despite the lack of new construction, vacancy rates remained about percent in 1993 and 1994. Vacancy rates have not declined because of the doubling up that has occurred in the depressed economy and the large number of renters who have taken advantage of favorable prices and interest rates to purchase homes.

Table I.4.1.1.6.2-1.-- Population and Housing Data for the Lawrence Livermore National Laboratory Area

Category	1980	1990	1996	1997	1998	1999	2000	2001	2
Estimated ROI population	2,109,052	2,538,312	2,767,679	2,795,646	2,823,903	2,852,453	2,881,300	2,905,074	2,9
Estimated total housing units	832,559	986,553	1,078,949	1,094,349	1,109,748	1,125,148	1,140,547	1,155,946	17
Estimated vacant owner units	23,722	28,541	31,750	32,075	32,579	33,048	33,589	34,094	34
Estimated vacant renter units	16,585	19,238	21,357	21,731	22,088	22,444	22,800	23,156	23
Estimated total vacant units in ROI	40,307	47,779	52,945	53,806	54,667	55,528	56,389	57,250	58
Source: Historical data from U.S. Department of Commerce 1994; projections by Halliburton-NUS 19									

The counties within the ROI are far more receptive to residential development than the San Francisco area on the western side of the bay. The ROI is likely to continue to experience strong residential development activity. Substantial inventories of suitable land remain, particularly in the southern portion of Alameda County and the eastern portion of Contra Costa County near LLNL (ULI 1995).

Solano and San Joaquin counties. These areas are poorly served by public transportation and are located along increasingly congested traffic arteries, such as Interstate 205. With the focus of new housing development likely to continue in these areas, traffic congestion is projected to worsen (ULI 1995).

LLNL is served by several public transportation providers. San Joaquin County provides bus access to LLNL from the San Joaquin Valley, Wheels Transit Service serves LLNL from the Tri-Valley region, and BART provides express buses during peak commuting hours (ULI 1995).

Table I.4.1.1.6.4-1.-- Baseline Traffic on Lawrence Livermore National Laboratory Access Roads

Route	From	To	Estimated 1995 AADT	Estimated 1995 LOS
Patterson Pass Road	Vasco Road	Greenville Road	1,040	A
East Avenue	Vasco Road	Greenville Road	11,250	A
East Avenue	Buena Vista Avenue	Vasco Road	13,800	A
East Avenue	Hillcrest Avenue	Buena Vista Avenue	18,700	A
Telsa Road	Vasco Road	Greenville Road	2,600	A
Telsa Road	Buena Vista Avenue	Vasco Road	6,400	A
First Avenue	N. Mines Road	Las Positas Road	28,300	B
Vasco Road	Brisa Street	Patterson Pass Road	18,300	A
Vasco Road	Westgate Drive	Mesquite Way	13,500	B
Vasco Road	East Avenue	Telsa Road	4,150	A
Greenville Road	Patterson Pass Road	Lupin Way	5,200	A

Note: AADT - average annual daily trips; LOS - level of service
Source: DOE and UC 1992.

Major railroads in the ROI are the Atchison, Topeka, and Santa Fe Railroad, the Southern Pacific Transportation Company, and the Union Pacific Railroad. The Union Pacific passes within km (1 mi) of LLNL; however, there is no direct rail access to LLNL.

The ROI is served by several airports, including Oakland International, San Jose International, Stockton Metropolitan, and San Francisco International Airport. The Livermore Municipal Airport serves local air traffic.

I.4.1.1.6.5 Environmental Justice

Environmental justice concerns the potential for high and adverse environmental or human health impacts to disproportionately affect minority or low-income populations. For this assessment, environmental justice is evaluated for impacts within the site region, defined as an 80 km (50 mi) radius around the site, and within the local area. Lazaro et al. (1996) presents the demographic analysis of minority and low-income population distributions on a regional and local basis.

In the LLNL site region in 1990, percent of the population was low income and percent was minority. These values are lower percentages of both low-income and minority persons than the California state averages percent low income and percent minority). However, within that area, census tracts closer to LLNL tend to have a higher proportion of minority population but a lower proportion of low-income population than do census tracts farther from the site.

I.4.1.1.7 Radiation and Hazardous Chemicals

I.4.1.1.7.1 Radiation Environment

Many of the activities that take place at LLNL involve handling radioactive materials and operating radiation-producing equipment. A detailed discussion of the radiation environment, including background, radiological releases, and doses to members of the public is presented in the publication Environmental Report 1993 (LLNL 1994d). The concentrations of radioactivity in various environmental media (air, water, soil) in the site region are also presented in that report.

Calculated radiological doses were used to estimate the potential health impacts to the public and onsite workers at LLNL from any releases of radioactivity. The annual doses to an individual, the surrounding population (within km [50 mi]), and workers are summarized in I.4.1.1.7.1-1; corresponding health risks are also presented in the table. These values are in addition to those from natural background, consumer products, and medical sources, which total about 365 millirems (mrem) per year. Background radiation doses are unrelated to LLNL operations. Regulatory limits that specify the maximum effective dose equivalent to individual members of the public and occupational workers are also presented in table I.4.1.1.7.1-1. The doses to the public presented in table I.4.1.1.7.1-1 are within regulatory limits (DOE 1990) and are small compared to background radiation. The onsite worker doses are also within regulatory limits.

Table I.4.1.1.7.1-1.-- Annual Radiation Doses to the General Public and Onsite Workers from Normal Operations at Lawrence Livermore National Laboratory

Receptor	Atmospheric Releases		Liquid Releases		Total		
	Regulatory Limit 12	Calculated	Regulatory Limit	Calculated 13	Regulatory Limit	Calculated	Risk 14
Individual Dose							
Average exposed individual 15 (mrem)	10	1.3×10^{-4}	4	0.0	100	1.3×10^{-4}	6.5×10^{-11}
Maximally exposed individual (mrem)	10	6.5×10^{-2}	4	0.0	100	6.5×10^{-2}	3.3×10^{-7}

Population Dose [16]							
Population within 80 kilometers (person-rem)	[17]	7.6×10^{-1}	[17]	0.0	[17]	7.6×10^{-1}	3.8×10^{-4}
Worker Dose [18]							
Average worker (mrem)	NA	NA	NA	NA	5,000	2.1	8.4×10^{-7}
Maximally exposed worker (mrem)	NA	NA	NA	NA	5,000	1,300	5.2×10^{-4}
Total worker [19] (person-rem)	NA	NA	NA	NA	None	18.3	7.3×10^{-3}

I.4.1.1.7.2 Hazardous Chemical Environment

The background chemical environment important to human health consists of the atmosphere, which may contain hazardous particulates or vapors that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example, soil through contact or via the food pathway). Exposure pathways to LLNL workers during normal operation may include inhaling the workplace atmosphere, drinking LLNL potable water, and possibly other contact with hazardous materials associated with work assignments. The maximum daily quantities of hazardous materials stored in 1992 are listed in I.4.1.1.7.2-1. The potential for health impacts varies from facility to facility and from worker to worker, and depends on the operations performed, as well as the materials handled. However, workers are protected from hazards specific to the workplace through appropriate training, engineering controls, work practices, administrative controls, monitoring, and protective equipment. LLNL workers are also protected by adherence to Occupational Safety and Health Administration (OSHA) and Environmental Protection Agency (EPA) standards that limit atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring, which reflects the frequency and amounts of chemicals utilized in the operation processes, ensures that these standards are not exceeded.

Table I.4.1.1.7.2-1.-- Maximum Daily Quantities of National Ignition Facility-Related Hazardous Materials Stored at Lawrence Livermore National Laboratory

Hazardous Material	Quantity
Acetone	3,577 kg
Alumina	3,345 kg
Ammonium hydroxide	2.23 kg
Copper	55.8 kg

Ethyl alcohol	13,244 L
Hafnium oxide	1,115 kg
Mercury	1,238 kg
Sodium hydroxide	9,455 kg
Tetraethyl orthosilicate	1,904 kg

kg - kilograms; L - liters.
DOE and UC 1992.

I.4.1.1.8 Waste Management

LLNL currently operates four waste management facilities. The Area 514 and Area 612 facilities contain treatment and storage units for hazardous and mixed wastes. The Building 693 facility is currently a container storage unit for mixed hazardous waste, Toxic Substances Control Act (TSCA)-regulated waste (such as polychlorinated biphenyls), and radioactive waste. The Building 233 container storage unit is currently used to store mixed waste, low-level waste (LLW), and transuranic (TRU) waste.

The current waste management practices at LLNL are outlined in table I.4.1.1.8-1. Wastes relevant to NIF that are managed at LLNL from research activities include LLW, mixed wastes, and hazardous and nonhazardous wastes. The exact nature of some of the LLNL waste is classified information. The NIF project is expected to generate low-level, mixed, hazardous, and nonhazardous wastes during operation; none of these wastes would be classified.

Table I.4.1.1.8-1.-- Current Waste Management at Lawrence Livermore National Laboratory

Category	1994 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity [20] (m^3)	Disposal Method	Disposal Capacity (m^3)
Low-Level							
Liquid	181	Neutralization, filtration, solidification, precipitation, oxidation, flocculation, blending	3,736 (34.1/ treatment episode)	Hazardous Waste Management Division Facilities	627	Treated wastewater discharged to city of Livermore sanitary sewer if within approved limits	None

Solid [21]	6,425 t	None	NA	Hazardous Waste Management Division Facilities	NA	Offsite landfill	NA

I.4.1.1.8.1 Low-Level Waste

Both liquid and solid LLW are generated and managed by LLNL. LLW solids at LLNL consist of gloves, absorbent paper, plastics, glass, and other solid materials contaminated with low-level radioactive materials. Liquid and solid LLW are processed or stored at the Building 514 and 612 complexes. Wastewater from retention-tank systems that exceed site radiological discharge limits or any special limits established for that tank, and that cannot be adjusted for discharge or released to the sanitary sewer, is treated as LLW. Smaller quantities of liquids may be accumulated in containers of various sizes and types. Nonreleasable wastewater is pumped into portable tanks for treatment at the Wastewater Treatment Tank Farm at the Building 514 Facility, where it is containerized and transferred into one of six 7,003-L (1,850-gal) treatment tanks for chemical treatment. These tanks are used to treat both radioactive and mixed liquid wastes. After treatment, if the analysis indicates that the contents of a treatment tank are within established sewer discharge limits, the liquid is discharged to the sanitary sewer. If the contents are not within discharge limits, they are retreated.

I.4.1.1.8.2 Mixed Low-Level Waste

Some of the generated mixed liquid LLW is treated at the Area 514 Wastewater Treatment Tank Farm before discharge to the sanitary sewer system so that hazardous constituents and radionuclides can be removed and this wastewater can be discharged within the allowable limits of the National Pollutant Discharge Elimination System (NPDES) permit. The residual solids from this treatment process may contain hazardous constituents such as oils and solvents, toxic metals, decontamination solutions, and dyes. Mixed LLW is treated or stored at the Area 514 Wastewater Treatment Tank Farm and Building 612 complexes.

I.4.1.1.8.3 Hazardous Waste

Hazardous wastes are generated by the numerous research and development (R&D) activities conducted at LLNL. Storage areas for nonradioactive and radioactive (or mixed) wastes are located at Area 612, Area 514, Building 233, and Building 833. Wastes that contain polychlorinated biphenyls and other wastes regulated by the TSCA are stored in Building 693. Nonradioactive, hazardous liquid waste may be stored in drums and portable tanks, pending consolidation and/or offsite transportation. A commercial waste handler transports the nonradioactive solid and liquid hazardous waste drums to an appropriately permitted disposal, treatment, or recycle facility. LLNL hazardous waste management units operate under Resource Conservation and Recovery Act (RCRA) interim status with an approved Part A Permit. Building 693 operates under interim standards and is used to store containerized RCRA-, TSCA-, and California-only regulated waste.

Wastewater may be accumulated in retention tanks, carboys, or drums at the various source locations throughout LLNL. The materials are then analyzed, and the determined waste contaminant levels are compared to LLNL and city of Livermore discharge limits. If the contaminant levels are below the regulatory limits, the material is released to the sanitary sewer. Industrial wastewater that contains constituents at concentrations greater than allowed by the city of Livermore discharge limits is managed as hazardous waste.

Hazardous wastes may be shipped through licensed commercial transporters to various offsite commercial RCRA-permitted treatment, storage, and disposal facilities.

The newly redesigned Decontamination and Waste Treatment Facility is planned to replace and upgrade current facilities used to process, treat, and store hazardous, radioactive, and mixed wastes. The Decontamination and Waste Treatment Facility would receive LLNL and other Oakland, California, generated medical waste, hazardous waste, LLW, and mixed LLW for consolidation, processing, treatment, and packaging before shipment and disposal offsite at a commercial RCRA-permitted facility.

I.4.1.1.8.4 Nonhazardous Waste

Solid nonhazardous wastes generated by LLNL consist of paper, plastics, glass, organic, and other wastes. LLNL does not have onsite solid waste disposal facilities. Solid wastes are collected in dumpsters and similar containers in such a manner as to ensure that they do not contain hazardous or radioactive wastes and transported to the Vasco Road Landfill for disposal.

If industrial wastewater generated by LLNL operations exceeds permissible discharge limits and is treatable by permitted LLNL waste treatment units, the water is processed to meet the release criteria and then monitored as it is discharged to ensure that permissible discharge limits are not exceeded. These wastes enter the city of Livermore's sewer system and are then processed at the city's Water Reclamation Plant. The treated wastewater is piped to San Francisco Bay for discharge, except for a small volume that is used for summer irrigation of the municipal golf course adjacent to the Livermore Water Reclamation Plant. Sludge from the treatment plant is disposed of in offsite landfills.

LLNL has an onsite sewage diversion and retention system that is capable of containing approximately 757 cubic meters (m^3) (26,700 cubic feet [ft3]) of potentially contaminated sewage until it can be analyzed and appropriate handling methods implemented. If the liquids cannot be processed for discharge, they are packaged for treatment or disposal at an offsite facility. Treatment residues, or solids generated from the treatment process, are also packaged for treatment or disposal at an offsite facility.

I.4.1.2 Environmental Impacts

The following sections describe the potential environmental impacts for land use and visual resources, air quality and noise, water resources, ecological resources, cultural and paleontological resources, and socioeconomics from constructing and operating NIF at LLNL. In addition, impacts associated with radiation, hazardous chemicals, and waste management are described.

I.4.1.2.1 Land Use and Visual Resources

I.4.1.2.1.1 Land Use

Impacts to land use at LLNL from construction and operation of NIF would be limited to the clearing of land, minor and temporary disruptions to contiguous land parcels, and a slight increase in vehicular traffic. No significant impacts to onsite or offsite land uses are anticipated from the project. The proposed location for the two buildings requiring construction for NIF would occupy a large parcel of relatively flat, vacant land in the northeastern corner of LLNL (figure I.3.4.1.1-2). The proposed location is in a section of LLNL where similar types of research and experimentation already occur. Therefore, no conversion of existing land use would result. The NIF buildings would require the clearing of an estimated 8 ha (20 acres) of land for structures, walkways, building access, and buffer space. Such acreage would account for approximately 11 percent of the land currently available for development inside the LLNL site boundaries (Gawronski 1995). An additional 2.0 ha (4.9 acres) would be cleared for a construction laydown area (figure I.3.4.1.1-2). This area would be restored after NIF construction is completed. No impacts to land use (including zoning) on land outside of LLNL or in nearby communities would be expected.

With appropriate erosion and sediment control measures, soil impacts during construction of NIF would be short term and minor. Seismic risks would be taken into account during construction and operation of NIF.

I.4.1.2.1.2 Visual Resources

With the exception of minor, temporary impacts (fugitive dust, equipment exhaust, etc.) associated with construction activities, no impacts to the visual character of LLNL or to surrounding visual resources would be expected. The Laser and Target Area and the Optics Assembly buildings would be constructed in a sector of LLNL that has similar structures. The plot that would contain the two new facilities consists of grassland and a few trees that are visually uniform and not distinct or unique. Because so much of LLNL is developed, views into the installation from surrounding points would not be altered by the two new buildings.

I.4.1.2.2 Air Quality and Acoustics

I.4.1.2.2.1 Air Quality

The potential air quality impacts resulting from construction and operation of NIF are discussed separately because the air pollutant emissions generated during construction would not occur during NIF operations.

Construction Emissions . Estimated construction emissions, including site-clearing emissions and emissions associated with facility construction, are listed in table I.4.1.2.2.1-1. The construction emission estimates are based on characteristics of the proposed LLNL location and on construction vehicle exhaust and fugitive emissions. Site clearing would occur the first year, followed by facility construction during the next four years (LLNL 1995b).

Table I.4.1.2.2.1-1.-- Estimated National Ignition Facility Construction Emissions for the Lawrence Livermore National Laboratory Location

Pollutant	Total Emissions (t/yr) [22]
Particulate matter 10 microns or smaller	14.51 [23]
Volatile organic compounds	0.44
Carbon monoxide	1.23
Nitrogen dioxide	3.76

Sulfur dioxide	0.43
Lead	Negligible

The site-clearing phase of construction, which would continue for about one month, would produce the greatest amount of fugitive dust (particulate matter of 10 microns or less [PM10]) emissions. The Industrial Source Complex, Short-Term Model, Version 2 (ISCST2, Version 93109 [EPA 1992a-b]) was used to determine the impact of site-clearing activities on ambient air quality. The Industrial Source Complex dispersion model is the EPA's preferred regulatory modeling tool for most applications in simple terrain (EPA 1995a). The ISCST2 Model was chosen because the general area from NIF location to nearby receptors of concern is relatively flat and is characterized as simple terrain. The data selected for modeling air quality were 1994 surface meteorological data from the LLNL site (LLNL 1995d). The surface wind speeds and directions are summarized in an annual wind rose (see figure I.4.1.1.2.1-1). In addition, a constant mixing height of 600 m (1,970 ft) was used throughout the year (LLNL 1995d). Detailed emission inventories associated with site clearing and facility construction; meteorological data used; and air quality model, assumptions, and model input parameters are presented in Lazaro et al. (1996).

The national and state 24-hour PM 10 standards are 150 and 50 micrograms g)/m^3, respectively. The 24-hour average PM 10 background concentration of 84 g/m^3 is already above the State Ambient Air Quality Standard (SAAQS) of 50 g/m^3 (see table I.4.1.1.2.2-1). Accordingly, site clearing should be conducted so as to minimize further impacts on ambient air quality. With a conventional water-spraying dust control system (that is, 50-percent control for excavation and 60-percent control for traffic on unpaved roads), maximum 24-hour average PM 10 concentrations of 104 g/m^3 over background are predicted at the site boundary (about 350 m [1,150 ft] east of the proposed NIF location). Operation with additional dust control measures that involve continuous water spraying and/or use of a chemical dust suppressant, would reduce PM 10 dust emissions from excavation by 75 percent and PM 10 emissions from traffic on unpaved roads by 90 percent. These measures would bring maximum 24-hour average PM 10 concentrations down to 46 g/m^3 over the background concentration. Including background concentration, maximum 24-hour concentrations would still be higher than the SAAQS for PM 10 . The ambient air quality impacts associated with site clearing would be limited to the area just outside the site boundary, which the general public is expected to occupy infrequently. In addition, site clearing at LLNL would be expected to last for only a month, so ambient air quality impacts associated with site clearing would be local and temporary.

Modeling efforts showed that over a year, the six highest 24-hour PM 10 concentration levels in descending order would be 62, 50, 43, 43, 43, and 36 g/m^3 above the background concentration. These levels were predicted for an area near the eastern boundary, which is the closest to the NIF location. In addition, annual average PM 10 concentrations were estimated for the entire one-year construction period, which consists of one month for site clearing, followed by facility construction. The estimated highest annual arithmetic mean PM 10 concentration level of 5 g/m^3 above the background concentration is well below the state standard of 30 g/m^3 in terms of geometric mean. (Note that the arithmetic mean is greater than or equal to the geometric mean.) As a consequence, long-term ambient air quality impacts associated with NIF construction would be minor. However, short-term ambient air quality impacts resulting from site clearing could be moderate, although local and temporary in extent. Additional regulatory information is provided in section I.5.2.1.

Emissions During Operations. Air pollutant emissions from operation of NIF at LLNL are expected to occur primarily from fuel combustion and solvent cleaning of the debris shields. Emissions of solvent volatile organic compounds (VOCs) (ethanol) from debris shield cleaning are estimated at about 0.50 metric tons per year (t/yr) (0.55 ton/yr) (LLNL 1995b). Other potential air pollutant emission sources not considered significant are target destruction under either the Conceptual Design or Enhanced options, emissions from vehicles used for freight shipments and employee commuting, and emissions from welding operations at the Fabrication Facility.

As indicated in table I.4.1.2.2.1-2, estimated air pollutant emissions due to NIF operation are well below 1 t/yr (1.1 ton/yr), except for nitrogen dioxide, which is below 2 t/yr (2.2 ton/yr). Estimated air pollutant emissions from NIF operations are less than 10 percent of LLNL 1994 emissions, except for carbon monoxide, which is approximately 11 percent of 1994 emissions. Existing ambient concentrations for these pollutants (see section I.4.1.1.2.2, table-I.4.1.2.2.1-1) are well below the ambient air quality standards except for PM 10 and ozone. The increase of 0.16 t/yr (0.18 ton/yr) PM 10 is less than 5 percent of LLNL 1994 emissions and is not expected to cause a measurable increase in the 24-hour and annual average ambient concentrations. VOC emissions related to NIF operations are estimated to increase by less than 5 percent for the existing emissions at LLNL. Estimated NIF VOC operating emissions at LLNL are 0.56 t/yr (0.61 tons/yr). Total 1995 VOC emissions for the BAAQMD are 269,248 t/yr (296,173 tons/yr) and from fuel combustion are 6,654 t/yr (7,319 tons/yr). Therefore, NIF contribution of VOCs to production of ozone would be almost insignificant (Mangat 1995). On the basis of this information, it can be concluded that NIF operations would have no adverse impact on air quality and would not contribute to a violation of the ambient air quality standards.

Table I.4.1.2.2.1-2.-- Annual Emission Increases with National Ignition Facility Operation at Lawrence Livermore National Laboratory

Pollutant	1994 Emissions [24] (t/yr)	Projected NIF Emissions (t/yr)[24]	1994 Emissions Plus NIF (t/yr)	NIF Percent of 1994 Emissions
Particulate matter 10 microns or smaller	3.36	0.16	3.52	8.8
Volatile organic compound	13.10	0.56	13.66	4.3
Carbon monoxide	3.99	0.43	4.42	11
Nitrogen dioxide	23.50	1.79	25.29	7.61
Sulfur dioxide	0.37	0.03	0.40	9
Lead	0.01	Negligible	0.01	Negligible

The NIF annual energy requirements based on heat and hot water demand for the Laser and Target Area Building and all necessary support facility buildings are listed in table I.4.1.2.2.1-3. All candidate sites would require construction of the Laser and Target Area Building. None of the candidate sites would require construction of the full complement of support facilities that are represented by the annual support facilities energy demand in table I.4.1.2.2.1-3. Therefore, NIF annual energy demand and resulting air pollutant emissions differ among sites based on the area of new buildings required. The ratio of the sum of new support building construction area to the sum of the area for all NIF required support buildings was used to adjust support building energy demand for each candidate site (see table I.3.4-1 for a listing of new buildings required by NIF for each candidate site).

Table I.4.1.2.2.1-2 lists the estimated LLNL annual air pollutant emissions on the basis of the anticipated NIF annual energy requirements provided in table I.4.1.2.2.1-3, adjusted to recognize that at LLNL only one new support building (area of 1,858 square meters [m2] [20,000 square feet {ft2}]) would be required out of the total complement of support buildings (area of 26,722 m2 [287,643 ft2]) indicated in table I.3.4-1. Published emission factors (EPA 1995b) were used to estimate the emissions. Emissions of VOCs from solvent cleaning are included. For comparative purposes, table I.4.1.2.2.1-2 includes the LLNL 1994 site-wide emissions. More detailed information on emission estimates is provided in Lazaro et al.

Table I.4.1.2.2.1-3.-- Estimated Annual Energy Requirements for the National Ignition Facility

Facility	Use	Fuel Type	Annual Energy Consumption
NIF Laser and Target Area Building	Heating, ventilation, and air conditioning	Natural gas	2.11x107 MJ
	Domestic hot water	Natural gas	3.11x105 MJ
	Stand-by power	Diesel	320 L
NIF Support Facilities [25]	Heating, ventilation, and air conditioning and hot water	Natural gas	1.95x107 MJ
	Stand-by power	Diesel	5,500 L

The BAAQMD may require that NIF external combustion facilities (boilers) be equipped with the best available control technology (BACT) for criteria and organic pollutants (Regulation 2, Rule-301) (BAAQMD 1995). BACT will be determined by the permitting process. EPA New Source Performance Standards would limit boiler nitrogen oxide air pollutant emissions according to the boiler-rated heat input. Gas-fired boilers with rated heat input greater than 105,600 megajoules per hour (MJ/hr) (100 million British thermal units per hour [Btu/hr]), but not over 264,000 MJ/hr (250 million Btu/hr), are limited to New Source Performance Standard nitrogen oxide emissions ranging from 43 to 86 nanograms per joule (ng/J) (depending on the heat release rate, which is a function of the furnace volume [40 CFR 60.44b]). There are no New Source Performance Standard emission limits for gas-fired boilers with a rated heat input at or less than 105,600 MJ/hr (40 CFR 60.40c).

VOC emissions, primarily ethanol (see Lazaro et al. 1996), from solvent cleaning of debris shields and treatment/refurbishment of optics and laser components would require no controls but might require emission offsets from the Small Facility Banking Account (Regulation 2, Rule 2-302). The Small Facility Banking Account was established by BAAQMD to provide emission offsets for small air pollutant emission facilities such as NIF. Additional regulatory information is presented in section I.5.2.1.

I.4.1.2.2.2 Acoustics

During the site-clearing phase of construction of NIF at the LLNL site, noise from construction equipment would cause an increase of 14 decibels (dB) (from 55-dBA to 69 dBA) in the average outdoor daytime sound level at the location of the maximally exposed individual 800 m (2,600 ft) east-northeast of the NIF target chamber room location on the eastern side of Greenville Road. The Composite Noise Rating (CNR) rank, adjusted for the estimated preexisting background level and for temporal and conceptual characteristics of the sound, is expected to be "F." Noise with CNR ranks "A" through "D" is generally considered to be acceptable, with "A" representing essentially no impacts. Rankings above "D" are usually addressed with mitigative measures unless the source is temporary.

The average outdoor daytime sound level at the nearest laboratory building would be expected to increase by 4 dB, to 59 dBA. The adjusted CNR rank for the resulting sound would be "B." This "B" rating for modified CNR refers to general activity outside the nearest laboratory building, as compared to ambient background levels. Noise from NIF construction is not included in the "B" rating. The average daytime sound level at the residential area approximately 1.6 km (1.0 mi) west of the construction site would not be expected to increase over the existing average daytime sound level, estimated to be 61 dBA.

These noise level predictions are estimates based on the assumptions given in Lazaro et al. (1996). The noise levels produced during construction are not expected to have a significant impact on LLNL employees or on staff working inside the veterinary hospital (nearest offsite public receptor). Complaints of annoyance may be expected from hospital employees working outside the hospital during heavy construction periods. However, noise levels are not expected to result in hearing loss or interference with speech.

I.4.1.2.3 Water Resources

Construction of NIF at LLNL would be expected to have minor to negligible effects on water quality. The current water supply and wastewater treatment capacities are expected to be sufficient to meet the requirements of NIF.

During construction, about 2.95 MLY (0.78 MGY) of water would be required (LLNL 1995b). The wastewater generated during construction would be handled by the existing sewer and treatment systems. The wastewater volume would be less than the water requirement of consumptive uses, such as incorporation into concrete and evaporation. Sanitary sewer discharges from LLNL go to the city of Livermore wastewater collection system, which is currently being renovated to reduce infiltration and inflow experienced during periods of heavy rainfall.

Water and wastewater utility requirements for NIF operations at LLNL are shown in table ,a href=#ti41231>I.4.1.2.3-1. The total raw water supply required for NIF would be about 152 MLY (40 MGY), of which about 18 MLY (4.7 MGY) would be for domestic use. The additional sanitary wastewater volume from NIF operations is estimated to be 18 MLY (4.7 MGY). A sewer diversion facility protects against accidental release of contaminants not usually associated with sewage into the Livermore treatment plant (LLNL 1994d). The wastewater volume at the LLNL site would increase about 4.5 percent as a result of NIF operations. The sewer diversion facility is capable of handling the projected increase. Wastewater containing nonsewage-related contaminants would be pretreated before release to the Livermore treatment

Table I.4.1.2.3-1.-- Water and Wastewater Utility Capacity at Lawrence Livermore National Laboratory

Utility System	Current Usage	NIF Requirement [26]	Projected Usage, Including NIF [27]	Current Capacity b
Water supply (MLY)	967[27]	152	1,119	3,980
Wastewater treatment (MLY)	402 [28]	18	420	2,340

Potential impacts of stormwater runoff from both the NIF and construction laydown locations on surface water quality are expected to be minor because NIF would be operated under the Livermore Site Industrial Activity Stormwater Pollution Prevention Plan to be developed in accordance with California Department of Transportation specification Section 7-1.0G and LLNL's General Construction Activity Stormwater Permit. The proposed bridge spanning Arroyo Las Positas to the staging area (option I) would be constructed so that its structure and supports would not increase the risk of a 100-year flood breaching the banks of the arroyo. The proposed NIF location has minimal flooding potential because it is outside the 500-year floodplain of Arroyo Las Positas although the staging area (option I) would be within the 500-year floodplain (figure I.4.1.1.3.-1). The staging area (option I) would not be used to store highly volatile, toxic, or water reactive materials. Therefore, locating the staging area in the 500-year floodplain would pose no environmental risk.

However, the proposed NIF location is within the 2000-year floodplain for Arroyo Los Positas. Nevertheless, severe flooding at NIF due to overflow of the arroyo would be relatively slow to develop. This would allow the opportunity to secure radioactive and hazardous material inventories and move them to a safe location. A severe flood could result in facility and equipment damage, but the likelihood of such an event would be small over the 30-year operational lifetime of NIF.

Potential effects of NIF on groundwater would be minor to negligible. No groundwater would be used for NIF, and no wastewater would be discharged to aquifers. Groundwater recharge at the LLNL site might be slightly reduced because of additional paved surface areas. Potential impacts of stormwater runoff on groundwater quality are expected to be negligible because NIF would be operated under the Industrial Activity Stormwater Pollution Prevention Plan.

I.4.1.2.4 Biotic Resources

I.4.1.2.4.1 Terrestrial Resources

The NIF location at LLNL would occupy a 8.1-ha (20.0-acre) parcel of grassland. The 2.0 ha (4.9 acres) areas designated as optional sites for the temporary staging area contain grassland (option I) or maintained lawns (options II and III) (I.3.4.1.1-2). Vegetation within these areas would be eliminated by construction and spoils disposal, resulting in a minor loss of habitat. This loss would be considered a slight adverse impact. Construction could also affect nearby vegetation through the deposition of dust and other particulates from soil disturbance and from the operation of vehicles and large machinery. This deposition could inhibit photosynthesis and, if chronic, result in a limited amount of plant mortality. In addition, soil compaction caused by heavy machinery could destroy the plants and indirectly damage roots of plants from adjacent areas by reducing soil aeration and altering soil structure. However, impacts from dust and compaction would be temporary, localized, and limited to common species that are found in disturbed areas. The quality of the vegetative community at the proposed NIF location is marginal, and since construction would occur in an area of previous disturbance, potential impacts are considered negligible.

Impacts to wildlife from NIF construction would include (1) loss and alteration of habitat and (2) disturbance of individual animals by noise and human activity. Suitable alternative habitats, and escape pathways to those habitats, exist for displaced individuals. However, these animals could face stronger competitive pressures, potentially resulting in the loss of individual animals. It is unlikely that construction activities would be a threat to the continued survival of any local wildlife populations.

The areas occupied by NIF buildings, equipment, access roads, and parking lots would be unavailable to wildlife for the life of the project. The construction laydown area would be unavailable to wildlife during the construction period. It would be restored to existing conditions following construction. Vegetation should be reestablished within a few growing seasons. Some portions of the NIF site, particularly those around the main buildings, would be landscaped with lawns and scattered bushes and trees. Such habitat currently exists around other LLNL facilities and is of limited use to many wildlife species. Nevertheless, species adapted to suburban areas would readily inhabit or utilize these areas.

Few impacts would occur to terrestrial biota during operation of NIF. Increased traffic and local disturbances could lead to increased losses of road-killed individuals of some species, but this impact is not considered significant.

I.4.1.2.4.2 Wetlands and Aquatic Resources

It is DOE policy (10 CFR 1022) to avoid impacts to wetlands to the maximum extent practicable, in compliance with Section 404 of the Clean Water Act and Executive Order 11990 (Protection of Wetlands). Because the proposed NIF location is nearly 300 m (1,000 ft) from the nearest wetland, the construction and operation of NIF would not be expected to affect wetlands at LLNL. The location of the temporary access bridge across Arroyo Las Positas for the option I staging area would be about 100 m (328 ft) east of the nearest wetland, and, thus, would not impact wetland habitat. The option I staging area would be the closest alternate laydown area to the wetland. It would be at least 23 m (75 ft) from the nearest wetland. Temporary barriers would be used to prevent inadvertent impacts to the wetland.

The potential for adverse impacts to aquatic resources would be extremely low because no waterbodies are located in the immediate vicinity of the construction area. Generally, impacts to surface waters from construction activities occur as a result of (1) habitat destruction or modification from construction activities within the waterbody or (2) increases in turbidity, sedimentation, or chemical contamination from runoff. Overall, construction impacts to aquatic resources at LLNL would not be considered significant because (1) critical habitats (such as spawning or rearing areas) for important species (recreational, commercial, or listed species) do not occur at the proposed NIF location and therefore would not be affected and (2) increased sedimentation, habitat removal or modification, or potential spills (such as of fuel) would be localized, short term, and mitigable. The increase in impervious land surface associated with NIF could increase runoff, which could accelerate erosion of unstable soils and add to the contaminant load entering nearby waterbodies. However, a stormwater pollution prevention plan would be implemented to control such events (section I.4.1.2.3). Landscaping around new NIF buildings would also minimize surface erosion and site runoff.

I.4.1.2.4.3 Rare, Threatened, and Endangered Species

No deleterious impacts to listed species would be expected from construction or operation of NIF. NIF would be located on previously disturbed grassland habitat that is surrounded primarily by developed laboratory facilities. Thus, NIF location does not provide suitable habitat for the listed species that could exist at LLNL. White-tailed kites have nested near the East Gate of LLNL. Mitigative measures that would be taken so that NIF construction traffic would not affect this species (that is, rerouting traffic during nesting) are discussed in section I.4.7. However, construction of the option I staging area and its access road could impact the western burrowing owls by reducing potential foraging habitat or disrupting resident individuals. Nevertheless, loss of foraging area is not expected to adversely affect this species, and burrows of this species would be avoided during construction.

I.4.1.2.5 Cultural and Paleontological Resources

Construction and operation of NIF would have no effects on archaeological sites or historic structures listed on or eligible for the National Register of Historic Places (NRHP) or important paleontological remains because these resources are absent in the affected area. Consultation is in progress to determine whether the proposed project could affect Native American cultural resources.

I.4.1.2.6 Socioeconomics

Locating NIF at LLNL would have a minor impact on socioeconomic conditions in the economic study region and in the ROI described in section I.4.1.1.6. This is because LLNL is located in a diverse regional economy with extensive inter- and intraregional, national, and global economic interactions and linkages. Also, because the NIF partnership would include representatives from government, industry, and the academic sectors throughout the United States, procurement and investment would be dispersed over a number of different regions, damping the concentration of economic effects of the program.

The following sections describe the effects of constructing and operating NIF on the host region's economy and employment, and on population and housing, public finances, public services, and local transportation in the ROI.

I.4.1.2.6.1 Regional Economic Impacts

Slight changes in employment and levels of economic activity in the economic study region would occur from local spending of employee wages, procurement of goods and services (including construction materials), and other local investment associated with constructing and operating NIF. In addition to creating new jobs (direct) at the site, indirect job opportunities, such as community support services, would also be created in the economic study area as a result of these new direct jobs. The total new jobs created (direct and indirect) would contribute slightly to reduce unemployment and increase income and economic output in the regional economy during both the construction and operation of NIF. Table I.4.1.2.6.1-1 presents the potential impacts to the regional

Local Transportation				
Number of trips generated at site per day	902	630		
Public Finance				
Percent change over 1995 fund balance (Alameda County)	-0.03	-0.02	NA [32]	NA
Public Services (LOS)				
Change in service demand (Alameda County)				
Police	0	0	762[32]	832
Fire	0	0	92[32]	100
General	7	2	11,230[32]	12,264
Physicians	3	1	3,923[32]	4,285
Teachers	5	1	7,001[32]	7,646

I.4.1.2.6.2 Population and Housing

Construction. Population in-migration resulting from NIF construction phase demands would begin in 1996 and peak in 1998, with a projected cumulative total of nearly 1,600 people moving into the ROI over the 3-year period (table I.4.1.2.6.1-1). This population increase would result in demand for an additional 580 housing units in the ROI. Baseline projections of the ROI housing market from 1996 (NIF construction start date) through 1998 indicate that nearly 54,000 housing units would be available over the 3-year period. The demand for additional housing units in the LLNL region for NIF-related in-migration would absorb approximately 1 percent of the estimated supply of vacant housing stock in the ROI. Most of this housing demand would be temporary and would primarily affect the renter segment of the ROI housing market. The NIF project would stimulate little demand for new housing construction because of the number of vacant housing units within the ROI and the proximity of LLNL to many communities in northern California with the ability to provide both temporary and permanent housing for in-migrating workers.

