Chapter 5
Environmental Consequences

CHAPTER 5
ENVIRONMENTAL CONSEQUENCES

This chapter describes the potential environmental impacts associated with the various alternatives:

- No Action Alternative (status quo)
- DARHT Baseline Alternative [complete and operate the Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility]
- Upgrade Alternative [upgrade the Pulsed High Energy Radiation Machine Emitting X-Rays (PHERMEX) Facility to DARHT capabilities]
- Enhanced Containment Alternative (operate the DARHT Facility with containment options)
  - Vessel Containment Option
  - Building Containment Option
  - Phased Containment Option (preferred alternative)
- Plutonium Exclusion Alternative (no experiments with plutonium at the DARHT Facility)
- Single Axis Alternative (operate only one axis of the DARHT Facility).

This chapter describes the potential environmental impacts, or changes, which would be expected to occur over the next 30 years if any of the alternatives analyzed in this EIS were implemented. Environmental impacts are described in terms of the various aspects of the affected environment which would be expected to change over time. The environmental impacts expected from the No Action Alternative are those associated with maintaining the status quo. The impacts from the No Action Alternative are discussed first to provide a basis of comparison for the impacts expected from the other alternatives. The environmental impacts that would be expected if any other alternative were to be implemented are described as a comparison to the impacts of No Action – whether the impacts would be the same or different. The discussion in this chapter is augmented by the classified supplement for this EIS.

Aspects of the environment which would not be expected to be affected (changed) as a result of implementing any of the six alternatives analyzed are not discussed in this EIS. In most cases, impacts among the six alternatives are similar, and are cross-referenced but not repeated in detail. The analyses in this EIS indicate that there would be very little difference in the environmental impacts among the alternatives analyzed. The major discriminators among alternatives would be: 1) potential impacts from depleted uranium contamination to soils, which would be substantially less under the Enhanced Containment Alternative, and 2) commitments of construction materials, which would be substantially greater under the Upgrade PHERMEX Alternative. A summary table of impacts is provided at the end of chapter 3 (table 3-3). The table provides direct comparisons of expected consequences for each environmental factor across the alternatives.

The evaluation of potential environmental impacts addresses those of the new Phased Containment Option, included under the Enhanced Containment Alternative. Other alternatives and options previously evaluated in the draft EIS encompass and bound potential impacts from the Phased Containment Option. The

Phased Containment Option is identical to the Vessel Containment Option for most (20 years) of the 30-year planned operation period for DARHT.

Sums and products of numbers in the chapter may not appear consistent because of rounding. Unless otherwise stated, the word dose refers to the effective dose equivalent.

5.1 NO ACTION ALTERNATIVE

This section presents the expected environmental consequences associated with the No Action Alternative.

5.1.1 Land Resources

5.1.1.1 Land Use

Continued dedication of about 11 ac (4 ha) in Technical Area (TA) 15 of the 28,000-ac (11,300-ha) Los Alamos National Laboratory (LANL) site for use of the PHERMEX Facility and 8 ac (3 ha) previously disturbed for DARHT construction would be consistent with current and past land uses at LANL and would have no reasonably foreseeable impact on established local land-use patterns.

5.1.1.2 Visual Resources

The PHERMEX Facility is an unobtrusive facility located in an isolated piñon/ponderosa pine forest area and is not accessible or readily visible from offsite; therefore, its continued use would have no impact on visual resources.

5.1.1.3 Regional Recreation

Although a variety of recreational opportunities are offered in the vicinity of LANL, only those individuals in areas relatively near TA-15 might be negatively impacted on occasion by noise associated with uncontained test firings at the PHERMEX site. Otherwise, no impacts on regional recreation would be expected.

5.1.2 Air Quality and Noise

Impacts on nonradiological air quality and the potential for noise impacts associated with the No Action Alternative of continued operation of PHERMEX are discussed in this section.

5.1.2.1 Air Quality

Air quality impacts in this section are presented for the maximally impacted point of unrestricted public access. These impacts were determined using methods described in appendix C, Air Quality and Noise.

5.1.2.1.1 Construction

Under the No Action Alternative, construction of the DARHT Facility would not be completed for its intended use. However, the structure would be completed in some fashion for other uses. It was assumed that any alternate construction activities would be less extensive and have no more than one-half of the potential air quality impacts of those for the DARHT Baseline Alternative. Air quality impacts from construction under the DARHT Baseline Alternative are presented in section 5.2.2.1.1. Construction impacts of the alternatives on air quality are compared in table 3-3.

5.1.2.1.2 Operations

Pollutant emissions are primarily from hydrodynamic testing, in particular, the detonation of high-explosive materials and suspension of associated test materials. High explosives would emit NO_2 and particulate matter (all of the aerosolized material is assumed to be respirable, i.e., classed as PM_{10}). The explosives used in testing do not contain sulfur compounds; however, minor amounts of SO_2 would be released from diesel-powered forklifts or other equipment used in setting up the tests. Estimates of air quality impacts from operations are provided in table 5-1. The standards for NO_2 and SO_2 are adjusted for elevation, based on the New Mexico Air Pollution Control Bureau Dispersion Modeling Guidelines. This adjustment provides an extra measure of conservatism.

