CHAPTER 5: ENVIRONMENTAL CONSEQUENCES

This chapter provides the scientific and analytical base for the comparison of the alternatives. Approaches used for addressing potential impacts are presented in Section 5.1.

The three alternatives analyzed in this *Site-wide Environmental Impact Statement for Continued Operation of Lawrence Livermore National Laboratory and Supplemental Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (LLNL SW/SPEIS) are the No Action Alternative (Section 5.2), Proposed Action (Section 5.3), and Reduced Operation Alternative (Section 5.4). Fifteen environmental resource elements are analyzed for each alternative:

- Land Uses and Applicable Plans
- Socioeconomic Characteristics and Environmental Justice
- Community Services
- Prehistoric and Historical Cultural Resources
- Aesthetics and Scenic Resources
- Geology and Soils
- Biological Resources
- Air Quality
- Water
- Noise
- Traffic and Transportation
- Utilities and Energy
- Materials and Waste Management
- Human Health and Safety
- Site Contamination

Bounding accident scenarios are presented in Section 5.5 and mitigation measurers are discussed in Section 5.6.

The impact analysis for this LLNL SW/SPEIS is based on the best data currently available. This LLNL SW/SPEIS will serve as a baseline document for the preparation of subsequent, tiered *National Environmental Policy Act* (NEPA) documents that may be required prior to implementation of future specific projects.

5.1 METHODOLOGY

The following paragraphs are brief descriptions of the impact assessment approaches used in the LLNL SW/SPEIS for addressing potential impacts of Lawrence Livermore National Laboratory (LLNL) operations under the No Action Alternative, Proposed Action, and Reduced Operation Alternative. Methodologies used for each resource area are discussed below to identify and, if possible, measure potential impacts.

5.1.1 Land Uses and Applicable Plans

To estimate possible impacts of the No Action Alternative, Proposed Action, and Reduced Operation Alternative, the land use analysis relied on information for current and planned facilities presented in Chapter 3 and Appendix A of this LLNL SW/SPEIS. A comparative methodology was used to determine land use impacts from the project alternatives in terms of function and acreage. Facility operations and particularly any facility construction activities were examined and compared to existing land use conditions. Impacts, if any, were identified as they relate to changes in land ownership and land use classifications as well as conflicting uses.

5.1.2 Socioeconomic Characteristics and Environmental Justice

The socioeconomic analysis measured the incremental effects from changes in expenditures, income, and employment associated with the No Action Alternative, Proposed Action, and Reduced Operation Alternative at LLNL, as well as their overall effect on the region of influence (ROI). The ROI, as described in Chapter 4 of the LLNL SW/SPEIS, is a four-county area surrounding LLNL where 93 percent of LLNL employees and their families live, spend their wages and salaries, and use their benefits. Impacts for the Livermore Site were analyzed in combination with those for Site 300 for population and housing because of the overlap in employee residence locations, and because employee statistics for non-LLNL employees are not available by individual site.

Spending by LLNL directly affects the ROI in terms of dollars of expenditures gained or lost for individuals and businesses, dollars of income gained or lost to households, and the number of jobs created or lost. Changes in employment at LLNL directly affect the overall economic and social activities of the communities and people living in the ROI. These changes directly affect the amount of income received by individuals and businesses. Businesses and households in the ROI respend LLNL money, which creates indirect socioeconomic effects from LLNL operations. Every subsequent respending of money by businesses and households in the ROI is another tier of indirect and induced socioeconomic effects originating from LLNL operations.

The analysis compared the magnitude of LLNL employment changes to the year 2014 with future employment, population, and housing levels. Determination of impacts was based on the percentage of these future levels that are attributable to LLNL influence.

Estimates of the geographic distribution of residences of potential new hires associated with the No Action Alternative, Proposed Action, and Reduced Operation Alternative were based on the existing distribution of the workforce residences. This demographic pattern could change over the project period due to various economic and quality of life factors. Indeed, a trend toward more employees living outside of the nearby communities of Livermore and Pleasanton has been observed in the past 11 years. From 1991 to 2002, the percentage of LLNL employees living in Livermore and Pleasanton has decreased from 49.3 percent to 43.2 percent. Only part of the redistribution has been to the Central Valley cities of Tracy, Manteca, Modesto, and Stockton (17.5 percent in 1991 increasing to 18.7 percent in 2002), as employees balance factors such as housing costs, commute times, and quality of schools. For purposes of this analysis, no change in the distribution was assumed because there could be limiting factors to redistribution such as significantly longer commute times from traffic congestion, the calculations of which were beyond the scope of this LLNL SW/SPEIS.