Operations. Population in-migration resulting from NIF operation phase demands could result in an additional 360 people moving into the ROI. While additional demand for housing would be longer term relative to construction, no perceptible strain on the market is expected, assuming that the general conditions associated with the housing market continue.

I.4.1.2.6.3 Public Finance

Construction. Given the population and economic growth associated with NIF during the construction phase, fiscal balances (revenues and expenditures) are expected to increase slightly for all the jurisdictions within the ROI. Short-term public financial impacts would peak during 1998 and would then decline as construction neared completion in 2002. Since the largest percentage of socioeconomic impacts are expected to occur in Alameda County (assuming current residential patterns), that county would experience larger fiscal impacts than elsewhere in the ROI (table

I.4.1.2.6.1-1).

Operations. The increase in population and economic growth as a result of NIF operations would slightly increase fiscal balances (revenues and expenditures) for all counties within the ROI, with the greatest impact in Alameda County. Fiscal impacts would remain relatively stable from the initial impact in 2003 through the duration of NIF operations.

I.4.1.2.6.4 Public Services

By 1998, Alameda County would need to hire five additional teachers and three additional doctors to maintain its current level of service. By 2003, when operations start, Alameda County would only need one additional teacher and one additional doctor over the baseline conditions to maintain their level of service (table I.4.1.2.6.1-1).

I.4.1.2.6.5 Local Transportation

In 1995, LLNL employed about 8,300 persons. Direct employment generated by the NIF project at LLNL for the life cycle of the project (1996 to 2033) would range from a maximum of 470 new jobs in 1998 to a minimum of 80 new jobs in 2001. The 470 new jobs at LLNL have the potential to generate up to 902 new vehicle trips per day (table I.4.1.2.6.1-1). These additional trips could increase congestion on roads around LLNL, particularly East Avenue (table I.4.1.2.6.5-1).

Indirect jobs could affect traffic flow within the LLNL region, depending on where those jobs were located. However, if the new indirect jobs were sufficiently dispersed, the road network in the San Francisco metropolitan area would likely handle new trips generated by indirect jobs associated with NIF.

Table I.4.1.2.6.5-1.-- Future Traffic Impacts from National Ignition Facility Project on Lawrence Livermore National Laboratory Access Roads

Route	From	To	Estimated 1995 AADT	Estimated Background and Peak Project Year AADT (1998)	Estimated Percent Change in AADT Between 1995 and Peak Construction Year (%)	Estimated 1995 LOS	Estimated Background and Peak Construction Year LOS (1998)
Patterson Pass Road	Vasco Road	Greenville Road	1,040	1,145	10	A	A
East Avenue	Vasco Road	Greenville Road	11,250	11,520	2	A	B
East Avenue	Buena Vista Avenue	Vasco Road	13,800	14,080	2	A	A
East Avenue	Hilcrest Avenue	Buena Vista Avenue	18,700	19,000	2	A	A

Telsa Road	Vasco Road	Greenville Road	2,600	2,700	4	A	A
Telsa Road	Buena Vista Avenue	Vasco Road	6,400	6,590	3	A	A
First Avenue	N. Mines Road	Las Positas Road	28,300	28,850	2	B	B
Vasco Road	Brisa Street	Patterson Pass Road	18,300	18,900	3	A	A
Vasco Road	West Gate Drive	Misquitte Way	13,500	14,200	5	B	B
Vasco Road	East Avenue	Telsa Road	4,150	4,400	6	A	A
Greenville Road	Patterson Pass Road	Lupin Way	5,200	5,370	3	A	A
AADT - annual average daily trips; LOS - level of service. DOE and UC 1992.							

I.4.1.2.6.6 Environmental Justice

Minorities, but not low-income persons, are clustered disproportionately in the local vicinity of the LLNL site (section I.4.1.1.6.5). Thus, the local area impacts from the construction and operation of NIF could disproportionately affect minorities. However, none of the local area environmental or health impacts from the construction and operation of NIF would be highly adverse or significant. Therefore, no environmental justice issues for local area impacts have been identified for this site.

For the population in the region within 80 km (50 mi) of LLNL, both minorities and low-income populations are in lower proportion to other populations than in California as a whole (section I.4.1.1.6.5). Thus, no environmental justice issues for regional impacts are identified for this site.

I.4.1.2.7 Radiation and Hazardous Chemicals

This section describes potential radiological and hazardous chemical impacts that could result from normal operations and postulated accidents of NIF at LLNL. Methods, data, and assumptions used in estimating these impacts are presented in Lazaro et al. (1996).

I.4.1.2.7.1 Normal Operations

The general public living in areas surrounding the LLNL site and workers at LLNL may be exposed to small quantities of radionuclides released and radiation emitted from routine NIF operations; however, the expected level of radioactive releases and radiation emissions would be well within regulatory limits. No impacts from hazardous chemicals should occur because only minute quantities of hazardous VOCs are expected to be emitted during routine NIF operations. Impacts from routine transportation of tritium targets would also not be expected, because there would be no detectable levels of radiation outside the packages carrying the low-energy beta-emitting tritium targets.

Table I.4.1.2.7.1-1 summarizes the potential impacts of radiation exposures from the Conceptual Design and the Enhanced options of NIF operations at LLNL.

Table I.4.1.2.7.1-1.-- Potential Radiological Impacts from Normal Operations of the National Ignition Facility at Lawrence Livermore National Laboratory

Receptor	Conceptual Design Option	Enhanced Option
Maximally Exposed Individual		
Dose (mrem/yr)	0.04	0.1
Percent of natural background	0.01	0.03
30-year fatal cancer probability	6x10 -7	2x10 -6
Population Within 80 Km		
Dose (person-rem/yr)	0.07	0.2
Percent of natural background	3x10 -6	8x10 -6
30-year fatal cancers	0	0
Workers Onsite		
Dose (person-rem/yr)		
Non-NIF workers	0.06	0.2
NIF workers	10	10
30-year fatal cancers	0	0
Model results.		

Impacts to the Public . For the Enhanced Option, the estimated radiation dose from all NIF sources to a maximally exposed member of the public located about 400 m (1,300 ft) east of NIF is 0.1 mrem/yr, which is much less than the dose limit of 100 mrem/yr resulting from all pathways combined (DOE 1990). The likelihood of the maximally exposed individual contracting a fatal cancer would be 1 in 500,000 for the entire operational life of NIF (dose/yr x 30-yr x fatal cancer risk factor of $5x10^{-4}$/rem). The estimated radiation dose to the surrounding public is 0.2 person-rem/yr; no cancer fatalities would be expected to occur in the public for the entire NIF operations at LLNL. For the Conceptual Design Option, estimated radiation impacts would be about one-third the impacts of the Enhanced Option; therefore, no adverse health effects would result.

Impacts to Workers. In addition to exposure to the radionuclides, the general LLNL workers outside NIF could be exposed to direct radiation resulting from high-yield experiments at NIF. For the Enhanced Option, the estimated radiation dose to these non-NIF workers at LLNL is 0.2 person-rem/yr. No cancer fatalities would be expected to occur among workers for the entire NIF operations at LLNL. For the Conceptual Design Option, estimated radiation impacts would be about one-third the impacts for the Enhanced Option and would carry extremely low risk of adverse health effects.

Potential radiation exposures inside NIF would be kept as low as reasonably achievable through facility design, material selection, shielding, and administrative controls. The design objective is to keep the individual radiation worker dose equivalent to or less than 500 mrem/yr. On average, it is natural disaster.

Transportation Impacts. Radiological impacts associated with the transportation of tritium targets would result from a release of tritium into the environment following a transportation accident. Since tritium is a pure beta emitter with no associated gamma radiation, radiological risks associated with routine (incident-free) transportation operations are considered to be negligible. The potential radiological impacts of transporting tritium targets were calculated for truck and air travel. Trucks were assumed to be used to transport the tritium targets from the manufacturing sites to the nearest major airport, while cargo aircraft were assumed to be used to transport the targets to Oakland International Airport. After arriving at the airport, the targets would be transferred to a truck for shipment to NIF at LLNL.

Table I.4.1.2.7.2-2 presents the risks associated with the transportation of tritium targets from each of the tritium manufacturing facilities to NIF at LLNL. Radiological risk from transportation activities is defined as the product of the accident consequence (dose) and the probability of the accident occurring, and is calculated by considering a wide range of accidents, from high-probability, low-consequence events to low-probability, high-consequence events (see Lazaro et al. 1996). Estimated latent cancer fatality risks are obtained by multiplying the dose risk by 0.0005 latent cancer fatalities per person-rem (International Commission on Radiological Protection [ICRP] 1991). Latent cancer fatality risks range from 5x10-10 to 9x10-9 per year for all cases. Nonradiological impacts associated with the ground transport of tritium targets are calculated under both routine (incident-free) and accident conditions. Nonradiological population risks for routine operations are calculated by multiplying the distance traveled by truck in urban population density zones by a risk factor for latent mortality from pollutant inhalation (Rao et al. 1982). Nonradiological population risks resulting from vehicular accidents are calculated in a similar manner by multiplying the state-specific accident fatality rate by the distance traveled by truck in the state.

Maximally exposed individual and population doses were calculated for a transportation accident involving the release of the entire tritium cargo (assumed to be five tritium targets). Radiological impacts resulting from a potential maximum consequence accident were assessed for a general population located in an urban population density zone. Maximally exposed individuals were assumed to be exposed and unshielded as the plume passed at a distance resulting in the largest dose to the individual. Radiological consequences were assessed using worst-case weather conditions (Pasquill Stability Class F) for both the collective population and the maximally exposed individual. For assessment purposes, it was assumed that the entire tritium cargo was released to the environment in oxide form. The estimated number of latent cancer fatalities from the maximum-severity transportation accident was calculated by multiplying the population-committed effective dose equivalent by 0.0005 latent cancer fatalities per person-rem (ICRP 1991). Table I.4.1.2.7.2-2 summarizes the impacts resulting from a maximum-consequence accident involved in the transportation of tritium targets.

Hazardous Chemical Impacts. A number of possible chemical accidents were studied in terms of their potential impacts on workers and the public outside the LLNL site boundaries. The four possible accidents likely to have the greatest impacts were studied in detail. The range of accidents considered (including an aircraft crash) and the four selected for more detailed study are discussed in Lazaro et al. (1996). The four accident scenarios considered in detail were as follows:

- A mercury release from the ignitron switches
- A combined alumina/silica release from the target chamber

- A carbonyl fluoride release from the optics treatment area
- A hydrogen fluoride release from the optics treatment area

The nearest public facility to the release points for accidents 1 and 2 is the veterinary hospital to the east. The nearest public facility to the release points for accidents 3 and 4 is the industrial park to the north.

A modeling study was conducted for each of the four release scenarios. More details, including predicted concentrations, are provided in Lazaro et al. (1996). The modeling study applied a dispersion model to each of the releases and used a health criterion representative of acute impacts from an exposure that might happen once in a lifetime. The health criterion (Emergency Response Planning Guidelines-2 [ERPG-2] level) was the concentration below which, if exposure occurred for an hour, would still allow the exposed individual to avoid irreversible health effects by taking emergency action. The results of the modeling yield the following conclusions:

- The threat zone from each of the four accidents would not extend to the boundary with the public under either typical or extreme meteorological conditions
- Nearby buildings and personnel outside would be at risk if any of the four accidents occurred. The assumption was made that the release would not be inhibited by walls of the NIF Laser and Target Area Building, and the wind would take the plume away from the building. The distances beyond which concentrations would fall below the ERPG-2 level for each of the accidents are as follows:
    - Mercury scenario--237 m (778 ft) for both the Conceptual Design and Enhanced options
    - Alumina/silica scenario--171 m (561 ft) for Conceptual Design Option and 231 m (758 ft) for Enhanced Option
    - Carbonyl fluoride scenario--99 m (325 ft) for both the Conceptual Design and Enhanced options
    - Hydrogen fluoride scenario--101 m (331 ft) for both the Conceptual Design and Enhanced options

The personnel in nearby buildings would likely be protected because the release (typically lasting 15 minutes) would pass by the buildings with little infiltration. Personnel in the Laser and Target Area Building and those outside in the immediate vicinity might be affected.

I.4.1.2.8 Waste Management Impacts

This section evaluates potential effects of wastes that would be generated by NIF on current waste management practices at LLNL during construction, normal operation, and the decommissioning of NIF at LLNL.

I.4.1.2.8.1 Waste Generation and Management During Construction and Operation

The estimated amounts and types of wastes that would be generated during construction of NIF are listed in table I.4.1.2.8.1-1. Most construction wastes would be nonhazardous and would be handled under conventional construction regulations. Adequate capacity exists at LLNL to handle these wastes. Any hazardous wastes would be handled accordingly, as discussed below.

Table I.4.1.2.8.1-1.-- Estimated Amounts and Types of Wastes Generated During Construction of the National Ignition Facility at Lawrence Livermore National Laboratory

Waste Type	Amount Generated (m 3)
Nonhazardous (sanitary liquid)	14,000
Nonhazardous (sanitary solid)	500
Other nonhazardous (liquid)	900
Other nonhazardous (solid)	900
LLNL 1994b.	

Table I.4.1.2.8.1-2 lists the quantities of wastes generated by category for both the Conceptual Design and Enhanced options (Andrews and Tobin 1995). The following discussions describe the proposed disposition of the wastes (using current practices) shown in that table. During operation, various low-level, mixed, hazardous, and nonhazardous wastes would be handled at NIF. Treatment or storage of NIF waste stream would not affect current treatment and/or storage capacities. The quantities of these waste streams at LLNL are presented in tables I.4.1.2.8.1-2 and I.4.1.2.8.1-3. Waste handling methods would be the same for both the Conceptual Design and Enhanced options. While total waste quantities would be somewhat higher for the Enhanced Option, no changes in handling methods would be necessary. Successive sections cover how developing technologies might be applied to minimize waste streams and, finally, disposition of wastes from decommissioning.

Table I.4.1.2.8.1-2.-- National Ignition Facility Waste Estimates for Low-Level, Mixed, and Hazardous Wastes for Both the Conceptual Design and the Enhanced Options (Per Year of National Ignition Facility Operation)

							Hazardous			
			Low-Level		**Mixed**		**LTAB**		**OAA**	
	Source of Waste	**Cleaned** 37 **(m^3)**	**Solid (m^3)**	**Liquid (m^3)**	**Solid (m^3)**	**Liquid (m^3)**	**Solid (m^3)**	**Liquid (m^3)**	**Solid (m^3)**	**Liquid (m^3)**
1.	Vacuum pump oil					0.20				
	Chamber pump down					0.20				
2.	Molecular sieves		0.37							
	Tritium processing system		0.98							
3.	Personal protective equipment and wipes	1.88	0.18	0.60	0.34	0.40				
	General cleaning	4.88	0.46	1.56	0.88	1.04				
4.	Pre- and HEPA filters		0.02							
	Chamber Ventilation		0.02							
	Target chamber decontamination									

5.	Hardware from chamber	0.06	0.12							
	Diagnostics target positioner	0.06	0.12							
6.	Debris shield	0.24 ea				0				
		0.63 ea				0				
7.	Capacitors, oil filled						1.38		0.5	
							1.38		0.5	
8.	General chemicals							0.5		0.18
								0.5		0.41
	Conceptual design total/yr		0.36	0.30	0.25	0.30	1.38	0.5	0.5	0.18
	Enhanced total/yr		0.69	0.78	0.65	0.78	1.38	0.5	0.5	0.41

Low-Level Waste . The solid LLW processed during NIF operations would be disposed of at the Nevada Test Site (NTS). LLNL presently generates waste streams similar to those that would be produced by NIF, and those wastes are currently approved for disposal at NTS. Further details and a discussion of low-level liquid waste handling are presented in section I.4.1.1.8.1.

Mixed Waste . Solid mixed wastes would be sent to an appropriately licensed commercial mixed waste disposal site. LLNL presently has a contract with a commercial handler for disposal of certain mixed waste streams that meet the waste acceptance criteria, and this agreement would be extended to include NIF mixed wastes.

If an acceptable mixed waste stream contained only "characteristic" hazards (non-listed hazards specific to NIF) and it met the appropriate treatment standards listed in 40 CFR 268, the waste would be approved for shipment to NTS. However, if the mixed waste stream contained a listed hazard, it would be shipped to an approved commercial handler after being stabilized and meeting land requirements. The mixed aqueous waste from cleaning the debris shield would be neutralized, stabilized, and shipped to NTS for disposal as an approved waste stream. If this waste were found to be contaminated with listed solvents not approved for NTS disposal, the stabilized waste would be sent to a commercial handler instead.

Hazardous Waste. LLNL currently disposes of large quantities of hazardous waste by a well-established system using onsite consolidation and shipment to commercial handlers. Capacitors and general chemicals are currently disposed of under this procedure. Under this approach, NIF solid hazardous wastes would be shipped to an approved commercial RCRA treatment, storage, and disposal facility.

Nonhazardous Waste . Storm drains would be available in the NIF site with a capacity adequate for local rainfall at a design-basis flood level. This capacity would be based on a low-hazard-use building under DOE Standard 1020-94, Section 6.1.3. Nonhazardous solid waste generation at the NIF site is estimated to total 6,000 m^3/yr (7,848-yd3/yr). This solid waste would be handled following general regulations.

Possible Waste Minimization During Operation . Several actions or technologies have been identified that, if successfully implemented, could significantly reduce or even eliminate certain forms of waste now projected for NIF (Andrews and Tobin 1995). In addition, some steps might be taken to reuse or recycle waste material. The proposed technology and procedures are briefly described here, and an estimate of the possible reduced waste streams is shown in table I.4.1.2.8.1-3. These estimates assume successful development of various new methodologies that are proposed to minimize the waste streams. As such, they represent an optimistic lower limit of waste generation at NIF. Comparing these projections to those in table I.4.1.2.8.1-2 indicates that wastes might be reduced significantly (by a factor of 2 to 10). The following discussion identifies some important aspects of the minimization plan.

The lifespan of a molecular sieve could be extended if subatmospheric chamber flushing were employed. The use of lower flushing pressure would reduce vapor loading. Further reductions might be achieved if chamber tritium (following laser beam target strikes) were pumped directly to liquid helium cryo panels.

Minimizing the scrap hardware removed from the chamber would be accomplished by concentrating on three design areas: utilizing activation-resistant materials, minimizing-weight and volume of structures, and discouraging the use of temporary setups.

Implementation of an oil-less vacuum roughing pump system would eliminate 200 L (52.8 gal) of liquid mixed waste. Such pumps have only recently become available and would be evaluated for use at NIF; however, their cost and dependability remain uncertain.

Cleaning of the debris shields with carbon dioxide pellets could remove the anti-reflective coating and activated particulate matter. If successful, this procedure could significantly reduce or even eliminate the production of radioactive sodium hydroxide, which is currently listed as liquid mixed waste.

A large fraction of the general chemical waste from the Optics Assembly Area would involve the anti-reflective coating solution. One method for reducing this waste would be to distill the ethanol from the waste solution and reuse it as a cleaner.

Capacitors in the Laser and Target Area Building would be the predominant source of hazardous waste. This source could be reduced by purchasing advanced capacitor units with a longer service life. This decision, however, would depend on the development and cost of such capacitors.

In addition to reducing or eliminating the liquid LLW from debris shield cleaning, carbon dioxide cleaning might also further reduce solid LLW. Far fewer wipes would be needed for general decontamination purposes if a "general decontamination carbon dioxide station" were developed and functional. Other liquid LLW streams, as well as solid mixed and liquid mixed streams, might also be reduced with such a system because carbon dioxide could possibly remove activated particulates, as well as tritium contamination, and eliminate the need for solvents.

Existing Waste Management Capabilities at LLNL . Comparison of the waste volumes that would be generated by NIF (see table I.4.1.2.8.1-2) with current waste handling at LLNL provides an indication of the capability of the existing facilities at LLNL to accommodate the various waste management tasks associated with NIF.

For reference, table I.4.1.1.8-1 shows the current waste management capacity at LLNL. Table target area, so this facility would pose the most complex operation.

Decommissioning of NIF Laser . All assemblies and equipment would be removed from the laser bays, pulse power bays, master oscillator room, and control room. The support systems, piping, and wiring in the laser bays would also be removed. Minimum disassembly would be done on laser components. Glass would be stored in the simplest, least costly manner. Detached assemblies or subassemblies would fall into three categories: those immediately transferable to other DOE projects, those of possible use in the future, and those not likely to be reused. The items in the first category would be reassigned; the items in the second category would be packaged and stored; and the items in the third category would be disposed of through salvage. Several components, namely ignitrons and capacitors, would be handled as wastes. As shown in table I.4.1.2.8.2-1 the volume of the resulting waste would total about 313 m^3 (409 yd3).

Table I.4.1.2.8.2-1.-- Estimated Quantities of Waste from Laser Decommissioning

Item	**Volume (m^3)**	**Mass (t)**
500 ignitron switches - required recycle, Hg, 0.44 L, 6 kg each; EPA 40 CFR 268.42	1.0	3.0
4400 Capacitors - low hazard waste; castor oil on dielectric paper, 140 kg, 0.07 m^3 each	312	616
Total	313	619
Hg - mercury. **Tobin and Latkowski 1995.**		

Decommissioning of NIF Target Area . Two issues dominate the complexity or ease with which structures in the target area would be decommissioned at the end of NIF operation: (1) the extent of tritium contamination and (2) the contact dose due to long-lived activation products induced in large structures such as the target chamber, space frame/mirror support frames, and concrete.

Semipermanent facility features that contain materials of concern for neutron activation, such as cable runs and diagnostics, would be maintained during NIF operations in such a way that contact dose rates would allow their reuse in other facilities. This condition would be achieved through a combination of periodic change-out, radioactive decay time, and shielding. If proven successful, the carbon dioxide system proposed for waste minimization would be adapted to meet NIF decontamination needs. As proposed, frequent cleaning of equipment and inner chamber surfaces exposed to tritium and activated debris would significantly reduce (if not virtually eliminate) the need for major end-of-life decontamination. NIF operations would be designed both to minimize the quantity and extent of contamination and to reduce the hazard level of wastes. NIF decommissioning operations would be designed to maximize reuse and recycle of all components of the target area. For present estimates, it is conservatively assumed that the tritium decontamination levels required to allow material to be reused in uncontrolled areas or to be scrapped is 10-disintegrations per minute per square centimeter (dpm/cm^2) (62.5-dpm/square inches [in^2]) of removable tritium or 50-dpm/cm^2 (312.5-dpm/in^2) of removable and fixed tritium (generally in compliance with DOE 1990). Material from NIF would be decontaminated to this level before being disposed of or reused in an uncontrolled area. It is assumed that items useful for other DOE facilities that contain or use tritium would be packaged and shipped to those locations rather than undergo extensive decontamination, pending cost/benefit safety analysis. LLNL assumed that the contact dose rate level required to allow material with induced radioactivity to be reused in uncontrolled areas or to be scrapped is the level permitted by DOE O 441.1. Such material would be held in storage at the NIF site until the contact dose rate level decayed to this level or until it could be disposed of as radioactive waste. The waste quantities are listed in table I.4.1.2.8.2-2. Values are provided for both a minimal case, which assumes a 385-MJ annual release over the projected 30-year operational period, and an expanded case, with a 1,200-MJ annual release. The chamber support structures represent the largest volume (3,058 m^3 [4,000 yd3]) to be handled, with a total volume of all components being about 4,400 m^3 (5,755 yd3).

Table I.4.1.2.8.2-2.-- National Ignition Facility Target Area Low-Level Radioactive Waste Quantities from Decommissioning

Item	Volume (m^3)	Mass (t)
Vacuum system	34	54
Tritium system	16	36
Diagnostics manipulators	12	3.6
Target positioner	2 (4)	1 (2)
Chamber shielding	282 (567)	310 (620)
Chamber plates	6.3	8.5
Laser light absorbers	1.3 (2.0)	1.9 (3.0)
Chamber support structures	3,058	3,364
Target area beam transport	220 (330)	111 (161)
Final optics hardware	754 (1,204)	545 (815)
Total	4,386 (5,233)	4,425 (5,057)

Values shown assume a 30-year life with 385-megajoule yields. Values in parentheses assume 1,200-megajoule annual yields.

Tobin and Latkowski 1995.

Handling of these components would require careful application of as low as reasonably achievable practices. Estimated dose rates encountered during decommissioning for these components are shown in table I.4.1.2.8.2-3. Assuming careful planning and handling of the disassembly, it is estimated that the occupational exposure involved would be on the order of background rates (table I.4.1.2.8.2-4). The operations required would be unique, but would be within the capability of LLNL personnel, considering LLNL's prior experience with decommissioning large facilities and LLW handling.

Lazaro et al. 1996; LLNL 1994a.

8: If reporting body did not distinguish between state and Federal revenue sources, the total for all intergovernmental revenue was combined and reported under the "State sources" heading. Alameda County 1994; Contra Costa County 1994; San Joaquin County 1994; city of Livermore 1994; city of Pleasanton 1994; city of Tracy 1994; city of Manteca 1994.

9: Pupil-teacher ratio is for grades 1-8.

10: Contra Costa Fire Protection District is the largest fire protection district in Contra Costa County; however, other districts also provide service throughout the county.

11: General Government number includes firefighters. Fire services in San Joaquin County are provided by approximately 27 fire protection districts, including city fire departments. NA - not applicable.
Contra Costa County 1994; Alameda County 1994; Contra Costa County School Districts 1994; American Medical Association 1994; Federal Bureau of Investigation 1993; San Joaquin County Schools 1995a; San Joaquin County Schools 1995b; city of Pleasanton Personnel Department 1995; city of Manteca Personnel Department 1995; city of Manteca Fire Department 1995; Contra Costa Fire Protection Department 1995; Alameda County Fire Department 1995.

12: The regulatory limits for individuals are given in DOE Order 5400.5. The 10 mrem/yr limit from airborne emissions is required by the Clean Air Act . The 4 mrem/yr limit is required by the Safe Drinking Water Act , and the total dose of 100 mrem/yr is the limit from all pathways combined. The occupational limit for workers is 5,000 mrem/yr (10 CFR 835).

13: The calculated dose values listed in this column conservatively include all water pathways, not just the drinking water pathway.

14: Based on latent fatal cancer risk factors of 5x10-7/mrem for individuals, 5x10-4 /person-rem for population, and 4x10-7/mrem for workers (ICRP 1991).

15: Obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the site.

16: Estimated for a population of approximately 6 million.

17: No regulatory limit exists for population doses; however, a 100 person-rem value for the population is found in proposed 58 FR 16268 (10 CFR 834).

18: Worker doses were estimated on the basis of readings from monitoring devices called thermoluminescent dosimeters.

19: The number of badged workers in 1994 was approximately 8,700. NA - not applicable. LLNL 1994d.

20: Storage capacity may include several storage units that may be permitted for several waste types.

21: This waste is not tracked by volume, and the weight of material is too variable to reliably convert.

NA - not applicable. Andrews and Tobin 1995; Bowers 1995.

22: Metric tons (1,000 kg) per year.

23: Includes 4.17 t/yr (4.60 ton/yr) of fugitive emissions for site clearing, using water spray control that occurs during a 30-day period in the first year and 10 t/yr (11.02 ton/yr) of facility construction emissions that occur for 11 months during the first year of construction. Lazaro et al. 1996.

24: Emissions based on site-estimated natural gas external combustion, diesel internal combustion, and volatile organic compound solvent cleaning (0.5 t/yr [0.55 ton/yr]) and emission factors (EPA 1995c; Lazaro et al. 1996). EPA 1993; Zahn 1995.

25: Represents energy consumption for all required NIF support facilities. See table I.3.4-1 for a list of NIF support facilities.

MJ - megajoule(s); L -liter(s).

LLNL 1995b; White 1995e.

26: From LLNL 1995b.

27: From LLNL 1995b and Paisner 1995.

28: From LLNL 1994d.

29: Construction period would be 1996 to 2002, with peak construction projected to occur in 1998.

30: Operating period would be 2003 to 2033, with impacts throughout the period projected to remain stable.

31: Regional earnings are in millions of constant 1994 dollars.

32: Projected 1998 fund balance for Public Finance, and projected 1998 level of service (LOS) for Public Services. Model results.

33: Collective population fatalities were calculated for 145 shipments (Conceptual Design Option) and 335 shipments (Enhanced Option). For example, a reported value of 4x10-3 fatalities suggests that no fatalities are expected for the proposed action. However, one single fatality out of the entire affected population might be expected over the course of 250 years if the same number of shipments were to continue for that length of time.

34: The most severe accidents assume that 100 percent of the target tritium is released in an oxide form during an accident. Accident consequences results were determined using RISKIND computer program which is described in Yuan et al. 1993. Stable weather conditions (Pasquill stability class F) with a wind speed of 1 m/s (2.2 mph) were assumed.

35: The maximum consequences would result from an accident occurring in an urban environment. The population was assumed to extend at a uniform density of 3,861 persons/km

2 (10,000 person/mi 2) to a radius of 80 km (50 mi) from the accident site. The population exposure pathways for urban environments include inhalation and resuspended inhalation. Urban environments were not assumed to produce food for local use or export, hence no ingestion dose was included.

36: The maximally exposed individual was assumed to be at the location of maximum exposure. The location of the maximally exposed individual was assumed to be 380 m (1,247 ft) from the accident under stable weather conditions. Individual exposure pathways include acute inhalation during passage of the plume. No ingestion dose was considered.

The transportation risk assessment assumed 100 percent of the tritium targets are manufactured and transported to NIF from each site. In practice, tritium targets would be produced and transported from more than one manufacturer. The transportation risk assessment was performed for offsite transportation only. Transportation risks from onsite tritium targets were assumed to be negligible compared with risks from offsite transportation. Model results.

37: Articles cleaned by wiping, carbon dioxide blasting, and other decontamination methods. These materials would be handled as solid low-level radioactive wastes. Numbers in bold italics refer to waste estimates for the Enhanced Option; LATB - Laser and Target Area Building; OAB - Optics Assembly Building; HEPA - high-efficiency particulate air.
Andrews and Tobin 1995; Bowers 1995.

38: Articles cleaned by wiping, carbon dioxide blasting, and other decontamination methods. These materials would be handled as solid low-level radioactive wastes. Numbers in bold italics refer to waste estimates for the Enhanced Option; LATB - Laser and Target Area Building; OAB - Optics Assembly Building; HEPA - high-efficiency particulate air. Andrews and Tobin 1995; Bowers 1995.

39: In order to translate the solid waste mass into an expression of volume and to calculate the values shown for the number of years to fill storage capacity with NIF flow alone, the following values for the densities of the materials were assumed: molecular sieves: density of diatomaceous earth (0.22 g/cm^3); personal protective equipment and wipes: density of paper (0.4 g/cm^3); pre- and high-efficiency particulate air filters: density of charcoal (1.8 g/cm^3); paper capacitors: density of paper (0.4 g/cm^3); hardware from the chamber: density of 50 percent aluminum and 50 percent stainless steel (5.3 g/cm^3).

40: The total amount of the low-level waste was found by adding the values in the column "Cleaned" of table I.4.1.2.8.1-2 to the column "Low-Level" of the same table. The density of the debris shield was assumed to be the density of iron (7.87 g/cm 3). The density of low-level liquid waste was assumed equal to 1.0 g/cm 3 . The amount of the "cleaned" personal protection equipment and wipes/general cleaning was added to the solid low-level radioactive waste.

41: The values for the hazardous waste are the sum of the Laser and Target Area Building and Target Area Building and Optics Assembly Area values. Calculated from table I.4.1.1.8-1 and Tobin 1995.

42: The following values for the densities of the materials were assumed: molecular sieves: density of diatomaceous earth (0.22 grams per cubic centimeter [g/cm^3]); personal protective equipment and wipes: density of paper (0.4 g/cm^3); pre- and high-efficiency particulate air filters: density of charcoal (1.8 g/cm^3); paper capacitors: density of paper (0.4 g/cm^3); hardware from the chamber: density of 50 percent aluminum and 50 percent stainless steel (5.3 g/cm^3).

43: Shipped offsite.

NA - not applicable.

Calculated from table I.4.1.1.8-1 and Tobin 1995.

44: w/l at% B - with 1 atom % boron. Values shown assume 30-year life with 385-megajoule yields and 1,200-megajoule annual yields.
Tobin and Latkowski 1995.

I.5 Environmental, Occupational Safety, and Health Permits and Compliance Requirements

I.5.1 Introduction

This chapter identifies the major laws, regulations, Executive Orders, and compliance instruments that apply to the National Ignition Facility (NIF) proposed action and alternatives. Various Federal environmental statutes impose environmental protection and compliance requirements upon the Department of Energy (DOE). Further, certain state and local environmental authorities are also applicable because they are delegated to the state for enforcement or implementation under Federal law. It is DOE policy to conduct its operations in an environmentally safe manner in compliance with all applicable statutes, regulations, and standards. Although this chapter does not address pending legislation or regulations that may become effective in the future, DOE recognizes that the regulatory environment is rapidly changing and that the construction and operation of NIF must be conducted in compliance with the applicable statutes, regulations, and standards in effect at the time.

Under the *National Environmental Policy Act* (NEPA) of 1969 (42 *United States Code* [U.S.C.] 4321 et seq.), Federal agencies are required to prepare an environmental impact statement (EIS) for proposed major Federal actions that might significantly affect the quality of the human environment. DOE has determined that the proposed siting, construction, and operation of NIF is such an action. Therefore, this project-specific analysis has been prepared as a part of the *Stockpile Stewardship and Management Programmatic Environmental Impact Statement* in accordance with the Council on Environmental Quality (CEQ) Regulations (40 *Code of Federal Regulations* [CFR] 1500-1508) implementing NEPA and DOE NEPA Implementing Procedures (10 CFR 1021).

Under the California Environmental Quality Act (California Statutes, Public Resources Code, Division 13 - Environmental Quality, Section 21000 et seq.), any California state public agency taking any action that may cause either a direct physical change in the environment or a reasonably foreseeable indirect physical change in the environment must consider qualitative factors, economic and technical factors, long-term benefits and costs, and alternatives to the proposed action. Public agency actions include the issuance of a state permit, license, certificate, or other entitlement. The public agency must determine whether it will prepare an environmental impact report to identify the significant effects of the proposed project on the environment. All applicants for permits, license, certificates, or other entitlements from a public agency in support of the NIF proposed action may be required to submit data and information necessary to enable the public agency to determine whether the proposed project may have a significant affect on the environment and whether to prepare an environmental impact report.

The Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) authorized DOE to establish standards to protect health or minimize dangers to life or property for its facilities and operations. DOE has established an extensive system of standards and requirements through DOE orders to ensure safe operation of its facilities.

Executive Order No. 12088, Federal Compliance with Pollution Control Standards, requires Federal agencies--including DOE--to comply with applicable administrative and procedural pollution control standards established by, but not limited to, the *Clean Air Act* (section I.5.2.1), the *Noise Control Act* (section I.5.2.1.4), the *Clean Water Act* (section I.5.3.1), the *Safe Drinking Water Act* (section I.5.3.2), the *Toxic Substances Control Act* (section I.5.7.2), and the *Resource Conservation and*

Recovery Act (section I.5.8.1).

I.5.2 Air Quality and Noise Requirements

I.5.2.1 *Clean Air Act*

Construction and operation of NIF would result in air emissions of criteria and noncriteria pollutants, including sulfur dioxide, nitrogen dioxide, volatile organic compounds (VOCs), carbon monoxide, and particulates (PM *10*). These emissions would be subject to the *Clean Air Act* (CAA) (42 U.S.C. 7401 et seq.), as amended. NIF would also be a source of radionuclide emissions, also subject to the CAA. No other emissions of hazardous air pollutants would be anticipated during construction or operation of NIF.

CAA requires the U.S. Environmental Protection Agency (EPA) to establish national primary and secondary ambient air quality standards as necessary to protect public health with an adequate margin of safety from any known or anticipated adverse effects of a pollutant. CAA also requires promulgation of national standards of performance for new major stationary sources, setting emissions limitations for any new or modified building, structure, facility, or installation that emits or may emit an air pollutant (42 U.S.C. 7411) and standards for emission of hazardous air pollutants (42 U.S.C. 7412). CAA also requires that specific emission increases from major sources be evaluated so as to prevent a significant deterioration in air quality (42 U.S.C. 7470). In addition, CAA requires EPA to promulgate rules to ensure that Federal actions conform to the appropriate state implementation plans (42 U.S.C. 7506).