The annual usage of depleted uranium, lead, and beryllium are shown in table 3-4 and were assumed to be 1,540 lb (700 kg), 30 lb (15 kg), and 20 lb (10 kg), respectively. Twenty-five percent of this inventory was assumed to be released during the 30-day averaging time for beryllium and heavy metals, and 50 percent was assumed released during the calendar quarter averaging time for lead. Analysis assumptions are shown in appendix C, table C1-8. Concentrations of beryllium and heavy metals are regulated by the New Mexico Ambient Air Quality Standards, and concentrations of lead are regulated under the National Ambient Air Quality Standard. Average concentrations of these metals and the fraction of the applicable standards are shown in table 5-1. The ambient air concentrations for uranium, lead, and beryllium are for the maximally exposed individual (MEI) located 0.9 mi (1.5 km) southwest of the site. Impacts on ambient air from testing operations are considered minor. See table 4-3 for a listing of the nonradiological ambient air quality standards.

Increases in the annual concentrations of NO_2 and PM_{10} over ambient would be small; concentrations of these pollutants would remain well within the applicable standards. Maximum offsite 24-h PM_{10} concentration would be on the order of the average ambient air concentration of PM_{10}, but the combination of the two (PHERMEX-related concentration plus ambient air concentration) would be less than five percent of the most stringent air quality standard.

Although the accelerator is pulsed about 25,000 times per year, the duration of the pulse is about 200 nsec. Hence, the total operating time would be about 5 thousandths of a second per year, suggesting that formation of ozone would be negligible.

Waste wood from the platforms used to support the experiments is taken to TA-36 for disposal in an open burn permitted by the New Mexico Environment Department (NMED). This wood is potentially contaminated with high explosives and/or depleted uranium. Dose dispersion calculations performed in

TABLE 5-1.—*Impacts on Air Quality from Operations under the No Action Alternative*

Pollutant	Averaging Time	Concentration at Maximally Impacted Point of Unrestricted Public Access ($\mu g/m^3$)	Percent of Regulatory Limit[a]
NO_2	Annual	0.004	0.06
	24-h	2	1.4
PM_{10}	Annual	0.01	0.02
	24-h	3.3	2.2
SO_2	Annual	2×10^{-4}	0.0005
	24-h	0.006	0.003
	3-h	0.03	0.003
Beryllium	30 days	5×10^{-6}	0.00005
Heavy Metals[b]	30 days	5×10^{-4}	0.005
Lead	Calendar Quarter	2×10^{-5}	0.001

[a] Uses the applicable regulatory limit shown in Table 4.3.
[b] Sum of the air concentration of uranium and lead.

Note: Applies to all alternatives except the Enhanced Containment Alternative.
Includes impacts from hydrodynamic testing and boiler emissions.
NO_2 and PM_{10} are from hydrodynamic testing and boiler emissions.
SO_2 is from boiler emissions.
Beryllium, heavy metals, and lead are from hydrodynamic testing.

support of the permit application estimated the effective dose equivalent at the nearest resident of 1×10^{-8} rem to 3×10^{-8} rem (DOE 1993). The NMED Air Quality Bureau concluded that there would be no health effects from this source (NMED 1993).

Other radiological impacts on air quality are described in section 5.1.8, Human Health.

5.1.2.2 Noise

Noise predictions were based on measurements made March 11, 1995, during a series of test explosions designed to investigate noise and shock wave behavior. Uncontained hydrodynamic testing, using high explosives similar to those used in the past at PHERMEX [150 lb (70 kg) maximum] would not exceed daytime standards for noise at nearby locations, such as Los Alamos or White Rock (appendix C, Air Quality and Noise). To be within Los Alamos County residential noise guidelines, propagated levels between 65 and 75 dBA are prohibited to exceed a duration of 10 min for a given hour between 7:00 am and 9:00 pm. Operating procedures and safety concerns limit the number of detonations to no more than three in one hour period; hence, it is not possible to exceed this limit. Noise exceeding 75 dBA is not permitted. However, because blast noise is sensitive to meteorological conditions, peak daytime standards of 75 dBA may be exceeded for large tests under unfavorable weather conditions, particularly at the ranger residence at Bandelier National Monument. For other than small tests close to the facility, nighttime standards (53 dBA) probably would be exceeded.

The general good health and abundance of wildlife in the Bandelier National Monument and on the LANL site indicate no impact on populations of wildlife from operations at the site. However, during the previously mentioned tests, browsing mule deer exhibited a startle and flight response on the first test, indicating that wildlife have not become indifferent to firing noise. On the other hand, birds did not appear to be disturbed by the noise.

Worker protection from noise would be provided in the form of ear muffs or ear plugs depending on the expected noise levels associated with PHERMEX activities.

Because of the limited amount of vehicular traffic associated with the operation of PHERMEX, traffic would not be a significant source of additional noise. Vehicular noise is exempted from Los Alamos County noise regulations.

5.1.3 Geology and Soils

Impacts of the No Action Alternative on geology and soils are described in the following subsections.

5.1.3.1 Geology

Continued operation of the PHERMEX facility would incur no new geologic hazards. PHERMEX has more than 30 years of operations history without site stability problems (see section 4.3.4, Site Stability).

5.1.3.2 Seismic

Seismically induced rockfalls could occur at the mesa rims, but the annual probability for earthquakes is low, and the PHERMEX facility has sufficient setback from the mesa rim to be unaffected by these rockfalls during its design life (see section 4.3.4, Site Stability). Vibratory ground motion resulting from the detonation of high explosives is small, in general, being less than the ground motion pulse caused by the air wave from the same detonation.

Although seismic events damaging buildings would have an impact on mission goals, no scenarios were identified wherein a seismic event could trigger an action at the PHERMEX Facility that would result in any offsite environmental impacts.