The potential for disproportionately high and adverse human health or environmental impacts from the alternatives on minority and low-income populations was examined in accordance with Executive Order (EO) 12898, *Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations* (59 FR 7629). Both the *Environmental Justice Guidance Under the National Environmental Policy Act* (CEQ 1997) and the *Guidance for Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analyses* (EPA 2002a) provide guidance for identifying minority and low-income populations and determining whether the human health and environmental effects on these populations are disproportionately high and adverse. The environmental justice analysis presents selected demographics and identifies the locations of minority and low-income populations living within a 50-mile radius of LLNL.

5.1.3 Community Services

The community services analysis measured effects on four local government support services: fire protection and emergency services, police protection and security services, school services, and nonhazardous solid waste disposal.

The analysis evaluated the burden placed on each of these support services by changes in LLNL demands under the No Action Alternative, Proposed Action, and Reduced Operation Alternative. In the case of impacts to school services resulting from changes in LLNL staffing levels, the analysis directly examined the increases or decreases in the number of children of LLNL employees attending schools. For the other community services, the analysis relied on indirect indicators of service needed, as data does not support the establishment of a relationship between activities under each alternative and demand for these services. In the case of fire protection, the analysis assumed changes in the demand for service would be proportional to gross square footage of usable floorspace across LLNL. In the cases of police protection and nonhazardous solid waste disposal, the analysis assumed changes in demand for service would be proportional to the number of LLNL employees.

5.1.4 Prehistoric and Historic Cultural Resources

Section 106 of the *National Historic Preservation Act* (NHPA) and its implementing regulations (36 CFR Part 800) state that an undertaking has an effect on a historic property when that undertaking may alter those characteristics of the property that qualify it for inclusion in the National Register of Historic Places (NRHP). An undertaking is considered to have an adverse effect on a historic property when it diminishes the integrity of the property's location, design, setting, materials, workmanship, feeling, or association.

Adverse effects include, but are not limited to:

- Physical destruction, damage, or alteration of all or part of the property
- Isolation of the property or alteration of the character of the property's setting when that character contributes to the property's qualifications for the NRHP
- Introduction of visual, audible, or atmospheric elements that are out of character with the property, or changes that alter its setting
- Neglect of a property resulting in its deterioration or destruction
- Transfer, lease, or sale of a property, without adequate provision to protect the property's historic integrity

The analysis addressed potential impacts or effects to NRHP-eligible resources located within the boundaries of the Livermore Site and Site 300. Proposed activities under the three alternatives were reviewed to identify those that would cause ground disturbance, introduce visual or audible changes, or make changes to existing buildings and structures. The proposed activities were then analyzed to determine if they would cause adverse effects to NRHP-eligible resources.

To fulfill its responsibilities under the NHPA, a Programmatic Agreement has been developed among the National Nuclear Security Administration (NNSA), the Advisory Council on Historic Preservation (ACHP), the California State Historic Preservation Officer (SHPO), and LLNL (Appendix G). The Programmatic Agreement is a guideline for NNSA to comply with Section 106 for all present and future actions until management plans are completed and this interim Programmatic Agreement is superseded by an agreement to implement the plans. The Programmatic Agreement was signed on July 11, 2003. Provisions of the Programmatic Agreement would serve as components of mitigation measures.

5.1.5 Aesthetics and Scenic Resources

The aesthetics and scenic resources analysis looked at the construction and operation of facilities described under the No Action Alternative, Proposed Action, and Reduced Operation Alternative and the resulting effects to the visual quality of the ROI. The ROI includes the Livermore Site and Site 300, as well as the view shed immediately surrounding these two areas.

The analysis of impacts to aesthetics and scenic resources used a comparative methodology and included a qualitative examination of potential changes to view sheds and viewpoints. Proposed activities under the No Action Alternative, Proposed Action, and Reduced Operation Alternative that would result in a change to the built environment on the Livermore Site and Site 300 were of particular interest. Construction of new facilities, extensive modification of existing facilities, and demolition of existing facilities associated with each alternative were examined, and any resulting changes were analyzed for potential impact to the existing aesthetic and scenic environment. Analysis focused on site development or modification activities that would alter the visibility of LLNL structures, obscure views of the surrounding landscape, or conflict with aesthetics or scenic resources in the surrounding area.