Pursuant to such direction, EPA promulgated the primary and secondary National Ambient Air Quality Standards, including standards for emissions of sulfur oxides (measured as sulfur dioxide), nitrogen dioxide, carbon monoxide, PM10, ozone, and lead (40 CFR 50); the standards of performance for new stationary sources within specific source categories enumerated in 40 CFR 60.16, including electric steam generating units, industrial-commercial-institutional steam generating units, and stationary gas turbines (40 CFR 60); the National Emission Standards for Hazardous Air Pollutants, including radionuclides (40 CFR 61); and the Prevention of Significant Deterioration (PSD) of Air Quality review regulations (40 CFR 52.21).

On November 30, 1993, EPA published its final rule for Determining Conformity of General Federal Actions to State or Federal Implementation Plans (58 Federal Register [FR] 63214). This rule requires states to file revisions to their state implementation plans to include conformity requirements (40 CFR 51.850-860). Once the state plans are revised, Federal agencies are subject to those revised state implementation plans. Until such revisions are submitted and approved, however, the rule adopts conformity requirements applicable to all Federal agencies (40 CFR 93.150-160). Only New Mexico and the Albuquerque/Bernalillo County Air Quality Control Board have revised their regulations to require conformity determinations for Federal actions (New Mexico Regulations, Title 20, Part 98 [uncodified]; Board Regulation No 43). The regulations apply to all nonattainment and maintenance areas for criteria pollutants for which the area is designated.

Under the new rules, a Federal agency must make a formal determination that a Federal action conforms to the applicable implementation plan before such action may be taken. For Federal actions, a conformity determination is required for each pollutant when the total of direct and indirect emissions in a nonattainment or maintenance area caused by a Federal action would equal or exceed certain limits (40 CFR 51.853 or 93.153) (table I.5.2.1-1).

The direct and indirect emissions from the construction and operation of NIF at any site would not exceed these limits (sections I.4.1.2.2, I.4.2.2.2, I.4.3.2.2, I.4.4.2.2, and I.4.5.2.2). In addition, the total of direct and indirect emissions of any pollutant from a Federal action must not equal or exceed 10 percent of a nonattainment or maintenance area's total emissions of that pollutant. If it does, it is defined as a regionally significant action and a conformity determination is required. It is not expected that emissions from NIF would equal or exceed this 10 percent limit.

CAA provides that each state must develop and submit for approval to EPA implementation plans for controlling air pollution and air quality in that state. Under EPA regulations, California, Nevada, and New Mexico all have approved state implementation plans; however, not all parts of the CAA requirements are met in such plans and, in some cases, dual Federal/state regulations must be implemented.

Table I.5.2.1-1.-- Conformity Determination Exceedance Limits

Pollutant	Limit (tons/yr)[1]
Nonattainment Areas	
Ozone (volatile organic compounds or nitrogen oxides)	
Serious Nonattainment Areas	50
Severe Nonattainment Areas	25
Extreme Nonattainment Areas	
Other ozone nonattainment areas outside an ozone transport region	
Marginal and moderate nonattainment areas inside an ozone transport region	
Volatile organic compounds	50
Nitrogen oxides	100
Carbon monoxide	100
Sulfur dioxide or nitrogen dioxide	100
Particulate matter 10 microns or smaller	
Moderate Nonattainment Areas	100
Serious Nonattainment Areas	70
Lead	25
Maintenance Areas	
Ozone (nitrogen oxides), sulfur dioxide or nitrogen dioxide	100
Ozone (volatile organic compounds	
Maintenance areas inside an ozone transport region	50
Maintenance areas outside an ozone transport region	100
Carbon monoxide	100

Particulate matter 10 microns or smaller	100
Lead	25

a To determine metric tons/year (t/yr), multiply values by 0.90718.

40 CFR 51.853 and 93.153.

California and Nevada have not been delegated the authority to regulate the emission of radionuclides from DOE facilities, and, therefore, Federal regulations would apply to such emissions at the Lawrence Livermore National Laboratory (LLNL) and the Nevada Test Site (NTS). In Nevada, the District Board of Health of Clark County and the Albuquerque/Bernalillo County Air Quality Control Board have adopted the Federal regulations, which would then be applicable to radionuclide emissions from the North Las Vegas Facility (NLVF) and Sandia National Laboratories/New Mexico (SNL). New Mexico has adopted the Federal standards for the emission of hazardous air pollutants (40 CFR 61); however, it has excluded from adoption Subparts H (National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities) and Q (National Emission Standards for Radon Emissions from Department of Energy Facilities). Therefore, Federal regulations would apply in New Mexico for the Los Alamos National Laboratory (LANL).

The Federal regulations for emissions of radionuclides and radon-222 from DOE facilities are set in 40 CFR 61, Subparts H and Q. Pursuant to 40 CFR 61.07, an application for approval of construction must be filed before construction begins (with Region IX for LLNL and NTS, with Region VI for LANL, with the District Board of Health of Clark County for NLVF, and with the Albuquerque/Bernalillo County Air Quality Control Board for SNL). Further, DOE must provide written notification to EPA (or appropriate authority) no more than 60 nor less than 30 days before the anticipated date of initial start-up of operations (40 CFR 61.09). However, if it is estimated that radionuclide emissions from the new construction or modification would be less than 1 percent of the effective dose equivalent of 10 mrem/yr to any member of the public, no application for approval of construction or notification of start-up is necessary (40 CFR 61.96). <>

I.5.2.1.1 *Clean Air Act* Requirements for California

The LLNL site is within the Bay Area Air Quality Management District (BAAQMD), and the district's regulations would apply to air emissions from NIF. NIF is not expected to have sufficient emissions to meet the definition of a major facility under California air regulations. The definition of one facility, however, includes related sources on a single property or contiguous properties, even though under different ownership, and related sources on noncontiguous properties under the same ownership. For this review, facilities under the same ownership that are located within a distance of 4.8 kilometers (km) (3 miles [mi]), property line to property line, are considered one facility if the facilities have the same first two digits in the Standard Industrial Classification code. However, current calculations show that LLNL's existing sources do not meet the definition of a major facility under the California regulations. Therefore, there is no requirement for a PSD review or major facility review for the construction and operation of NIF at LLNL (Regulation 2, Rules 2 and 6). New Source Performance Standards (40 CFR 60, Subpart D, as adopted by BAAQMD Regulation 10) would have to be met for the operation of steam boilers constructed as or modified to be support facilities for NIF. Under such requirements, any fossil-fueled steam boilers exceeding 73 megawatts (MW) input rate (250 British Thermal Units per hour [BTU/hr]) must meet the standards for PM10, nitrogen oxides, sulfur dioxide, and opacity.

Under BAAQMD regulations, any person responsible for the emission of air contaminants must register with the district (Regulation 1, Rule 1-410). In addition, any person who builds, installs, modifies, alters, or replaces any article, machine, equipment, or other contrivance, the use of which might cause, reduce, or control the emission of air contaminants, must first apply for and obtain an authority to construct from the Air Pollution Control Officer (Regulation 2, Rule 1-301). Also, any person wishing to use or operate such article machine, equipment, or other contrivance must obtain a permit from the Air Pollution Control Officer (Regulation 2, Rule 1-302).

Any facility that must obtain an authority to construct must be reviewed as a new source. Under the new source review rules (Regulation 2, Rule 2), the aggregate sum of all increases in emissions from a new or modified source must be calculated. These calculations will provide mechanisms, including the identification of best available control technology (BACT) and emission offsets, by which the District will grant the new or modified source the authority to construct (Regulation 2, Rule 2-101). Fugitive emissions of PM10 from temporary construction activities are not included in the calculation of the total potential to emit for the facility (DeBoisblance 1995). BACT must be applied to any new or modified source that will result in emissions of precursor organic compounds, non-precursor organic compounds, nitrogen oxides, sulfur dioxide, PM10, or carbon monoxide in excess of 4.5 kilograms (kg) (10 pounds [lb]) per highest day (Regulation 2, Rule 2-301). Estimated emissions from boiler operations may exceed 4.5 kg (10 lb) per day, and BACT may have to be applied as determined by the permit process.

If the facility will emit more than 45 metric tons (t) (50 tons) per year of precursor organic compounds or nitrogen oxides, federally enforceable emission offsets will be required before a permit will be granted (Regulation 2, Rule 2-302). If the facility will emit more than 13.6 t (15 tons) per year but less than 45 t (50 tons) per year of precursor organic compounds or nitrogen oxides, the district will provide the emission offsets from the Small Facility Banking Account (Regulation 2, Rule 2-302). Offsets for PM10 and sulfur dioxide are mandatory only for major facilities with emissions over 91 t (100 tons) per year. A facility that emits less than 91 t (100 tons) per year of PM10 or sulfur dioxide may voluntarily provide emission offsets for all or any portion of their cumulative increase.

I.5.2.1.2 *Clean Air Act Requirements for Nevada*

NTS is located in Nye County and air emissions for the construction and operation of NIF would be governed by the Nevada State Air Pollution Control Regulations (NAC 445B.001 through 445B.395). NIF at NTS is not expected to be a major facility under Nevada regulations. The District Board of Clark County Air Pollution Control Regulations (APCR) are approved as part of the Nevada state implementation plan, and these regulations would govern air emissions from the construction and operation of NIF at NLVF. NIF is not expected to be a major facility under Clark County regulations. New Source Performance Standards (40 CFR 60, Subpart D, as adopted by NAC 445B.308 and Clark County APCR, section 14) would have to be met for the operation of steam boilers constructed as, or modified to be, support facilities for NIF. Under such requirements, any fossil-fueled steam boilers exceeding 73 MW heat input rate (250 million Btu/hr) must meet the standards for PM10, nitrogen oxides, sulfur dioxide, and opacity.

In Clark County, all new, reconstructed, or modified stationary sources of volatile organic compounds, lead, PM10, particulate precursors, and carbon monoxide that are proposed to be located in the Las Vegas Valley must register with the District (APCR, section 15.14). Under Clark County Air Pollution Control regulations, any person who proposes to install or construct any new stationary source of air emissions must apply for an "Authority to Construct" certificate before construction is begun (APCR, section 12.1.1.1).

Certain requirements must be met for specific air contaminants before a permit will be issued. NIF project, as a nonmajor source of PM10 in Las Vegas Valley (with a potential to emit less than 64 t [70 tons] per year), must incorporate BACT (APCR, section 12.2.1.1). The applicant must also provide documentation of emission reduction credits against other emissions if the total potential to emit for the new source will exceed 23 kg (50 lb) per day of total suspended particulates (APCR, section 12.2.1.3). Qualified road paving projects approved by the local public works department are recognized by the Control Officer as emission reduction credits for PM10 (APCR, section 12.4.1). Such credits are good for seven years. A one-year emission reduction credit is available by payment to the closest local participating public works department (APCR, section 12.4.2).

As a nonmajor source of VOCs in Las Vegas Valley (VOC emissions under 45 t [50 tons] per year), NIF must incorporate emissions controls that are designed for BACT (APCR, section 12.2.4.1). The applicant must also provide documentation of emission reduction offsets to all anticipated annual emission increases (APCR, section 12.2.4). The applicant must also apply BACT for sulfur dioxide and lead emissions and demonstrate that the total potential to emit will not cause, or contribute to, ambient concentrations that exceed ambient air quality standards for sulfur dioxide or lead (APCR, sections 12.2.8 and 12.2.10).

An applicant must apply BACT for all emissions of nitrogen oxides and must demonstrate that the total potential to emit will not cause, or contribute to, ambient concentrations exceeding the ambient air quality standard for nitrogen oxides (APCR, section 12.2.10.1). Emission credits equivalent to twice the new source's potential to emit are required (APCR, section 12.2.10.4). As a nonmajor source of carbon monoxide in Las Vegas Valley (potential to emit less than 64 t [70 tons] per year), NIF must incorporate emission controls that are designed with the BACT (APCR, section 12.2.11.1), and emission reduction credits must be greater than twice the potential to emit for the new source (APCR, section 12.2.11.4).

In addition, an operating permit is required for the operation of any emission unit in a stationary source (APCR, section 16). Such an operating permit might contain conditions, including emission limits, production rates, control methods, or operation limitations, subject to annual review.

For construction activities at NIF within Clark County, a Permit for Construction Activities is required (APCR, section 17) to satisfy the Authority to Construct requirements of APCR, section 12.2.1. As a condition of such a permit, the applicant must present and agree to implement an acceptable method to prevent particulate matter from becoming airborne. In addition, any person engaged in the operation of machines and equipment, the grading of roads, and the operation and use of unpaved parking facilities must take all reasonable precautions to abate fugitive dust from becoming airborne. Reasonable precautions may include, but are not limited to, the conditions agreed upon in the permit for the project, sprinkling, compacting, enclosure, chemical and asphalt sealing, cleaning up, sweeping, or other such measures as the Control Officer may specify.

ACPR, Section 41, also requires control of fugitive emissions during construction activities. Fugitive emission prohibitions include the following:

- Visible plume of dust, resulting from contruction activities beyond the nearest property line, whichever is less

- Visible dust emissions on an upward road at a construction site being used by haul trucks
- Visible dust emissions generated by vehicles traveling over mud and directly carried out to a paved road near or adjacent to a construction site
- Handling, transporting, or storing material in such a manner to become airborne

The regulations further indicate that a visible plume of dust resulting from construction activities that extends more than 45.7 meters (m) (150 feet [ft]) from the point of origin, but less than 91.4 m (300 ft) and that has not crossed the property line may be subject to a Notice of Violation, including an Order to take Corrective Action.

Under Nevada air regulations, NTS, as the owner or operator of a proposed new nonmajor stationary source or a proposed modification to an existing nonmajor stationary source, must file an application and obtain a Class II operating permit before construction is begun (NAC, section 445B.291). A separate operating permit is required for each new and existing stationary source (NAC, section 445B.287). Before an operating permit may be issued for a new stationary source, any source that has the potential to emit greater than 23 t (25 tons) of a regulated air pollutant per year must submit an environmental evaluation to enable the director to make an independent air quality impact assessment and determine that the source will not prevent the attainment and maintenance of the state or national ambient air quality standards, cause a violation of the applicable control strategy contained in the approved state implemented plan, or cause a violation of any applicable requirement (NAC, section 445B.310). Because NIF is not expected to emit in excess of 23 t (25 tons) of any regulated air pollutant per year, no assessment would be necessary.

Construction activities at NTS would require an operating permit for any surface area disturbance (such as clearing, excavating, and leveling the land) involving more than 2 hectares (ha) (5 acres) of land (NAC, section 445.365). No person may engage in construction or use of unpaved or untreated areas without first putting into effect an ongoing program using the best practical methods to prevent particulate matter from becoming airborne (NAC, section 445B.365).

I.5.2.1.3 *Clean Air Act Requirements for New Mexico*

New Mexico Air Quality regulations would apply to air emissions from NIF if it was located at LANL. However, the Albuquerque/Bernalillo County Air Quality Control Board regulations would apply to air emissions from NIF if located at SNL.

Under New Mexico Air Quality regulations (which would apply at LANL), a permit must be obtained before constructing a stationary source or modifying an existing source with a potential emission rate greater than 4.5 kg/hr or 23 t/yr (10 lb/hr or 25 tons/yr) of any regulated air contaminant for which there is a Federal or New Mexico ambient air quality standard (Environmental Improvement Board/Air Quality Control Regulations [EIB/AQCR] 702, Part 2). If the threshold is exceeded for any one regulated air contaminant, all regulated air contaminants emitted are subject to permit review. A permit is also required for any source or equipment that is subject to the New Source Performance Standards, for any toxic air pollutant emissions or any major source of hazardous air pollutants, any source meeting the applicability requirements of the PSD review, or for permits for nonattainment areas (EIB/AQCR 702). It is not anticipated that the construction or operation of NIF at LANL would emit toxic air pollutants, be a major source of hazardous air pollutants, or be located in a nonattainment area. Therefore, no permit application would be required under this section. One PSD Class I Area, the Bandelier National Monument Wilderness Area, borders LANL to the south; however, to date, LANL has not been subject to PSD requirements (see section I.4.2.1.2.2). New

Source Performance Standards (40 CFR 60, Subpart D, as adopted by 20 NMAC 2.77) would have to be met for the operation of steam boilers constructed as or modified to be support facilities for NIF. Under such requirements, any fossil-fueled steam boilers exceeding 73 MW heat input rate (250 million Btu/hr) must meet the standards for PM *10* , nitrogen oxides, sulfur dioxide, and opacity.

Under Albuquerque/Bernalillo County Air Quality Control Board regulations, SNL as the owner or operator of NIF, a commercial or industrial stationary source that emits more than 0.9 t (1 ton) of any air contaminant per year, must obtain a registration certificate for the source (Regulation No. 22). In addition, any persona planning to construct a new stationary source or modify an existing stantionary source of air contaminants over certain thresholds must obtain a permit from Alburquerque/Bernalillo County Air Qulaity Control Board vefore construction.

For construction of NIF in Alburquerque/Bernalillo County, a permit would be neccesary for the disturbance of more than 0.30-ha (.75 acre) surface area (Regulation 8.03). In addition, the permittee must employ means specified in the permit to prevent the escape from the site of airborne particulate matter, if the opacity of which exceeds the opacity of the surrounding airborne background particulate matter by 10 percent.

I.5.2.1.4 Noise Requirements

Section 4 of the *Noise Control Act* of 1972 (42 U.S.C. 4901 et seq.) directs all Federal agencies to carry out programs in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health or welfare. EPA has not published regulations concerning noise levels from construction operations. However, the agency has issued guidelines for outdoor noise levels that are consistent with the protection of human health and welfare against hearing loss, annoyance, and activity interference (EPA 1974). Such guidelines state that "undue interference with activity and annoyance will not occur if outdoor levels [of noise] are maintained at an energy equivalent of 55 decibel." These levels are not to be construed as standards, however.

I.5.3 Water Resources Requirements

Regardless of the site selected for the project, NIF would use water for sanitary and domestic purposes, low-conductivity cooling, manufacturing, and processing operations for target and optics maintenance, environmental control of the site and facilities, and emergency and safety systems. It is also anticipated that industrial and sanitary/domestic water would be discharged from the operation of NIF at all sites. For construction activities, stormwater discharges are regulated.

I.5.3.1 *Clean Water Act*

The Federal *Clean Water Act* (CWA) (33 U.S.C. 1251 et seq.) provides that it is illegal to discharge pollutants from a point source into navigable waters of the United States except in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. Through administrative and judicial interpretation, the navigable waters of the United States encompass any body of water for which the use, degradation, or destruction would affect or could affect interstate or foreign commerce, including but not limited to interstate and intrastate lakes, rivers, streams, wetlands, playa lakes, prairie potholes, mudflats, intermittent streams, and wet meadows. This program is administered by the Water Management Division of EPA pursuant to regulations in 40 CFR 122 et seq. Any state may administer its own permit program for discharges into navigable waters within its jurisdiction by submitting the state program to EPA for approval (33 U.S.C. 1342[b]).

Sections 401 and 405 of the *Water Quality Act* of 1987 added section 402(p) to the CWA, which requires EPA to establish regulations for issuing permits for stormwater discharges associated with industrial activity. The language of the *Water Quality Act* of 1987 requiring an NPDES permit for stormwater discharge was codified into EPA regulations at 40 CFR 122.26 (54 FR 246, effective January 4, 1989). Pursuant to revised 40 CFR 122.26(a)(1)(ii), any stormwater discharge associated with industrial activity requires an NPDES permit application. EPA has delegated NPDES permitting authority to the States of California and Nevada. New Mexico, however, has not received such delegation, and NPDES permits in New Mexico are issued by EPA, Region VI. The New Mexico Environment Department certifies that permits meet all state and Federal regulations.

Pursuant to Section 404 of the CWA (33 U.S.C. 1344), there may be no discharges of dredged or fill material into waters of the United States, including rivers, streams, wetlands, and playa lakes (33 CFR 328.8), done than the Corps of Engineers, without a permit issued pursuant to Corps of Engineers rules and regulations (33 CFR 320 through 328). these regulations prescribe special policies, practices, and procedures to be followed by the Corps of Engineers in reviewing apllications for such permits to authorize such discharges (33 CFR, Parts 320, 323, and 325). Pursuant to 33 CFR 320.4., the Corps in issuing such permits must consider the impact that such an activity would have on floodplains and wetlands in accordance with Executive Orders 11988 and 11990.

I.5.3.1.1 *Clean Water Act Requirements in California*

California has NPDES permitting authority, and any permits or permit modifications required by the construction or operation of NIF at LLNL would be issued by the State Water Resources Control Board, Division of Water Quality. Sanitary wastewater from NIF located at LLNL would be discharged to the city of Livermore Water Reclamation Plant. Therefore, no NPDES permit would be necessary for NIF operations. Under current calculations, wastewater treatment capacity at the Reclamation Plant is expected to be sufficient to meet the additional requirements of NIF. However, it might be necessary to report any change in amount or character of discharges to the Livermore Plant under LLNL/city of Livermore pretreatment agreements, since discharge of spent cooling water would be considered an industrial discharge (Steenhoven 1995).

Construction activity associated with NIF would require Notice of Intent to the State Water Resources Control Board to participate in the California General Construction Activity Stormwater Permit. Under the permit, a stormwater pollution prevention plan would have to be developed to mitigate potential water quality impacts from construction activities through the use of best available technology and best conventional pollutant control technology. Once construction was completed, NIF would have to be added to the Livermore Site Industrial Activity Stormwater Pollution Prevention Plan through notification to the State Water Resources Control Board.

I.5.3.1.2 *Clean Water Act Requirements in Nevada*

Nevada is an NPDES-delegated state with general permitting authority. Although NTS holds a sewage treatment permit (GNEV 93001) from the Department of Conservation and National Resources for its current treatment systems, a sanitary wastewater treatment lagoon would have to be constructed to accommodate NIF operations at NTS. The new lagoon would not discharge to any water of the state (Monroe 1995). Under the Nevada Water Pollution Control Law, it is unlawful to discharge pollutants into waters of the state (which includes all streams, lakes, ponds, impounding reservoirs, marshes, watercourses, waterways, wells, springs, irrigation and drainage systems, and all bodies or accumulations of water, surface and underground, natural and artificial) without a written permit for such discharge under such reasonable terms and conditions as required by the Department of Conservation and Natural Resources and Environmental Protection Division (NRS, Title 40, chapter 445.287).

Industrial wastewater and sanitary sewage from NLVF are discharged into the city of North Las Vegas Water Treatment Plant. The North Las Vegas plant holds a current NPDES permit issued by the Nevada Division of Environmental Protection. Under Nevada Water Pollution Control regulations, no permit is required for discharges of pollutants, other than toxic materials, into a publicly owned treatment works, if the owner of such publicly owned treatment works has a valid permit from the state (NAC, section 445.140). Therefore, no permit is necessary for the discharge of NIF wastewater into the North Las Vegas plant. However, under pretreatment agreements and permits with the publicly owned treatment works, NLVF might have to report to the publicly owned treatment works the change in amount and character of its discharge resulting from the construction and operation of NIF. (NAC, section 445.169).

Both NTS and NLVF have requested the Department of Conservation and Natural Resources to issue a determination that stormwater from the sites does not discharge to waters of the state, and, therefore, no stormwater permits, for construction or industrial activity are necessary.

I.5.3.1.3 *Clean Water Act Requirements in New Mexico*

New Mexico has not been delegated NPDES permitting authority; therefore, EPA, Region VI, would issue any new NPDES permits or modify existing permits as necessary. The New Mexico Environment Department reviews and certifies NPDES draft permits issued by EPA to ensure that they meet all state and Federal regulations and standards. Sanitary wastewater from NIF construction and operations would be discharged into LANL's existing sewer system, which has been permitted by the Federal EPA (NPDES Permit NM 0028355). All reporting requirements under the permit regarding changes in the quantity, quality, or character of the discharge resulting from NIF operations must be made to EPA, Region VI (40 CFR 122.41(l), 122.62, 122.63). This requirement would include significant changes in process and quantity or quality of effluent discharged into the existing system and any new discharges. DOE, LANL, and New Mexico Environment Department have entered into a Settlement Agreement to study the stream uses associated with LANL effluent discharges under its NPDES regulations.

In addition to Federal requirements, the New Mexico Water Quality Control Commission regulations require that any person intending to make a new water contaminant discharge, or to alter the character or location of an existing discharge, must file a notice with the Water Pollution Control Bureau of the Environmental Improvement Division (WQCC 821-1-201). If it were necessary to modify the sewer system in a manner that would substantially change the quantity or quality of the discharge from the system, LANL would also have to file plans and specifications of the construction or modification with the Bureau. Otherwise, modifications having a minor effect on the character of the discharge would only have to be reported as of January 1 and June 30 of each year (WQCC 821-1-202).

Sanitary and industrial wastewater from SNL are discharged to the Alburquerque Wastewater Treatment Plant, which holds a Federal NPDES permit. The SNL has pretreatment standards for SNL industrial wastewaters prior to discharge to the plant. Therefore, it would have to notify the plant of any changes in discharges associated with the operation of NIF (40 CFR 403.12).

Since New Mexico has not been delegated NPDES permitting authority, LANL has submitted a Notice of Intent to the federal EPA, Region VI, to participate in the Federal General Permit for Storrwater Discharges Associated with Construction Activities. As a condition of the permit, each facility must have a Stormwater Pollution Prevention Plan. Any construction associated with NIF would have to conform to the conditions of this permit.

I.5.3.2 Safe Drinking Water Act

The primary objective of the *Safe Drinking Water Act* (42 U.S.C. 300(f) et seq). is to protext the qulity of public water supplies, water suplly and distribution systems, and all sources of drinking water. Sections of the Act address public water systems, protection of undergrounds sources of drinking water, emergency powers, genreal provisions, and additional requirements to regulate underground injection wells. The Nation Primary Drinking Water regulations (40 CFR 141 et. seq), administered by EPA, establish standards applicable to publuc water systems. the regulations include maximum contaminant levels, including those for radioactivity, for community and noncommunity water systems. No new public water supply system is anticipated to be constructed at any of the sites.

I.5.3.2.1 *Safe Drinking Water Act Requirements in California*

Water used at the LLNL site is purchased primarily from the city of San Francisco Hetch Hetchy Aqueduct and from the Alameda County Flood and Water Conservation District, Zone 7. Significant alterations to LLNL's drinking water supply requirements due to NIF construction and operation might require that the suppliers be notified of such modification to ensure the new service connection would not cause pressure reduction below state standards (22 *California Code of Regulations* [CCR] 64568).

I.5.3.2.2 *Safe Drinking Water Act Requirements in Nevada*

Nevada has adopted the National Drinking Water regulations (40 CFR 141) for its public water systems regulations (NAC 445.247). NTS will acquire domestic water from its permitted water supply system to serve NIF requirements. Notification of any modification to accommodate NIF operations would be made to the Department of Health Services, including submission of water system modification plans for approval (NAC 445A.657). NLVF would acquire domestic water for NIF from the city of North Las Vegas under an existing agreement. The city would have to be notified of any increase in NLVF water supply usage (Monroe 1995).

I.5.3.2.3 *Safe Drinking Water Act Requirements in New Mexico*

New Mexico has a comprehensive water supply program (NM Regulations [NMR] Title 20, Chapter [uncodified]), under which every public water supply system must site, construct, and maintain its operation in compliance with the requirements of such program. Domestic water to be used at NIF would come from LANL's public water supply system. Under the New Mexico regulations, prior written approval from the New Mexico Environment Department must be obtained before starting any addition to, or modification of, an existing public water supply system that may affect the system reliability or the quantity or quality of the water supplied (NMR 20-7 502). Such approval is not required if the construction or modification is less than 305 m (1,000 ft) of distribution piping appurtenance during any 60-day calendar period, or if such construction or modification takes place at a facility where the water utility staff includes a professional engineer registered in New Mexico who will have responsibility for the project (NMR 20-7-502).

SNL does not own or operate a public water supply system but instead obatins its domestic water suplly from the city od Albuquerque system or the Kirtland Air Force Base system. Official approcal for any additional usage might have to be obtained from these water suplliers, although current water supply capacity is expected to be sufficient to meet the requirements of NIF (section I.4.5.2.3). Any new hookups would have to conform with any requirements of those suppliers.

I.5.3.3 Executive Order 11988 - Flooodplain Management; Executive Order 11990 - Protection of Wetlands

Executive Order 11988 (May 21, 1977) requires federal agencies to establish procedures to ensure that any actions undertaken in a floodplain consider the potential effects of flood hazards and floodplain management and that floodplain impacts be avoided to the extent praticable. Executive Order 11990 (May 24, 1977) requires all federal agencies to consider protection of wetlands in decision making for proposed action.

DOE has established procedures for compliance with these orders entitled "Compliance with Floodplain/Wetlands Environmental Review Requirements" (10 CFR 1022). These regulations require DOE to assess the effects of a proposed action on the survival, quality, and natural or beneficial values of wetlands and to avoid impacts to floodplains to the extent practicable. Pursuant to the regulations and concurrent with DOE's review of a proposed action, DOE shall prepare a floodplain/wetlands assessment that evaluates the positive and negative, direct and indirect, and long- and short-term effects of NIF construction on wetlands and floodplains and alternatives to the proposed action that might avoid adverse effects to floodplains or wetlands, and measures to mitigate the adverse effects of actions in a floodplain or wetlands area (10 CFR 1022.12). None of the sites selected for the construction are located in floodplains or wetlands (sections I.4.1.2.3, I.4.2.2.3, I.4.3.2.3, I.4.4.2.3, I.4.5.2.3, I.4.1.2.4.2, I.4.2.2.4.2, I.4.3.2.4.2, I.4.4.2.4., and I.4.5.2.4.2). However, the option I temporary construction staging area for LLNL would be built in the 500-year floodplain, and the bridge spanning Arroyo Las Positas would be within the 100-year floodplain. The bridge would be designed not to increase the risk of flooding. Also, no highly volatile, toxic, or water reactive materials would be stored in the staging area.

I.5.4 Ecological Resources Requirements

I.5.4.1 *Endangered Species Act*

The *Endangered Species Act* (16 U.S.C.he Interior (all other plant and animal species and their habitats). Section 16 U.S.C. 1536 requires DOE to consult with the Department of the Interior, Fish and Wildlife Service, and/or Department of Commerce, National Marine Fisheries Service, to determine whether endangered and threatened species are known to have critical habitats on or in the vicinity of the sites for the proposed action. The identification of endangered and threatened species and their habitats is provided in 50 CFR 17 and 402. Each site has consulted with the Department of the Interior, Fish and Wildlife Service, concerning impacts on endangered and threatened species, migratory birds, and their critical habitats in the vicinity of the proposed locations for NIF.

I.5.4.2 *Migratory Bird Treaty Act*

The *Migratory Bird Treaty Act*, as amended (16 U.S.C.s 703 et seq.), is intended to protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and the former Soviet Union Socialist Republics. It regulates the harvest of migratory birds by specifying the mode of harvest, hunting seasons, and bag limits. The Act stipulates that it is unlawful at any time, by any means, or in any manner to "kill . . . any migratory bird." Although no permit is required under this Act, DOE would consult with the U.S. Fish and Wildfife Service, as appropriate, regarding impacts to migratory birds and to evaluate ways to avoid or minimize these impacts.

I.5.4.3 *Bald and Golden Eagle Protection Act*

The *Bald and Golden Eagle Protection Act* (16 U.S.C. 668 - 668d) makes it unlawful to take, pursue, molest, or disturb bald (American) and golden eagles, their nests, and eggs anywhere in the United States. No permits or approval procedures are required unless a nest is found to interfere with resource development; in that case, a permit must be obtained from the Department of the Interior to relocate the nest. If a bald (American) or golden eagle nest was found in the vicinity of NIF activities during NIF development and construction, DOE would consult with the Department of the Interior regarding requirements under this Act.

I.5.5 Cultural and Paleontological Resources Requirements

Executive Order 11593, Protection and Enhancement of the Cultural Environment (May 15, 1971), requires Federal agencies to locate, inventory, and nominate qualifying properties under their jurisdiction or control to the National Register of Historic Places (NRHP). This process requires DOE to provide the opportunity for the Advisory Council on Historic Preservation to comment on the possible impacts of the proposed action on any potentially eligible or listed resources.

I.5.5.1 *National Historic Preservation Act*

The *National Historic Preservation Act* (16 U.S.C. 470 et seq.) provides that places with significant national historic value be placed on the NRHP. No permits or certifications are required under this Act. However, pursuant to regulations in 36 CFR 800 et seq., if a proposed action might impact a historic property resource, consultation with the State Historic Preservation Officer and the Advisory Council on Historic Preservation is required. Such consultation generally results in execution of a Memorandum of Agreement that includes stipulations that must be followed to minimize adverse impacts. No historic places were identified by the appropriate State Historic Preservation Officers at any of the sites.

I.5.5.2 Archaeological and Historic Preservation Act

The *Archaeological and Historic Preservation Act* (16 U.S.C. 469a et seq.) is directed at the preservation of historic and archaeological data that would otherwise be lost as a result of Federal construction. It authorizes the Department of the Interior to undertake recovery, protection, and preservation of archaeological and historic data. If the Federal agency determines that a proposed action might cause irreparable damage to archaeological resources, that agency is required to notify the Department of the Interior in writing. The agency involved may then undertake recovery and preservation or may request that the Department of the Interior undertake preservation measures. No such sites were identified at the proposed NIF locations.

I.5.5.3 *American Indian Religious Freedom Act*

The purpose of the *American Indian Religious Freedom Act* (42 U.S.C. 1996) is to protect and preserve for Native Americans their inherent right of freedom to believe, express, and protect the traditional religions of Native Americans, including, but not limited to, access to religious or traditional sites, use and possession of sacred objects, and freedom to worship through ceremonial and traditional rites. DOE has consulted with all affected Native American groups, and no Native American cultural resources were identified at any proposed NIF location (sections I.4.1.1.5, I.4.2.1.5, I.4.3.1.5, I.4.4.1.5, and I.4.5.1.5).

I.5.6 Environmental Justice

On February 11, 1994, President Clinton issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (59 FR 7629). This Executive Order, with accompanying cover memorandum, calls on Federal agencies to incorporate environmental justice as part of their missions, including decisions made in compliance with NEPA. Specifically, the President's cover memorandum to the Environmental Justice Executive Order mentions NEPA in two contexts:

Each Federal agency shall analyze the environmental effects, including human health, economic and social effects, of Federal actions, including effects on minority communities and low-income communities, when such analysis is required by NEPA. Mitigation measures outlined or analyzed in an environmental assessment, environmental impact statement, or record of decision, whenever feasible, should address significant and adverse environmental effects of proposed Federal actions on minority communities and low-income communities.

Each Federal agency shall provide opportunities for community input in the NEPA process, including identifying potential effects and mitigation measures in consultation with affected communities and improving the accessibility of meetings, crucial documents, and notices.

No formal guidance has been issued by the Federal Working Group on Environmental Justice or DOE concerning this Executive Order. Therefore, the analysis of environmental justice issues presented in the Socioeconomics sections of chapter I.4 may somewhat vary from whatever final guideance may be issued.

I.5.7.1 Atomic Energy Act of 1954

The *Atomic Energy Act* of 1954 (42 U.S.C. 2011 et seq.) authorized DOE to establish standards to protect health or minimize dabgers to life or property for its operations and facilities. In accordance with the *Energy Reorganization Act* of 1974, DOE-realted operations are not subject to licensing by the U.S. Nuclear regulatory Commission (10 CFR 50.11). The transportation, storage, and use of radioactive and hazardous materials is governed by DOE orders. The major DOE orders pertaining to radioactive and hazardous material management at NIF are listed in table I.5.7.1-1.

In addition, DOE has promulgated regulations for the protection of occupational workers from radiation exposure (10 CFR 835). These regulations set occupational exposure limits and require DOE facilities to develope and comply with radiation program, including periodic audits.

Table I.5.7.1-1.--U.S. Department of Energy Orders Applicable to the National Ignition Facility Project

Order	Subject
O 151.1	Comprehensive Emergency Management System
O 232.1	Occurrence Reporting and Processing of Operations Information
O 430.1	Life Cycle Asset Management
O 440.1	Worker Protection Management for DOE Federal and Contractor Employees
O 460.1	Packaging and Transportation Safety
O 460.2	Departmental Materials Transportation and Packaging Management
O 470.1	Safeguards and Security Program
5400.1	General Environmental Protection Program
5400.5	Radiation Protection of the Public and the Environment
5480.4	Environmental Protection, Safety, and Health Protection Standards
5482.1B	Environment, Safety, and Health Appraisal Program
5484.1	Environmental Protection, Safety, and Health Protection Information Reporting Requirements
5630.12A	Safeguards and Security Inspection and Assessment Program
5700.6C	Quality Assurance

In addition, DOE has promulgated regulations for the protection of occupational workers from radiation exposure (10 CFR 835). These regulations set occupational exposure limits and require DOE facilities to develop and comply with a radiation program, including periodic audits.

I.5.7.2 Toxic Substances Control Act

EPA has promulgated regulations governing the use, marking, storage, and disposal of polychlorinated biphenyl (PCB)-contaminated transformers or hydraulic equipment (40 CFR 761) under the *Toxic Substances Control Act* (15 U.S.C. 2601 - 2671). If any such PCB articles are removed during the renovation of existing buildings, they must be stored and disposed of properly. PCB transformers and equipment would be diposed of at licensed incinerators or chemical wast landfills. Shipment offsite of transformers or equipment contaminated with waste PCBs would be manifested, and a proper certificate of Destruction would be obtained.