5.1.3.3 Soils

Operating PHERMEX for an additional 30 years at a moderately higher level of testing, as compared to that of the last 32 years, would result in soil contamination levels approximately double those observed today at PHERMEX. Under the No Action Alternative, maximum average depleted uranium soil contamination in the vicinity of the firing point is not anticipated to be greater than about 9,000 ppm uranium after 30 more years of operation (see appendix D.6). The present PHERMEX firing site has a soils contamination circle around the firing point of about a 460-ft (140-m) radius. Inside this circle, soils are at or above the background concentration for uranium; outside this circle, soils exhibit background concentrations. Because the variety and magnitude of explosive charges to be used in future tests will resemble those previously tested at PHERMEX, the area around the firing point where soils would exhibit uranium concentrations above background is anticipated to remain approximately the same, i.e., a circle with a 460-ft (140-m) radius. The area of land contaminated above background would be about 15 ac (6 ha). Soils sampling has shown that beryllium and lead contamination falls to background levels much closer to the firing point than uranium contamination. Thus, the soil contamination circle defined for uranium would apply to the other metals of interest. Concentrations of metal contaminants in sediments within drainage channels may approximately double; however, depleted uranium concentrations have been observed to significantly decrease with increasing distance from the firing point. Contaminants within the soil contamination circle would be available for migration in surface runoff to the canyons and deep drainage through the mesa.

5.1.4 Water Resources

Water resources examined for impact in the No Action Alternative are:

- Surface water and sediment in Potrillo and Water canyons, which discharge into the Rio Grande
- The main aquifer underlying Threemile Mesa

The water quality of surface water entering the discharge sink in Potrillo Canyon (see appendix E3) is assumed to be an estimate of the quality of water that may ultimately recharge the main aquifer from this area. Stream losses to the bed of Water Canyon are analyzed for their potential to migrate through the vadose zone to the main aquifer. Infiltration is examined for its ability to carry metals in solution into the mesa top at the firing point and communicate contaminants through the unsaturated zone to the main aquifer. Supporting information on deep drainage, the geochemistry of metals in LANL waters and sediments, surface water modeling, and vadose zone and ground water modeling as applied in this EIS can be found in appendix E.

A combination of data review and geochemical analysis was used to determine the solubility and sorption characteristics of several metals in the LANL water and soil/sediment environment (see appendix E2). Because they represent the largest fraction of expended materials in the tests to be conducted, depleted uranium, beryllium, lead, copper, and aluminum were all studied. The study revealed that a realistic value of solubility for beryllium in LANL waters was at its drinking water standard of 4 μg/L [40 CFR 141.62]. A realistic value for lead solubility in LANL waters was at its maximum concentration level (MCL) of 50 μg/L [40 CFR 141.11] and approximately a factor of three above its action level of 15 μg/L [40 CFR 141.80]. Values of solubility for both copper and aluminum were both found to be substantially below their secondary drinking water standards. Thus, while the analysis examines the migration of beryllium and lead to gain insight into their migration and behavior in the environment, there is no need to simulate beryllium, copper, or aluminum. The solubility of uranium in LANL waters appeared to be substantially above its proposed MCL value, and therefore its migration was modeled to estimate impact on the water resource.

5.1.4.1 Surface Water

The hydrology-sediment-contaminant transport modeling procedure described in appendix E3 was applied to assess the potential impacts of the No Action Alternative. In this alternative, the transport by surface runoff during the past 32 years for releases of depleted uranium, beryllium, and lead and for releases during the next 30 years from the PHERMEX site was analyzed. Table 5-2 shows the simulated peak concentration of contaminants in the infiltrated water at the discharge sink in Potrillo Canyon and at Water Canyon channels below the source. Details of the analysis and the treatment of runoff, storm water, and cooling water blowdown discharge at the DARHT site are described in appendix E3.

Because of their low solubility, the concentrations of beryllium and lead reach a plateau in their release to Potrillo and Water Canyons but still remain well below drinking water standards. Drinking water standards for beryllium and lead are 4 and 15 μg/L, respectively. Depleted uranium has a relatively high solubility in LANL surface and ground waters. While releases of depleted uranium to the discharge sink of Potrillo Canyon are an order-of-magnitude below the proposed MCL (20 μg/L), simulations reveal that concentrations of depleted uranium in surface waters released to Water Canyon immediately below PHERMEX could be slightly above the proposed MCL. The Rio Grande is the nearest off-LANL access point for surface water carrying contamination from the firing point. As shown in table 5-2, the quality of surface water entering the Rio Grande is forecast to be more than an order-of-magnitude below the drinking water standard for uranium and several orders-of-magnitude below the drinking water standards for beryllium and lead.

5.1.4.2 Ground Water

Two analyses of depleted uranium, beryllium, and lead migration were conducted. Stream losses into the bed of Water Canyon were analyzed to estimate the migration of contaminants through the vadose zone to the main aquifer. Similarly, infiltration carrying metal in solution into the mesa top at the PHERMEX firing point was analyzed to estimate contaminant migration to the main aquifer.

The peak concentrations of contaminants in infiltration to Threemile Mesa and in surface water losses from the uppermost reach of Water Canyon opposite the PHERMEX facility are shown in table 5-3. For those cases where the drinking water standards (shown in bold) are exceeded, analyses are necessary. Only three cases must be modeled: depleted uranium in the uppermost reach of Water Canyon and depleted uranium and lead on the mesa top at the firing point. However, all releases of beryllium and lead were analyzed to better understand the influence of dispersion and sorption on the migration of these and less mobile metals.