5.1.6 Geology and Soils

The geology and soils analysis looked at the effects of the construction and operation of facilities and of activities described in the No Action Alternative, Proposed Action, and Reduced Operation Alternative in the ROI. The ROI includes the lands occupied by and immediately surrounding the Livermore Site and Site 300.

The analyses evaluated the amount of disturbance that might affect the geology and/or soils of areas at the Livermore Site and Site 300. Impacts could include erosion and effects to potential geologic economic resources, such as mineral and construction material resources and fossil locations. In general, impacts to soils were defined as taking areas with soils that support agriculture out of production. Impacts to soils were quantified as the amount of area disturbed by construction activities. Impacts are evaluated and the severity of impacts are determined. Possible mitigation is identified for adverse impacts.

The seismicity of the region surrounding each site was evaluated to provide perspective on the probability and severity of future earthquakes in the area. This information was used to provide input to the evaluation of accidents due to natural phenomena.

5.1.7 Biological Resources

A qualitative analysis addresses the impacts of the activities under each alternative to biological resources. The methodology focused on those biological resources with the potential to be appreciably affected, and for which analyses assessing alternative impacts were possible. Biological resources include vegetation, wildlife, protected and sensitive species, and wetlands that are present or use the Livermore Site, Site 300, and contiguous areas. The potential sources of impacts from normal operations and security measures to biological resources that were considered include noise, outdoor tests, erosion, construction, demolition, and prescribed burns.

The biological data from earlier projects, wetlands surveys, and plant and animal inventories of portions of the Livermore Site and Site 300 were reviewed to identify the locations of plant and animal species and wetlands. Lists of sensitive species potentially present on the Livermore Site and Site 300 and areas designated as critical habitat were obtained from the U.S. Fish and Wildlife Service (USFWS). A similar request was made to the California Department of Fish and Game.

Activities and potential releases identified under the No Action Alternative, Proposed Action, and Reduced Operation Alternative were reviewed for their potential to affect plants, animals, and the sensitive species under Federal and state laws and regulations. Potential beneficial and negative impacts to plants and animals were evaluated for gain, loss, disturbance, or displacement. Impacts to wetlands were evaluated to determine if their areal extent would change. Monitoring data on sensitive plants and animals were reviewed for impact to these resources.

5.1.8 Air Quality

5.1.8.1 *Nonradiological Air Quality*

The primary activities that emit air pollutants, associated with current and continued laboratory operations, include fuel combustion in boilers and emergency generators, vehicular activity particularly with employees commuting to and from the site, and construction and maintenance activities. Air pollutant emission rates and potential impacts of these activities were assessed using standard methods endorsed by the U.S. Environmental Protection Agency (EPA) and local air pollution control agencies (BAAQMD 1999, EPA 2003c). As available, site-specific parameters developed by local air quality regulatory agencies were incorporated and conservative assumptions were used so as not to underestimate the potential impact.

The assessment of impacts from increased vehicular activity follows a methodology developed by the Bay Area Air Quality Management District (BAAQMD) in conjunction with the California Air Resources Board (CARB), Association of Bay Area Governments (ABAG), and the Metropolitan Transit Commission. The method took into account the current and projected typical mix of vehicles (fleet type and age), gasoline formulations, ambient temperature, effectiveness of vehicle inspection and maintenance programs, typical driving habits, the impact of planned regulatory program requirements for more efficient engines and cleaner burning fuels, and reduction in vehicle miles traveled resulting from planned transportation demand management. In addition to estimating emissions from vehicles, maximum potential carbon monoxide concentrations are assessed along congested corridors to determine whether increased motor vehicle use associated with new projects would contribute to a carbon monoxide level that would exceed ambient air quality standards. This assessment considered projected peak hourly traffic volumes along Vasco Road and Patterson Pass Road, which serve the major flow of traffic to LLNL.