I.5.7.3 Emergency Planning and Community Right - to - Know Act of 1986

Under the *Emergency Planning and Community Right - to - Know Act of 1986* (EPCRA or SARA, Title III)(42 U.S.C 1101 et seq.), industria facilities are required to provide information, such as inventories of specific chemicals used or stored there, to the appropriate State Emergency Response Commission and Local Emergency Planning Committee (LEPC) to ensure that emergency plans are sufficient to respond to accidental release of hazardous substances. The Act orginally did not appear to apply to Federal Agencies; however, on August 3, 1993, Federal Order 12856 was issued making each Federal agency and its jurisdictional facilities subject to the provisions of the EPCRA and the *Pollution Prevention Act* of 1990. Under EPCRA, facilities with more than a threshold quality of an "extremely hazardous substance" (40 CFR 355, appendixes A and B) must provide a representative to the LEPC, promptly inform the LEPC of any "relevant changes" at the facility, and upon request, promptly provide LEPC with "information . . . neccesary for the developing and impplementing the emergency plan." Also, all covered facilities that exceed certain volume thresholds must provide an inventory of the types and quantities of hazardous materials stored or used onsite to LEPC (40 CFR 370). It is not anticipated that NIF operations would require storage of extremely hazardous substances; however, if the site already had submitted information to the LEPC, any relevant changes resulting from NIF operations should be communicated to LEPC.

The transportation of radioactive or hazardous materials is governed by the *Hazardous Materials Transportation Act* (49 U.S.C. 1801 et seq.). The implementing regulations by the Department of Transportation (DOT) (49 CFR 171-179) establish requirements for shipments along public highways, including shipping papers, marking, labeling, placarding, training, emergency response information, and packaging. Therefore, any shipments of radioactive or hazardous materials to or from the NIF location would have to comply with DOT shipping requirements.

I.5.8 Waste Management

I.5.8.1 Solid Waste Disposal Act, as Amended by the Resource Conservation and Recovery Act and the Hazardous Solid Waste Amendments of 1984

The treatment, storage, or disposal of solid, both nonhazardous and hazardous, waste is regulated under the *Solid Waste Disposal Act* , as amended by the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. 6901 et seq.) and the *Hazardous Solid Waste Amendments* of 1984 (HSWA). Under Section 3006 of the Act, any state that seeks to administer and enforce a hazardous waste program pursuant to RCRA may apply for EPA authorization of such program. Approved state programs are not static, and as new Federal regulations, limitations, and restrictions are promulgated by EPA, state programs must be revised in response to such changes. Prior to HSWA, changes to Federal requirements were not enforced in authorized states until the state's program was appropriately modified and approved by EPA. Now, EPA enforces Hazardous Solid Waste Amendments requirements in an authorized state until the state receives approval under section 3006 (g).

California, Nevada, and New Mexico have all received authorization to enforce a hazardous waste program under Subpart C of RCRA. Nevada and New Mexico have adopted the Federal requirements for hazardous waste management. California has an authorized hazardous waste program; however, not all the Hazardous Solid Waste Amendments to RCRA have been incorporated, and California operates under a dual state-Federal regulatory system.

Under RCRA, "source, special nuclear, and by-product materials," as defined by the *Atomic Energy Act* of 1954, are excluded from the definition of solid waste and, therefore, cannot be considered hazardous waste. However, by definition, a mixture of hazardous and radioactive wastes (mixed waste) contains constituents that require regulation under RCRA. On July 3, 1986, EPA issued a clarification that the hazardous components of radioactive mixed waste are regulated under RCRA, and the radioactive components are governed by applicable *Atomic Energy Act* regulations. Because of the dual nature of this waste, it was not until 1988 that EPA issued another clarification that states could submit for authorization to regulate mixed waste storage, treatment, and disposal under state programs. When treatment standards for the land disposal restrictions were issued for mixed waste in 1990, problems arose with the long-term storage of mixed waste, since under land disposal restrictions, restricted wastes may not be stored for more than one year (40 CFR 268.50). The storage and treatment capacity problems for mixed wastes created an enforcement problem for those storing mixed wastes, including DOE.

Congress addressed the problems of DOE mixed waste storage in the *Federal Facility Compliance Act* (FFCA) of 1992 (Public Law 102-386, 106 Stat. 1505, October 6, 1992). Although *FFCA* made it clear that sovereign immunity is waived for the enforcement of state RCRA regulations, it granted DOE facilities a 3-year extension period before waiving sovereign immunity concerning the enforcement of land disposal restrictions regulations as applied to mixed waste (October 1995). Section 104 of the Act requires DOE to submit a draft report to EPA and to authorized states that lists national inventories of all mixed waste on a state-by-state basis and analyzes mixed waste treatment capacities and technologies. To extend the application of such sovereign immunity beyond the 3-year period, DOE must also comply with section 105 of the Act, which requires DOE to develop a comprehensive plan to treat mixed wastes for all DOE facilities. Such plans must include a comprehensive requirement for developing schedules for almost all phases of mixed waste disposal. The plans are submitted to EPA, which in turn submits them to the authorized state. DOE announced it would develop such a National Compliance Plan for its mixed waste (57 FR 57710).

Currently California, New Mexico, and Nevada have been authorized to regulate mixed waste under RCRA. Therefore, any necessary permitting of facilities for the treatment, storage, or disposal of mixed waste resulting from NIF operations in California, New Mexico, and Nevada would proceed through their normal RCRA permitting process.

I.5.8.1.1 *California Resource Conservation and Recovery Act Requirements*

LLNL operates treatment, storage, or disposal facilities under Part A interim status pursuant to filings to the California Environmental Protection Agency, Department of Toxic Substances Control (previously the Department of Health Service). Under California regulations, no facility operating under interim status may manage hazardous wastes that are not specified in Partdescribed in Part A of the permit application, or exceed the design capacities specified in Part A of the permit application (22 CCR § 66265.1[c]). LLNL's Part A Permit application does have limitations as to the waste streams that may be stored or treated in the facilities and capacity limitations. However, if all hazardous waste and mixed waste generated at NIF were accumulated onsite and shipped offsite for treatment and disposal within 90 days, such permit requirements would not apply (22 CCR § 66265.1 [d]). If hazardous or mixed wastes were to be stored for more than 90 days in the permitted treatment, storage, or disposal facility, it might be necessary to amend the facility permit to include new waste streams or new capacity requirements resulting from NIF operations (22 CCR § 66270).

I.5.8.1.2 *Nevada Resource Conservation and Recovery Act Requirements*

NTS has a permitted treatment, storage, or disposal facility for storage of hazardous wastes near the Radioactive Waste Management Site in Area 5; however, it is anticipated that hazardous waste, except mixed waste, will be accumulated onsite and shipped offsite for treatment and disposal. Such accumulation does not require a permit if it meets all Federal RCRA generator requirements (40 CFR 262), as adopted by Nevada (NAC 444.8632). NTS has submitted a revised Part B Permit application, which includes a separate storage and disposal unit for solid mixed waste. Such application is pending action by the Nevada Division of Environmental Protection. NTS operates a mixed waste storage facility under PartLevel Land Disposed Restricted Mixed Waste between the State of Nevada and DOE). No mixed waste disposal is currently being conducted at the Part A interim status land disposal unit, pending land disposal restriction treatment determination. Mixed liquid waste may not be disposed of at NTS pursuant to the NTS Waste Acceptance Criteria, NVO-325. However, there are plans to develop this capability, and such a liquid mixed waste treatment facility would have to be permitted by the Nevada Division of Environmental Protection. Otherwise, mixed liquid waste can be stored at the NTS Part A interim status mixed waste storage facility for shipment to an offsite facility for treatment and disposal.

NLVF does not have a permitted treatment, storage, or disposal facility, and hazardous waste at NIF would be accumulated for transportation to offsite treatment, storage, or disposal facilities. Mixed waste would be accumulated for shipment to NTS, once the NTS Part B Permit is issued. Such accumulation would not require a permit if it met all Federal RCRA generator requirements (40 CFR 262), as adopted by Nevada (NAC 444.8632). If hazardous or mixed waste were to be stored for more than 90 days, a treatment, storage, or disposal facility would have to be sited, permitted, and operated under the regulations governing and operators of such facilities (40 CFR 264).

I.5.8.1.3 New Mexico Resource Conservation and Recovery Act Requirements

SNL has a permitted treatment, storage, or disposal facility for the storage of hazardous waste. Hazardous waste generated at NIF would be stored in this facility until it is shipped offsite to an approed disposal facility. SNL is currently storing its liquid mixed waste at the site of generation (Wheeler 1995), SUch accumulation does not require a permit if it meet all Federal RCRA generator requirements (40 CFR 262), as adopted by New Mexico (NM Regulations, Title 20, chapter 4). SNL is currently performing treatability studies at its Radioactive and Mixed Waste Management Facility to obtain a Part B Permit from the state of New Mexico. Once the facility is permitted, mixed waste will be treated there to remove the hazardous component. The residue will be disposed of as radioactive waste. When treatment of hazardous component is not feasible, the mixed waste will be stored onsite until a disposal option becomes available. It may be neccesary to amend the facility permit or the Part A application to include new waste streams or capacity (40CFR 270.42 and 270.72).

LANL has a permitted treatment, storage, or disposal facility; however, it is anticipated that all hazardous waste and mixed waste at NIF would be accumulated onsite and shipped offsite for treatment and disposal. Such accumulation would not require a permit if it mat all Federal RCRA generator requirements (40 CFR 262), as adopted by New Mexico (NM Regulations, Title 20, chapter 4). LANL also has Part A interim status facilities. It might be neccesary to amend the facilty permit to include new waste streams or new capacity.

I.5.8.2 Low-Level Radioactive Waste

It is anticipoated that low-level radioactive waste (LLW) will be generated as a result of the operation of the NIF. As stated above, The *Atomic Energy Act* of 1954 authorized DOE to establish standards to protect human health or minimizethe dangers to life or property. In accordance with the *Energy Reorganization Act* of 1974, DOE-related operations, including the treatment, storage, and disposal of LLW, are not subject to licensing by ythe U.S. Nuclear Regulatory Commission (10 CFR 50.11). Under the *Low-Level Radioactive waste Policy Act* (42 U.S.C 2021b et seq.), the Federal Government is responsible for the disposal of LLW owned or generated by DOE. The disposal of LLW at disposal facilities established or operated exclusively for the disposal of waste generated by the Federal Government is not subject to the other portions of the Act concerning the establishment of state-governed compacts for the disposal of LLW in those states. Therefore, the transportation, treatment, storage, and disposal of LLW generated by DOE is governed by DOE orders. The major DOE orders pertaining to LLW resulting from operation of NIF are listed in table I.5.8.2-1. DOE Order 5820.2A establishes policies and guidelines that are the framework for the LANL LLW management program.

TABLE I.5.8.2-1. - U.S. Department of Energy Orders Concering Low-Level Waste

Order	**Subject**
O 232.1	Occurance reporting and Processing of Operations Information
5400.5	Radiation Protection of the Public and the Environment
5820.2A	Radioactive Waste Management

On March 25, 1993, DOE published a Notice off Proposed Rulemaking to establish standards for the prtection of the public and the environment against radiation from DOE activities (Draft 10 CFR 834). The requirements would be applicable to the control of rediation exposures to the public and the environment from normal operations under the control of DOE and DOE contractor personnel. The regulations include the four basic elements of the radiation protection system:

- **Establish dose limits for exposure of members of the public to radiation and implementation of DOE's as low as reasonably achievable policy.**
- **Manage radioactive materials in liquid waste discharges, in soil columns, and in selected solid-waste-containing radioactive materials, including groundwater protection programs for each DOE site.**
- **Establish requirements for decontamination, survey, and release of buildings, land, equipment, and personal material; and for the management, storage, and disposal of wastes generated by these activities.**
- **Establish an environmental radiation protection program and plan, including an effluent monitoring and environmental surveillance program, to set forth the programs, plans, and other processes to protect the public from exposure to radiation. On August 31, 1995, DOE issued a Notice of Limited Reopening of Comment Period for the draft regulation.**

Once promulgated as a final rule, 10 CFR 834 would govern the management of radiocactive materials and wastes at all the proposed NIF sites.

1. To determine metric tons/year (t/yr), multiply values by 0.90718.

I.6 List of Preparers

Name	Education/Expertise	Contribution
Timothy Allison	M.S. Mineral and Energy Resource Economics, M.A. Geography; 11 years experience in regional analysis and economic impact analysis	Socioeconomic Analysis
John Arnish	M.S. Nuclear Engineering, B.S. Physics; 2.D. Chemistry; 5 years experience in radiological pathway analysis, dose calculations, radiological transportation risk analysis	Radiological Transportation Risk Analysis
Christopher Burke	M.S. Technology Management, B.A. Geology; 20 years experience in environmental and energy impact assessment; 5 years experience in site and technology assessment	Purpose and Need, Site Descriptions
Young-Soo Chang	Ph.D. Chemical Engineering; 9 years experience in air quality impact analysis	Air Quality
John D. DePue	M.S. Biology; 20 years experience in technical editing of environmental assessment documents	Technical Editor
Lisa Durham	M.S. Geology; 7 years experience in hydrogeologic analysis; 8 years experience in environmental impact statements	Environmental Impacts Assessment
Rebecca Haffenden	J.D. Law; 15 years experience in legal research and analysis; 5 years experience in environmental impact statements	Environmental, Occupational Safety and Health Permits and Compliance Requirements

John F. Hoffecker	Ph.D. Anthropology; 20 years experience in archaeology; 12 years experience in environmental assessment and cultural resources management	Cultural and Paleontological Resources	
Kou-John Hong	P.E., C.H.P., Ph.D. Nuclear Engineering; 16 years experience in radiological engineering and risk assessment.	Radiological Impact Assessment	
Sunita Kamboj	Ph.D Health Physics, M.S. Physics; 5 years experience in health physics instrumentation, environmental monitoring; 1 year experience in radiological risk assessment.	Proposed Action	
Fred Kirchner	Ph.D Radiation Biology, Diplomate, American Board of Toxicology; 16 years experience in toxicology	Affected Environment	
David Kuhaneck	P.E., M.S. Environmental Engineering, B.S. Civil Engineering; 15 years experience in environmental analysis, permitting, and regulations	Air Quality, Acoustics	
Michael A. Lazaro	P.E., M.S. Environmental/Atmospheric Sciences; M.S. Nuclear Engineering; 19 years experience in atmospheric and environmental science research and assessment; 12 years experience in project management; 6 years experience in hazard/consequence assessment	Project Manager	
William Metz	Ph.D. Geography; M.I.S. Information Management; 20 years experience in socioeconomic assessment and mitigation; 10Marshall Monarch	M.A. Administration; B.S. Chemical Engineering, P.E.; 25 years experience in technology and regulatory evaluation of industrial air pollution/control systems and energy analysis	Air Quality Impacts

Lee Northcutt	Program Assistance; 20 years of editorial and program management assistance; 5 years experience in environmental impact statement preparation	Glossary, List of Preparers, Abbreviations, Chemical Symbols and Units of Measure, Metric Conversion Chart
Edwin D. Pentecost	Ph.D. Zoology/Ecology; 25 years experience in environmental assessment, terrestrial ecosystem analysis, natural resources management and planning	Assistant Project Manager
John M. Pfingston	M.A. History, M.P.A. Environmental Administration; 4 years experience in energy and natural resource research; 5 years experience in environmental assessment and land-use analysis	Land Use
Anthony J. Policastro	Ph.D. Civil Engineering; 20 years experience in air quality analyses; 15 years experience in environmental assessment	Air Quality, Hazardous Chemical Impact Assessment, Acoustics
Markus Puder	Master Law; 3 years experience in environmental and energy legislation, regulation, and policy; 1 year of experience in environmental impact statements	Public Participation, Scoping
Elisabeth Ann Stull	Ph.D. Zoology; 25 years experience in environmental assessment and ecological sciences	Project Description, Purpose and Need
William Vinikour	M.S. Ecological Resources; 20 years experience in environmental research and assessment; 19 years experience in environmental impact statements	PSA Coordinator, Ecological Resources
David Walitschek	M.S. History; 8 years experience in archaeological research; 3 years experience in environmental assessment	References, Distribution List

Dee Wernette	Ph.D. Sociology/Demographics; 15 years experience in social impacts, demographics, and related social science analyses	Environmental Justice Analysis
Stephen Yin	M.S. Civil Engineering; 10 years experience in environmental impact studies; 15 years experience in hydrologic analysis and water resources planning and design	Water Resources

I.7 Glossary

acoustic: Containing, producing, carrying, arising from, actuated by, related to, or associated with sound.

activation products: The radionuclides formed as a result of a material being activated. For example, cobalt-60 is an activation product resulting from neutron activation of cobalt-59.

acute exposure: The absorption of a relatively large quantity of radiation or intake of radioactive material over a short period of time.

Air Quality Control Region (AQCR): An interstate or intrastate area designated by the Environmental Protection Agency for the attainment and maintenance of National Ambient Air Quality Standards.

air quality maintenance area: An area which, due to current air quality or projected residential and industrial growth, has the potential for exceeding a national ambient air quality standard.

air quality: Measure of the health-related and visual characteristics of the air, often derived from quantitative measurements of the concentrations of specific injurious or contaminating substances. Air quality standards are the prescribed level of constituents in the outside air that cannot be exceeded during a specific time in a specified area.

ALARA (as low as reasonably achievable): 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.

alluvial fan: Cone-shaped deposits of alluvium made by a stream. Fans generally form where streams emerge from mountains onto the lowland.

alluvial/alluvium: Relating to material deposited by running water, such as clay, silt, sand, and gravel. Sedimentary material transported and deposited by the action of flowing water.

alpha particle: A positively charged particle consisting of two protons and two neutrons that is emitted during radioactive decay from the nucleus of certain nuclides. It is the least penetrating of the three common types of radiation (alpha, beta, and gamma). Symbol: a.

ambient air: The surrounding atmosphere as it exists around people, plants, and structures.

ambient noise levels: All encompassing background noise levels associated with a given environment, usually a composite of sounds from many sources, near and far.

ambient sound level (LDN): The 24-hour equivalent continuous sound level with a night-time penalty added, i.e., the time-averaged A-weighted sound level, in decibels, from midnight to midnight, obtained after the addition of 10 dB to sound levels from midnight to 7:00 a.m. and from 10:00 p.m. to midnight.

American Indian Religious Freedom Act of 1978: This Act establishes national policy to protect and preserve for Native Americans their inherent right of freedom to believe, express, and exercise their traditional religions, including the rights of access to religious sites, use and possession of sacred objects, and the freedom to worship through traditional ceremonies and rites.

AP-42: see "emission factors".

aquifer: A saturated geologic unit through which significant quantities of groundwater can migrate under natural hydraulic gradients.

Argus: Laser system at Lawrence Livermore National Laboratory.

arithmetic mean: The average of a set of terms, computed by dividing their sum by the number of terms. See "geometric mean".

arroyo: A gully or channel cut by an intermittent stream.

atmospheric dispersion: The spreading downwind of airborne material due to wind speed and atmospheric turbulence; the greater the spread, the greater the dilution and the smaller the airborne material concentrations.

attainment area: An area considered to have air quality as good as or better than the national ambient air quality standards as defined in the *Clean Air Act* . An area may be an attainment area for one pollutant and a nonattainment area for others (see "nonattainment area").

background radiation: Ionizing radiation present in the environment from cosmic rays and natural sources in the Earth; background radiation varies considerably with location.

basement rocks: The undifferentiated complex of rocks that underlies the rocks of interest in an area. The crust of the earth below sedimentary deposits, extending downward to the Mohorovicic discontinuity. In many places the rocks of the complex are igneous and metamorphic and of Precambrian age.

beamlets: Independent laser beams.

Best Available Control Technology (BACT): A term used in the *Federal Clean Air Act* that means the most stringent level of air pollutant control considering economics for a specific type of source based on demonstrated technology.

Best Management Practices: Activities, procedures, or physical structures for reducing the amount of pollution entering the surface water and groundwater.

beta particle: An elementary particle emitted from a nucleus during radioactive decay; it is negatively or positively charged, identical in mass to an electron, and in most cases easily stopped, as by a thin sheet of metal. Symbol: b.

Biological Resources Evaluations Team (BRET) : The team within the Environmental Protection Group of Los Alamos National Laboratory responsible for biological assessments.

biota: The plant and animal life of a region.

bounding: In the context of accident analysis, bounding is a condition, consequence, or risk that provides an upper bound that is not exceeded by other conditions, consequences, or risks. The term is also used to identify conservative assumptions that will likely overestimate actual risks or consequences.

British thermal unit (Btu): A unit of heat; the quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit. One British thermal unit equals 1,055 joules (or 252 calories).

cancer: A group of diseases characterized by uncontrolled cellular growth. Increased incidence of cancer can be caused by exposure to radiation or to certain chemicals at sufficient concentrations and exposure durations.

candidate sites: Candidate sites for the National Ignition Facility are Lawrence Livermore National Laboratory (LLNL) as the preferred site, and Los Alamos National Laboratory (LANL), Sandia National Laboratories (SNL), and the Nevada Test Site (NTS) (Area 22 main site location and North Las Vegas Facility [NLVF] location near NTS) as alternative sites.

carbon monoxide (CO): A colorless, odorless gas that is toxic if breathed in high concentration over a period of time.

change-out: A procedure by which components affected by induced radioactivity are periodically rotated between in-service and out-of-service status to allow the induced radioactivity to decay below predetermined limits and thus maintain a lower total level of radioactivity or a longer useful life. In some cases, decontamination cleaning may also be done during the out-of-service period.

chronic exposure: The absorption of radiation or intake of radioactive and/or chemical materials over a long period of time.

Class I area: Pristine areas in the United States whose air quality requires special protection from pollution from new sources.

Class II area: Areas in the United States with acceptable air quality levels where moderate increases in air pollutant concentrations from new sources are allowed.

Class III area: Areas in the United States with acceptable air quality levels where larger increases in air pollutant concentrations from new sources are allowed than in Class II areas.

Clean Air Act Amendments of 1990: Expands the Environmental Protection Agency's enforcement powers and adds restrictions on air toxins, ozone-depleting chemicals, stationary and mobile emissions sources, and emissions implicated in acid rain and global warming.

Clean Air Act: Federal Act that mandates the promulgation and enforcement of air pollution control standards for stationary sources and motor vehicles.

Clean Water Act of 1972, 1987: Federal Act regulating the discharge of pollutants from a point source into navigable waters of the United States in compliance with a National Pollution Discharge Elimination System permit as well as regulating discharges to or dredging of wetlands.

climatology: The science that deals with climates and investigates their phenomena and causes.

Code of Federal Regulations (CFR): All Federal regulations in force are published in codified form in the Code of Federal Regulations.

collective committed effective dose equivalent: The committed effective dose equivalent of radiation for a population.

colluvium: A general term applied to any loose, heterogeneous, and incoherent mass of soil material and/or rock fragments deposited by rainwash, sheetwash, or slow continuous downslope creep, usually collecting at the base of gentle slopes or hillsides. Deposition by a combination of gravity and water.

committed dose equivalent: The predicted total dose equivalent to a tissue or organ over a 50-year period after an intake of radionuclides into the body. It does not include external dose contributions. Committed dose equivalent is expressed in units of rem or Sievert. The committed effective dose equivalent is the sum of the committed dose equivalents to various tissues of the body, each multiplied by the appropriate weighting factor.

Composite Noise Rating: see "Modified Composite Noise Rating" (CNR).

Conceptual Design Option: This option would use an ICF approach called indirect drive. In indirect drive, laser beams would illuminate and heat the interior surfaces of a metal case (hohlraum) containing a deuterium-tritium-filled capsule. The beams would cause the case to emit x rays that would strike the fusion target capsule and drive the fusion reaction.

criteria pollutants: Six air pollutants for which national ambient air quality standards are established by the Environmental Protection Agency under Title I of the *Federal Clean Air Act* . The six pollutants are sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, particulate matter smaller than 10 microns in diameter (PM10), and lead.

critical habitat: Air, land, or water area and constituent elements, the loss of which would appreciably decrease the likelihood of survival and recovery of a listed species or a distinct segment of its population.

cryogenic target positioner: The system that is composed of a telescoping arm that is used to insert and withdraw the complete target cryogenic system and target, and allows aiming, alignment, and engagement by the NIF laser.

cultural resources: Archaeological sites, architectural features, traditional use areas, and Native American sacred sites or special use areas.

curie (Ci): A unit of radioactivity equal to 37 billion disintegrations per second; also, activity of that quantity of material in which 3.7 x 10 *10* atoms are transformed per second.

dBA (Decibel, A-weighted): A unit of weighted sound pressure level that correlates overall sound pressure levels with the frequency response of the human ear; measured by the use of a metering characteristic and the "A" weighting specified by the American National Standard Institute S1.4-1971 (R176).

decommissioning: The process of removing a facility from operation, followed by decontamination, entombment, dismantlement, or conversion to another use.

decontamination: The actions taken to reduce or remove substances that pose a substantial present or potential hazard to human health or the environment--such as radioactive contamination from facilities, soil, or equipment--by washing, chemical action, mechanical cleaning, or other techniques.

deuterium: The hydrogen isotope that is twice the mass of ordinary hydrogen and that occurs in water; also called heavy hydrogen.

diatomaceous : Composed of or containing numerous diatoms or their siliceous remains.

DOE Orders: Requirements internal to the U.S. Department of Energy (DOE) that establish DOE policy and procedures, including those for compliance with applicable laws.

dose: The amount of energy deposited in body tissue due to radiation exposure. Various technical terms--such as dose equivalent, effective dose equivalent, and collective dose--are used to evaluate the amount of radiation an exposed individual or population receives.

driver: A device for supplying the primary source of energy to an inertial fusion energy target; drivers can be lasers, ion beams, or intense gamma ray sources.

effective dose equivalent (EDE): The sum of the products of the dose equivalent to the organ or tissue and the weighting factors applicable to each of the body organs or tissues that are irradiated. The EDE includes the dose from radiation sources internal and/or external to the body and is expressed in units of rem. The International Commission on Radiological Protection defines this as the effective dose.

emission factors: An average value that relates to the quantity of an air pollutant released to the atmosphere with the activity associated with the release of the pollutant and usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity that emits the pollutant. Emission factors are widely used for estimating air pollutant emissions and are often acceptable by regulatory authorities as an appropriate estimation of air pollution emissions to determine compliance with regulations.

emission offsets: Areas that allow no net increase in air pollution emissions require that a new source offset emission increases by decreasing an equivalent amount of emissions from an existing source. In some cases emission offsets or credits can be obtained from a depository that collects emission credits from retired sources.

endangered species: Any species that is in danger of extinction throughout all or a significant portion of its geographic range.

Enhanced Option: The Enhanced Option would include the indirect drive operations of the Conceptual Design Option and a second approach called direct drive. The Enhanced Option would also include the capability to perform an increased number of yield experiments to accommodate greater user needs. No hohlraum would be used in the direct drive approach. Instead, a large number of laser beams would be employed to ensure good uniformity of the driving force (laser light) over the face of the target. The laser beams would impinge directly on the deuterium-tritium-filled capsule to drive the fusion reaction.

Environmental Assessment (EA): A concise public document that provides sufficient evidence and analysis for determining whether to prepare an environmental impact statement (EIS) or a finding of no significant impact for a proposed action. An EA includes brief discussions of the need for the proposed action, the features of alternatives, the environmental impacts of the proposed action and alternatives, and a listing of agencies and persons consulted.

Environmental Impact Statement (EIS): A document required of Federal agencies by the *National Environmental Policy Act* for major proposals or legislation significantly affecting the environment. A tool for decisionmaking, it describes the positive and negative effects of the undertaking and alternative actions.

environmental justice: The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment implies that no population of people should be forced to shoulder a disproportionate share of the negative environmental impacts of pollution or environmental hazards due to a lack of political or economic strength.

ERPG-2 (Emergency Response Planning Guidelines-2): Concentration level for a 1-hour inhalation exposure that would allow a person to take protective action and avoid irreversible health effects.

exposure pathways: The course a chemical or physical agent takes from the source to the exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a release site. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium such as air is also included.

exposure: The condition of being made subject to the action of radiation. Sometimes also used as a generic term to refer to the dose of radiation absorbed by an individual or population.

fault: 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.

federally listed species: see "threatened, endangered, candidate, or rare species".

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.

flood, 100-year: A flood event of such magnitude it occurs, on average, every 100 years (equates to a 1-percent probability of occurring in any given year).

flood, 500-year: A flood event of such magnitude it occurs, on average, every 500 years (equates to a

0.2-percent probability of occurring in any given year).

floodplain: The lowlands adjoining inland and coastal waters and relatively flat areas including, at a minimum, that area inundated by a 1-percent or greater chance flood in any given year. The base floodplain is defined as the 100-year (1.0 percent) floodplain. The critical action floodplain as defined as the 500-year (0.2 percent) floodplain.

footprint: The layout of a facility on the ground; also refers to an area affected by release of radioactive materials.

fugitive dust: The dust released from activities associated with an alternative such as construction, manufacturing, or transportation.

fugitive emissions: Uncontrolled emissions to the atmosphere from pumps, valves, flanges, seals, and other process points not vented through a stack. Also includes emissions from area sources such as ponds, lagoons, landfills, and piles of stored material.

fusion: Nuclear reaction in which light nuclei are fused together to form a heavier nucleus, accompanied by the release of immense amounts of energy and fast neutrons.

fusion fuel: Mixture of deuterium and tritium contained in a small capsule called the target.

fusion reaction: When two nuclei of lighter elements are brought into close enough proximity, they can undergo thermonuclear fusion forming a single nucleus and releasing energy at the slight expense in mass of the original constituents. Typically, a deuterium and tritium nucleus are fused in such a reaction to produce a helium nucleus plus one free neutron. The released energy of 17.6 MeV (million electron volts) is carried mostly as kinetic energy by the neutron (14 MeV).

gamma: High-energy, short-wavelength electromagnetic radiation (a packet of energy) emitted from the nucleus. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best stopped or shielded against by dense materials such as lead or uranium. Gamma rays are similar to x rays, but are usually more energetic. Symbol: g.

geometric mean: For a set of *n* terms, the *n* th root of their product. For a set of positive numbers, the geometric mean is always less than or equal to the arithmetic mean (see "arithmetic mean").

habitat: Area where a plant or animal lives.

hazardous chemical: Any chemical that is a physical hazard or a health hazard as defined by the Occupational Safety and Health Administration (29 CFR 1910.1201). For *Superfund Amendments and Reauthorization Act* (SARA) Title III, Section 311, the term is defined the same with certain named exceptions.

hazardous waste: Under the *Resource Conservation and Recovery Act* , a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. Source, special nuclear material, and byproduct material, as defined by the *Atomic Energy Act* , are specifically excluded from the definition of solid waste.

hohlraum: The metal case surrounding the target on indirect-drive inertial confinement fusion.

igneous: Refers to a rock or mineral that solidified from molten or partly molten material, i.e., from a magma; also, applied to processes leading to, related to, or resulting from the formation of such rocks. Igneous rocks constitute one of the three main classes into which rocks are divided, the others being metamorphic and sedimentary.

ignition: Ignition (fusion) is defined as the conditions leading to the self-heating of the fusion fuel by the fusion driver (such as laser beams). That condition occurs during the final part of the laser pulse when the fuel core is compressed to 20 times the density of lead (226 g/cm *3*) and simultaneously heated to 100 million °C. The self heating of the fuel capsule is caused by alpha particle (fusion reaction byproduct) deposition. Ignition occurs when the reaction product deposition becomes faster than the heating caused by compression.

ignitron switch: A high current switch used to discharge energy storage capacitors, which are used to fire laser flashlamps.

inertial confinement fusion (ICF): An energetic driver beam (laser, x ray, or charged particle) initiated nuclear fusion using the inertial properties of the reactants as a confinement mechanism.

inertial fusion energy (IFE): The use of high-repetition-rate lasers or ion drivers (about 10 pulses per second) to accomplish laboratory and commercial thermonuclear fusion.

ingestion dose: An internal dose that results from the oral intake of food, water, soil, or other media contaminated with radioactive material.

input parameters: Values of variables needed to run a computer model.

interim (permit) status: Period during which treatment, storage, and disposal facilities coming under the *Resource Conservation and Recovery Act* of 1980 are temporarily permitted to operate while awaiting denial or issuance of a permanent permit.

isotope: An atom of a chemical element with a specific atomic number and atomic mass. Isotopes of the same element have the same number of protons but different numbers of neutrons and different atomic masses.

Joule: A metric unit of energy, work, or heat, equivalent to 1 watt-second, 0.737 foot-pound, or 0.239 calorie.

Key Decisions (KDs): The Department of Energy's procedure for approving large projects such as NIF is based on "Critical Decisions" (formerly known as Key Decisions) made by the Secretary of Energy. In January 1993, the Secretary approved "Key Decisions" 0, which affirmed the need for NIF and authorized a collaborative effort by the three DOE defense laboratories and the University of Rochester Laboratory for Laser Energetics to produce a conceptual design report. This report was completed in April 1994. "Key Decisions" 1 was signed by the Secretary in October 1994. This decision initiated preliminary design, safety analysis, cost and schedule validation and a two-year

EIS, which will include public involvement. Critical Decision 3 (formerly known as Key Decision 3), scheduled for late 1997, will authorize construction and major procurements.

laser optics: Many large optical components are required for NIF and are located throughout the laser system. These include laser slabs housed within the amplifier columns, lenses used in the spatial filters for image relaying and on the target chamber for final focusing of the beams on the target, mirrors to reflect the beams within the laser cavity, and to direct the beam on the target chamber, polarizers and potassium dihydrogen phosphate crystal for switching and frequency conversion, and phase plates to smooth the beams and protect the final focus lenses from debris. Many other optical elements are used in laser diagnostics, in beam control systems, and for pulse injection into the main amplifiers.

laser pulse: The duration of time from the beginning of laser deposition on a surface to the end of the laser deposition.

laser: A device that produces a beam of monochromatic (single-color) "light" in which the waves of light are all in phase. This condition creates a beam that has relatively little scattering and has a high concentration of energy per unit area of the beam.

latent cancer fatality: Term used to indicate the estimated number of cancer fatalities which may result from exposure to a cancer-causing element. Latent cancer fatalities are similar to naturally occurring cancers and may occur at any time after the initial exposure.

LDN: see "ambient sound level".

leaching test: A test conducted to determine the leach rate of a waste form. The test results may be used for judging and comparing different types of waste forms, or may serve as input data for a long-term safety assessment of a repository.

level of concern: The concentration of an extremely hazardous substance (EHS) in the air above which there may be serious irreversible health effects or death as a result of a single exposure for a relatively short period of time.

level of service (LOS): The extent of community, health care and educational services provided by local jurisdictions in the vicinity of the proposed NIF sites. LOS is measured in terms of per capita expenditures on services in each of these categories. In traffic studies, LOS means 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. 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.

location: In this EIS, location refers to the proposed location of the National Ignition Facility within or near the larger DOE-controlled Federal site.

LOS : see "level of service."

low-income status: Based on Census data definitions of individuals below the poverty line. For the 1990 Census, for example, low-income status included individuals in 4-person families with 1989 incomes at or below $12,674. Other poverty thresholds are provided by the Census Bureau for larger and smaller family sizes.

low-level waste (LLW): Waste that contains radioactivity but is not classified as high-level waste, transuranic waste, spent nuclear fuel, or "11e(2) by-product material" as defined by DOE Order 5820.2A, *Radioactive Waste Management.* Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided the concentration of transuranic waste is less than 100 nanocuries per gram.

maintenance pollutants: Criteria air pollutants in an Air Quality Maintenance Area that may exceed the ambient air quality standard over time.

master-oscillator power-amplifier (MOPA) chain: Solid-state laser design that provides the required laser beam energy and power amplification using a single-pass MOPA chain. The MOPA chain starts with a small oscillator (the master oscillator) that produces a laser pulse, which enters a preamplifier before making a single pass through a chain of amplifiers of gradually increasing size.

Master Oscillator Room (MOR): A self-contained special-purpose room that would house the NIF Master Oscillators and their supporting equipment. The purpose of this facility is to supply the 192 individually shaped and timed low-level laser pulses to the Preamplifier Modules located beneath the Spatial Filters in the main laser hall.

maximally exposed individual (MEI): A hypothetical individual who could potentially receive the maximum possible dose of radiation (or hazardous chemical).

maximum contaminant levels: Maximum permissible concentration of a contaminant in water which is delivered to any user of a public water system.

maximum design yield: The NIF Target Area has been designed to safely confine and withstand the effects of the yield of its targets up to this yield on some routine basis (e.g., weekly).

maximum yield experiment: A fusion ignition experiment that generates maximally expected fusion energy.

meteorology: The science dealing with the atmosphere and its phenomena, especially as it relates to weather.

millirem (mrem): One-one-thousandth of a rem (see "rem").

minority populations: Includes individuals who report themselves as belonging to any of the following racial groups: Black (reported their race as "Black or Negro," or reported entries such as "African American, Afro-American, Black Puerto Rican, Jamaican, Nigerian, West Indian, or Haitian"); American Indian, Eskimo, or Aleut; Asian or Pacific Islander, or "Other Race." In addition, individuals identifying themselves as Hispanic origin are also included in the minority category. Hispanics can be of any race, however. To avoid double-counting minority Hispanic individuals, only white Hispanics were included in the number of racially based minorities in a tabulation, since nonwhite Hispanics had already been counted under their minority racial classification.