Analysis of depleted uranium migration through the vadose zone arising from releases to the stream bed of Water Canyon showed a peak concentration of about 0.02 μg/L after nearly 20,000 years in soil water being delivered to the main aquifer. Simulation of depleted uranium migration through the mesa to the main aquifer showed a peak concentration of about 150 μg/L after approximately 40,000 years. Water Canyon stream losses yield soil water entering the main aquifer at concentrations well below the proposed MCL for uranium (20 μg/L); however, releases from the firing point on the mesa top yield soil water concentrations approximately eight times the MCL. Simulation of lead migration through the mesa to the main aquifer showed a peak concentration of 26 μg/L in soil water entering the aquifer, nearly double the drinking water standard. Upon entering the main aquifer, the small-scale and low-volume releases from

TABLE 5-2.—*Contaminant Concentrations and Time-to-peak for the No Action Alternative*

Contaminant	Discharge Sink (Potrillo Canyon)	Reach 12 (Water Canyon)	Reach 13 (Water Canyon)	Reach 14 (Water Canyon)	Reach 15 (Water Canyon)	Rio Grande (in solution)[a]	Rio Grande (on sediment)
Peak Concentration	(in μg/L)	(in μg/L)	(in μg/L)	(in μg/L)	(in μg/L)	(in μg/L)	(in μg/g)
Depleted Uranium	2	2.8×10^{1}	6	1.7	6.6×10^{-1}	**6.8×10^{-1}**	6.8×10^{-2}
Beryllium	1.1×10^{-3}	1.6×10^{-3}	7.0×10^{-4}	3.0×10^{-4}	1.4×10^{-4}	1.4×10^{-4}	1.4×10^{-5}
Lead	4.2×10^{-3}	3.9×10^{-3}	2.2×10^{-3}	5.0×10^{-4}	1.8×10^{-4}	1.9×10^{-4}	3.6×10^{-4}
Time, years							
Depleted Uranium	360	40	90	100	100	100	100
Beryllium	4,340	740	4,350	2,570	4,130	4,130	4,130
Lead	5,000	1,850	2,570	2,570	4,660	4,660	4,540

[a] Concentration of surface water entering Rio Grande; bold number in this column is basis for water resource number in tables S-1 and 3-3.

Note: Drinking Water Standards:
Uranium, 20 μg/L [56 FR 33050]
Beryllium, 4 μg/L [40 CFR 141.62]
Lead, 15 μg/L [40 CFR 141.80]

Table 5-3.—*Peak Input Concentrations under No Action Alternative to Water Canyon Reaches and Threemile Mesa Predicted by Surface Runoff-sediment-contaminant Transport Model*

Location	Contaminant		
	Uranium (μg/L)	Beryllium (μg/L)	Lead (μg/L)
Drinking Water Standards	20 [56 FR 33050]	4 [40 CFR 141.62]	15 [40 CFR 141.80]
Threemile Mesa	300,000	4	50
Water Canyon Reach 12	28	0.002	0.004
Water Canyon Reach 13	5.9	0.0007	0.002
Water Canyon Reach 14	1.7	0.0003	0.0005
Water Canyon Reach 15	0.7	0.0001	0.0002

the mesa top would be dispersed in the aquifer and further mixed either with ground water (if it were recovered in the municipal water supply well), or with the waters of the Rio Grande. The average yield of the Pajarito Field wells of 2.7 ft^3/s (7.7×10^{-2} m^3/s) is assumed to be representative of a water supply well which could be developed in the vicinity of Threemile Mesa (see appendix E4). The total flow rate of contaminated water from the mesa top firing point would be 1.1×10^{-3} ft^3/s (3.2×10^{-5} m^3/s). This gives a concentration reduction factor greater than 2,000, more than sufficient to reduce the concentrations of depleted uranium and lead in municipal water supplies to levels well below the drinking water standards. Based on the average annual flow rate of the Rio Grande [~1,500 ft^3/s (~42 m^3/s) at Otowi], the reduction factor would be even greater for ground water release to the Rio Grande.

Both beryllium and lead releases to the stream bed of Water Canyon and the mesa were analyzed for migration to the main aquifer. The quality of surface water infiltrating the stream bed and mesa is initially below drinking water standards for both these metals (i.e., 4 and 15 μg/L respectively); therefore, releases to the main aquifer will be well below the drinking water standards after undergoing dispersion and sorption in the vadose zone. After 100,000 years in the canyon, beryllium release is less than 0.001 μg/L, and the lead release is less than 1.0×10^{-5} μg/L. From the mesa, the beryllium release is less than 4 μg/L.

Releases to the ground water pathway from operation under the No Action Alternative would not adversely impact ground water quality.

5.1.5 Biotic Resources

Biotic resources examined for impact in the No Action Alternative include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species.

5.1.5.1 Terrestrial Resources

Both construction and operation impacts were evaluated for terrestrial resources.

5.1.5.1.1 Construction Impacts

Under the No Action Alternative, no further construction-related impacts to terrestrial biological resources would be expected at the PHERMEX or DARHT sites. Impacts for small and large mammals and birds would continue from construction that has already altered approximately 8 ac (3 ha) of piñon-juniper/ ponderosa pine habitat (Risberg 1995). Further losses of habitat and harassment to biota from noise and human activities would not occur. Populations of plants and animals from surrounding areas may reinvade the site and colonize those parts of the site that provide habitat. Habitat destruction has already caused small mammals formerly occurring there to disperse into similar surrounding habitat. Some small losses may have occurred due to increased vulnerability to predation or absence of suitable habitat. It is not known if the increased density of small mammals resulting from this emigration would have any impacts on populations already inhabiting the surrounding area. There likely would have been a population readjustment based on habitat availability.