As a final assessment, total emissions from project operations (including motor vehicle emissions) were compared to significance and conformity levels. Annual and daily significant emission levels are established by local air districts in response to local air quality concerns. By evaluating project emissions as a whole, including motor vehicle emissions, this affords the air district a greater level of control over a project not limited to source permitting. A project that generates criteria air pollutant emissions in excess of the significance levels would be considered to have a significant air quality impact and stringent mitigation would be required. Rules for conformity also consider total project emissions. These rules were established under the Federal *Clean Air Act* (CAA) and pertain specifically to Federal actions. The underlying basis for the conformity demonstration is to preclude actions that would generate growth in air pollutants to a degree that is inconsistent with the local clean air plan, and thereby frustrate regional efforts to attain and maintain the National Ambient Air Quality Standards (NAAQS). Within the Bay Area, projects that generate emissions of precursor organic compounds, oxides of nitrogen, or carbon monoxide in excess of 100 tons per year are required to fully offset or mitigate the emissions caused by the action (BAAQMD 1999).

In addition to operational emissions, construction activities, although generally short-term in duration, can cause substantial increases in localized concentrations of particulates. Particulate emission rates vary greatly depending on the level of activity, the specific operations taking place, the equipment being operated, local soils, weather conditions and other factors. Despite this variability in emissions, experience has shown that there are a number of feasible control measures that can be reasonably implemented to significantly reduce particulate matter emissions from construction. The BAAQMD's approach to analyses of construction impacts relative to signifigance levels is to emphasize implementation of effective and comprehensive control measures rather than detailed quantification of emissions. From the district's perspective, quantification of construction emissions is not necessary; the determination of significance with respect to construction emissions should be based on a consideration of the control measures to be implemented (BAAQMD 1999). However, a conformity analysis requires quantification of construction related emissions.

The BAAQMD has identified a three-tiered set of feasible control measures designed to reduce emissions of respirable sized particulates (PM_{10}) from construction activities: Basic Measures should be implemented at all construction sites, regardless of size; Enhanced Measures should be implemented at larger construction sites (greater than 4 acres) where PM_{10} emissions generally would be higher; and Optional Measures may be implemented if further emission reductions are deemed necessary by local agencies. If all of the control measures depending on the size of the project area would be implemented, then air pollutant emissions from construction activities would be considered a minor impact. Similarly, any demolition, renovation, or removal of asbestos-containing building materials would be considered a minor impact if the activity complies with the requirements and limitations of BAAQMD Regulation 11, Rule 2: Hazardous Materials, Asbestos Demolition, Renovation and Manufacturing (BAAQMD 1999).

5.1.8.2 *Radiological Air Quality*

Routine radiological emissions from LLNL facility operations were evaluated on the basis of dose to the site-wide maximally exposed individual (MEI) and collective dose to the general population within 50 miles of the site (population dose). Section 5.1.14 presents further information on health effects from nonradiological and radiological emissions. The MEI evaluation was compared to the National Emissions Standards for Hazardous Air Pollutants (NESHAP) (40 CFR Part 61). NESHAP limits the radiation dose that a member of the public may receive from radiological material released to the atmosphere from normal operations to 10 millirem per year. Although there is no standard that governs population dose, it is compared with the population dose received from naturally occurring radiation.

The baseline year for radiological emissions was taken as 2002. The effect of perturbations to individual facility emissions on MEI dose for the various alternatives was considered by scaling the baseline facility dose given in the *LLNL NESHAP 2002 Annual Report* (LLNL 2003z). The contribution of new facilities or releases (e.g., the National Ignition Facility [NIF]) on MEI dose and location was calculated using the EPA-approved *Clean Air Assessment Package* (CAP88-PC 2000) computer model. CAP88-PC, used also in the NESHAP annual report, conservatively calculates radiological impacts extending up to 50 miles. Doses from both internal (e.g., inhalation, ingestion of foodstuffs) and external exposure (e.g., standing on ground contaminated with radioactive material) were considered. Spatial population distributions at each site were based on 2000 data. Agricultural data used were for the State of California, as contained in the CAP88-PC database. It was assumed that the entire source of ingested vegetables and meat is grown within the affected area. No milk production was found in the area; all milk was assumed imported from outside the area.