Miocene: A geologic epoch in the Cenozoic Era dating from 26 to 7 million years ago.

mixed waste: Radioactive waste that contains nonradioactive toxic or hazardous materials that could cause undesirable effects in the environment. Such waste has to be handled, processed and disposed of in such a manner that considers the chemical as well as its radioactive components.

model: A conceptual, mathematical, or physical system obeying certain specified conditions, whose behavior is used to understand the physical system to which it is analogous.

Modified Composite Noise Rating (CNR): Noise rating system that determines impacts from a fixed noise source using objective and subjective factors. Noise ranked A through D is generally considered to be acceptable with "A" representing essentially no impacts. Rankings above "D" are usually addressed with mitigative measures unless the source is temporary.

molecular sieve: A material with a rigid, uniform pore structure that completely excludes molecules larger than the structure pore openings and that can absorb certain classes of small molecules from a fluid in contact with the material.

MOR: see "Master Oscillator Room".

mrem: One one-thousandth of a rem (see "rem").

NAAQS: see "National Ambient Air Quality Standards".

National Ambient Air Quality Standards (NAAQS): Air quality standards established by the *Clean Air Act*, as amended. The primary National Ambient Air Quality Standards are intended to protect the public health with an adequate margin of safety, and the secondary National Ambient Air Quality Standards are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Environmental Policy Act (NEPA) of 1969: The Act that established the national policy to protect humans and the environment, requiring environmental reviews of Federal actions that have the potential for significant impact on the environment, and established the Council on Environmental Quality.

National Historic Preservation Act of 1966, as amended: This Act provides that property resources with significant national historic value be placed on the National Register of Historic Places. It does not require any permits but, pursuant to Federal code, if a proposed action might impact an historic property resource, it mandates consultation with the proper agencies.

National Ignition Facility (NIF): The proposed international research center comprising the world's most powerful laser, NIF would achieve ignition of fusion fuel and energy gain for the first time in a laboratory.

National Pollutant Discharge Elimination System (NPDES): Federal permitting system required for hazardous effluents regulated through the *Clean Water Act*, as amended.

National Register of Historic Places: A list maintained by the National Park Service of architectural, historic, archaeological, and cultural sites of local, state, or national significance.

neodymium: A rare-earth metal listed in the periodic table of elements with an atomic number of 60 and an atomic weight of 144.24. The metal has a bright silvery metallic luster. Neodymium is one of the more reactive rare-earth metals and quickly tarnishes in air, forming an oxide that spalls off and exposes the metal to oxidation. Besides its use in producing coherent light in glass lasers, this metal has been used in astronomical work to produce sharp bands by which spectral lines may be calibrated. Neodymium salts are also used as a colorant for enamels, and in its separated form it is used to color glass in delicate shades ranging from pure violet to wine-red and warm gray.

neodymium glass laser: A type of solid-state laser that uses neodymium-doped optical fibers, rods, or glass slabs, with small amounts neodymium added, in which laser generation and amplification equipment are made. This equipment includes a master oscillator, preamplifier, and a series of amplifiers needed to generate and propagate laser beamlines that are highly stable and with the desired peak power level and frequency.

NEPA: see *National Environmental Policy Act.*

neutron: An uncharged elementary particle with a mass slightly greater than that of the proton, found in the nucleus of every atom heavier than hydrogen-1; a free neutron is unstable and decays with a half-life of about 13 minutes into an electron and a proton.

nitrogen oxides (NOx): Refers to the oxides of nitrogen, primarily NO (nitrogen oxide) and NO 2 (nitrogen dioxide). These are produced in the combustion of fossil fuels and can constitute an air pollution problem. When nitrogen dioxide combines with volatile organic compounds, in sunlight, ozone is produced.

No Action alternative: Under this alternative, DOE would not construct and operate NIF and its support facilities. In the absence of NIF, the Nova Facility at LLNL would continue to operate beyond the year 2000.

Noise Control Act of 1972: This Act directs all Federal agencies to carry out programs in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health or welfare.

nonattainment area: An air quality control region (or portion thereof) in which the Environmental Protection Agency has determined that ambient air concentrations exceed national ambient air quality standards for one or more criteria pollutants.

nonhazardous wastes: Routinely generated, nonhazardous wastes include general facility refuse such as paper, cardboard, glass, wood, plastics, scrap, metal containers, dirt, and rubble. These wastes are segregated and recycled whenever possible.

normal operations: All normal conditions and those abnormal conditions that frequency estimation techniques indicate occur with a frequency of more than 0.1 event per year.

Nova: A 10-beam, neodymium glass fusion laser facility at Lawrence Livermore National Laboratory capable of operating at 50 terawatts at 1/3 micrometers that was completed in 1984 and used for inertial confinement fusion target irradiation experiments.

NPDES: see "National Pollutant Discharge Elimination System" .

nuclear weapon: The general name given to any weapon in which the explosion results from the energy released by reactions involving atomic nuclei, either fission, fusion, or both.

Occupational Safety and Health Administration (OSHA): Oversees and regulates workplace health and safety, created by the *Occupational Safety and Health Act* of 1970.

opacity restrictions: Visible-emission regulations that are based on the light-scattering properties of suspended matter in the ambient atmosphere and apply to near-field emissions of fixed sources.

ozone (O3): The triatomic form of oxygen. In the stratosphere, ozone protects the Earth from the sun's ultraviolet rays; in lower levels of the atmosphere, ozone is considered an air pollutant.

paleontology: The study of fossils.

particulate (airborne): Small particles that are emitted from fixed or mobile sources and dispersed in the atmosphere.

Pasquill stability categories: Classification scheme that describes the degree of atmospheric turbulence. Categories range from extremely unstable (A) to extremely stable (F). Unstable conditions promote the rapid dispersion of atmospheric contaminants and result in lower air concentrations as compared with stable conditions.

perennial stream: A watercourse that flows year-round.

Permissible Exposure Limit (PEL): Occupational exposure limits endorsed by OSHA. May be for short-term or 8-hour duration exposure.

person-rem: The unit of collective radiation dose commitment to a given population; the sum of the individual doses received by a population group.

pH (potential of hydrogen): A measure of the hydrogen ion concentration in aqueous solution. Pure water has a pH of 7, acidic solutions have a pH less than 7, and basic solutions have a pH greater than 7.

photochemical oxidant: A class of compounds typified by ozone that represents oxidizing compounds created in the atmosphere with sunlight as a catalyst under low wind conditions.

piedmont: An area, plain, slope glacier, or other feature at the base of a mountain.

playa: Level area at the bottom of a desert basin that at times is temporarily covered with water; a dry lake bed.

Pleistocene: The geologic epoch that began approximately 1.8 million to 10,000 years ago (is generally equated with the "Ice Age").

Pliocene: Geologic epoch between the Miocene and the Pleistocene epochs approximately 5.5 to 1.8 million years ago.

plume: The spatial distribution of a release of airborne or waterborne material as it disperses in the environment.

PM10: Particulate matter of aerodynamic diameter less than 10 micrometers.

population dose (population exposure): Summation of individual radiation doses received by all those exposed to the source or event being considered. The collective radiation dose received by a population group, usually measured in units of person-rem.

Precambrian: Dating from before the Cambrian geologic period more than 570 million years ago.

precursor pollutants: Pollutants that must be present in the atmosphere before chemical reactions take place and form the pollutant of interest. For example, nitrogen oxides, volatile organic compounds, and carbon monoxide are precursor pollutants to the formation of ozone.

preferred alternative: The preferred alternative for NIF is the Enhanced Option (indirect and direct drive) constructed at LLNL, the preferred site.

Prevention of Significant Deterioration (PSD): Regulations established by the 1977 *Clean Air Act* Amendments to limit increases in criteria air pollutant concentrations above baseline.

Project-Specific Analysis (PSA): This document provides an environmental evaluation of the impacts of construction and operation of the NIF as a basis for DOE's decision on whether to construct and operate such a facility at any of five locations at four candidate sites.

Proposed Action alternative: To site, construct, and operate the National Ignition Facility, which would be capable of achieving fusion ignition by the inertial confinement fusion process.

PSD: see "Prevention of Significant Deterioration".

public: Anyone outside the boundary of a DOE site at the time of an accident or during normal operations.

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.

radiation: The emitted particles or photons from the nuclei of radioactive atoms. Some elements are naturally radioactive; others are induced to become radioactive by bombardment in a reactor. Naturally occurring radiation is indistinguishable from induced radiation.

radioactive decay time: Associated with the spontaneous transformation of one nuclide into a different nuclide or into a different energy state of the same nuclide; the process results in a decrease, with time, in the number of original radioactive atoms in the sample. The half-life decay "time" is generally defined in terms of the time required for one-half of the original species to decay.

radioactive decay: The decrease in the quantity of a radioactive material with the passage of time.

radioactive waste: Materials from nuclear operations that are radioactive or are contaminated with radioactive materials and for which use, reuse, or recovery are impractical.

radioactivity: The spontaneous decay or disintegration of unstable atomic nuclei, accompanied by the emission of radiation.

radiological risk: The product of the accident consequence (dose) and the probability of the accident occurring; calculated by considering a wide range of accidents, from high-probability low-consequence events to low-probability high-consequence events.

radionuclide: An atom that exhibits radioactive properties. Standard practice for naming a radionuclide is to use the name or atomic symbol of an element followed by its atomic weight (e.g., cobalt-60 or Co-60, a radionuclide of cobalt).

rare species: Populations and/or individuals occurring in very low numbers relative to other similar taxa in the state, although common or regularly occurring throughout much of their range. They may be found in a restricted geographic region or occur sparsely over a wider area. Although rare, populations are apparently stable.

region of influence (ROI): The area surrounding each proposed NIF site in which at least 90 percent of the current DOE workforce lives, and counties in which at least 5 percent of the DOE workforce lives.

rem: The dosage of an ionizing radiation that will cause the same biological effect as one roentgen of x ray or gamma-ray exposure.

Resource Conservation and Recovery Act (RCRA), as amended: The Act that provides a "cradle to grave" regulatory program for hazardous waste and that established, among other things, a system for managing hazardous waste from its generation until its ultimate disposal.

resuspended inhalation: Exposure route in which radioactive materials enter the body through inhalation of air contaminated with radioactive particulates that were previously deposited on the ground following an accidental release.

riparian: Of, on, or pertaining to the bank of a river, stream, or lake.

risk factor: Numerical estimate of the severity of harm associated with exposure to a particular risk agent.

roentgen: a unit of exposure to ionizing x- or gamma radiation equal to or producing 1 electrostatic unit per cubic centimeter of air. It is approximately equal to 1 rad.

Safe Drinking Water Act, as amended: This Act protects the quality of public water supplies, water supply and distribution systems, and all sources of drinking water.

SARA: see *Superfund Amendments and Reauthorization Act.*

sedimentary rock: A rock resulting from the consolidation of loose sediment that has accumulated in layers, consisting of mechanically formed fragments of older rock transported from its source and deposited in water or from air or ice.

seismic zone: An area defined by the Uniform Building Code (1991), designating the amount of damage to be expected as the result of earthquakes. The United States is divided into six zones: (1) Zone 0 - no damage; (2) Zone 1 - minor damage; corresponds to intensities V and VI of the modified Mercalli intensity scale; (3) Zone 2A - moderate damage; corresponds to intensity VII of the modified Mercalli intensity scale (eastern United States); (4) Zone 2B - slightly more damage than 2A (western United States); (5) Zone 3 - major damage; corresponds to intensity VII and higher of the modified Mercalli intensity scale; (6) Zone 4 - areas within Zone 3 determined by proximity to certain major fault systems.

seismicity: The tendency for the occurrence of earthquakes.

severity: Function of the magnitudes of the mechanical forces (impact) and thermal forces (fire) to which a package may be subjected during an accident; any sequence of events that results in an accident in which a transport package is subjected to forces within a certain range of values is assigned to the accident severity category associated with that range.

shielding: Any material or obstruction (bulkheads, walls, or other constructions) that absorbs radiation in order to protect personnel or equipment.

shot: Refers to all (192) laser beams hitting the target simultaneously.

site: In this PSA, the term "site" refers to a DOE-controlled Federal site, such as Los Alamos National Laboratory or the Nevada Test Site.

socioeconomics (analyses): Analyses of those parts of the human environment in a particular location that are related to existing and potential future economic and social conditions. The welfare of human beings as related to the production, distribution, and consumption of goods and services.

Solid Waste Management Unit (SWMU): Any discernible unit at which solid wastes have been placed at any time regardless of whether the unit was intended for solid or hazardous waste management.

source: Any physical entity that may cause radiation exposure, for example by emitting ionizing radiation or releasing radioactive material.

stability class: see "Pasquill stability categories".

Stockpile Stewardship and Management Program: A single, highly integrated technical program for maintaining the safety and reliability of the U.S. nuclear stockpile in an era without nuclear testing and without new weapons development and production.

Stormwater Pollution Prevention Plan: A plan required by an NPDES permit for controlling stormwater pollution resulting from construction or industrial activities.

sulfur oxides (SOx): A general term used to describe the oxides of sulfur; pungent, colorless gases formed primarily by the combustion of fossil fuels. Sulfur oxides, which are considered major air pollutants, may damage the respiratory tract as well as vegetation.

Superfund Amendments and Reauthorization Act (SARA): Public Law 99-499 passed in 1986 which amends the *Comprehensive Environmental Response, Compensation and Liability Act* (CERCLA) of 1980. SARA more stringently defines hazardous waste cleanup standards and emphasizes remedies that permanently and significantly reduce the mobility, toxicity, or volume of wastes. Title III of SARA, the *Emergency Planning and Community Right-to-Know Act* , mandates establishment of community emergency planning programs, emergency notification, reporting of chemicals, and emission inventories.

targets: Refers to a microstructure containing a tiny fuel capsule at which the lasers are directed.

tectonic: Pertaining to the processes causing, and the rock structures resulting from, deformation of the earth's crusts.

terawatt (TW): The equivalent of one trillion watts (1012).

terrestrial: Pertaining to plants or animals living on land rather than in water.

thermoluminescent dosimeter: A radiation detection device that accumulates a dose or exposure over a period of time.

threatened species: Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

threshold limit value (TLV): The recommended concentration of a contaminant that a worker may be exposed to according to the American Council of Governmental Industrial Hygienists.

time-weighted average (TWA): Time-weighted average representing 8 hours per day for 40 weeks for 40 years of exposure.

total suspended particulates (TSP): Particulate matter present in the atmosphere.

Toxic Substances Control Act of 1976 (TSCA): Act authorizing the Environmental Protection Agency to secure information on all new and existing chemical substances and to control any of these substances determined to cause an unreasonable risk to public health or the environment. This law requires that the health and environmental effects of all new chemicals be reviewed by the Environmental Protection Agency before they are manufactured for commercial purposes.

transuranic (TRU) waste: Waste contaminated with alpha-emitting radionuclides of atomic numbers greater than 92 with half-lives greater than 20 years and concentrations greater than 100 nanocuries/gram at time of assay. It is not a mixed waste.

tritium: A radioactive isotope of the element hydrogen with two neutrons and one proton. Common symbols for this isotope are H-3 and T.

tuff: A rock formed of compacted volcanic fragments, generally smaller than 4 millimeters in diameter.

Type A packaging: Packaging designed to retain the integrity of containment and shielding required by regulation under normal conditions of transport as demonstrated by the required test. Type A packaging (e.g., 55-gallon drums) is typically used to transport materials such as low-level radioactive waste.

volatile organic compounds (VOCs) : A broad range of organic compounds (such as benzene, chloroform, and methyl alcohol), often halogenated, that vaporize at ambient or relatively low temperatures.

waste management: The planning, coordination, and direction of those functions related to generation, handling, treatment, storage, transport, and disposal of waste, as well as associated surveillance and maintenance activities.

waste minimization: Actions that economically avoid or reduce the generation of waste by source reduction, reducing the toxicity of hazardous waste, improving energy usage, or recycling. These actions will be consistent with the general goal of minimizing current and future threats to human health, safety, and the environment.

weapons effects: Deals with outputs of nuclear weapons and the associated effects on materials and the environment.

wetland: Land or area containing hydric soils, saturated or inundated soil during some portion of the plant growing season, and containing plant species tolerant of such conditions (includes swamps, marshes, and bogs).

wind rose: A depiction of wind speed and direction frequency for a given period of time.

x rays: Penetrating electromagnetic radiations with wavelengths shorter than those of visible light, usually produced by irradiating a metallic target with large numbers of high-energy electrons. In nuclear reactions, it is customary to refer to photons originating outside the nucleus as x rays and those originating in the nucleus as gamma rays, even though they are the same.

yield experiments: A measure of fusion energy/neutron production in experiments that use a mixture of deuterium and tritium isotopes as fuel.

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APPENDIX J: CONTAINED FIRING FIRING FACILITY PROJECT-SPECIFIC ANALYSIS

J.1 Introduction

The Department of Energy (DOE) proposes to construct and operate a facility to provide containment of explosives test experiments at Lawrence Livermore National Laboratory (LLNL). These tests are currently conducted outdoors on a firing pad (also called a firing table) at the existing operational Building 801 (B801) facility, located at LLNL's Experimental Test Site (Site 300). Detonation experiments using explosives have been conducted outdoors at Site 300 since the early 1950s. The proposed Contained Firing Facility (CFF) would be a modification to the existing B801 Flash X-Ray (FXR) Facility and would consist of an enclosed Firing Chamber, a Support Facility, and a Diagnostic Equipment Facility. An Office Module, to be constructed approximately 46 meters (m) (150 feet [ft]) from the proposed Firing Chamber, is also proposed.

Two alternatives to the proposed action are addressed in this environmental assessment:

- No action (continue operation of the current B801 facility and its outdoor firing activities at planned levels).
- Build the CFF at an alternative Site 300 location (vicinity of B851).

The Record of Decision (ROD) issued January 27, 1993, for the August 1992 Final Environmental Impact Statement and Environmental Impact Report for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore, DOE/Environmental Impact Statement (EIS) 0157, (1992 EIS/Environmental Impact Report [EIR]) (DOE/University of California [UC] 1992), published the Secretary of Energy's decision to continue to operate LLNL, including near-term proposed projects (those within 5 to 10 years). The proposed B801 CFF is described as one of the projected, budgeted new facilities under the proposed action, (table 3-3) in the 1992 EIS/EIR, and is further discussed in section J.2.5.3 (Proposed Construction Projects, LLNL, Site 300) and table 4.15-2 (LLNL Site 300, Overview) of the 1992 EIS/EIR. The potential impacts of construction and operation of the proposed CFF are expected to be within the scope of the impacts of normal Site 300 operations and potential Site 300 accidents as outlined in the 1992 EIS/EIR. This environmental impact analysis is tiered from the 1992 EIS/EIR and provides additional detailed information on CFF operations and its potential impacts.

This environmental impact analysis was prepared in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended, (42 *United States Code* section 4321 et seq.) and adheres to policies and procedures for DOE compliance with the NEPA as set forth in 10 *Code of Federal Regulations* , Part 1021 (57 *Federal Register* [FR] 15122, April 24, 1992).

J.2 Purpose and Need for Action

To meet its present and future strategic stockpile stewardship responsibilities DOE needs to insure its long-term ability to continue conducting hydrodynamic testing of certain explosive and metal containing materials at its existing FXR Facility (Building 801) at LLNL's Site 300. As the most up-to-date U.S. hydrodynamic test facility, the current Building 801 FXR Facility serves a key role in providing essential hydrodynamic test data needed by DOE to assess key elements of stockpile safety and reliability in the absence of nuclear testing by the United States.

In order to assure its continued future ability to provide this needed test data at its Site 300 facility and consistent with its policy of improving environmental, safety, and health posture of its operations, DOE proposes to further reduce the environmental, safety, and health impacts of its current Site 300 explosives tests by conducting certain experiments (such as those involving depleted uranium, tritium, and beryllium) in an enclosed Firing Chamber.

The purpose of the CFF enclosure would be to reduce gaseous and particulate air emissions from explosives testing, reduce the generation of solid low-level radioactive waste (LLW) (resulting from present Site 300 outdoor firing table activities), reduce testing noise, improve the safety of testing by controlling fragment dispersion, and improve the quality of diagnostics data derived from testing by better controlling experimental conditions.

Without the CFF's enclosed Firing Chamber and supporting project elements, hydrodynamic testing would have to continue to be done in the outdoor environment, thus reducing test scheduling flexibility, and continuing the currently projected outdoor firing, environmental, and safety postures.

Siting such a facility at LLNL's Experimental Test Site, Site 300, was included as a projected facility under the proposed action of DOE's 1992 EIS/EIR to continue operation of LLNL (section 3.1.2 and table 3-3, 1992 EIS/EIR); the Secretary of Energy issued the ROD on this EIS January 27, 1993 (58 FR 6268).

J.3 Description of the Proposed Action and Alternatives

J.3.1 Proposed Action

The proposed action is to design, construct, operate, and ultimately decontaminate and decommission (D&D) a CFF in the area of B801 at LLNL's Site 300 (figures J.3.1-1 and J.3.1-2) and to modify the existing FXR Facility in B801 so as to preclude damage to FXR equipment when detonations occur in the adjacent, proposed CFF Firing Chamber (figure J.3.1-3) (LLNL 1995).

J.3.1.1 Design

J.3.1.1.1 Current B801 Complex

The core elements of the current 1,628 square meters (m^2) (17,522 square feet [ft^2]) B801 complex are the bunker, housing the firing control room, and the linear induction accelerator/FXR Facility and other diagnostic equipment, as well as an outdoor gravel pad firing table. Detonations of explosives assemblies (which may contain depleted uranium, beryllium, and/or tritium-containing components) are done on the gravel firing table, and the dynamics of the detonation process are recorded by the FXR system and associated diagnostics equipment through ports in the B801 FXR Facility. Other infrastructure at the present B801 complex includes support buildings, loading docks, underground control and gas storage bunkers, an underground camera (optics) room, and utilities.

J.3.1.1.2 Proposed Contained Firing Facility Design Concept

The proposed CFF would augment and be collocated with (adjacent to) the current B801 (see figure J.3.1-3). The four main elements of CFF would be the Firing Chamber, Support Facility, Diagnostic Equipment Facility, and an Office Module, totaling approximately 2,685 m 2 (28,900 ft 2) of additional developed space within the present B801 complex area. The present B801 gravel firing table would be partially paved after it was ensured that any gravel and debris contaminated above regulatory limits were removed. The new proposed facility elements would be designed and placed to provide an efficient, safe, fully integrated test and diagnostics complex that would operate for a projected 30-year lifetime. The facility would be designed and operated in full compliance with applicable DOE orders as well as applicable Federal and state laws and regulations.

J.3.1.1.3 Firing Chamber

The Firing Chamber would be designed to contain the blast overpressure and fragment effects from detonations of explosives assemblies (figure J.3.1.1.3-1). It would retain solid debris, gases, and particulate and aerosol products generated from the detonation, allowing for their selective removal, or, in the case of certain gases, their controlled release to the atmosphere through use of scrubbers, absorbents, high-efficiency particulate air (HEPA) filters, and other similar equipment. The explosives quantities would vary with a maximum of 60 kilograms (kg) (132 pounds [lb]) of plastic-bonded explosive 9404, or an equivalent trinitrotoluene design weight of 94 kg (207 lb). The inside walls of the chamber would be protected from high-velocity detonation fragments by replaceable shielding.

The Firing Chamber would be a cast-in-place, steel-reinforced concrete structure with diagnostic and optical line-of-sight ports for data collection. Walls would be 1.2-m (4-ft) thick and would support a 1.4-m- (4.5-ft)-thick ceiling slab and be supported on a 1.8-m- (6-ft)-thick floor slab. On the south side, an existing camera room would be integrated into and be used as part of the chamber. The 0.9-m (3-ft)-thick existing roof of the camera room would be covered by a 0.6-m- (2-ft)-thick concrete overlay to increase its structural capacity.

All interior surfaces of the chamber would be lined with 1.3 centimeters (cm) (0.5 inches [in]) steel plate. Replaceable 2.5 cm (1 in) thick steel tiles would be attached to the steel-lined walls and ceiling. Floors would also be covered with replaceable steel tiles whose thickness would vary with the experiment. Equipment would be brought into the Firing Chamber through a 3.7 m (12 ft) by 4.3 m (14 ft) blast door. Two personnel safety exit doors would be situated to provide egress during test setup. Blast doors would also be protected from detonation fragments. The chamber would have conditioned air, lighting, a water washdown system, a separate tritiated-gas stripping system, a drain leading to a holding tank, and water recycling and evaporation systems. The air supply and exhaust openings would also be protected from blast damage by shielding dampers and blast valves.

The air management system supporting the chamber would consist of a normal operation exhaust system with a post-firing air purge system, and a gas-stripping system for use after experiments involving tritium. During normal operation, the exhaust system (figure J.3.1.1.3-2) would maintain a negative pressure in the Firing Chamber relative to the Support Facility.

Following a test firing, an air purge system would exhaust air, suspended particulates, and gases from the chamber through filter and scrubber systems before the discharge of air and remaining gases to the atmosphere through a roof-mounted stack approximately 15.2 m (50 ft) above ground level. Air would be taken in through openings in the chamber wall. Ductwork would be protected from dynamic and static blast overpressure. The filtration system for use after detonations would consist of a centrifugal precipitator; a 95-percent efficient pulse-jet dust collector with fusible sprinkler head; 30-percent efficient prefilters; 99.97-percent efficient, nuclear-grade HEPA filters; a scrubber system to remove gases and vapors; and a fan. The filter housing would be a bag-out type, and would include ports for testing HEPA filter-bank efficiency and monitoring pressure drop across the filters. Any waste storage and treatment areas that may be required for processing liquid from the gas absorption wet scrubber would be designed and operated in conformance with applicable waste management procedures and DOE orders.

After tests involving tritium-containing materials, a tritium scrubber system would be activated. In addition to filtering particulate, this system would also remove at least 95 percent of any tritium. The tritium scrubbing system would consist of a standard hot catalyst/desiccant system designed to ensure oxidation and removal of airborne tritium as primarily tritiated water (HTO).

The chamber also would be designed with water washdown systems for post-test cleaning and fire protection (figure J.3.1.1.3-3). The washdown system installed in the ceiling of the chamber, consisting of an articulating nozzle, would direct water to all interior surfaces. The high-velocity spray nozzle could operate automatically or manually via remote controls with the use of video monitoring. When operated manually, personnel would use hoses from reels located outside the chamber. Residual water retained by pitted floor tiles would be removed by manual or mechanical methods. A floor drain (protected by a blast-resistant valve) would collect contaminated water and direct it to a holding tank for analysis followed by filtration and evaporation or transfer to an appropriate treatment facility.

J.3.1.1.4 Support Facility

The Support Facility would provide a staging area for preparation of the nonexplosive components of an experiment; storage of equipment and materials; and personnel locker rooms, rest rooms, and decontamination showers. A mezzanine above the personnel area would house mechanical equipment. A mechanical equipment area would be located adjacent to the staging area. The size of the Support Facility would be approximately 1,542 m^2 (16,600 ft^2).

The Support Facility would be separated into gray and clean areas. The gray areas would be areas in which contamination could occur. Egress from the gray areas would require passage through decontamination and change areas prior to entering the clean areas. The Support Facility rooms would have a negative air pressure relative to the clean areas to control the potential for migration of contamination to clean areas.

J.3.1.1.5 Diagnostic Equipment Facility

The Diagnostic Equipment Facility would house various diagnostic equipment used to evaluate the results of explosives tests. The Diagnostic Equipment Facility would be similar in construction to the Support Facility but would be designed to protect personnel who occupy this area during the tests. The facility would be approximately 576 m^2 (6,200 ft^2) . The Diagnostic Equipment Facility would be controlled as, and be considered to be, a clean area. An additional 0.6 m (2 ft) thickness of reinforced concrete wall would be placed 1.2 m (4 ft) from the Firing Chamber wall to create a utility corridor for diagnostic devices, as well as to provide an additional safety buffer wall for personnel. Pressure-rated personnel doors would be installed at either end of the corridor for access. The Diagnostic Equipment Facility would be the main personnel entrance into the new CFF complex.

J.3.1.1.6 Office Module

A premanufactured Office Module of approximately 223 m 2 (2,400 ft 2) would be constructed adjacent to the north side of the existing B801D, approximately 46 m (150 ft) southwest of the proposed Firing Chamber. This facility would provide administrative space for the B801 complex staff.

J.3.1.2 Construction

Site preparation would require site excavation and demolition work. The CFF design concept would require excavation of about 41,300 cubic meters (m 3) (54,000 cubic yards [yd 3]) of existing soil from adjacent hillsides. This material would be sampled and analyzed to verify that it is uncontaminated. Any identified hazardous, LLW, or mixed wastes would be appropriately packaged and labeled in accordance with all applicable regulatory, DOE, and LLNL requirements. Site preparation would also require removal of an underground utility bunker and the relocation of a 0.8 m (2.5 ft) storm drain line. Explosives tests would be diverted from the B801 complex to other firing facilities (principally to B851) during construction at B801. Site improvements would include excavation, grading, trenching, electrical service augmentation, underground utilities augmentation, curbs and gutters, and debris removal. Structures would be designed in accordance with the requirements of the most current edition of the Uniform Building Code.

J.3.1.3 Operation

When CFF is constructed and operational, it is estimated that approximately 100 explosives research and diagnostic experiments could be conducted annually. Quantities of explosives expended in most typical tests would be less than 25 kg (55 lb). Certain of these tests typically involve some components of beryllium and depleted uranium. General pre-test, test, and post-test activities at CFF are described below.

J.3.1.3.1 Pre-Test and Test Activities

Nonexplosive support fixtures and apparatus needed for the test assemblies would be assembled in the Support Facility, then transported to and set up in the Firing Chamber. This apparatus often includes heavy foundations or shot stands to support the explosive experiment, armored radiographic film cassettes, heavy steel momentum-transfer plates, mild steel and wooden shrapnel shields, glass optical turning mirrors and mounting hardware, expendable capacitor discharge units, high-pressure gas-filled devices, and other special diagnostic equipment. Much of this apparatus is expended in the test. Motor-driven cranes and forklifts may be used to move both the inert apparatus and the explosives, if needed. Strict administrative controls would be applied to restrict personnel movement and location while certain of these setup operations are conducted.

The explosive charge would usually be the last item to be placed at the Firing Chamber. When all other equipment has been readied, the explosives assembly would be brought by truck to the chamber from its assembly point at the Site 300 process area or from an explosives storage magazine and carefully set in position, with only essential personnel in attendance. System checks in the form of dry runs would be performed to show that all electrical and mechanical systems have been properly connected and to verify that proper time delays between individual events have been programmed.

When all dry run testing is complete, the chamber would be secured, personnel assembled and accounted for (mustered) within the protected control room (bunker), and the experiment conducted.

J.3.1.3.2 Post-Test Activities

Tests Not Involving Tritium. After an experiment that does not involve tritium, the Firing Chamber would be allowed to cool. Television cameras and infrared sensors would be used to survey the chamber interior for burning debris. Fires would be quenched by a short-duration water washdown or allowed to self-extinguish. The chamber purge system would draw air through scrubber, filtration, and exhaust systems (figure J.3.1.1.3-2). Gas sampling devices would monitor the chamber gas concentrations before and after purging.

After about 10 fresh-air makeup exchanges (and after observation of the television monitor indicates that entry is permissible), qualified explosives handlers (using breathing protection, if necessary) would reenter the chamber. Any smoldering materials or unreacted explosive would be rendered safe so that others could enter. Diagnostics data would be collected and the chamber cleaned in preparation for the next experiment.

The chamber washdown system, consisting of an articulating, ceiling-mounted nozzle would be used to periodically wash detonation test residue from the chamber walls (figure J.3.1.1.3-3). A manually operated hose would be used to complete the washdown once access is permitted. The washdown water would be supplied from Site 300's domestic water supply system, supplemented by recycled washdown water. This washdown water and spent scrubber liquid would be diverted to a holding tank, filtered, and reused, evaporated, or sent to LLNL's Hazardous Waste Management Division for processing. Floor drains, floor sinks, drainage trenches, wash basins, and emergency shower and eyewash drains from portions of the Support Facility would also be gravity-fed into a separate water collection system. This wash water would be monitored, filtered, and recycled for reuse as part of the Firing Chamber washdown system.

Evaporation would be used to substantially reduce the volume of wastewater. Waste residues from this process would be treated by methods that meet applicable criteria for handling industrial wastewater (e.g., treatment and/or stabilization). Sludge containing metals and other contaminants that would be typical residue from evaporating this form of wastewater would be routinely handled by LLNL's waste management facilities.

Tests Involving Tritium. Tests involving tritium-containing components are administratively limited to 20 milligrams (mg) (200 curies) tritium each, and it is estimated that a maximum of 10 such tests per year would be performed. After an experiment, the tritium scrubber system would be activated. The system would operate in a recirculating mode until monitoring and analysis indicated that most undesirable gases had been removed. Additional tritium removal would then be accomplished by adding a few liters of water as a mist to moisturize the air and chamber surfaces to help remove additional tritium (as tritiated water, HTO). (The chamber air would then be scrubbed again to remove additional tritium.) These moisturize/scrub cycles would be repeated until most readily exchanged tritium (as HTO) had been removed and monitored chamber tritium levels were deemed acceptable for reentry. Reentry scheduling would also be dependent on the levels of any other residual radiation, the intensity of which would also be monitored during and after an experiment. The tritium (as tritiated water vapor, HTO) would be absorbed and collected onto a solid medium, such as molecular sieves, during this air-scrubbing process.

As an adjunct to the air-scrubbing removal of tritium, a more aggressive water washdown of the chamber surfaces would be done with about 1,900 liters (L) (500 gallons [gal]) of water. The volume of this washdown water would be controlled to minimize generation of tritium-contaminated water. This would be achieved by regulating the flow into the articulating, ceiling-mounted nozzle, limiting washdown time, and/or manual washing of the chamber. Washdown water would separately be collected and may be reduced in volume, then be managed as low-level liquid (or solidified) radioactive waste. The estimated volume of the wastewater filtration sludge expected from this process would be approximately 85 L (22 gal).

It is estimated that up to 25 55-gallon (208 L) drums and 2 2.8 m^3 (100 ft^3) boxes of solid LLW would be generated for each tritium-containing test.

J.3.1.4 Decontamination and Decommissioning (Closure)

A useful lifetime of 30 years is assumed for CFF. Projections of the need for D&D versus conversion to different usages for CFF after that time cannot yet be made. Such proposals, when identified, would be subject to separate NEPA review, if necessary.

J.3.2 Alternatives to the Proposed Action

J.3.2.1 No Action Alternative

The No Action alternative would leave B801 in its current configuration and would continue the routine detonation of explosives experiments outdoors. No construction disturbance would occur with this alternative. The primary effect of adopting the No Action alternative would be an annual release of emissions from up to an estimated 100 test detonations of explosives and associated materials, equipment, and assemblies directly into the atmosphere and surrounding soils or gravel; the continued generation of solid LLW from test debris and the periodic removal and processing of firing table gravel; and the continued noise levels and blast overpressure to the surrounding area.

An indication of the explosion-related product amounts released to the environment under the No Action alternative (continued outdoor testing) can be derived from the database of materials used in past outdoor explosives experiments at Site 300. Table J.3.2.1-1 shows the estimates of annual hazardous, radioactive, and other material dispersals that could be expected each year under the No Action alternative, based on compositions of tests at B801 for calendar years 1990 to 1994. Most of this material dispersal would be in the form of solid debris that is recovered after the test or is deposited in firing table gravel. Because the experiments were conducted outdoors, the remainder has, for the most part, been dispersed to the environment (primarily as metal or oxides). The materials listed in table J.3.2.1-1 are, therefore, an indication of what would constitute the source terms for waste streams and/or emissions that would likely result from conducting approximately 100 tests per year outdoors at B801 under the No Action alternative.

As noted above, solid LLW in the form of contaminated firing pad gravels after a series of outdoor tests involving radioactive material at B801 would continue if CFF is not built and operated. (By comparison, no contaminated gravel from enclosed B801 CFF operations would be generated under the preferred alternative.) Additional solid LLW in the form of test debris (such as wood, plastic, metal, and burlap bags) is generated each year under the No Action alternative; the generation of these types of test debris would likely continue under the No Action alternative as well as under the proposed action.

The organic explosives (noted in table J.3.2.1-1) used at B801 can be expected to oxidize very efficiently upon detonation to produce gaseous carbon dioxide less than 97 percent, water, and trace amounts of nitrogen, carbon monoxide, carbon (soot), oxides of nitrogen, and assorted volatile organic compounds (VOCs) (U.S. Army Armament, Munitions, and Chemical Command [AMCCOM] 1992).