5.1.5.1.2 Operation Impacts

Test fragments originating from continued use of PHERMEX are highly unlikely to further impact terrestrial biota; however, tests often start grass fires. These fires are quickly controlled by the firefighters who are stationed outside the exclusion fence at the time of the tests. However, some disturbance, and possibly mortality, with respect to some individual plants and animals might occur. Confirmed nesting sites and hunting areas for the red-tailed hawk and the Cooper's hawk have been documented in the PHERMEX site vicinity; other raptors, such as the American kestrel, the flammulated owl, and the great-horned owl use the area. Although not listed as threatened or endangered, these species are protected from collection and maiming under the Migratory Bird Treaty Act (Risberg 1995). No additional impacts to these species are expected under this alternative.

The concentration of depleted uranium and metals in the soil and plants is expected to remain negligible. Consequently, no additional impacts to biotic resources due to biological uptake of these substances is expected to occur under this alternative.

5.1.5.2 Wetlands

Although floodplains lie at the bottom of Potrillo Canyon and Cañon de Valle, no wetlands lie within TA-15; thus, no impacts to wetlands would occur (Risberg 1995).

5.1.5.3 Aquatic Resources

No additional impacts to the aquatic resources located within the canyons surrounding TA-15 are expected.

5.1.5.4 Threatened and Endangered Species

It is unlikely that ongoing activities at PHERMEX would change the attractiveness of the area for potential use by threatened or endangered species. The concentration of depleted uranium and metals in prey or food of threatened and endangered species is expected to remain negligible. Ingestion of these substances is not expected to have any consequences to these populations. Ongoing activities should have no adverse impacts to the nesting Mexican spotted owls in the vicinity.

5.1.6 Cultural and Paleontological Resources

Impacts on cultural and paleontological resources from the No Action Alternative are described in the following subsections.

5.1.6.1 Archeological Resources

Continuation of normal operations of the PHERMEX Facility would not change any direct or indirect impacts on known archeological sites eligible for the National Register. Debris from 30 years of testing at PHERMEX is observable in the immediate vicinity of archeological sites, especially those sites within the 490-ft (150-m) blast radius. This debris, however, has not changed the research potential of any of the identified archeological sites. As stated, an additional archeological survey is under way in those areas unsurveyed. A minimal number of new archeological sites is expected to be found as a result of this survey, but any new sites would be expected to be similar in nature to those already recorded. Impacts to any new sites are therefore expected to be the same as for the sites previously identified.

Seismic tests conducted on March 11, 1995 (Vibronics 1995) indicated that potential impacts due to the air waves is a greater concern than vibratory ground motion. An explosion of 150 lb of TNT at PHERMEX would give an overpressure of 0.02 psi (12 kg/m^2) at Nake'muu. This overpressure, 0.02 psi (12 kg/m^2), is approximately one-tenth the amount for window breakage and would not affect the standing walls at Nake'muu (DOE 1992, table D.4-4).

5.1.6.2 Historical Resources

No direct or indirect impacts on historic structures are anticipated.

5.1.6.3 Native American Resources

There would be essentially no impacts on Native American cultural resources.

5.1.6.4 Paleontological Resources

Because of the nature of the soil and geological substrate, the occurrence of paleontological resources is not anticipated; no potential effects are postulated.

5.1.7 Socioeconomics and Community Services

Environmental impacts on socioeconomics and community services for the No Action Alternative are presented in the following subsections.

5.1.7.1 Demographic Characteristics

The No Action Alternative would not stimulate any change in the existing demographic characteristics of communities within the region-of-interest, as described in section 4.7.1.

5.1.7.2 Economic Activities

The No Action Alternative is not expected to have a significant impact on the level of economic activity in the region-of-interest. Under this alternative, the PHERMEX facility would continue operations while DARHT-related capital funding would be phased out during FY 1995 and FY 1997, as indicated in table 5-4. Under the No Action Alternative, the DARHT Facility, which is currently 34 percent complete and under a stop-work court injunction, would be completed for some other use. This construction will not disturb any additional area, but does represent economic activity under the alternative. The funding of PHERMEX operations would continue to support a variety of personnel, including operations support staff, physics support staff, security clearance staff, and a firing crew. The operations funding also covers the costs of facility scheduling, facility space tax, and safety and environmental compliance.

TABLE 5-4.—*Capital-funded Construction and Operating Costs for the No Action Alternative (in millions of 1995 dollars)*

Year/Cost	1995	1996	1997	1998	1999	2000	2001	2002	Total
Capital	6.6	5.8	1.0	0	0	0	0	0	13.4
Operations and Maintenance	4.2	4.1	4.1	4.0	4.0	3.9	3.9	3.9	32.2

The underlying cost data in table 5-4 were provided by LANL (Burns 1995a; Burns 1995b). The costs do not include any expenses associated with site cleanup, nor do they include any decontamination or decommissioning costs associated with either the proposed DARHT or PHERMEX facilities. The construction and operations costs were adjusted for future price escalation based on the escalation price change index for U.S. Department of Energy (DOE) defense-related construction projects (Pearman 1994; Anderson 1995). A discussion of the analytical model, assumptions, and procedures underlying the economic impact analysis of the various DARHT alternatives relative to the No Action Alternative is provided in appendix G, Socioeconomic Environment.