The MEI is a hypothetical member of the public assumed to be located outdoors in a public area where the radiation dose from a particular source is highest. This individual is assumed to be exposed to the entire plume in an unshielded condition. The impacts on the MEI are therefore greater than the impacts that any member of the public can be expected to receive. The site-wide MEI is located where the composite dose from all site sources is greatest. The two LLNL sites, Livermore and Site 300, are far enough apart that the site-wide MEI from each does not affect the other. A separate site-wide MEI is defined for each of the two LLNL sites. Similarly, separate collective doses to the population are noted for each of the two sites. Since there is overlap in the affected site populations, a composite collective dose is also noted.

5.1.9 Water

Surface Water

The affected environment discussion includes a description of local surface water resources at the Livermore Site and Site 300, flow characteristics and relationships, and existing water quality. Data used for impact assessments included rates of water consumption and wastewater discharge. The existing water supply was evaluated to determine if sufficient quantities were available to support an increased demand by comparing projected increases with the capacity of the supplier.

The water quality of potentially affected receiving waters was determined by reviewing current monitoring data for contaminants of concern. Potential impacts from releases of radioactive materials are discussed in Appendix C, Section C.4, Environment, Safety, and Health. Focus was given to parameters that exceeded applicable water quality criteria as determined by the State of California. Monitoring reports for discharges permitted under the National Pollutant Discharge Elimination System (NPDES) were examined for compliance with permit limits and requirements. The assessment of water quality impacts from wastewater (sanitary and process) and stormwater runoff addressed potential impacts to the receiving waters' average flow during construction and operation. Suitable mitigation measures for potential impacts such as stream channel erosion, sedimentation, and stream bank flooding were identified.

Floodplains were identified to determine whether any of the proposed facilities would be located within the 100-year and 500-year floodplains.

Groundwater

Groundwater resources were analyzed for effects on aquifers, groundwater use and storage, and groundwater quality within the regions. Groundwater resources were defined as the aquifers underlying the site and their extensions downgradient, including discharge points. The affected environment discussion included a description of the local hydrogeology, occurrence, flow, and quality. Groundwater usage was described and projections of future usage were made based on changing patterns of usage and anticipated growth patterns.

Available data on existing groundwater quality were compared to Federal and state groundwater quality standards, effluent limitations, and safe drinking water standards. Additionally, Federal and state permitting requirements for groundwater withdrawal and discharge were identified. Impacts of groundwater withdrawals on existing contaminant plumes due to construction and facility operations were assessed to determine the potential for changes in their rates of migration and the effects of any changes in the plumes on groundwater users. Impacts were assessed by evaluating local hydrogeology, groundwater quality, and groundwater availability.

5.1.10 Noise

Various activities at LLNL result in noise that may be heard in surrounding offsite locations. To understand the potential impact of planned or proposed activities, noise levels attributed to activities such as construction, demolition, and operating equipment were characterized in terms of decibel level and described in relation to comparative noise levels of activities commonly encountered in community settings and land use compatibility guidelines. For noncontinuous sources, such as construction, demolition, and the unique impulse noise associated with explosives firings, activity levels were provided to give a sense of the amount of time that intermittent sources would be operated and contribute to ambient noise levels. Source location is also discussed where proximity to community receptors would result in a higher likelihood that a source would be heard in offsite areas.

5.1.11 Traffic and Transportation

NNSA selected traffic congestion and collective radiation dose and latent cancer fatalities (LCFs) to the general population as analytical endpoints for the transportation analysis. Traffic congestion was determined by qualitatively comparing current traffic levels with projected employment changes for the various alternatives. Radiological doses from transport of radioactive materials and wastes were calculated by computer modeling. The radiological transportation analysis methodology is summarized below. Appendix J, Radiological Transportation Analysis Methodology, provides additional information on methods and assumptions for the radiological transportation analysis.

All transportation of radioactive materials was assumed to take place by truck. LLNL identified origin-destination pairs for each shipment campaign. NNSA then used the Transportation Routing Analysis Geographic Information System (TRAGIS) computer code (ORNL 2000) to determine the most suitable routing. TRAGIS was constrained to only provide routes consistent with the U.S. Department of Transportation's highway route-controlled quantity regulations. Besides identifying the route, TRAGIS provided useful inputs to the remainder of the modeling such as miles per population density category and population within 800 meters of the route for each state and population density category.