Table J.3.2.1-1.-- Estimated No Action Hazardous Materials Release to the Environment (Air, Solid Debris, and Particulate)

Material	Estimated Dispersal per Year, kg 1,2
Barium	0.002
Beryllium	15.3
Chromium 3	6.9
Cobalt	0.01
Copper 4	580
Fluoride salts	3.6
Lead	4.1
Molybdenum	1.3
Nickel *c*	8.6
Silver	1.6
Vanadium	3.6
Zinc	0.1
Lithium salts	22.6
Depleted uranium 5	430
(Explosives) 6	(1,662)
Tritium 7	0.0002

J.3.2.2 Build the Contained Firing Facility at an Alternative Site 300 Location (B851)

B851 is a 1,270 m 2 (13,681 ft *2)* complex located in the northwest quadrant of Site 300. It features a gravel firing pad, an electron beam accelerator, and several laboratories, shop areas, and offices. B801 has a more powerful and modern accelerator (the FXR) than B851 and is therefore much more capable of performing a thorough data analysis of test results from certain tests than the facilities at B851.

Construction of CFF at the B851 site would have about the same construction-related impacts as construction at B801. Operational impacts would also be similar in terms of safety, potential accident impacts, and noise. Thus, although possibly a reasonable alternative, it offers no significant advantages and several significant disadvantages to the B801 site.

J.4 Description of the Affected Environment

A brief description of the environment surrounding the location of the proposed facilities is presented in this section. A more detailed description can be found in the 1992 EIS/EIR (DOE/UC 1992), which is incorporated by reference.

J.4.1 Topography

Site 300 is located in the Altamont Hills and consists of southeasterly trending ridges and canyons of moderate-to-high relief. These ridges vary in elevation from slightly more than 153 m (500 ft) at the Corral Hollow Creek entrance to the site to over 518 m (1,700 ft) at the highest point. The onsite drainage pattern is well-developed and flows generally east and south toward Corral Hollow Creek.

CFF would be built as a modification to B801 and would, therefore, be nestled among hills ranging from 34 to 104 m (110 to 340 ft) above its floor elevation to the north, east, and south. The floor level would be at approximately 323 m (1,060 ft) above mean sea level.

J.4.2 Seismicity

Site 300 is located on the eastern edge of the seismically active San Francisco Bay area. A number of active faults are considered capable of causing strong ground motion at Site 300. The nearest of these faults to Site 300 is the Carnegie-Corral Hollow Fault, which crosses the southwest portion of the site (Carpenter et al., 1991). No significant recorded earthquakes have occurred on any of the local faults. The effect of seismic activity at Site 300 is likely to be confined to ground shaking with no surface displacement. Raber and Carpenter (1983) have identified the principal seismic hazard at Site 300 as being the potential for strong ground shaking caused by an earthquake on the Greenville Fault, located about 8 kilometers (km) (5 miles [mi]) west of Site 300.

J.4.3 Climate

Site 300 has a semi-arid, Mediterranean-type climate. Annual mean precipitation is approximately 28 cm (11 in), most of which falls between October and April during major winter storms. Strong, persistent winds are characteristic of the Site 300 area as marine air flows through the canyons of the Site into Corral Hollow and the San Joaquin Valley to the east. This flow results in strong afternoon and evening winds with gusts up to 70 km/hour (hr) (44 mi/hr).

J.4.4 Air Quality

J.4.4.1 Criteria Air Pollutants

The California Air Resources Board conducts criteria pollutant monitoring for the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD), which includes Site 300. Based on the California Air Resources Board's measurements, the district is classified as a nonattainment area for ozone and particulate matter smaller than 10 micrometers (or microns).

J.4.4.2 Hazardous Air Pollutants

Toxic air contaminants are subject to the National Emission Standards for Hazardous Air Pollutants (NESHAP). NESHAP standards pertaining to operations at Site 300 are those for beryllium and radionuclides. Beryllium concentrations from test activities at Site 300 are monitored by LLNL and average 0.42 percent of the SJVUAPCD NESHAP standard. Airborne radionuclide concentrations also are monitored at Site 300. In 1994, uranium-238 and uranium-235 concentrations were 5x10 -5 g/m 3 and 3x10 -7 g/m 3 , respectively. In contrast, the derived concentration guide (a calculated concentration of radionuclides that could be continuously consumed or inhaled and not exceed the DOE primary radiation protection standard to the public of 100 millirem per year effective dose equivalent) for uranium-238 and uranium-235, respectively, were 0.3 g/m3 and 0.047 g/m3. The effective dose equivalent to the maximally exposed member of the public due to potential radionuclide releases from B801 testing in 1994 was 0.041 millirem (the NESHAP allowable standard is 10 millirem). Thus, the monitored concentrations for outdoor testing activities at Site 300 are already well below guideline levels, and operations also comply with the NESHAP limits.

J.4.5 Hydrology: Surface and Groundwater

Several ephemeral streams flow through Site 300 during the wet winter months and discharge into Corral Hollow Creek at the southern boundary of the site. Most flow is direct runoff with a very small contribution from both intermittent and perennial springs. Minor erosion results from both natural and induced conditions.

The groundwater of the Site 300 area is characterized by two regional aquifers or major waterbearing zones: (1) an upper water-table aquifer in the sandstones and conglomerates of the Neroly formation about 30 m (100 ft) below ground surface, and (2) a deeper, confined aquifer located in Neroly sandstones just above the Neroly/Cierbo contact, about 91 m (300 ft) below ground surface (Raber and Carpenter, 1983).

In addition to the two regional aquifers, several localized perched aquifers contain water at higher elevations above low-permeability layers (6 to 15 m [20 to 50 ft] belowground surface). Depth to groundwater beneath B801 is estimated as at least 30 m (100 ft). Neither the groundwater beneath firing tables at B801 nor B851 are known to be contaminated with tritium or uranium from past operations.

J.4.6 Vegetation

Five major vegetation types are found at Site 300. They are (1) introduced annual grassland, (2) native perennial grassland, (3) coastal sage scrub, (4) oak woodland, and (5) riparian (Taylor and Davilla, 1986). Most of the vegetation at Site 300 is grassland dominated by mixtures of introduced annual and native perennial grasses.

A detailed, systematic survey for populations of rare and endangered plants was conducted at Site 300 in the spring of 1986 (Taylor and Davilla, 1986); an additional survey was conducted in 1991 in support of the 1992 EIS/EIR (DOE/UC 1992). The only sensitive plant species known to exist at Site 300 is the large-flowered fiddleneck (Amsinckia grandiflora), listed as both federally-endangered and state-endangered. This species has been identified in two locations at Site 300. Neither are near the proposed B801 CFF site. Both Amsinckia grandiflora populations are closer to B851 than to B801.

J.4.7 Wildlife

The wildlife at Site 300 strongly reflects the dominance of grasslands. Twenty-six species of mammals, 70 species of birds, and 20 species of reptiles and amphibians were observed at Site 300 during threatened and endangered species surveys in 1986 and 1991. The 1991 survey was conducted for the 1992 EIS/EIR (DOE/UC 1992). Since the 1991 surveys, an additional 12 species have been identified: 1 mammal, 1 amphibian, 9 birds, and 1 nonsensitive fairy shrimp species. The only sensitive species that might be expected to exist in the vicinity of the proposed CFF are the burrowing owl (Athene cunicularia) and the American badger (Taxidea taxus), both state species of special concern. The 1992 EIS/EIR mitigation measures routinely implemented before conducting construction projects (such as the proposed CFF) include the field surveys for these latter two species. Burrowing owl dens are known to occur approximately 1.6 km (1 mi) north of the present B801 complex, in spite of the conduct of routine outdoor testing of explosives at that site. A burrowing owl den was identified in 1994 to be within 0.32 km (0.2 mi) (west) of B851 (figure J.4.7-1). Transient badgers also use ground squirrel dens in areas near B801 and B851.

Site 300 is located in the extreme northern portion of the range of the San Joaquin kit fox (Vulpes macrotis mutica) (Federal endangered species, state threatened species). Detailed surveys for the kit fox were conducted at Site 300 in 1980 (Rhoads et al., 1981), 1986 (Orloff 1986), and 1991 (DOE/UC 1992). Since that time, approximately 54 project-specific surveys for active kit fox dens have been made at Site 300; all have been negative. Neither the kit fox nor active dens were observed at Site 300 during any of these surveys. At present, the kit fox is not considered a resident species at Site 300, although the site may offer potential habitat. Field surveys for the presence of the kit fox are, however, still routinely performed before conduct of any ground-disturbing project (as they will be before construction of the proposed CFF) as part of the mitigation measure commitments implemented subsequent to issuance of the 1992 EIS/EIR ROD in January 1993.

J.4.8 Cultural Resources

Site 300 was surveyed for cultural resources in 1981, and 24 archaeological sites were identified (Busby, Garaventa, and Kobori, 1981). Of these 24 sites, 3 were prehistoric, 20 were historic, and 1 was a multicomponent site consisting of both prehistoric and historic materials. Also, recent archival research and field surveys were performed in support of the 1992 EIS/EIR (DOE/UC 1992). An additional 4 prehistoric and 1 historic sites have been located since 1992. One identified site is within approximately 396 m (1,300 ft) of B851 and another is within approximately 396 m (1,300 ft) of B801.

J.4.9 Land Use and Socioeconomic Factors

Most of Site 300 is located in San Joaquin County, with a small portion in Alameda County. The proposed action is located entirely within San Joaquin County. Site 300 is located approximately 13 km (8 mi) southwest of Tracy in a remote rural area in the Altamont Hills that has traditionally been used for cattle grazing and recreation. Much of the land adjacent to Site 300 is private ranch land and is used for grazing. Physics International, Inc. (adjacent to Site 300) and SRI International (south of Site 300) also have facilities that are used to routinely test explosives. The Carnegie State Vehicular Recreation Area off-road motorcycle park is located immediately south of Site 300 on Corral Hollow Road.

The San Joaquin County General Plan land-use designation for Site 300 is Public and Quasi-Public Other Governmental and Institutional (DOE/UC 1992). This designation allows the use of Site 300 for military installations and other major Government buildings. There is no prime agricultural land at Site 300, and grazing and other agricultural activities are excluded.

Since 1993, private developers have been pursuing a proposal to build residential units adjacent to Site 300's northern and eastern boundaries (Tracy Hills project) and commercial and industrial facilities further east of Site 300, astride Interstate 580 and west of the Tracy Municipal Airport. A project-specific EIR under provisions of the *California Environmental Quality Act* is being planned for preparation by the city of Tracy in 1995.

The 1993 population of Tracy has been estimated to be 34,000. Approximately 200 full-time LLNL employees and full-time support contractor staff work at Site 300; of this number, an average of approximately 20 employees work at the present B801/FXR complex.

J.4.10 Soils

Site 300 soils have developed on marine shales and sandstones, uplifted river terraces, and fluvial deposits. They are classified as loamy Entisols (young soils with little or no horizon development). Clay-rich soils (Vertisols) are also present and have been mapped as the AloVaquero complex. Vertisols are mineral soils, characterized by a high clay content, that are subject to marked shrinking and swelling with changes in water content. The Entisols erode easily; the Vertisols exhibit low permeability and are subject to moderate erosion. Soils in the B801 area are generally classified in the AloVaquero complex.

J.4.11 Wetlands

Wetlands at Site 300 were mapped during 1991 using the unified Federal method (Federal Interagency Committee for Wetland Delineation, 1989), and a total of 2.7 hectares (ha) (6.76 acres) of wetlands were identified (DOE/UC 1992) (figure J.4.7-1). These wetlands are small and are in areas associated with natural springs or runoff from several building complexes onsite. The majority of the wetlands 1.9 ha (4.58 acres) exist at springs in the bottom of deep canyons in the southern half of the site. Other wetlands 0.76 ha (1.88 acres) were formed from building runoff, including a small *Typha latifolia* wetland formed by B801 cooling tower drainage that begins approximately 61 m (200 ft) south-southwest of B801. A small wetlands patch 0.032 ha (0.08 acre) exists approximately 213 m (700 ft) southeast of B851 and another 0.072 ha (0.18 acre) exists immediately adjacent to the B851 complex.

J.4.12 Noise

Existing chronic noise sources at Site 300 include vehicular traffic and heating, ventilating, and air conditioning equipment. Acute sources include construction activities; a small arms range; and explosives testing. Background noise levels are generally low, ranging from 56 to 66 decibels (DOE/UC 1992).

Meteorological conditions at Site 300 are monitored before each test, so that noise levels can be projected through use of a well-established computer program. Based on the results of this computer modeling, the quantities of the explosives that can be tested at the present B801 outdoor firing table without adverse noise generation as measured at six Tracy-area receptor site locations (stations) are projected. These stations monitor peak noise levels for a period of 90 seconds, starting at detonation. The results of these noise-monitoring activities demonstrate that noise levels from explosives testing at LLNL Site 300 have not exceeded 126 decibels at the city of Tracy station locations.

J.4.13 Water Use

Water consumption for domestic, infrastructure operation, and programmatic activities at Site 300 averaged approximately 120 million liters per year (31.8 million gallons per year) during the period from 1986 to 1990 (DOE/UC 1992).

J.5 Potential Effects of the Proposed Action and Alternatives

J.5.1 Impacts Related to Construction Activities

Containment of firing operations at B801 would result in minor construction-related impacts at Site 300 in the vicinity of the B801 complex. Construction noise and dust would be experienced throughout a 21-month excavation and construction period. Soils from the hill to the north of the firing pad, and the berm to the east of the firing pad would be excavated and removed to provide space for the new facility. Dust suppression and stormwater pollution prevention (runoff) mitigation technologies would be applied to reduce these impacts to insignificance. Biological surveys for special status, threatened, and endangered species would be conducted prior to any land-disturbing activities. If sensitive species are observed, appropriate mitigation measures to avoid any significant impact would be taken, as outlined in the 1992 EIS/EIR (DOE/UC 1992) and its associated Mitigation Action Plan (MAP) and Mitigation Monitoring and Reporting Program (MMRP). These measures have been routinely applied at Site 300 since 1992. The closest archaeological site is approximately 396 m (1,300 ft) away and is not expected to be affected by the proposed action. Experimental tests would be scheduled at other firing facilities (principally at B851) during construction in the B801 area, possibly increasing the workload and traffic to this area to a minor degree.

j.5.1.1 Ground Disturbance Topography Change

Construction of CFF would require excavation of about 41,300 m *3* (54,000 yd *3)* of material surrounding the current facility. The proposed facility extends into hillsides to the northeast and southeast of the existing bullnose (the high-energy end of FXR, which is covered with protective armor) (figure J.3.1-3). Cut hillsides would be sloped and, where local geology allows, revegetated (using hydroseeding) to prevent erosion. The direction and volume of existing runoff would not be altered by the proposed site work because all earthwork would be accomplished within the same micro-drainage area below the division for adjacent watersheds. All construction and ground-disturbing activities would be done according to the requirements of the National Pollutant Discharge Elimination System California General Construction Activity Stormwater Permit.

All cut slopes, excavations, and/or fills would be designed and constructed in accordance with the Uniform Building Code Chapters 29 and 70 and any other applicable requirements. It is expected that the area of permanent ground disturbance immediately around the B801 complex would only be about 1.2 ha (3 acres) as a result of necessary slope contouring and construction of CFF.

J.5.1.2 Soils

In 1991, soils surrounding the existing firing pad were sampled and analyzed for 17 different metals and radioactivity (gamma radiation) using approved methods. LLNL has previously determined that surface soils contamination from beryllium cadmium, copper, and uranium-238 exists near the B801 firing pad (or table) (Webster-Scholten 1994). Samples will be taken and tested during construction to determine whether or not contamination exists. If isolated areas are determined to be contaminated, the soils would be handled in accordance with approved DOE procedures and all applicable Federal and state regulations.

Soils exposed by project construction, especially on the hillsides, are considered to be moderately vulnerable to erosion; their clay content provides slightly more resistance to erosion than does the high loam content of Entisols, which dominate Site 300 soil types. Erosion, if it occurs, would not be an important impact because of the brevity of the erosion event and the small quantity of soils expected to be lost. Erosion of the small hillsides surrounding the proposed project would not be expected beyond one growing season.

J.5.1.3 Air Quality

Construction could result in some short-term particulate matter emissions; dust suppression measures would be implemented to mitigate these emissions to levels that meet SJVUAPCD requirements. Site 300 air emissions from vehicle and equipment exhausts would be expected to increase approximately 15 to 20 percent temporarily (during the early months of the 21-month construction period). This incremental increase is expected to be an insignificant contributor to air basin emission levels, given the continued high rate of construction activity envisioned by the city of Tracy's growth projections noted in its 1993 Urban Management Plan/General Plan.

J.5.1.4 Cultural Resources

No impact is expected to one identified cultural resource site approximately 396 m (1,300 ft) from the proposed project at the existing B801 Facility. If culturally important artifacts are discovered during construction activities, work would stop until the discovery could be evaluated by a qualified archaeologist in accordance with the DOE MAP and the University of California MMRP, implemented in conjunction with the 1992 EIS/EIR (DOE/UC 1992).

J.5.1.5 Sensitive Species

No known Federal- or state-listed endangered plant or animal species are present within the zone of direct or indirect influence of project construction (1992 EIS/EIR DOE/UC 1992 and later surveys). However, a preconstruction survey monitoring for San Joaquin kit fox (Vulpes macrotis mutica) would be conducted not earlier than 60 days prior to the start of construction, as outlined by the mitigation measures discussed in the MAP, MMRP, and 1992 EIS/EIR (DOE/UC 1992). If kit fox is discovered within the project site, the steps prescribed in the MAP and MMRP would be followed prior to construction startup.

Dens of the American badger, a state species of special concern, have been identified within the vicinity of the proposed project in the past. Similarly, dens of the burrowing owl are known to occur within approximately 1.6 km (1 mi) (north) of the proposed site. The proposed project's impact on the badger is considered slight to none because of the relatively small portion of the badger's home range (less than 1 percent) occupied by the project, the large amount of unrestricted land at Site 300, and the widely recognized transient nature of badgers. Similarly, no impacts to burrowing owl dens are expected because they have actually become established during periods of road construction south of

B801 and during long periods of outdoor explosives testing at the present B801 complex. A pre-construction survey for dens of American badger and burrowing owl would be conducted within 60 days of project start. If found, active dens of the badger or owl would be avoided by construction activity through the establishment of exclusion zones around the dens. If direct impact to an active den is considered unavoidable, the California Department of Fish and Game would be consulted for permission to reduce the size of the exclusion zone or for permission to relocate the animal to other lower-impact areas within Site 300, as outlined in the MMRP and the 1992 EIS/EIR.

J.5.1.6 Wetlands

Soil transport from stormwater runoff during construction would be controlled so as to ensure that there is no potential for adverse impact to the wetlands patch identified approximately 61 m (200 ft) south-southwest of the B801 complex.

J.5.1.7 Socioeconomic Factors

Construction of CFF will take place over a 21-month period during which CFF contractor construction crew and staff day-shift population may reach a maximum peak of 20 to 30 workers during a peak 6-month period, while being less during the remaining parts of the construction period. The addition of this incremental number of onsite, day-shift contractor crew is not expected to significantly affect Site 300 infrastructure and support services or facilities or city of Tracy support services for its 34,000 population.

J.5.1.8 Water Usage

A maximum of 3,800,000 L (1,000,000 gal) of water would be used for dust suppression and other related activities during construction.

J.5.2 Impacts Related to Facility Operations

J.5.2.1 Air Quality

It is expected that emissions (such as particulate metal oxides and soot, acid gases, and VOCs) from Firing Chamber operations would be below regulatory limits because of the extensive air scrubbing, filtration, and absorption systems that would be operated in conjunction with CFF. The bulk of the resulting emissions from the air control system should then be limited to those such as carbon dioxide, nitrogen, water, and, when tritium is used in the chamber, tritiated water as well as very minor amounts of activated air gas molecules.

It is expected that the projected scrubber removal rate for the gases ammonia (NH2), hydrogen cyanide (HCN), hydrogen fluoride (HF), and hydrogen chloride (HCl) would be 90 percent, and would be 50 percent for oxides of nitrogen (NOx) which may be produced. Although some removal of detonation-produced carbon monoxide (CO) by air scrubbing would occur, no reduction of CO is assumed, resulting in a conservative conclusion. Based on these factors, the following approximate levels of CFF-related emissions can be expected to reach the atmosphere annually from detonating explosives during 100 tests at CFF: NH2 < 1.8 kg (4 lb), HCN ~0.9 kg (2 lb), HF ~0.9 kg (2 lb), HCl < 1.4 kg (3 lb), and NOx < 12 kg (27 lb). Additionally, CO emissions would be expected to be less than 15 kg (33 lb) and all VOCs and semivolatile combustion products combined should be limited to approximately 0.2 kg (0.4 lb) (based on emission factors from trinitrotoluene detonation data contained in Volume 2 of the 1992 AMCCOM report). Particulate air emissions are expected to be negligible due to the extensive use of air scrubbing and filtration systems. These emission levels should have an insignificant (negligible) adverse impact on the air quality of the area air basin. The net impact of containing these 100 CFF tests per year by use of CFF (when compared to the No Action alternative) is beneficial.

The air emission of potentially greatest (bounding) impact is HTO. On approximately 10 tests per year, up to 200 curies (20 mg) of tritium may be used on each test. It is assumed that, as a worst case, all tritium would become converted to HTO. Of the 200 curies of tritium present in the chamber, 180 curies (90 percent) is expected to be vapor, and 20 curies (10 percent) would condense on the steel walls, floor, equipment, and debris. After completion of air scrubbing and chamber cleanup, it is expected that the 200 curies of tritium would be partitioned as follows: approximately 175 curies would reside in solidified waste from processing the various air scrubbing and filtration systems, 18 curies (from the 20 curies of HTO condensed on walls or solids) would also reside in a separate solidified waste from a water washdown of the chamber walls and surfaces, a maximum of 5 curies might escape to the atmosphere by leakage from the chamber, and 2 curies would remain adsorbed on interior surfaces and may, therefore, become transferred to waste water used after a non-tritium-containing test which would normally follow as the next test. This 2 curies of HTO would be evaporated to the atmosphere as part of the approximately 94,600 L (25,000 gal) of such wastewater. On balance, a possible maximum of 7 curies of the original 200 curies of tritium used in the test may escape as HTO to the atmosphere over a several-day to week-long period following each of the 10 tritium-containing tests; the remainder would be captured as LLW. By comparison, the amount of tritium contained in the typical theater exit sign is about 10 curies.

All appropriate and applicable air permits would be obtained for facility construction and operation. It is expected, based on a preliminary analysis of proposed normal facility operation, that Environmental Protection Agency Region IX approval and notification of startup for operations involving radionuclides will not be required. Provisions for sampling radionuclide air effluents would be incorporated into the design of CFF, and continuous monitoring, if required, would be performed according to NESHAP requirements.

J.5.2.2 Waste

A beneficial impact of the proposed action is that essentially all detonation products would be captured before release of remaining, mainly innocuous gases, to the environment. Two distinct waste streams would result from totally containing the tests at B801. The first waste stream consists of the shot debris, canisters, HEPA filters, scrubber fluids, and any other component of the pollution control system that becomes contaminated. The second stream is the washdown water itself and/or components of the washdown water system. The levels of the washdown water would be processed (filtered), stored, reused throughout an extended number of firings and eventually evaporated. Components of the processing system, such as used filters and washdown water system sludge, would be characterized and handled as hazardous, radioactive, or mixed waste.

The proposed facility, with its washdown and tritium removal system, would result in the generation of LLW and/or mixed waste because of the collection of sludge produced by the washdown operations. Conservative estimates are that 25 55-gal (208-L) drums of evaporator solids, tritium adsorption media, and stabilized washdown water, and 2 2.8 m *3* (100 ft *3*) boxes of shot or test debris would be generated from each test with tritium. Generation of mixed waste is not expected, but to be conservative, a projection of 0.1 m *3* (3.7 ft *3*) of mixed waste per shot is assumed. The balance would be conservatively considered LLW. For tests performed without tritium, only one 2.8 m^3 (100 ft^3) box of debris (LLW) would be generated. Because CFF would eliminate the use of firing table gravels, the total amount of solid waste that would be generated represents a significant reduction from the total amount of solid waste that is now generated annually during uncontained testing at B801.

The proposed CFF represents a decrease in waste generation from current and projected levels should the CFF not be constructed and operated. The types of waste generated at CFF would have some, but manageable, impact on waste handling activities at LLNL. Table J.5.2.2-1 shows the amounts of mixed, hazardous, and radioactive waste generated in activities conducted at LLNL and compares those values with the amounts of wastes, by type, expected to be generated at CFF annually. The CFF data in this table are based on the assumption that an average of 50 tests, and possibly up to 100 tests would be conducted annually, either at CFF or at the present B801 gravel firing pad (the No Action alternative). These projected annual test rates are based on recent (1991-94) testing data at the present B801 Facility. None of the waste types expected to be generated by the CFF/FXR would be unique to LLNL and each type would be processed and managed, stored, treated, disposed, or transported appropriately as is routinely done at LLNL for the same types of wastes from other current LLNL operations.

Table J.5.2.2-1.-- Comparison of Annual Lawrence Livermore National Laboratory and Contained Firing Facility Waste-Generation Rates (Weights Rounded)

Columns	1	2	3	4	
Category	Waste Generation from All LLNL Activities (1992 EIS/EIR) (kg)	Waste Generation from Only S300 Activities (kg)	Waste Generation from B801 (50 Tests per year) (kg)[8]	Projected Waste Generation from CFF, (kg)	
				50 Tests/yr	100 Tests/yr
Hazardous[9]	1,413,000	173,000	6,100	6,100	12,000
Low-level radioactive[10]	295,000	152,000	53,000	23,000	45,000
Mixed[11]	43,000	~900	~0	(0 to 2,200)	(0 to 4,400)
Transuranic[12]	36,000	0	0	0	0
Total	1,789,000	325,000	59,000	31,000	62,000

Waste generated by facility D&D is assumed to be all LLW and is conservatively estimated to be 110 percent of the volume of the Firing Chamber construction materials. This would be approximately 1,830 m^3 *(64,610 ft3)*. If built at B851, as an alternative, these waste generation impacts should not be different than those for CFF that would be sited at B801. The waste would be handled in the same manner as other solid LLW generated from LLNL operations at that time.

J.5.2.3 Noise

The proposed action would have beneficial effects on the environment and on employees by reducing noise levels onsite and offsite, respectively. The current practice at the Site 300 firing areas relies on a combination of administrative and operating controls to ensure that neither site workers nor the public are adversely affected by exposure to high-impulse noise generated by the explosives test activities. These controls include restricted entry into the firing area when tests are scheduled, required accounting for all test-site-area personnel inside the protective building prior to testing, and limiting the size of the test (or precluding testing altogether) during unfavorable meteorological conditions. Containing the detonations of explosives would greatly reduce noise levels under all conditions and would eliminate the possibility that a test would need to be canceled or rescheduled because of potential noise levels resulting from inappropriate atmospheric conditions.

Noise sources anticipated during and following explosives tests in a containment facility would include low-energy impulse from the test, the relief of containment vessel overpressure, and other noises associated with the operation of the air handling system used to purge the containment vessel. These noises are not expected to be perceptible to Tracy-area residents or area ranchers, and they would not exceed the occupational noise exposure limits adopted by DOE for the protection of employees.

J.5.2.4 Ionizing Radiation

Detonations in the Firing Chamber could involve radioactive materials such as tritium (up to 20 mg on each of 10 tests), depleted uranium, and on some tests, thorium. Additionally, certain test configurations may occasionally generate small quantities of neutrons, which may then yield neutron-activation products. Because of the modest neutron production potential, (1016 neutrons per test on certain tests), the very effective shielding provided by the Firing Chamber, and the low specific activity of depleted uranium, the potential radiation impacts are dominated by tritium and activation-product buildup. These potential impacts to involved workers, noninvolved workers, and members of the general public are summarized in table J.5.2.5-1. Because these results are based on very conservative assumptions used when calculating projected impacts (as described below), they are considered bounding for routine CFF operations.

Some of the assumptions used in deriving table J.5.2.5-1 estimates were:

- A maximum of 10 detonation tests per year involving a maximum of 20 mg (200 curies) of tritium each.
- A maximum level of diagnostic neutron production (1016) per test, on a maximum of 10 tests per year.
- From each of 10 tests per year, up to 5 curies of released tritium as HTO from the Firing Chamber at ground level by leakage during chamber cooling and scrubbing, and an additional 2 curies of residual tritium released as HTO later during evaporation of washdown water through the facility stack that is also assumed released at ground level for purposes of dispersion modeling.
- Up to three involved CFF-area workers spend up to 2 days each within the Firing Chamber, entering the first day after detonation, and after air-scrubbing and chamber cleanup have reduced the tritium level in the chamber to approximately 5x10 *-6* curies/m *3* ; all three workers are assumed to spend full time within 2 m of the shot location, where activation product doses would be maximized.
- Primary washdown water and dry air-scrubbing would yield an estimated maximum of 193 curies per test as solid low-level radioactive waste.

If the maximally exposed individual in the general public stayed at the nearest fenceline to CFF over the entire expected 30-year lifetime of the facility, the estimated lifetime fatal cancer risk to that individual from potential whole-body effective dose equivalent exposure to 3.8×10^{-5} person-rem would be 5.7×10^{-7} (that is, about one fatal cancer in 2 million). This potential dose is about 1,000 times less than the DOE guideline dose limit (that which might produce 1 fatal cancer per 2,000). Additionally, each of the three CFF workers who would be expected to accrue the greatest exposure dose (from removing debris from and cleaning the Firing Chamber after each test) should each receive a dose of less than 0.25 rem per year. This is less than 5 percent of the DOE worker exposure limit guideline of 5 rem per year. By comparison, the average annual dose received by an aircraft flight attendant is about 0.5 rem, or twice the dose expected for these CFF Firing Chamber workers.

J.5.2.5 Slope Stability

Document review suggests that existing B801 site slopes are stable. Unconsolidated overburden is only a few feet thick in the area and bedrock dips at a shallow angle (about 5 degrees) northeast. However, a recently active landslide deposit has been observed within about 244 m (800 ft) east of the site. This landslide is reported having generated a mudflow which reached the vicinity of the B801 site during a 15-year period prior to 1983. This mudflow appears to have been mitigated by placement of an earthen fill between the flow and the B801 site. Appropriate slope stabilization measures would be taken in design and construction of graded slopes (see also section J.5.1.1).

Table J.5.2.5-1.--
Maximum Potential Annual Radiation Exposure Impacts from Normal Contained Firing Facility Operations

Individual or Group	Individual Potential Dose, Rem Per Year[13] Tritium	Activation	Total	Excess Cancer Fatalities (per year)[14]
Involved CFF-area worker	0.09	0.16	0.25	1.0×10^{-4}
Non-involved worker (50 m)[15]	5.2×10^{-3}	0	5.2×10^{-3}	2.1×10^{-6}
Total worker[16]	1.6	0.5	2.1	8.4×10^{-4}
Collective Potential Dose, Person-Rem Per Year				
Maximally exposed member of general public (site boundary, 1,340 m)	3.8×10^{-5}	0	3.8×10^{-5}	1.9×10^{-8}
Total general public[17]	0.32	0	0.32	1.6×10^{-4}

J.5.2.6 Water Use

It is expected that washdown of the CFF Firing Chamber, after considering the contribution of planned water recycling activities, would involve the use of 950,000 L (250,000 gal) of water annually. This water consumption level, plus that for cooling towers (1,100,000 L [300,000 gal]), and domestic uses 190,000 L (50,000 gal), would add a total of approximately 2,300,000 L (600,000 gal) annually to the Site 300 water consumption rate of approximately 120 million L (31.8 million gal) over projected groundwater use (DOE/UC 1992), which is less than a 3-percent increase.

J.5.3 Accident Scenarios

The reasonably foreseeable accident scenarios that could produce the greatest potential impacts are the following:

- Case 1: Accidental detonation of a test of a 60-kg (132-lb) charge of explosives at the B801 firing table. (Applicable to No Action alternative.)
- Case 2: Accidental detonation of a 60-kg (132-lb) test that could contain up to 20 mg (200 curies) of tritium with dispersal through an unsecured blast door during final preparation. No neutron generation potential would exist, because blast doors would be closed before any accident scenario that would involve neutron generation (misfire). (Applicable to either B801 or B851 alternatives.)

One accident scenario that was considered but was not felt to be reasonably foreseeable included:

- Case 3: Same test configuration as in Case 2, but the planned detonation takes place yielding the potential for neutron generation; accidental rupture of the CFF Firing Chamber occurs (considered to be a beyond-design basis accident and therefore, not reasonably foreseeable). (Applicable to either B801 or B851 alternatives.)

In each case, the involved workers would probably be fatally injured from blast effects due to peak overpressure and debris, but there would be no injury offsite to members of the general public. No damage to current buildings offsite or in other areas of Site 300 would be expected, although window rattling might occur. Projected radiation effects from two scenarios are summarized in table J.5.4-1.

These projected radiation doses are still lower than DOE guideline limits for workers and for the general public; thus, the greatest effects would be fatalities or injuries to workers due to primary blast effects, as noted above.

J.5.4 Cumulative Impacts

Table J.5.4-1.-- Radiation-Related Dose Effects Due to Accidents; Contained Firing Facility and Alternatives

Scenario	Involved Worker, 30 m, rem	Uninvolved Worker, 50 m, rem	Offsite Member of Public, 1,340 m, rem	Excess Cancer Fatalities, Offsite Member of Public[18]
Case 1	0	0	0	0
Case 2	0.026	0.015	1.1×10^{-4}	5.5×10^{-8}
Case 3[19]	0.031	0.015	1.1×10^{-4}	5.5×10^{-8}

The primary negative impacts resulting from the proposed action would occur as a result of construction-related activities. These activities would be short term and are not expected to result in significant increases in ambient amounts of airborne dust or noise. Approximately 45,000 kg (20,500 lb) of solid LLW from Firing Chamber air-scrubbing and washdown following contained firing operations could be generated each year. This volume of waste represents a reduction from the levels that would be projected if the same number of detonations were to take place at the current facility (No Action alternative). The proposed project is expected to greatly reduce the air emission of detonation combustion products and to reduce cumulative buildup of LLW by eliminating outdoor explosive testing on gravel firing tables (which must be handled as LLW because some of the explosive test devices would contain radioactive components). The proposed action would therefore greatly reduce the release of emittants to the air and ground.

J.5.5 Conformity

Site 300 is in an air basin area designated as non-attainment with respect to ozone. The design, construction, operation, and ultimate D&D of CFF would not result in levels of emissions of ozone precursors (oxides of nitrogen and precursor organic compounds) that would place Site 300 above conformity thresholds; and the facility would not cause or contribute to any violation of the National Ambient Air Quality Standards. The facility would be operated in conformance with all rules and regulations of the SJVUAPCD which are included as part of the state implementation plans.

J.5.6 Socioeconomic Factors and Environmental Justice

J.5.6.1 Staffing

The addition of another 5 to 6 full-time LLNL employees (for CFF operation) to augment the present B801/FXR operating staff (which averages 20 employees) will be an insignificant incremental impact over that of operating the current FXR Facility and its associated firing table.

J.5.6.2 Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires that Federal agencies identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their programs and activities on minority and low-income populations. DOE is developing official guidance on the implementation of the Executive Order. However, given the demographic makeup of Tracy and its surrounding agricultural areas, it is expected that there would be insignificant or no potential for differential or disproportionate impacts from the proposed action (or from its alternatives) to offsite populations that could be characterized as predominantly minority or low-income.

J.6 Persons and Agencies Contacted

No persons or agencies outside the LLNL and DOE have been contacted.

J.7 References

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FOOTNOTES

1

Projected future dispersals per year based on the estimated composition of 100 tests. The basis for these projections is the B801 shot materials database for the previous 5 years (1990 to 1994), during which the number of tests ranged from 21 to 97 per year and averaged 50 per year.

2

Only a very small fraction of the weights of the metallic materials and salts listed in this table would be expected to be volatilized as gaseous or aerosol products.

3

Source is primarily alloying materials on test hardware, such as nuts, bolts, etc. Most of this material is large enough to be retrieved by hand following an experiment, so that it can be disposed of in a managed waste stream, or recycled.

4

Source is primarily electrical leads and wire. Most pieces of this material are large enough in size as to be retrieved by hand following an experiment, where it is disposed of in a managed waste stream or recycled.

5

In rare instances, thorium may be used in place of depleted uranium.

6

This weight of explosives would be converted to thermodynamically stable products of combustion (such as carbon dioxide and water) very efficiently upon detonation.

7

Tritium has not been used in the most recent past few years. However, the 1992 DOE/UC EIS/EIR discusses an administrative limit of 20 milligrams (mg) of tritium, an environmental emission that can be expected under the No Action alternative. This projection is based on an estimated maximum of ten tests per year at 20 mg each.

Model results.

8

The selection of the 50-tests-per-year level analyzed here is based on an annual average of tests done at B801 from 1990 through 1994. The maximum annual testing level was approximately 100 tests a year. Waste projections were based on average annual data from 1991 to 1994. If 100 tests per year were conducted (the No Action alternative), waste projections shown in this column would be doubled.

9

Columns (1), (2), and (3) reflect hazardous waste generation data found in tables B-15 and B-17 of the 1992 EIS/EIR. This waste consists primarily of waste oil, oil-contaminated rags and equipment as well as film processing solids and solutions used in support operations. The solid portion is approximately 4,000 kg (8,800 lb). Liquid volumes were converted into kg using 1,000 kg per m3. Column (4) represents wastes projected from CFF operations at a level of 50 tests per year (average annual) and 100 tests per year (maximum annual).