5.1.7.3 Community Infrastructure and Services

The existing community infrastructure in the region-of-interest under the No Action Alternative would be the same as described in section 4.7.3. No significant change in the existing community infrastructure under the No Action Alternative is expected.

5.1.7.4 Environmental Justice

No significant adverse environmental impacts are identified with the continued operation of the PHERMEX Facility. Specifically, these environmental impacts include offsite air emissions and noise caused by the detonation of high explosives (section 5.1.2) and surface or underground water contamination (section 5.1.4). Also, no significant human health impacts appear to exist from either the release of radioactive or hazardous material or from exposing receptors onsite (workers) or offsite (section 5.1.8). Continued PHERMEX Facility operations would have no known disproportionate adverse health or environmental impact on minority or low-income populations in the region-of-interest [populations residing within 50 mi (80 km) of the site].

5.1.8 Human Health

This section presents the impacts to the health of the public and workers from routine operations that would be conducted at the PHERMEX Facility under the No Action Alternative. Impacts may potentially result from routine release and atmospheric transport of radioactive and hazardous material from the facility firing site as a result of planned detonations. Detailed results and methods and assumptions used in calculating potential impacts are described in appendix H, Human Health.

Radiological impacts may result from exposure to depleted uranium and tritium released to the atmosphere from detonations at the PHERMEX site. Depleted uranium would be the principal contributor to radiation dose; tritium would contribute about 1×10^{-7} the dose of depleted uranium for chronic releases. The major exposure pathway would be inhalation of material released to the atmosphere, which would contribute more than 99 percent of the dose. Potential human health impacts may be *over-estimated* by a factor of 100 because of the simplified, elevated point-source atmospheric dispersion model used, rather than an explosive atmospheric dispersion model (see appendix H, Human Health).

DOE plans to perform dynamic experiments that would involve high-explosive driven mixtures of plutonium isotopes and alloys, which would be chosen for the purposes of the experiment. DOE has analyzed the impacts of dynamic experiments with plutonium that would be expected to occur under all six alternatives analyzed in the DARHT EIS. All such experiments would be conducted inside double-walled steel containment vessels. All experiments would be arranged and conducted in a manner such that a nuclear explosion could not result.

5.1.8.1 Public

Potential impacts to the MEI were evaluated at three locations in the vicinity of the PHERMEX site: Los Alamos, White Rock, and Bandelier. These locations are representative of the neighboring residential clusters in close proximity to LANL. Potential impacts to the surrounding population were also calculated. Potential radiological and nonradiological impacts are presented in the sections below.

5.1.8.1.1 Radiological Impacts

The maximum annual radiation dose to any nearby resident from routine operations would not exceed 2×10^{-5} rem EDE. Using a risk conversion factor of 5×10^{-4} latent cancer fatalities (LCFs) per person-rem for members of the public, the estimated maximum probability of a latent fatal cancer from this dose would be about 1×10^{-8}. The estimated maximum cumulative dose to an individual over the anticipated 30-year life of the project would be about 7×10^{-4} rem. The estimated maximum probability of a latent cancer fatality from this dose would be about 4×10^{-7}.

The annual collective dose to the population residing within 50 mi (80 km) of the PHERMEX site would be about 0.9 person-rem EDE. Latent cancer fatalities would not be expected among the population from this dose (5×10^{-4} LCFs). Over the 30-year operating lifetime, the population dose would be about 30 person-rem (1×10^{-2} LCFs).

The contribution from plutonium to the maximum annual individual dose would be about 2×10^{-10} rem over the 30-year lifetime of the project. The maximum probability of an LCF would be about 8×10^{-14}. The contribution from plutonium to the population dose would be about 3×10^{-7} person-rem over the lifetime of the project. Latent cancer fatalities would not be expected (1×10^{-10} LCFs).

5.1.8.1.2 Nonradiological Impacts

Members of the public might also be exposed to heavy metals and other materials released during the detonation, including uranium, lead, beryllium, and lithium hydride. The maximum probability of a beryllium-induced cancer would be about 4×10^{-11}. Toxicological effects from releases of uranium, beryllium, lead or lithium hydride would not be expected (maximum Hazard Index of 1×10^{-7}). The cumulative probability of a beryllium-induced cancer over the anticipated 30-year life of the project would be about 1×10^{-9}. The maximum Hazard Index expected in the first year immediately after 30 years of operations, accounting for any toxicological effects from buildup of hazardous material in soil, would not exceed 1×10^{-7}. Toxicological effects would not be expected.

Cancer from exposure to beryllium released during a year of normal operations (total incidence of 4×10^{-7} cancers) would not be expected in the population in a 50-mile (80-km) radius.

5.1.8.2 Noninvolved Workers

A noninvolved worker is defined as a LANL employee who works in TA-15, but is not directly involved with the facility operations. This worker would be assumed to work continuously 2,500 ft (750 m) distant from the firing site. This distance would be based on a hazard radius that would typically be put in place for hydrodynamic testing. LANL implements this administrative exclusion area based on explosive safety principles (DOE 1994).

The annual dose to a nearby noninvolved worker would be 2×10^{-5} rem EDE. Using a risk conversion factor of 4×10^{-4} LCFs per person-rem for workers, the maximum probability of an LCF from such a dose would be about 9×10^{-9}. Over the 30-year anticipated operating life of the facility, the same noninvolved worker's cumulative dose would be about 7×10^{-4} rem. The maximum cumulative probability of contracting a fatal cancer from this dose would be about 3×10^{-7}.