NNSA then used the U.S. Department of Energy (DOE) code, RADTRAN 5 (SNL 2000), to calculate incident-free radiological impacts (normal transport without any accident releasing radioactive materials) to a member of the public. Members of the public are those residing within 800 meters of the route, those sharing the route in other vehicles, and those near the shipment at rest stops. Besides route length and demographics, the radiation dose 1 meter from the truck was the most important parameter. NNSA used a dose rate of 1 millirem per hour for shipments of special nuclear material and low-level waste (LLW) and 4 millirem per hour for transuranic (TRU) waste. RADTRAN 5 was used to calculate the collective dose for each type of material shipped between the various origin-destination pairs. The results were then multiplied by the numbers of shipments for each campaign.

For accidents, NNSA used RADTRAN 5 to calculate the collective dose should an accident occur. NNSA conservatively selected the highest consequence accident in the most populated area to report.

Collective doses from incident-free and accident analyses were multiplied by the conversion factor for converting collective dose to numbers of LCFs. This factor is 6×10^{-4} LCFs per person-rem, as determined by the Interagency Steering Committee on Radiation Standards (Lawrence 2002).

5.1.12 Utilities and Energy

Incremental changes to utilities and energy use at both the Livermore Site and Site 300 were assessed by comparing the support requirements of the alternatives to current site utility demands (e.g., water, sewer, electricity, fuel) based on projected square footage requirements and available capacities. Utility usage at each site was adjusted for contributions from the selected facilities and program projections. Three programs, the Advanced Materials Program, the NIF, and the Terascale Simulation Facility, were specifically evaluated for impacts. Impacts of other facilities and programs were evaluated based on average use per square foot.

5.1.13 Materials and Waste Management

Materials include chemicals, radioactive materials, or explosives that were used by LLNL in operations or research. Materials do not include waste. The methodology used to determine environmental impacts of the proposed alternatives on waste and materials management involves a three-step screening analysis as illustrated in Figure 5.1.13–1.

- Step 1 performs an initial screening analysis of new or modified projects or proposals, historical data, projections based on activity levels, permit modifications, changed circumstances, and new regulations. The initial screening analysis determines the specific environmental impact categories (e.g., air quality) that may exceed the bounds of the affected environment (existing conditions), as described in Section 4.15, Materials and Waste Management.

- Step 2 analyzes those impact categories that are likely to exceed the material and waste management existing or No Action Alternative conditions.

- Step 3 assesses the material and waste management to determine the environmental consequences of the increase or decrease to the affected environment or No Action Alternative.

The material management analysis examined potential impacts associated with material handling, management, and storage activities at LLNL, including radioactive materials, explosives, and hazardous chemicals. Impacts from nonhazardous materials are not discussed due to reduced risk to human health and the environment. The ongoing material management practices related to handling, using, and storing materials are described below. The analysis also considered the regulatory framework as it applies to material management and a summary of current and projected material management activities. Selected facilities or activities that use materials were evaluated for changes in the existing or No Action Alternative operations quantity of materials used as a result of the alternatives. LLNL storage capacities were evaluated for any impacts on their capabilities to manage materials before receipt. The analysis of potential impacts considered physical safety, regulatory requirements, and security measures associated with storage capacity, personnel safety, and usage capacity.

The waste management analysis examines potential impacts associated with waste generation activities at LLNL, including LLW, mixed low-level waste (MLLW), TRU, mixed TRU, hazardous waste, *Resource Conservation and Recovery Act* (RCRA) construction waste, decontamination and decommissioning (D&D) waste, municipal solid waste, and process (including domestic) wastewater. The ongoing waste management practices relating to generating, handling, treating, permits modifications, and storing wastes are described. The analysis also presents a summary of the regulatory framework as it applies to waste management and a summary of current and projected waste generation activities. Selected facilities or activities that generate waste were evaluated for changes in the existing or No Action Alternative quantity of waste generated as a result of the alternatives. LLNL treatment and storage facilities were evaluated for any impacts on their capabilities to manage wastes before transportation to offsite disposal. At LLNL, several organizations manage waste at waste management facilities including Plant Engineering, Chemistry and Materials Science Directorate, and the Radioactive and Hazardous Waste Division. For simplicity, the term Radioactive and Hazardous Waste Management (RHWM) covers all of these organizations. The analysis of potential impacts considered physical safety, regulatory requirements, and security measures associated with storage capacity, personnel safety, and treatment capacity.