10

Columns (1), (2), and (3) reflect LLW values. Column (1) data was derived from tables B-10 and B-12 of the 1992 EIS/EIR for the Livermore Site, plus Site 300 data from Column 2. Column (2) was derived by averaging annual Site 300 shipping log information from 1989 to 1994. Column (3) was derived from annual average from 1991 to 1994. Column (4) data includes an estimated expected 25-percent reduction in the weight of waste debris below that of current operations and complete elimination of the generation of gravel waste since the CFF would not use a gravel firing table and would not use tent structures as are presently used at B801.

11

Columns (1) and (2) reflect mixed waste values derived from Table B-13 and the discussion in Section B.4.3.3 of the 1992 EIS/EIR. Column (4) estimates were derived from conservative assumptions that operation of CFF could generate up to 0.1 m^3 (440 kg per m^3) of mixed waste from each test although none is expected. This waste would derive from evaporator sludge, from water washdown activities, and spent filter media. This further assumes that all CFF wastes would potentially be contaminated by low-level radioactivity after the first test that involves uranium, thorium, or tritium.

12

Transuranic (TRU) wastes are not now generated from explosives testing at Site 300. Table B-11 of the 1992 EIS/EIR shows 6 months of generation at the LLNL Livermore Site in 1990 to be 36 m^3 (1,271 ft^3). Thus, a year's generation would be estimated to be 72 m^3 (2,543 ft^3). An average density of 500 kg per m3 was used to convert volume to weight (Column [1]).

DOE/UC 1992.

13

See discussions, section J.5.2.4.

14

Based on DOE dose-to-risk conversion factor of 4×10^{-4} (4 in 10,000) latent cancer fatalities per person-rem for workers and 5×10^{-4} (5 in 10,000) for the general public.

15

Assumed to be all Site 300 noninvolved workers (approx. 260) standing 50 m from CFF resulting in an extremely conservative estimate.

16

The total worker cumulative dose is the sum of doses to both the involved CFF workers and noninvolved workers within 50 m of the CFF.

17

Using the EPA-approved computer code, CAP88-PC, version 1.00, the total general public cumulative dose estimate was calculated by considering the approximate population within 80 km (50 mi) of Site 300 and using annual site meteorological data.

Model results.

18

See footnote b, table J.5.2.5-1, for conversion factors used.

19

Beyond-design basis accident considered not to be reasonably foreseeable.

Model results.

APPENDIX K: ATLAS FACILITY PROJECT-SPECIFIC ANALYSIS

K.1 Purpose and Need for Agency Action

K.1.1 Background

This project-specific analysis for the proposed Atlas Project is intended to provide specific information about the siting and construction of Atlas at the Los Alamos National Laboratory (LANL) in Los Alamos, NM. The purpose and need set forth in this document is focused on the additional capabilities that the Atlas Project would provide to LANL. Environmental impacts resulting from this proposed action are assessed for LANL only. Information relating the Atlas Project to the broader assessment of complex wide Stockpile Stewardship and Management environmental impacts is found in the Stockpile Stewardship and Management Programmatic Environmental Impact Statement (PEIS).

Modeling of nuclear weapons to assess and ensure safety, reliability, and performance as weapons age or are modified or remanufactured, is part of the science-based stockpile stewardship mission. Without nuclear testing, mathematical calculations based on experimental data would be the only way to obtain needed information on weapons performance and reliability. However, the Department of Energy (DOE) has not yet determined how to predict this behavior with sufficient accuracy from calculations alone. Developing and verifying more accurate predictive modeling requires both empirical data on underlying physics and benchmarking of computational predictions against experimental observations. This is particularly necessary in the case of nuclear weapon stewardship, for which substantial simplifications of physics are necessary for practical computational models. To ensure that the physical approximations and models are adequate, and provide proper physical data and adequate benchmarking, experiments must be done in regimes of appropriate physical parameters.

It is the requirement as presented in the Stockpile Stewardship and Management PEIS for experimental data in the regimes of extreme physical parameters common to nuclear weapons that underlie the need for high-energy-density experimental facilities. Lasers and pulsed-(electrical)-power experimental facilities are complementary in providing these capabilities. High-energy lasers provide the highest temperatures and pressures in small experimental volumes for a few billionths of a second. High energy pulsed-power facilities make different aspects of this high-energy-density regime accessible because pulsed power can focus much higher total energy on a larger (e.g., centimeter [cm] scale) experimental target for a much longer time, albeit at somewhat lower temperature and pressures. Pulsed power will be of most value to the science-based stockpile stewardship program in addressing properties of materials, implosion hydrodynamics, and radiation flow physics. These are some of the areas identified by DOE as the most significant concern to weapons scientists.

LANL already has capability in pulsed power in the microsecond regime and applies it to stockpile stewardship. In particular, LANL uses the Pegasus II 4-megajoule (MJ[1]) capacitor bank, as well as high-explosive (HE)-driven pulsed power generators such as the Procyon generator, which are used in single-shot experiments at appropriate HE firing locations. Typically, the pulsed electrical currents produced by the capacitor bank or HE generator create strong magnetic fields that implode a cylindrical "liner," which would impact a centimeter-scale target to produce hydrodynamic pressure. Alternatively a liner accelerated to high velocity toward the axis of the cylinder could produce soft x rays when it impacts. The 4-MJ Pegasus II capacitor bank is already used for a variety of experiments associated with the physics of both primaries and secondaries. Heavy liners can provide highly symmetric and smooth implosion drive, with asymmetries of 0.5 percent or less, that can help weapons scientists isolate and study certain physical phenomena without complicating effects.

K.1.2 Purpose and Need

DOE must maintain the safety, security, and reliability of the U.S. nuclear weapons stockpile. As a result of the moratorium on underground nuclear testing and pursuit of a Comprehensive Test Ban Treaty, DOE is forming a science-based stockpile stewardship program. This program is being carried out by the weapons laboratories using a variety of technologies, including lasers and pulsed power to support the computer modeling of nuclear weapons' performance over time as the stockpile ages.

As a result of the stockpile stewardship mission, LANL is tasked with enhancing their pulsed-power capability, resulting in the ability to accurately benchmark calculations on weapon performance. An extensive amount of high-energy shots need to be performed for a variety of potential physical defects such as cracks, voids, corrosion, or other modifications to material that may be caused by aging or introduced from remanufacturing. The capability and energy of existing facilities is insufficient to reach the pressures, volumes, and energy densities needed to accurately benchmark weapon-related computational predictions as required to support the stockpile stewardship mission at LANL. In particular, existing facilities cannot support large-scale experiments in the ionized regime, an important capability for analyzing primary and secondary-physics issues, such as implosion hydrodynamics, materials properties, and interactions.

K.2 Description of Alternatives

K.2.1 Proposed Action

K.2.1.1 Description

The need to perform experiments with macroscopic pulsed-power targets, as well as with lasers, exists not only because of the limits of measurement diagnostics or improved ease of measurement at larger scale, but also because some of the physical phenomena that must be investigated cannot be readily scaled down to smaller sizes without affecting some parameters of importance. For example, DOE must perform experiments to develop and benchmark calculations on weapon performance for a variety of potential physical defects such as cracks, voids, corrosion, or other local modifications to material that may be caused by aging or introduced from remanufacturing. Studying the hydrodynamic effects of such perturbations in a pulsed-power experiment and comparing the results to calculations is one of the means used. Figure K.2.1.1-1 illustrates this hydrodynamic process. If the perturbations being investigated were scaled down to the volumes accessible by laser experiments, in many cases the perturbations would be of a similar size to natural material grains or pores, which would complicate or even obscure the experimental results.

However, the energy of Pegasus II is insufficient to reach the pressures and volumes needed to accurately benchmark weapon-related computational predictions. In particular, Pegasus is not adequate to drive dense hydrodynamic targets into the ionized regime, an important capability for analyzing some secondary-physics issues.

Atlas has been designed to provide enhanced pulsed-power capability specifically to address these areas. Atlas has been conceptually designed as a 36-MJ inductive energy store capacitor bank that would nominally deliver 25 to 30 megamperes (MA) (60 MA peak) to an imploding liner or plasma. For hydrodynamic experiments, Atlas would implode heavy precision liners to velocities of over 2 cm/microsecond with final kinetic energies of 2 to 5 MJ. Pressures of >5 to >30 megabars would be achieved (depending on design of the experiment). One dimensional calculations benchmarked to past HE pulsed-power results predict that Atlas will produce x-ray yields > 2 MJ with temperatures >100 electron volts (eV). In a switched mode of operation, Atlas x-ray output would approach 200 eV temperature.

For study of material properties and development of dynamic materials models, Atlas would produce pressures and strain rates in cubic centimeter (cc) scale samples at least 5 to 10 times greater than possible with the present Pegasus Facility.

Fidelity of scaled implosion hydrodynamics experiments is essential for them to be used to verify predictions of design codes. Even the simplest set of physical equations governing compressible hydrodynamics have four parameters that should be the same for fidelity. High-energy density hydrodynamic flow calculations must be validated by experiments with an energy density high enough to get materials into the appropriate state of matter, to ensure adequate fidelity of the important parameters.

A key need satisfied by the Atlas Facility would be the capability of doing large-scale hydrodynamic experiments at high temperatures to ionize the material. This is important for understanding physics phenomena associated with late stages of primary as well as secondary implosion. Atlas will be the first pulsed-power facility that will have the capability for generating the state of matter -- ionized, highly correlated materials -- that governs two of the most important of these similarity parameters, compressibility and Reynolds number. For metals, this requires 500 kilojoules (kJ)/cc, and for plastics 200 kJ/cc. To access this energy density regime, a typical experiment large enough to have easily resolved features needs to be driven with 2 to 5 MJ of kinetic energy. Solid-liner kinetic energies in this range cannot be achieved on presently operating pulsed-power facilities.

Atlas would provide these conditions in large experimental volumes (cc) for benchmarking and verifying models used to evaluate effects of aging (e.g., high aspect ratio cracks), or changes due to remanufacturing, on weapon performance and reliability. Atlas would make available an order of magnitude increase in dynamic pressure over Pegasus, which would greatly enhance DOE's ability to study such important phenomena as melting and hydrodynamics in primaries, early and late time spall in converging geometries, distortion in implosion systems, and effects of gaps.

The expected lifetime of the Atlas Facility is 20 years. After that time, the facility would be cleaned up and decommissioned, which would generate an estimated quantity of nonhazardous waste totaling approximately 841 cubic meters (m^3) (30,000 cubic feet [ft^3]). This waste would be recycled or disposed of at a sanitary landfill. A separate *National Environmental Policy Ac* t (NEPA) analysis would be conducted at that time.

K.2.1.2 Facility

The Atlas Facility would be located at LANL's Technical Area (TA)-35 (see figure K.2.1.2-1). TA-35 is used primarily for research and development (R&D) activities in the fields of physics, chemistry, fusion, and materials science. Construction of the facility would involve renovating existing buildings for use in performing pulsed-power experiments. The construction phase would also involve the installation of high-power electrical Special Facilities Equipment (SFE). To accommodate the facility and its support requirements, five existing buildings within TA-35 would be modified, and external concrete pads, transportable office/diagnostic space, and storage tanks would be added. These relatively minor modifications have an estimated cost of $2.5 million and would be completed within 6 to 9 months of the facility construction start-date.

Atlas operations would require the following major SFE elements: 1,430 megawatt (MW) generator (existing); 80 MW alternating current to direct current (ac-to-dc) converter; 50 MJ inductive energy transfer system; 36 MJ capacitor bank; target chamber; and various control, diagnostic, and data acquisition equipment. The facilities and infrastructure requirements necessary to support this SFE include heavy lab construction with overhead material handling capability, vibration-free high-power generation, electromagnetically-shielded and security-hardened data acquisition areas, and dielectric fluid storage and transfer equipment. All SFE and supporting facilities/infrastructure meet or will be designed to meet the construction requirements for a "low hazard, non-nuclear" facility.

The Atlas Facility would use portions of Buildings 124, 125, 126, 294, and 301 at TA-35 (see figure K.2.1.2-2) in the following manner to meet these SFE facility and infrastructure requirements:

TA-35- P>	**Atlas Experimental Area,**
124/125	Control Room and Coordination Center
TA-35-126	Mechanical Services Building
TA-35-294	Power Supply Building
TA-35-301	Generator Building

Detailed building-use information, including building modifications, is included in the following paragraphs. Up to 35 construction workers would be involved in the building modifications and equipment installations at any given time; the workers would be a combination of relocated workers from other completed construction sites and a limited number of new hires as needed. Approximately 15.3 m3 (20 yd *3*) of noncontaminated construction waste would be generated during construction.

Buildings 35-124 and 35-125 . The total space the Atlas Facility would use in these buildings is approximately 1,151 square meters (m *2*) (11,770 square feet [ft *2*]). Buildings 124 and 125 are proposed to house the primary Atlas Facility components because they could provide safe, secure, and convenient working and experimentation space; access to the Atlas capacitor bank could be controlled and limited; and diagnostic support platforms are available for conducting and analyzing proposed experiments. These buildings have the following special features:

- *Heavy-industrial, high-bay construction.* Atlas requires, at a minimum, 929 m *2* (10,000 ft *2*) of high-bay building with a heavy-duty gantry crane to house the capacitor bank and user-support facilities. Building 124 and 125 were designed for large-scale experimental work and have high ceilings with heavy duty gantry cranes that can access the entire interior space. Buildings 124 and 125 satisfy all the Atlas space requirements.

- *Reinforced walls and ceiling.* Atlas requires reinforced walls and ceilings to protect workers and the public against shrapnel from possible high-energy electrical faults in the capacitor bank. Buildings 124 and 125 were designed to house the power amplifiers and target chamber of a laser-fusion facility. To protect the public from associated hazards, the buildings were constructed with concrete walls and roofs. This type of construction is ideal for a high-energy capacitor bank because shrapnel from possible faults will be contained within the building. The walls and ceiling will also contain any diagnostic x rays produced. Buildings 124 and 125 satisfy all the containment requirements of Atlas.
- *Collocation with the 1430-megavolt ampere (MVA) generator.* Atlas would utilize a multi-hundred MVA generator to charge the capacitor bank rapidly. The facility housing this generator (Building 301) includes a spring-mounted generator pad which isolates vibrations due to generator operations from surrounding experimental areas. This rapid charging technique is similar to other large physics facilities for which power from the existing electrical grid is insufficient to meet the facility technical requirements. In the case of Atlas, this requirement stems from a common fault mode for large capacitor banks; premature electrical breakdown (prefire) of a capacitor switch. A prefire usually destroys the target and much of the rest of the experimental assembly, both of which are expensive and require days to replace. Since the probability of prefire is proportional to the time during which the switches must hold high voltage, the problem is greatly diminished by rapidly charging the capacitor bank and then quickly triggering the switches.

Due to the large number (300) of capacitor switches in Atlas and the programmatic and cost impacts of recovering from frequent prefires, Atlas will use rapid charging to satisfy its reliability requirements. Because of the extremely large energy storage required, even multi-megawatt power lines would still take 10 to 20 seconds to charge the Atlas capacitor bank. DOE has estimated that a faster charging rate will be required to provide sufficient confidence that Atlas will meet its reliability requirements. Buildings 124 and 125 are proposed to house Atlas because a 1430-MVA generator, located adjacent to these buildings in Building 301, is available and is capable of charging the capacitor bank in as little as 0.04 seconds. This configuration forms the basis of the Atlas conceptual design.

- *Electromagnetically shielded, data-acquisition room for classified data.* Atlas will require an electromagnetically shielded, data-acquisition room for classified data. The laser-fusion machine, for which Building 124 was originally designed, has many similarities to Atlas' operational requirements, including the capability to retrieve and store classified data. Inside the building is an electrically shielded data acquisition room that is also protected by a concrete wall. During classified tests, the entire building could be secured, and all classified data could be electronically routed to this room. This room satisfied the requirement for a secure site for classified data for the laser-fusion machine, and would also satisfy the Atlas requirement.
- *Electromagnetically shielded room for machine-control and unclassified data.* Atlas requires a machine-control room that is isolated from the machine and provides space for unclassified data acquisition. Just outside Building 124 in Building 125 is an 86 m *2* (925 ft *2*) electrically shielded control and data acquisition room that was originally constructed to control the laser-fusion facility. This room already has conduit to Building 124 for machine-control and unclassified data acquisition lines. This room satisfies Atlas requirements for machine-control and unclassified data acquisition.
- *Oil storage.* Atlas will likely require storage capabilities for electrically insulating mineral oil. Just outside Building 125 are 3 underground oil storage tanks with a total capacity of 90,850 liters (L) (24,000 gallons [gal]). These tanks were installed to support the laser-fusion pulsed-

power systems. Ownership of these tanks recently became available, and if Atlas uses oil for capacitor-bank insulation, these tanks would help satisfy Atlas oil-storage requirements.

Figure K.2.1.2-3 provides a perspective of the Atlas primary facility components, including the SFE, proposed for installation at TA-35. These consist of:

- Target chamber containing implosion target
- Imaging radiography darkrooms
- 36 MJ capacitor bank
- Target assembly clean room
- Laser diagnostic systems
- Satellite control room
- Diagnostic screen rooms
- Diagnostic trailer
- Axial diagnostics
- Spare Marx module
- Vacuum pumps
- Structural platforms and stairwells
- Flat-plate radial transmission line
- Oil storage and transfer system
- Transmission line ballast
- Chilled water, nitrogen, and compressed air systems

Structural modifications and improvements to Buildings 124 and 125 and surrounding areas required to accommodate the Atlas Facility components would include the following:

- The heating, ventilation, and air conditioning may be modified or relocated. Stairwells may require installation in the floor to permit access to and from the interior of the capacitor bank inner area. A 300 L (80 gal) liquid nitrogen storage tank and a supplemental 151,400 L (40,000 gal) non-polychlorinated biphenyl mineral oil storage tank would be stationed aboveground outside these buildings and piping connecting the tanks to the facility would be added. The oil storage tank would be bermed or similarly contained and would comply with all Spill Prevention Control and Countermeasures requirements.
- Support utilities such as compressed air, chilled water and electrical distribution systems would be added or improved to support the SFE equipment.
- A new 16.8-meter (m) by 24.4-m by 15-cm (55-feet [ft] by 80-ft by 6-inch [in])-thick concrete slab would be installed to accommodate two portable diagnostic trailers, a mobile air conditioning unit, and a power pedestal. The pad would slope slightly from north to south to provide positive drainage.
- A diagnostics data center, project management office, and a visitor center would be constructed and housed in Building 125.

All other facility requirements already exist in Buildings 124 and 125, and no other facility modifications would be required.

Building 35-126. Building 126 was constructed in 1980 of concrete block and cast-in-place concrete with exterior-applied insulation. The roof system is made of precast concrete tees with insulation and single-ply roofing. The 640 m^2 (6,900 ft^2) building houses the existing heating, ventilation, and air conditioning and major electrical equipment that serves Building 125 and 294. No modifications to this building would be required.

Building 35-294. Building 294 was constructed in 1990 of steel framing with synthetic stucco panels at the east and west ends. The building is approximately 75.6 by 20 by 11.6 m (248 by 66 by 38 ft) in size. The building fills the space between Building 124 to the north and Building 125 to the south and shares the exterior north and south walls of these buildings. The Atlas Facility components in this building would occupy about 163.5 m 2 (1,760 ft 2). Atlas component equipment to be installed in this building includes an ac-to-dc converter, communication circuits, and the switching system.

The only building modifications would be the addition of internal trenches and cable tray supports for the communication and electrical systems.

Building 35-301. Building 301 was constructed in 1990. The structure is a pre-engineered steel building set on a concrete pad. The 1087 m 2 (11,700 ft 2) building houses a 1430 MVA generator, unique in the DOE-Defense Program complex, which can rapidly charge the Atlas capacitor bank. This building has several significant features to isolate generator vibrations from surrounding buildings. The generator and associated controls and alarms currently serves the National High Magnetic Field Laboratory (NHMFL), located in Building TA-35-127. The NHMFL would continue to use the generator when it is not in use serving the Atlas Facility. Only one application would be run by the generator at any one time. No modifications are planned for this building.

K.2.1.3 Operations

The heart of the Atlas Facility would be a pulsed-power capacitor bank that would deliver a large amount of electrical and magnetic energy to a centimeter-scale target in a very short time (<10 microseconds [(ms]). Each experiment would require extensive preparation of the experimental assembly and diagnostic instrumentation. The Atlas Facility would be designed to handle up to 100 experiments per year, but not more than 3 experiments per week. Approximately 15 workers would be employed at TA-35 in support of the Atlas Facility once it is operational. The workers would be a combination of relocated workers from currently operating facilities and a limited number of new hires as needed.

Atlas would support many related types of experiments. For example, in a typical experiment, a hollow cylindrical piece of metal (such as aluminum, copper, or gold) fabricated with known cracks, voids, or other defects would be placed in the target chamber. Heavy (e.g., 30 gram (g) [1.1 ounce {oz}]) targets would be used in such experiments designed to validate computer simulations of the hydrodynamic effects of such defects, which in turn support evaluation of potential defects in aging weapons. Light (e.g., 50 milligram [0.00175 oz]) targets would be imploded to produce a hot plasma source of soft (<200 eV) x rays to study radiation physics pertinent to stockpile stewardship.

During an experiment, electromagnetic energy would go sequentially from the generator to the ac-to-dc converter, through the inductor (optional), to the capacitor, and would finally be delivered to the target.

The Atlas capacitor bank would be designed to be flexible enough so that it has the capability to transfer energy in various quantities and within a spectrum of time intervals. The following is a description of what would happen during an experiment requiring maximum possible currents and generating the maximum possible magnetic fields from the facility.

When such an experiment setup was completed, power from the LANL electrical grid would be used to spin the generator to 1,800 revolutions per minute (rpm) over a period of 15 to 20 minutes (the generator may already be spinning for NHMFL experiments). When full speed is reached, a switch would close to allow electricity to flow from the generator to an 80-MW ac-to-dc converter. This converter would transform the high-voltage ac output of the generator to a low-voltage dc charging current in the inductor. The converter would provide this charging current for 3 to 5 seconds. When the peak current of 28 kiloamperes is reached, a switch would disconnect the converter from the inductor. The inductor would produce peak magnetic fields of 40,000 gauss (G) at the coil surface during this few-second interval.

When the inductor reaches 50 MJ of stored energy, various switches would close and open, and energy would be transferred to the capacitor bank, which consists of an array of Marx modules. Within 40 milliseconds, each stage in the Marx modules would acquire a voltage of 60 kilovolts. When the capacitor bank reaches full charge, switches would connect all of the modules into a series configuration, producing many times the original voltage (nominally <1 MV) at the terminals of the transmission line. At this time, the 36 MJ of energy stored in the capacitor bank would be discharged as electric current through the transmission line into a load or liner in the target chamber. The discharge would take approximately 10 ms. If the experiment requires low energy x-ray production, then Atlas may utilize a "plasma flow switch" in the electrical transmission section near the target to decrease the implosion time from several ms down to half a ms or less.

This very large current would produce a large magnetic field in the localized area around the target, causing it to implode, and possibly vaporize or melt, depending on the thickness of the metal. A light liner used inside the target would collide with itself on axis, producing a plasma and low energy x rays. A heavy liner used within the target would compress sample materials to high pressures or, when driven into a central target, would produce extremely high shock pressures that can produce partial material ionization. Solid shrapnel and vaporized molecules would be generated but would be stopped by the walls of the target chamber. Vaporized molecules would deposit onto the walls of the target chamber.

The target chamber would be equipped with a number of ports to allow connection of diagnostic equipment and data acquisition equipment. Diagnostic equipment would include air monitoring devices, voltage probes, current probes, and magnetic field measuring instruments. Data acquisition equipment would consist of cameras, lasers, x-ray detectors, and other similar equipment. Experiments with heavy targets would yield laser holographic images and x-ray radiographs of the implosion which would be captured and recorded to determine the hydrodynamic behavior of the experiment. Experiments with light targets would measure the quantity and energy of radiation (x rays) generated during the implosion and investigate the interaction of this radiation with other parts of the experimental assembly.

After each experiment, LANL personnel would clean the target chamber of metallic debris and deformed metallic targets. Up to 150 L (42 gal) of ethanol would be used each year for cleaning. Discarded materials following each experiment would consist mostly of small amounts of aluminum, copper, very small quantities of gold, and oxides of these metals, or other similar nonradioactive heavy metals. Any metal pieces recovered would be salvaged for reuse. Personnel would also perform routine maintenance, such as replacement of worn dielectric insulation. All waste would be sampled and analyzed in accordance with LANL procedures to determine whether *Resource Conservation and Recovery Act* (RCRA)-regulated hazardous materials are present in regulated quantities. For purposes of this analysis it is assumed that a small amount (<1 m3 annually) of liquid or solid hazardous waste would be generated by occasional experiments involving lead or other simulant materials. This waste would be staged in the onsite hazardous waste accumulation area and shipped to off-site commercial RCRA-permitted treatment, storage and disposal facilities. Uncontaminated waste (such as paper waste), expected to be about 0.15 m3 (5 ft *3*) per week, would be disposed of at the Los Alamos County Landfill.

K.2.2 Continued Operations Alternative (No Action)

K.2.2.1 Description

For the purpose of this analysis, Pegasus II would remain at its current energy level and current rate of experiments. The Pegasus II Facility is located at TA-35 and features a capacitor bank consisting of 8 Marx modules that store up to 4.3 MJ of electrical energy. The Pegasus II Facility is being used by personnel in the weapons physics community to perform experiments in hydrodynamics and radiation transport. It has served as a test bed and will continue to provide important data for experiments in a particular energy regime.

The No Action alternative analysis provides an environmental baseline from which to measure the potential impacts of the proposed action and other alternatives against. However, the No Action alternative does not meet DOE's purpose and need for action. Continued operation of only the Pegasus II Facility would mean that pressure and temperature regimes, critical to understanding weapon aging effects, will not be attained. For instance, in hydrodynamic experiments, Pegasus does not have sufficient power to drive shock pressures that can ionize dense materials. In radiation transport experiments, Pegasus does not have sufficient power to produce >1 MJ of x rays with temperatures >100 eV. Both of these capabilities are important to study relevant issues associated with thermonuclear secondary devices. For experiments relevant to primary physics, Pegasus has insufficient power to drive the larger-scale hydrodynamic targets required for high-fidelity diagnostic access. Operation of only Pegasus II would prevent DOE from providing adequate experimental validation of computer predictions of the effects of certain aging phenomena.

The expected lifetime of the Pegasus II Facility is 15 to 20 years; it became operational in 1987. Future decontamination and decommissioning activities associated with the Pegasus II Facility would require separate NEPA analyses.

The Pegasus II Facility is included as part of the No Action alternative for the Stockpile Stewardship and Management PEIS (DOE 1995a).

K.2.2.2 Facility

The Pegasus II Facility is located at TA-35, Building 86 (see figure K.2.1.2-1). The Pegasus II capacitor bank is situated in Room 100, and the control center, data collection room, and office areas are located in Rooms 101 and 205. The detonators used in firing the capacitor bank are stored in a non-propagating container in a steel safe in Room 101.

The Pegasus II Facility occupies 1,300 m 2 (14,000 ft 2) of combined laboratory and office space. The building is constructed of prefabricated metal building components (steel columns, sheet metal siding, and masonry brick) on a concrete pad. The lower level (Room 100) houses the experimental area.

No construction or remodeling of the Pegasus II Facility is anticipated under the No Action alternative.

K.2.2.3 Operations

The heart of the Pegasus II Facility is a 4.3 MJ capacitor bank used to deliver a pulse of electrical and magnetic energy to a target. The capacitor bank has eight modules and uses air as the dielectric between the individual capacitors. The Pegasus II Facility is used for up to 24 experiments per year. In a typical experiment, a metal cylinder is placed in the target chamber, diagnostic equipment is attached to the target chamber, and the air in the chamber is pumped out with a vacuum system to form a vacuum condition for the experiment. Operators in Room 100 prepare the power supply system, and personnel are evacuated from the room. Operators in Room 205 open and close switches to charge up the individual capacitors and allow the eight modules to be hooked up in the test configuration. HE detonator switches then fire to transfer energy from the capacitor bank. The 4.3 MJ of energy stored in the capacitor bank discharges as a 12 MA current through a transmission line to the target. The discharge rises in about 6 ms. For experiments which require production of low energy x rays, a special switch ("plasma flow switch") can be placed just before the target to decrease the discharge rise time to only a few tenths of a microsecond.

After each experiment, LANL personnel clean the target chamber of metallic debris and deformed metallic targets. About 5 L (1.3 gal) of ethanol are used per year to clean the target chamber and other parts. Discarded materials generated from each experiment consist mostly of aluminum and copper and oxides of these metals. Any metal parts are salvaged for reuse. About 0.06 m *3* (2 ft *3*) of uncontaminated waste (such as paper waste) per month is disposed of at the Los Alamos County Landfill. No hazardous waste is generated.

The detonator switches use a total of 19.2 g (0.672 oz) of HE per experiment, for a total of about 461 g (16.2 oz) per year. All HE is destroyed during detonation. After the test shot is complete, switches are disposed of at the Los Alamos County Landfill.

K.2.3 Alternatives Considered but Eliminated from Further Consideration

The following alternatives were considered but eliminated from further analysis in this project-specific analysis because they fail to meet the purpose and need for DOE action. Failure to meet this purpose and need results from programmatic deficiencies identified in the Stockpile Stewardship and Management PEIS or from technical inadequacies which preclude these alternatives from being reasonable alternatives to the proposed action.

K.2.3.1 Build Atlas at Another DOE Site

DOE considered, but dismissed as unreasonable, the alternative of locating, constructing, and operating the Atlas Facility at a site other than LANL and other than at the Pegasus II Facility. As discussed in section 2.1.1, Atlas would expand the capabilities of the existing Pegasus II Facility through the addition of enhanced pulsed-power and other equipment sufficient to reach the temperatures necessary to ionize materials. Other sites at LANL, as well as other DOE sites which have a hydrodynamic testing infrastructure, do not have the existing special equipment provided by the Pegasus II Facility. Although it would be possible to duplicate this special equipment elsewhere, DOE considers this to be an unreasonably expensive option.

K.2.3.2 Use An Alternate Building at LANL

Under this alternative, DOE would construct and operate the Atlas Facility at a LANL location other than TA-35. The requirements for an alternate site at LANL are the same requirements as those described in section K.2.1.2. Siting and construction of a new building at LANL to house the Atlas Facility would require placement near the 1430-MVA generator building. Additional environmental disturbances from foundation and utility work would occur. Although other existing buildings could fulfill requirement 1, with extensive and costly modifications, none of these sites fulfill requirements 2 to 6. Therefore, this alternative has been eliminated from further consideration.

K.2.3.3 Modify Pegasus II to Conduct Atlas Experiments

Action under this alternative would involve modifying the existing Pegasus II Facility so that it could function at the Atlas Facility power level to meet DOE's purpose and need for action. Currently, the Pegasus II Facility supplies limited data regarding weapons physics, but the facility does not have sufficient energy capability to reach all the conditions required to adequately investigate primary and thermonuclear secondary issues. Modifying the Pegasus II Facility would require extensive expansion of the existing building housing the facility. During this expansion process, which would include construction, procurement, and verification testing, the current Pegasus II operations could not be conducted. The current Pegasus II operations are critical to DOE's existing nuclear weapons stockpile stewardship and management mission. Due to direct conflicts with the existing critical operations of Pegasus II, this alternative does not meet DOE's purpose and need for action.

K.2.3.4 Explosive-Based Pulsed Power Technology

As an alternative to the proposed action, DOE could rely solely on conducting tests using explosive-based pulsed power technology, such as that used by the Procyon generator at LANL. Procyon currently furnishes limited data regarding weapons physics. Although the explosive-based pulsed-power technology would apply to the type of experimental tests needed, this technology can only support a maximum of 12 to 15 experiments per year due to test preparation time constraints, scheduling of detonation, and subsequent site cleanup following detonation. The Agency need for action requires a capability of conducting up to 100 experiments per year. Because of this factor, this alternative has been eliminated from further consideration.

K.3 Affected Environment

This section presents a summary of information regarding the general environmental setting of LANL and the immediate TA-35 site vicinity. More extensive information about the LANL environment is presented in the annual LANL Environmental Surveillance Report (LANL 1994b), as well as LANL's Site-Wide Environmental Impact Statement (DOE 1979).

K.3.1 General Site Setting

LANL and the associated residential and commercial areas of Los Alamos and White Rock are located in Los Alamos County in north-central New Mexico (figure K.3.1-1). LANL facilities cover approximately 560 hectares (1400 acres) of the Federal land managed by DOE in Los Alamos County. The LANL developed area is divided into 30 active TAs for administrative purposes (figure

K.2.1.2-1). Unoccupied land area surrounds LANL buildings, providing security, safety buffer zones, and a reserve for future development.

TA-35 is located near the center of Pajarito Mesa, a southeast-trending mesa immediately north and east of Pajarito Canyon in Los Alamos County. Pajarito Road bounds the proposed Atlas Facility site less than 0.8 kilometer (km) (0.5 mile [mi]) to the south, and Pecos Drive bounds the site directly to the north. Although the general public is currently allowed free access to these roads, and Pajarito Road has heavy public traffic, access to all roads in the general site area are DOE-controlled. They can be closed for brief periods as needed. The proposed TA-35 site is surrounded by adjacent TAs - 63, -50, -55, -48, -60, and -52. These TAs include facilities conducting a variety of ongoing R&D that may involve use of chemicals and radioactive materials. The site is generally considered highly developed.

Los Alamos County has an estimated population of approximately 18,115 (U.S. Census 1994); the Los Alamos town site has an estimated population of 11,400, and White Rock has an estimated population of 6,800. There is a small, privately owned residential area, Royal Crest Trailer Park, surrounded by LANL property. Royal Crest Trailer Park is situated approximately 1.6 km (1 mi) northwest of the proposed project area with an estimated population of 500 (Morris 1994). The principal population centers are Santa Fe, Espanola, and the Pojoaque Valley located within an 80 km (50 mi) radius of LANL with an approximate population of 214,707 people. Fourteen pueblos are located within a 80 km (50 mi) radius of LANL. The populations of the four closest pueblos are as follows: the San Ildefonso Pueblo has a population of 1,499; the Santa Clara Pueblo has a population of about 3,000; the Cochiti Pueblo has a population of 1,342 people; and the Jemez Pueblo has a population of 1,750 people (Commerce 1991). LANL employs approximately 12,250 people (LANL 1994b) principally living within 80 km (50 mi) of LANL.

K.3.2 Environmental Issues Considered But Dismissed

The following environmental issues were not discussed as part of the affected environment because they either do not exist in the proposed action site vicinity (since the proposed action is in an existing building in a developed area) or neither the proposed action nor the No Action alternative would have any identified effect on these resources:

- Hydrology: surface and groundwater
- Vegetation
- Wildlife (Biotic Resources) -- threatened, endangered and sensitive species, critical habitat, and migratory birds; wild horses and burros; wetlands and floodplains; wild and scenic rivers; coastal or tundra zones
- Cultural and Paleontological Resources
- Land Resources -- mineral and timber resources; prime or unique farmlands
- Socioeconomics
- Water Quality -- drinking water from surface or underground aquifers
- Soils and geology
- Parks, Monuments, Public Recreational Areas
- Site Infrastructure
- Visual Impacts
- Transportation

Under Executive Order 12898, Federal agencies are responsible for identifying and addressing the possibility of disproportionately high and adverse health and environmental impacts of programs and activities on minority (all people of color, exclusive of white non-Hispanics) and low-income (household incomes less than $15,000 per year) populations. Within a 16 km (10 mi) radius of the proposed Atlas site, about 14 percent of the population is of minority status. Within an 80 km (50 mi) radius, about 54 percent of the population is of a minority status. In terms of low-income populations, 8 percent of the households within a 16 km (10 mi) radius have annual incomes below $15,000. Within an 80 km (50 mi) radius of the site, 24 percent of the households have annual incomes below $15,000. Detailed environmental justice information is contained in the *Dual-Axis Radiographic Hydrodynamic Test* (DARHT) *Facility Final Environmental Impact Statement* (EIS) (DOE 1995b)[2].

TA-35 is situated on top of a mesa in a developed, disturbed area. Any impacts associated with building construction have already occurred and no new impact potential has been identified for the proposed action or the No Action alternative.

K.3.3 Environmental Issues Considered

K.3.3.1 Air Quality

Prevailing winds at LANL are affected by several factors, including large-scale atmospheric wind patterns, regional weather disturbances (thunderstorms and cold fronts), complex surface terrain, and local cold-air drainage across the Pajarito Plateau. Winds in Los Alamos consist of light westerly surface winds that average 2.8 meters per second (m/s) (6.3 miles per hour [mph]). The strongest winds typically occur between March and June, when intense seasonal storms and cold fronts move through the region. During this season, sustained winds blow from the southwest to the northeast and can exceed 11 m/s (25 mph), with peak gusts exceeding 22 m/s (50 mph). Historically, no tornadoes have been reported to have touched down in Los Alamos County. Strong dust devils can produce winds up to 34.4 m/s (77 mph) at lower elevations in the area. The irregular terrain at Los Alamos affects wind motion and spreading. Localized wind gusts may not be in the same direction as average wind patterns. The wind behavior results in greater dilution of air contaminants that are released into the atmosphere.