A noninvolved worker could also be exposed to heavy metals and other materials released during the detonation, including uranium, lead, beryllium, and lithium hydride. The maximum probability of a beryllium-induced cancer would be about 3×10^{-11}. Toxicological effects from releases of uranium, beryllium, lead, or lithium hydride would not be expected (maximum Hazard Index of 2×10^{-7}). The probability of a beryllium-induced cancer over the anticipated 30-year life of the project would be about 9×10^{-10}. The maximum Hazard Index expected after 30 years of operations, accounting for any toxicological effects from buildup of hazardous material in soil, would not exceed 1×10^{-7}. Toxicological effects would not be expected.

The estimated dose to a noninvolved worker over the 30-year project life from hypothetical routine releases of plutonium would be 6×10^{-10} rem. The maximum probability of an LCF from such a dose would be about 2×10^{-13}.

5.1.8.3 Workers

Average dose to workers at the facility was estimated to be no more than 0.01 rem EDE annually. The maximum probability of such a worker contracting a latent fatal cancer would be 4×10^{-6}. Over the

30-year operating life of the facility, an involved worker's maximum probability of contracting a latent fatal cancer would be about 1 x 10^{-4}. The annual collective worker dose was estimated to be about 0.3 person-rem/year. No LCFs would be expected among the worker population from this dose (1 x 10^{-4} LCFs). The cumulative worker dose over the anticipated 30-year life of the project would be about 9 person-rem. No LCFs would be expected among the worker population from this dose (4 x 10^{-3} LCFs). There would be no routine exposure to plutonium; therefore, these dose estimates include potential exposures to plutonium and were based on past PHERMEX operating experience. No operating information was available on exposure to chemicals or metals. The risks of exposure to these materials would be expected to be similarly low to those for radiation exposure.

Worker exposures to radiation and radioactive materials under normal operations would be controlled under established procedures that require doses to be kept as low as reasonably achievable. Any potential hazards would be evaluated as part of the radiation worker and occupational safety programs at LANL, and no impacts outside the scope of normal work activities would be anticipated.

5.1.9 Facility Accidents

This section presents the impacts from postulated facility accidents to members of the public, nearby noninvolved workers, and workers at the facility. The bounding accident evaluated under the No Action Alternative was the inadvertent detonation of a test assembly on the PHERMEX firing site. Accident initiation events are not addressed; instead, the accidents were evaluated on a "what if" basis even though the likelihood of occurrence is very small. More detailed results, identification of postulated facility accidents, and methods of analysis are described in greater detail in appendix I, Facility Accidents. Much of the technical basis for the health impact of the accident analysis is included in appendix H, Human Health. Transportation-related accidents are described in section 5.7, except for plutonium transportation accidents, which are included under accidental detonations below.

Radiological impacts may result from exposure to depleted uranium and tritium released from the PHERMEX site. Depleted uranium would be the principal contributor to radiation dose; tritium would contribute about 1 x 10^{-8} the dose of depleted uranium for acute releases. The major exposure pathway would be inhalation of material released to the atmosphere, which would contribute more than 99 percent of the dose. Potential human health impacts may be *over estimated* by a factor of 100 because of the simplified, elevated point-source atmospheric dispersion model used, rather than an explosive atmospheric dispersion model (see appendix H, Human Health).

In the past, DOE has conducted dynamic experiments at LANL with plutonium. Future experiments with plutonium would always be conducted in double-walled containment vessels, and these experiments could not reasonably be expected to result in any release of plutonium to the environment. However, for purposes of this EIS, health consequences of hypothetical accidental releases of plutonium have been estimated and are provided below and in appendix I. Potential health consequences of exposure to plutonium are well understood (Sutcliffe et al. 1995).

5.1.9.1 Public

Potential impacts to individual members of the public from accidents involving depleted uranium were evaluated for three nearby points of public access – State Road 4, Pajarito Road, and the Bandelier National Monument. The MEI was located at the State Road 4 location, approximately 0.9 mi (1.5 km) southwest of the site. An individual at this location under the assumed accident and exposure conditions would receive a radiation dose of about 6×10^{-4} rem EDE. The maximum probability of an LCF from such a dose would be about 3×10^{-7}. The maximum probability of a beryllium-induced cancer would be about 4×10^{-10}. Toxicological effects would not be expected, as no more than 0.01 mg of any of the released constituents (uranium, beryllium, lead, lithium hydride) would be inhaled, and these inhalation intakes would be less than 0.1 percent of the applicable immediately dangerous to life and health (IDLH) equivalent intake values. Additional results are presented in appendix I, Facility Accidents.

Population impacts of acute accidental releases were evaluated for the direction that would result in the highest impact. Population in the maximally exposed, 22.5-degree sector (east through southeast) out to 50 mi (80 km) is about 50,000 (appendix H, Human Health, table H-6). The maximally exposed population sector in relation to distributions of minority and low-income populations within 30 mi (48 km) of DARHT is shown in Figures 5-1 and 5-2. Dose to the population in the maximally exposed direction (east-southeast) would be about 1.9 person-rem. Latent fatal cancers among the population would not be expected from this dose (9×10^{-4} LCFs). Cancer would not be expected among the population from exposure to beryllium (total incidence of 1×10^{-6} cancers).