A quantity projected under the No Action Alternative represents the maximum average quantity reported for any year during the 10-year timeframe 1993-2002. Waste volume and material maximum inventory estimates are considered to be conservative and bounding based on current annual projections.

For each selected facility, the waste and material quantity projected under the Proposed Action represents the maximum possible waste and material generation level, and thus the bounding level of operation. This applies to all waste types including LLW, MLLW, and hazardous waste and all material types including radioactive, explosive, and chemical.

A quantity projected under the Reduced Operation Alternative represents that of waste generated or material used during any given year as a result of maintaining programmatic capabilities across LLNL at minimum operational levels.

5.1.14 Human Health and Safety

LLNL operations that could potentially impact human health and safety include radiological and nonradiological exposures and occupational injuries, illnesses, and fatalities resulting from normal, accident-free operations on site facilities. Impacts are given in LCFs, emergency response planning guideline (ERPG) values, injury and illness recordable cases, and lost/restricted workday cases. The following paragraphs discuss how each of these human health and safety issues is estimated. Impacts are estimated for involved workers, noninvolved workers, and the public. See Appendix C of this LLNL SW/SPEIS for detailed methodology on human health and safety.

Nonradiological Health Impacts

Occupational Safety

Occupational injuries and illnesses are those incidents that result during the performance of an individual's work assignment. Occupational injury, illness, and fatality estimates were evaluated using site-specific occupational incidence rates. DOE Computerized Accident/Incident Reporting System (CAIRS) and LLNL Occupational Accident/Injury/Illness Analysis Support and Information System (OAASIS) data were used. Projected occupational injury and illness cases were calculated using 2002 data. Occupational injury, illness, and fatality categories used in this analysis were in accordance with Occupational Safety and Health Administration (OSHA) definitions. Incident rates were developed for facility operations.

Hazardous Chemicals (Nonradiological)

Health risks from hazardous chemical releases were not assessed for normal (accident free) operations because the LLNL-measured data for workplace concentrations of hazardous materials (see Appendix C for details) did not indicate the potential for adverse health impacts to involved and noninvolved workers.

Radiological Health Impacts

Radiological health impacts from normal operations were evaluated in terms of the probability of a premature fatality. Such impacts were quantified by noting the probability that a given radiation exposure would result in an LCF to an individual. When evaluated over a population, the individual probabilities can be generalized to make a statement as to how many people (but not which people) in the population would be affected.

The Interagency Steering Committee on Radiation Standards (Lawrence 2002) recommended a risk estimator of 6×10^{-4} excess (above those naturally occurring) fatal cancers per person-rem of dose in order to assess health effects to the public and to workers. The probability of an individual worker or member of the public contracting a fatal cancer is 6×10^{-7} per millirem. Radiation exposure can also cause nonfatal cancers and genetic disorders. The probability of incidence of these is one third that of a cancer fatality (Lawrence 2002).

Worker health effects from occupational exposure to radiation are projected based on recent experience with continuing operations and projections of specific additional operation impacts on involved workers. The bulk of the dose to involved workers from current operations, approximately 90 percent of total worker dose, is from operations at Building 332. This trend is expected to continue; changes in involved worker dose at LLNL are due chiefly to increased operations in that building (LLNL 2003az). The only exception to this is for increases due to NIF operations. Worker dose from NIF operations is based on operation-specific studies (LLNL 2003d).

Radiological health impacts to the general population were calculated from radiation exposure to the site-wide MEI and the population as a whole. A similar calculation was performed for the noninvolved worker population dose. These doses were converted to health impacts using the dose to risk estimators. The air transport pathway currently results in almost all of the doses to the public from LLNL, either directly or through deposition and subsequent inhalation and ingestion.

5.1.15 Site Contamination

Site contamination analyses focused on two distinct areas: soil contamination and groundwater quality.

The soil contamination analysis considered the potential for human contact of near-surface (the top 6 inches to 1 foot) contaminated soils and limitations on future land use of these areas. The analysis examined the types of sites where soil contamination could be present (environmental restoration and outdoor testing areas) and site characteristics. Soil contaminant concentrations were considered under each alternative and compared with criteria for future designated land use.

The groundwater quality analysis determined to what extent contamination from LLNL sites in the unsaturated and saturated zones would limit the potential use of groundwater, particularly as drinking water. Unsaturated zone and groundwater contamination sites were characterized in terms of their contaminants, concentrations, and extent.