Air quality in the LANL area is typical of arid-climate clean air. Median visibility ranges between 106 and 161 km (66 and 100 mi). The New Mexico Environment Department under the Environmental Protection Agency designated the LANL area as an air quality attainment area under the *Clean Air Act* or National Ambient Air Quality Standards in which all regulated ambient air quality standards are to be met. These standards apply to the following air emissions: total suspended particulates (TSP), particulate matter less than or equal to 10 microns in diameter (PM_{10}), sulfur dioxide, total reduced sulfur, hydrogen sulfide, carbon monoxide, and nitrogen oxides (New Mexico Environmental Improvement Board [NMEIB] 1981). Current emissions from operations around the proposed project site are within the required and existing permitted thresholds for LANL.

K.3.3.2 Human Health

As part of ongoing operations at LANL, several TAs, including TA-35 and those in close proximity to it, have facilities that conduct experiments involving electrical hazards and the generation of magnetic fields and x rays. Ongoing experiments and operations are conducted according to strict guidelines established by existing LANL standard operating procedures. Under these standard operating procedures, engineering and administrative controls are implemented to minimize worker and public exposure to electrical hazards, magnetic fields, and x rays. The magnitude of electrical hazards and x rays present from these experiments is regulated by Occupational Safety and Health Administration standards implemented under specific DOE orders. In addition, magnetic field threshold limit values have been developed as guidelines by the American Conference of Governmental Industrial Hygienists.

Generation and potential exposure to x rays is closely monitored under the implementation of existing health and safety requirements for maintaining worker exposure to as low as reasonably achievable standards, but not to exceed the current threshold of 5 rem per year. Magnetic fields are generated by the NHMFL at TA-35. These fields will not be additive to the fields produced during the charging of the Atlas capacitor bank because only one application can be conducted at a time. The public exposure to static magnetic fields in the TA-35 area is much less than the current pacemaker warning limit (10 G). Members of the public receive less than a 0.1 rem dose from x-ray sources generated in the TA-35 area or less than the admissible dose under DOE orders regulating public exposure to radiation.

K.3.3.3 Waste Management Facilities

RCRA-regulated hazardous chemical waste management is conducted at TA-54, Area L. TA-54, Area J, has a landfill dedicated to administratively controlled sanitary, non-hazardous wastes. All other sanitary waste is disposed in the Los Alamos County Landfill located near TA-3 along West Jemez Road.

K.4 Environmental Consequences

Neither the proposed action nor the No Action alternative would pose a disproportionate adverse health or environmental effect on minority or low-income populations within an 80 km (50 mi) radius of the proposed site.

K.4.1 Environmental Issues Considered

A summary of environmental issues is presented in table K.4.1-1. A discussion of the issues associated with the proposed action and the No Action alternative follows in the succeeding paragraphs.

Table K.4.1-1.-- Environmental Issues Considered for Normal Operations/Accidents

Issue	Proposed Action Alternative	No Action Alternative
		Potential impacts discussed in appendix section K.4.3.1. Per experiment: minor metals (same as proposed action

Air Quality	Potential impacts discussed in appendix section K.4.2.1. Per experiment: minor metals (copper, aluminum, gold [less than 1 g]); and solvent (1.5x103 g ethanol) air emissions. Occasional small (<30 g) quantities of isopropyl alcohol, trichloroethylene and 1,1,2-trichloroethane may also be used as solvents.	for copper and aluminum, no gold used), solvent (18.1 g ethanol), and high explosive (12.7 g carbon monoxide, 34.0 g nitrogen oxides, 95.2 g PM *10* , 0.91 g volatile organic compounds, all per year) air emissions.
Human Health	No radioactive materials; potential health effects of electricity, magnetic fields, x rays discussed in appendix sections K.4.2.2 (normal operations) and K.4.4 (accidents).	No radioactive materials; potential health effects of electricity, magnetic fields, x rays discussed in appendix sections K.4.3.2 (normal operations) and K.4.4 (accidents).
Waste	Disposal of uncontaminated construction waste (15.3 m3), other uncontaminated, nonhazardous solid waste, such as paper, dielectric insulation, etc. (7 m3 per year), and small amounts (<1 m3 annually) of liquid or solid hazardous waste would be generated by occasional experiments involving lead or other simulant materials. Within normal scope of LANL waste management activities, appendix section K.4.2.3.	Disposal of uncontaminated, nonhazardous solid waste, such as paper and dielectric insulation, etc. (0.7 m3 per year), within normal scope of LANL waste management activities, appendix section K.4.3.3.

K.4.2 Proposed Action

K.4.2.1 Air Quality

The air emissions expected due to operations at the Atlas Facility are presented in table K.4.2.1-1, along with the health-based New Mexico Air Quality Control Regulations (AQCR) 702-regulated levels. All expected emissions generated during normal operations would be below current regulatory levels. No permitting would be required under AQCR 702 or under the National Emission Standards for Hazardous Air Pollutants (NESHAP). No use of facility air filters or scrubbers would be required. Most of the metal targets used during experiments would vaporize and deposit onto the inside surface of the target chamber. Only minute quantities of metals would stay volatilized. Other nonradioactive heavy metals may also be used, but the metals listed in table K.4.2.1-1 are representative of any metals that would be used. The majority of the ethanol used for cleaning would evaporate. Small amounts of hazardous chemicals such as isopropyl alcohol, trichloroethylene and 1,1,2-trichloroethane may occasionally be used as cleaning solvents and would also evaporate. The quantity of air emissions as shown in table K.4.2.1-1 would not harm workers, collocated workers (those at TA-35 but not involved with the Atlas project), or members of the public. Small amounts of dust would be generated due to outdoor excavation activities. Standard dust suppression techniques, such as watering, would be used as needed.

Table K.4.2.1-1.-- Air Emissions from the Atlas Facility

Constituent	Calculated Emissions[3]	AQCR 702 Limit
Aluminum	less than 1 g (0.0022 lb)	0.133 lb/hr
Copper	less than 1 g (0.0022 lb)	0.0133 lb/hr
Gold	less than 1 g (0.0022 lb)	0.42 lb/hr
Ethanol	less than 1.5x10 *3* g[4] (3.3 lb)	10 lb/hr
Isopropylalcohol	less than 30 g[5]	65.3 lb/hr
Trichloroethylene	less than 30 g [5]	18.01 lb/hr
1,1,2-Trichloroethane	less than 30 g[5]	3 lb/hr

K.4.2.2 Human Health

This section presents potential health hazards to site workers, collocated workers, and the general public during normal operations of the Atlas Facility experiments. The identified hazards to human health are electrical hazards, magnetic field hazards, and radiological hazards.

Electrical. Normal operations at the Atlas Facility during conduct of experiments would include electrical hazards to researchers, technicians, and other Atlas Facility personnel because the capacitors associated with Atlas would be charged to a high-voltage. The Atlas capacitor bank could deliver an instantaneous lethal current if special operating precautions are not taken. To minimize electrical risks associated with Atlas experiments, all applicable electrical codes specified by DOE Order 6430.1A (such as adequate grounding and lightening protection) would be incorporated into the Atlas capacitor bank and facility and related electrical components. In conjunction with meeting local electrical codes and DOE Order requirements, the Atlas capacitor bank would be isolated in an interlocked room where access would be controlled. During the actual charging, discharging, and energy release of the system, personnel access to the room would be denied. To aid in assuring no admittance takes place, guards would also be posted at the entrance. Other engineering safety features would be built into the Atlas Facility, such as:

- All switches would be fail-safe; i.e., either a loss of compressed air or electrical power would disengage the switches.
- A direct cut-off to the Atlas Facility systems would be available to the control room operator should the master computer malfunction. The direct cut-off would automatically return systems to their normal fail-safe position.
- Switches could not be operated until all interlocks have been made.
- If an interlock is broken during a charge cycle, shutdown would occur.

These Atlas Facility engineering controls, as well as administrative controls such as personnel training and standard operating procedures, would significantly decrease the probability of an electrical accident occurring during normal operations.

Magnetic Fields. The generator located in Building 301 would be running for 15 to 20 minutes at the beginning of each experiment. The generator would generate magnetic fields during operations of either the Atlas Facility or the NHMFL, but only one operation would be conducted at any one time; therefore, no cumulative impacts to workers would be expected due to magnetic fields resulting from generator operations. The ultimate magnetic field generated would have a frequency dependent on the final rotation speed of the generator (1800 rpm); this frequency would be approximately 60 cycles per second. Workers and members of the public are shielded from the magnetic field by the building's walls, and the generator itself is designed with adequate shielding so that a magnetic field of less than 10 G would exist near the generator. The magnetic field due to the generator would be less than 1 G at Pecos Drive, the nearest public-access roadway, about 75 m (245 ft) from Building 301.

A second source of magnetic field would come from the energy transfer into the inductors' storage coils. During the 3 to 5 seconds that it would take to transfer energy into the inductor, a dc current would be present in the coils of the inductor located on the roof of Building 124. This dc current would have an associated magnetic field of 40,000 G near the coils. There would be a few-second duration magnetic field of less than 10 G at Pecos Drive, which is approximately 33 m (110 ft) from Building 124.

All Atlas Facility workers and nearby collocated workers would be informed of the magnetic hazards associated with individual proposed experiments and those with pacemakers, etc., would be moved to a safe location. Administrative and engineering controls would be in place during experiments to keep magnetic field exposure as low as reasonably achievable. Atlas Facility workers and nearby collocated workers would be exposed to the two magnetic fields during each experiment, for a total of up to 100 times per year. Atlas Facility workers and nearby collocated workers without pacemakers, etc., would not be exposed to more than an instantaneous magnetic field exceeding 500 G.

Magnetic fields of as much as 20,000 G are not considered harmful to individuals who do not have pacemakers or other metallic body inclusions (ACGIH 1993). A magnetic field (such as that produced by the generator) of 1 G can affect some types of cardiac pacemakers; larger fields can also exert a force on suture staples, aneurysm clips, prostheses, etc. Administrative controls, such as exclusion from Buildings 124, 125, and 294 during individual experiments, would be placed on employees with pacemakers or metallic inclusions so that exposure to excessive magnetic levels would be avoided for these individuals. If there is a potential for the public to be exposed to non-static magnetic fields of 1 G or more generated during experiments, warning signs and other administrative controls (such as road blocks) would be in place prior to operation of the Atlas Facility for conduct of those experiments. Magnetic fields would be monitored at various locations at and near the Atlas Facility during experiments to ensure that these levels are not exceeded.

Radiological. The Atlas Facility experiments would utilize a target chamber which would have walls of stainless steel 2.54 cm (1 in) thick, twice the thickness of the Pegasus II Facility's target chamber walls. An individual target implosion would produce an estimated one to four MJ of 100 to 200 eV x rays at the time of the experiment. These low-energy x rays are not expected to penetrate the stainless steel target chamber; the energy would be converted into heat and dissipated into the target chambers' walls.

Neither Atlas Facility workers, collocated workers, nor members of the public onsite or offsite would be exposed to these x rays because x rays would be contained within the target chamber and because personnel would be excluded from the area of the target chamber during an experiment. Standard LANL radiological protection procedures would be followed, including standard operating procedures developed for the Pegasus II Facility, and revised as needed.

Diagnostic apparatus used to take x rays of the events occurring during experiments within the target chamber would be located outside the chamber and would use high-energy x rays, similar to medical x rays. The diagnostic apparatus operation would be interlocked to the entrances to the target area such that the apparatus would not operate if an exterior door were opened. Existing standard operating procedures and facility shielding would be used to protect workers. In addition, personnel protection staff would conduct surveys in and around the target area to measure radiation produced by the diagnostic x-ray apparatus when they are operated. Additional shielding would be added if needed.

Collocated workers or members of the public, either onsite or offsite, would not be exposed to high-energy x rays. These x rays would be shielded and contained within the interlocking room housing the capacitor bank.

K.4.2.3 Waste Management Facilities

Uncontaminated waste (such as paper waste and dielectric insulation), expected to be about 7 m *3* (240 ft *3*) per year, would be disposed of at the Los Alamos County Landfill. The landfill would not require expansion due to the waste generated by the Atlas Facility. For purposes of this analysis it is assumed that a small amount (<1m3 annually) of liquid or solid hazardous waste would be generated by occasional experiments involving lead or other simulant materials. This waste would be staged in the onsite hazardous waste accumulation area and shipped to offsite commercial RCRA-permitted treatment, storage, and disposal facilities. Construction waste (about 15.3 m *3* [20 yd *3*]) would be disposed of at the Los Alamos County Landfill.

K.4.3 No Action Alternative

K.4.3.1 Air Quality

The air emissions due to the Pegasus II Facility are presented in table K.4.3.1-1, along with the health-based New Mexico AQCR 702-regulated levels and the AQCR 707 (Prevention of Significant Deterioration)-regulated levels. All emissions are below current regulatory levels. No permitting is required under AQCR 702, AQCR 707, or NESHAP. No special air filtration or scrubber is required for the Pegasus II Facility. Most of the metals would vaporize and deposit onto the inside surface of the target chamber. Only minute quantities of metals would stay volatilized. The majority of the ethanol used for cleaning would evaporate. The quantity of air emissions would not harm workers, collocated workers (those at TA-35 but not involved with the Pegasus II project), or members of the public.

Table K.4.3.1-1.-- Air Emissions from the Pegasus II Facility

Constituent	Calculated Emissions[6]	AQCR 702/707 Limits
Aluminum	less than 1 g (0.0022 lb)	0.133 lb/hr
Copper	less than 1 g (0.0022 lb)	0.0133 lb/hr
Ethanol	18.1 g (0.04 lb)	10 lb/hr
High Explosives[7]	12.7 g (0.028 lb) carbon monoxide	200,000 lb/yr
	34.0 g (0.075 lb) nitrogen oxides	40,000 lb/yr
	95.2 g (0.21 lb) particulate matter 10 microns or smaller	25,000 lb/yr
	0.91 g (0.002 lb) volatile organic compounds	40,000 lb/yr

K.4.3.2 Human Health

Electrical. Normal operations during conduct of experiments at the Pegasus II Facility present electrical hazards to researchers, technicians, and other Pegasus II Facility personnel because the Pegasus II capacitor bank is charged to a high voltage. The Pegasus II capacitor bank could deliver an instantaneous lethal current if special precautions are not taken during experiments. Engineering controls and administrative controls the same as or similar to those described for the proposed Atlas Facility, such as interlocked rooms, fail-safe switches, standard operating procedures, and direct cut-offs, significantly decrease the probability of an electrical accident occurring during normal operations.

Magnetic Fields. Magnetic fields are not generated during the conduct of experiments under the No Action alternative; power for charging the Pegasus II capacitor bank is obtained from the existing LANL electrical power grid and does not require the use of a separate facility power generator.

Radiological. Experiments conducted at the Pegasus II Facility produce up to 0.2 MJ of low-energy x rays, 10 percent of the level expected during the same type of experiment from the proposed Atlas Facility (2.0 MJ). Operating experience has demonstrated that these low-energy x rays do not penetrate the target chamber. Neither Pegasus II Facility workers, collocated workers, nor members of the public either onsite or offsite would be exposed to x rays from continuing to operate the Pegasus II Facility experiments.

K.4.3.3 Waste Management Facilities

About 0.7 m3 (24 ft3) of uncontaminated waste (such as paper waste and dielectric insulation) per month is disposed of at the Los Alamos County Landfill. No RCRA-regulated hazardous waste is generated.

K.4.4 Impacts Associated With Accidents

This section considers bounding case accidents that could be associated with the operation of the

Atlas Facility that could affect site workers, collocated workers, the public, and the environment. Accidents with the highest consequence to workers have the likelihood of occurring once in 100 years. Accidents with the highest consequence to collocated workers, the public, and the environment have the likelihood of occurring once in 10,000 years. This information is summarized in section K.7. Other accident scenarios are contained within the Preliminary Hazard Analysis for the proposed Atlas project (LANL 1995). Accidents analyzed in this project-specific analysis are summarized in table K.4.4-1.

Table K.4.4-1.-- Accidents Analyzed

Accidents	Likelihood of Event	Worst Consequence
Worker Mechanical collapse of crane; High-energy power source electrocution	Less than 1 in 100 years	Serious worker injury or death
Collocated worker Fire resulting from capacitor bank failure and release of smoke and sprinkler system water	Less than 1 in 10,000 years	Irritation or discomfort but no permanent health effects
Public Fire resulting from capacitor bank failure and release of smoke and sprinkler system water	Less than 1 in 10,000 years	Irritation or discomfort but no permanent health effects
Environment Fire resulting from capacitor bank failure and release of smoke and sprinkler system water	Less than 1 in 10,000 years	Release of smoke and effluent discharge containing sprinkler system water and mineral oil

LANL 1995.

K.4.4.1 Site Worker

The bounding case accident for a site worker involves electrocution from a high-energy power source or mechanical collapse of the overhead crane. Of these scenarios, both have an equal likelihood of occurrence. The impact to a site worker in these scenarios could be death; however, the likelihood of occurrence is less than once in 100 years of operation.

K.4.4.2 Collocated Worker

The most likely accident scenario that could result in an impact to collocated workers involves exposure to emissions and effluents from a capacitor bank fire. In this scenario, a collocated worker would receive minimal exposure to smoke and sprinkler system water containing mineral oil spilled from a Marx module. The impact to a collocated worker in this scenario would be temporary irritation and discomfort; however, the likelihood of occurrence is less than once in 10,000 years of operation. In the event of a fire, all site and collocated workers would be evacuated immediately.

K.4.4.3 Public

The most likely accident scenario that could result in an impact to the public involves exposure to emissions and effluents from a capacitor bank fire. In this scenario, a member of the public could receive minimal exposure to smoke. The impact to a member of the public in this scenario would be less than that experienced by a collocated worker. Exposure to smoke could result in very mild and temporary irritation and discomfort. The likelihood of this accident occurring is less than once in 10,000 years of operation. In the event of a fire, all members of the public would be evacuated from the site area immediately and road closures and exclusion zones would be implemented, as appropriate. Based on the accident scenario and impact analysis in section K.7, there are no probable accidents which would result in an adverse impact to the public.

K.4.4.4 Environment

The bounding case accident scenario that could result in an impact to the environment involves the release of emissions and effluents from a capacitor bank fire. In this scenario, smoke and sprinkler water containing spilled mineral oil could be released to the environment. The impact to the environment in this scenario would be temporary and minimal. Smoke from a fire in this scenario would disperse quickly and the sprinkler water containing mineral oil would be contained by site soils and controlled drainage systems. Water containing mineral oil does not present a serious environmental concern given the nonhazardous nature of mineral oil, and in the event of a fire, spill prevention control measures would be implemented immediately. The likelihood of such an accident occurring under normal operating conditions is once in 10,000 years.

K.5 Agencies and Persons Consulted

No external agencies or persons were consulted for the project-specific analysis of the proposed Atlas Facility.

K.6 Permit Requirements

No external regulatory or permit requirements have been identified for the Atlas Facility.

K.7 Supplementary Information: Accidents

Tables K.7-1 and K.7-2 provide a summary of the types of hazards and scenarios that could result in impacts to the public, environment, collocated worker or the facility worker. Listed in table K.7-2 are the risk ranks resulting from the likelihood and consequence of a given scenario and hazard.

Table K.7-1.-- Hazard Sources for Atlas Preliminary Hazard Assessment Chart

Electricity	-High voltage current -Static electricity

Radiant energy	-Electromagnetic fields
Radiation	-X rays
Mechanical structures	-Failure and collapse of critical structural assemblies -Leaks from storage tanks
Chemicals	-Toxic materials -Flammable materials -Asphyxiant gas
Implosion/ explosion	-Target chamber malfunction
Fire	-Mechanical/electrical malfunction -Target chamber malfunction

LANL 1995; Model results.

Table K.7-2 shows that the highest consequence of any Atlas hazard scenario would have the greatest impact on the facility worker (Column 5, Impact on Worker). This is indicated by three hazards (radiation, mechanical structures, and fire) showing a risk ranking factor of two. The other impact receptors (e.g., collocated worker or environment) all have maximum risk ranks of 3 which means that risks are acceptable with sufficient controls and safeguards in place. Information charts on the following pages of this project-specific analysis have been provided to present the methodologies used to determine risk categories, probabilities, consequences, and requirements for risk mitigation during the typical preliminary hazard assessment process. The final preliminary hazard assessment risk reduction recommendations would be incorporated into the project design or in the project standard operating procedures.

Table K.7-2.-- Summary of Hazards and Impacts with Risk Ranks from the Atlas Preliminary Hazard Assessment

Hazard	Scenario	Impact on Public (Risk Rank)	Impact on Collocated Worker (Risk Rank)	Impact on Worker (Risk Rank)	Impact on Environment (Risk Rank)	Highest Consequence (Risk Rank)
Electricity	Access Breach	No	No	Yes (3)	No	Potential fatality

Radiant energy (EMF)	Inadvertent access of personnel to roof during charging	No	No	Yes (3)	No	Potential exposure of personnel to EMF
Radiation (x rays)	Implosion of experiment	No	Yes (4)	Yes (2)	No	Potential exposure of facility/ collocated workers
Mechanical structures	Failure and collapse of critical structures	No	No	Yes (2)	No	Potential worker injury/fatality
Mechanical structures	Leaks from storage tanks	No	No	No	Yes (3)	Release of untreated fire suppression water
Chemicals	Marx tank oil leak	Yes (3)	Yes (3)	Yes (3)	Yes (3)	Mineral oil is leaked to the facility and possibly to the environment
Chemicals Asphyxiant	Sulfur hexafluoride resupply hose leaks	No	No	No	Yes (3)	Sulfur trifluoride vaporizes and escapes; Potential exposure of facility/co-located workers
Explosion	Capacitor explodes	No	No	Yes (3)	No	Debris and mineral oil released to facility, possible worker injury
Implosion	Target chamber malfunction	No	No	No	No	Loss of vacuum and operational capability
Fire	Generator fire during power generation	No	No	Yes (3)	No	Worker injury from inhalation of fire combustion products

Fire	Marx generator capacitor banks fail	Yes (3)	Yes (3)	Yes (2)	Yes (3)	Fire in capacitor banks, potential injury to facility worker

Consequence Likelihood Categories

I (1 to 0.1)	Normal Operations: Frequency as often as once in 10 operating years or at least once in 10 similar facilities operated for 1 year.
II (0.1 to 0.01)	Anticipated Events: Frequency between 1 in 10 years and 1 in 100 years or at least once in 100 similar operating facilities operated for 1 year.
III (10 -2 to 10 -*4*)	Unlikely: Frequency between 1 in 100 years and 1 in 10,000 years or at least once in 10,000 similar facilities operated for 1 year.
IV (10 -*4* to 10 -*6*)	Very Unlikely: Frequency between 1 in 10,000 years and once in 1 million years or at least once in a million similar facilities operated for 1 year.
V	Improbable: Frequency of less than once in a million years.

EMF - electromagnetic force.

LANL 1995.

Consequence Severity Categories, Maximum Possible Consequence

Category	**Public**	**Collocated Worker**	**Worker**	**Environment**
A	Immediate health effects	Immediate health effects	Loss of life.	Substantial offsite contamination
B	Long-term health effects	Long-term health effects	Severe injury or disability.	Substantial contamination of originating facility/activity, minor onsite contamination; no offsite contamination.
C	Irritation or discomfort but no permanent health effects	Irritation or discomfort but no permanent health effects	Lost-time injury but no disability	Minor or no contamination of originating facility/activity; no offsite contamination
D	No substantial offsite release	No substantial offsite effect	Minor or no injury and no disability	Minor or no contamination of originating facility/activity; no offsite contamination

Offsite: Public, private, or Indian lands that are not part of Laboratory property; Onsite: Laboratory property but not necessarily the originating technical area; Facility: Originating technical area of the Laboratory.

Risk Ranking Matrix

	Likelihood of Consequence				
Severity of Consequence	**I**	**II**	**III**	**IV**	**V**
A	1	1	2	3	3
B	1	2	2a	3	4
C	2	3	3	4	4
D	3	4	4	4	4

a Assign risk rank of 3 if severity category rank of B is based upon worker injuries and offsite consequence severity is less than B.

Risk Rank	Recommendation
1	Unacceptable: Should be mitigated to risk rank 3 or lower as soon as possible.
2	Unacceptable: Should be mitigated to risk rank 3 or lower within a reasonable time period.
3	Acceptable with Controls: Verify that procedures, controls, and safeguards are in place.
4	Acceptable as is: No action is necessary.

Further information may be found in the preliminary hazard assessment for Atlas (LANL 1995).

K.8 Glossary

Angstrom (Å): Unit of length equal to 1x10-10 meter.

Dielectric: A nonconductor of electric current.

Electrolyte recirculation system: A water circulation system with salt additives which is used for controlling resistance near the capacitors.

Electron volt (eV): The energy equivalent (1.602x10-19 Joules) of an electron passing through a voltage differential of 1 volt.

Environmental impact statement: A document required by the *National Environmental Policy Act* (NEPA) of 1969, as amended, for proposed major Federal actions involving potentially significant environmental impacts.

Foil implosion: To burst inward; i.e., the effect of applying large doses of electrical current to a thin walled cylinder.

Gauss (G): Unit of magnetic induction in the electromagnetic and Gaussian systems of units. Equal to 1 maxwell (measure of magnetic flux through an area) per square centimeter.

High-energy pulsed-power: A technique used in compressing electrical energy and storing it at high levels and then releasing it to a target in a very short time period.

High-energy x ray: An x ray in the 0.03 to 1 Angstrom wavelength range (e.g., medical x rays).

High explosives: Any chemical compound or mechanical mixture that, when subjected to heat, impact, friction, shock, or other suitable initiation stimulus, undergoes a very rapid chemical change with the evolution of large volumes of highly heated gases that exert pressures in the surrounding medium; the term applies to materials that detonate.

Joule: Unit of energy equivalent to one watt-second.

Low-energy x ray: An x ray in the 1 to 10 Angstrom wavelength range. Low-energy x rays do not have enough energy to penetrate a sheet of paper.

Marx modules: Assemblage of electric capacitors charged in parallel and discharged in a series are said to be of a "Marx Configuration."

Megajoule (MJ): One million joules which is a measure of energy or work in the meter-kilogram-second system of units, equal to 1 Newton.

Micron: A unit of length equal to one-millionth of a meter; one meter equals 3.2 feet.

National Emission Standards for Hazardous Air Pollutants: Hazardous air pollution standards established through the *Clean Air Act* , as amended.

Plasma flow switch: An electrical switch used to open a circuit through the use of ionized gas (plasma).

Prevention of Significant Deterioration: Refers to provisions in the *Clean Air Act* , as amended, and state air quality regulations, to ensure that an area in attainment with the National Ambient Air Quality Standards will stay in attainment.

Rem: Roentgen equivalent man; unit for measuring radiation dose equivalence. The rem takes into account the energy absorbed (dose) and the biological effect on the body (quality factor) due to the different types of radiation.

Resource Conservation and Recovery Act of 1976: Establishes a comprehensive "cradle-to-grave" approach to the regulation of hazardous waste. Also establishes a framework for instituting corrective action for releases of hazardous wastes.

Reynolds Number: A dimensionless numerical value relating fluid density and viscosity to particle size and relative velocity.

Roentgen: A unit of exposure to ionizing x- or gamma radiation equal to or producing one electrostatic unit of charge per cubic centimeter of air.

Science-based stockpile stewardship: DOE program to develop a new approach, based on scientific understanding and expert judgment, to ensure continued confidence in safety, performance, and reliability of the nuclear weapons stockpile.

SOP: *Standard operating procedures; written and authorized procedures for conducting an activity.*

Special facilities equipment (SFE): An assemblage of high power electrical equipment and systems to support Atlas (i.e., target chamber, vacuum equipment, etc.).

Swale: A low-lying stretch of land where water could collect or puddle.

Threshold limit value: Refers to airborne concentrations of substances and represents conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects.

K.9 References

ACGIH 1993: American Conference of Governmental Industrial Hygienists, "1993-1994 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices," Cincinnati, OH, 1993.

Commerce 1991: U.S. Department of Commerce, Economics and Statistics Administration, Bureau of Census, "1990 Census of Population and Housing: Summary Population and Housing Characteristics - New Mexico," 1990-CPH-1-33, August 1991.

DOE 1979: U.S. Department of Energy, "Final Environmental Impact Statement: Los Alamos Scientific Laboratory Site, Los Alamos, New Mexico," DOE/EIS-0018, 1979.

DOE 1995a: U.S. Department of Energy, "Notice of Intent to Prepare a Programmatic Environmental Impact Statement for the Stockpile Stewardship and Management Program," Office of Reconfiguration, U.S. Department of Energy, Alexandria, VA, Federal Register, June 6, 1995.

DOE 1995b: U.S. Department of Energy, "Final Environmental Impact Statement: Dual Axis Radiographic Hydrodynamic Test Facility," DOE/EIS-0228, August 25, 1995.

LANL 1991: Los Alamos National Laboratory, "Preliminary Hazard Analysis for Pegasus II," Los Alamos, NM, September 1991.

LANL 1994a: Los Alamos National Laboratory, "Conceptual Design Report for Atlas," Los Alamos, NM, April 1994.

LANL 1994b: Los Alamos National Laboratory, "Environmental Surveillance at Los Alamos During

1992," Report LA-12764-ENV, 1994.

LANL 1995: Los Alamos National Laboratory, "Preliminary Hazard Analysis for the Atlas Project," Los Alamos, NM, September 1995.

Morris 1994: Telephone conversation with D. Morris, co-owner of Royal Crest Trailer Park, June 16, 1994.

NMEIB 1981: New Mexico Environmental Improvement Board, "Air Quality Control Regulation 201: Ambient Air Quality Standards," June 15, 1981.

U.S. Census 1994: U.S. Bureau of the Census, "County and City Data Book: 1994," Washington, DC.

1

1 megajoule is 0.28 kilowatt-hrs of electricity.

2

The DARHT Final Environmental Impact Statement was issued on August 25, 1995. The Record of Decision for DARHT was issued on October 11, 1995.

3

Amount calculated is per experiment using that specific type of metal or cleaning solvent. Any emissions would occur after the target chamber is repressurized to ambient pressure and temperature.

4

Scientific notation (see glossary for explanation).

5

Total for isopropyl alcohol, trichloroethylene, and 1,1,2-trichloroethane.

Model results; NMEIB 1981.

6

Amount calculated is per experiment using that specific type of metal. Any emissions would occur after the target chamber is repressurized to ambient pressure and temperature.

7

Emissions due to high explosives are calculated for one year, not per experiment.

Model results; NMEIB 1981; 40 CFR 52.21.

List of Figures for Appendix I

Figure I.4.5.1.3-1 Floodplain Map for Technical Area II at Sandia National Laboratories. *not available electronically*

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Area					
square inches	**6.4516**	sq. centimeters	sq. centimeters	**0.155**	sq. inches
sq. feet	**0.092903**	sq. meters	sq. meters	**10.7639**	sq. feet
sq. yards	**0.8361**	sq. meters	sq. meters	**1.196**	sq. yards
acres	**0.40469**	hectares	hectares	**2.471**	acres
sq. miles	**2.58999**	sq. kilometers	sq. kilometers	**0.3861**	sq. miles
Volume					
fluid ounces	**29.574**	milliliters	milliliters	**0.0338**	fluid ounces
gallons	**3.7854**	liters	liters	**0.26417**	gallons
cubic feet	**0.028317**	cubic meters	cubic meters	**35.315**	cubic feet
cubic yards	**0.76455**	cubic meters	cubic meters	**1.308**	cubic yards
Weight					
ounces	**28.3495**	grams	grams	**0.03527**	ounces
pounds	**0.43560**	kilograms	kilograms	**2.2046**	pounds
short tons	**0.90718**	metric tons	metric tons	**1.1023**	short tons
Temperature					
Fahrenheit	**Subtract 32, then multiply by 5/9**	Celsius	Celsius	**Multiply by 9/5, then add 32**	Fahrenheit

Prefix	**Symbol**	**Multiplication Factor**
exa-	**E**	1 000 000 000 000 000 000 = 10^{18}
peta-	**P**	1 000 000 000 000 000 = 10^{15}
tera-	**T**	1 000 000 000 000 = 10^{12}

giga-	**G**	1 000 000 000 = 10^9
mega-	**M**	1 000 000 = 10^6
kilo-	**k**	1 000 = 10^3
hecto-	**h**	100 = 10^2
deka-	**da**	10 = 10^1
deci-	**d**	0.1 = 10^{-1}
centi-	**c**	0.01 = 10^{-2}
milli-	**m**	0.001 = 10^{-3}
micro-	**μ**	0.000 001 = 10^{-6}
nano-	**n**	0.000 000 001 = 10-9
pico-	**p**	0.000 000 000 001 = 10^{-12}
femto-	**f**	0.000 000 000 000 001 = 10^{-15}
atto-	**a**	0.000 000 000 000 000 001 = 10^{-18}

Units of Measure

cm	centimeters
ft	feet
ft2	square feet
ft3	cubic feet
gal	gallons
ha	hectares
hr	hour
in	inches
kg	kilogram
km	kilometers
L	liters
lb	pounds
mg	micrograms
m	meters
m2	square meters
m3	cubic meters
mg	milligrams

Metric Conversion Chart and Metric Prefixes

To Convert to Metric			**To Convert from Metric**		
If You Know	**Multiply By**	**To Get**	**If You Know**	**Multiply By**	**To Get**
Length					
inches	2.54	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.0328	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.0936	yards
miles	1.60934	kilometers	kilometers	0.6214	miles
Area					
square inches	6.4516	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.092903	sq. meters	sq. meters	10.7639	sq. feet
sq. yards	0.8361	sq. meters	sq. meters	1.196	sq. yards
acres	0.40469	hectares	hectares	2.471	acres
sq. miles	2.58999	sq. kilometers	sq. kilometers	0.3861	sq. miles

Volume					
fluid ounces	29.574	milliliters	milliliters	0.0338	fluid ounces
gallons	3.7854	liters	liters	0.26417	gallons
cubic feet	0.028317	cubic meters	cubic meters	35.315	cubic feet
cubic yards	0.76455	cubic meters	cubic meters	1.308	cubic yards
Weight					
ounces	28.3495	grams	grams	0.03527	ounces
pounds	0.45360	kilograms	kilograms	2.2046	pounds
short tons	0.90718	metric tons	metric tons	1.1023	short tons
Temperature					
Fahrenheit	Subtract 32, then multiply by 5/9	Celsius	Celsius	Multiply by 9/5, then add 32	Fahrenheit

Prefix	**Symbol**	**Multiplication Factor**	
exa-	E	1 000 000 000 000 000 000 = 1018	
peta-	P	1 000 000 000 000 000 = 1015	
tera-	T	1 000 000 000 000 = 1012	
giga-	G	1 000 000 000 = 109	
mega-	M	1 000 000 = 106	
kilo-	k	1 000 = 103	
hecto-	h	100 = 102	
deka-	da	10 = 101	
deci-	d	0.1 = 10-1	
centi-	c	0.01 = 10-2	
milli-	m	0.001 = 10-3	
micro-		atto-	a 0.000 000 000 000 000 001 = 10-18

Metric Conversion Chart and Metric Prefixes

To Convert to Metric			To Convert from Metric		
If You Know	**Multiply By**	**To Get**	**If You Know**	**Multiply By**	**To Get**
Length					
inches	2.54	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.0328	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.0936	yards
miles	1.60934	kilometers	kilometers	0.6214	miles
Area					
square inches	6.4516	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.092903	sq. meters	sq. meters	10.7639	sq. feet
sq. yards	0.8361	sq. meters	sq. meters	1.196	sq. yards
acres	0.40469	hectares	hectares	2.471	acres
sq. miles	2.58999	sq. kilometers	sq. kilometers	0.3861	sq. miles
Volume					
fluid ounces	29.574	milliliters	milliliters	0.0338	fluid ounces
gallons	3.7854	liters	liters	0.26417	gallons
cubic feet	0.028317	cubic meters	cubic meters	35.315	cubic feet
cubic yards	0.76455	cubic meters	cubic meters	1.308	cubic yards
Weight					
ounces	28.3495	grams	grams	0.03527	ounces
pounds	0.45360	kilograms	kilograms	2.2046	pounds
short tons	0.90718	metric tons	metric tons	1.1023	short tons
Temperature					
Fahrenheit	Subtract 32, then multiply by 5/9	Celsius	Celsius	Multiply by 9/5, then add 32	Fahrenheit

Prefix	**Symbol**	**Multiplication Factor**
exa-	E	1 000 000 000 000 000 000 = 1018
peta-	P	1 000 000 000 000 000 = 1015
tera-	T	1 000 000 000 000 = 1012
giga-	G	1 000 000 000 = 109
mega-	M	1 000 000 = 106
kilo-	k	1 000 = 103
hecto-	h	100 = 102

deka-	da	10 = 101	
deci-	d	0.1 = 10-1	
centi-	c	0.01 = 10-2	
milli-	m	0.001 = 10-3	
micro-		atto-	a 0.000 000 000 000 000 001 = 10-18