Accidents involving plutonium were evaluated on a "what-if" basis, assuming the accident did occur without considering the very low probability of occurrence. It is important to note that any accidents involving plutonium would not be nuclear detonations, but rather detonations of the high explosive that could disperse particles of plutonium. Potential dose to an MEI of the public from accidental detonation of a plutonium-containing assembly was estimated to be about 76 rem. The maximum probability of an LCF from this dose would be about 0.04. Potential dose from a containment breach was estimated to be about 14 rem to the MEI. The maximum probability of an LCF from this dose would be about 0.007.

Population impacts of hypothetical acute releases of plutonium were evaluated using both 50th and 95th percentile atmospheric dispersion factors. Plume depletion due to natural settling and deposition processes and diffusion of released material across an entire exposed sector were considered. Dose in the maximally exposed sector from an accidental detonation was estimated to range from 9,000 to 24,000 person-rem. Latent cancer fatalities in the population would be expected to range from 5 to 12. Dose from a containment breach was estimated to range from 210 to 560 person-rem. No LCFs would be expected among the population from this dose (0.1 to 0.3 LCFs).

In addition to calculating the potential dose to the population in the hypothetical maximally-exposed sector, at the request of the State of New Mexico Environment Department and various American Indian pueblos, the potential dose to the populations of a number of individual communities in the vicinity of LANL were calculated. The communities included in this evaluation and the results of calculations are presented in appendix I.

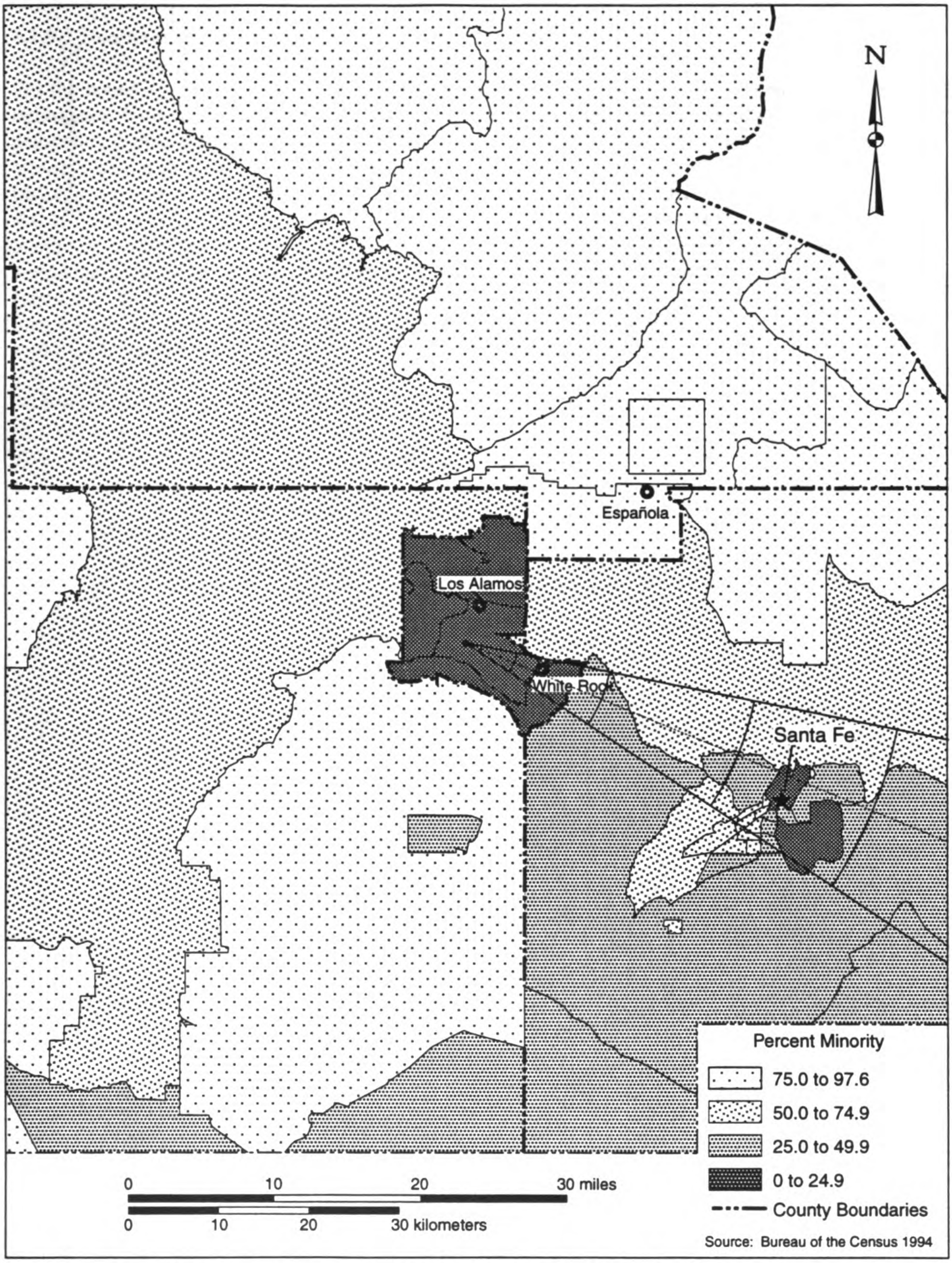

FIGURE 5-1.—*Maximally Exposed Population Sector Overlain on Distribution of Minority Population within a 30-mi (48-km) Radius of the DARHT Site.*

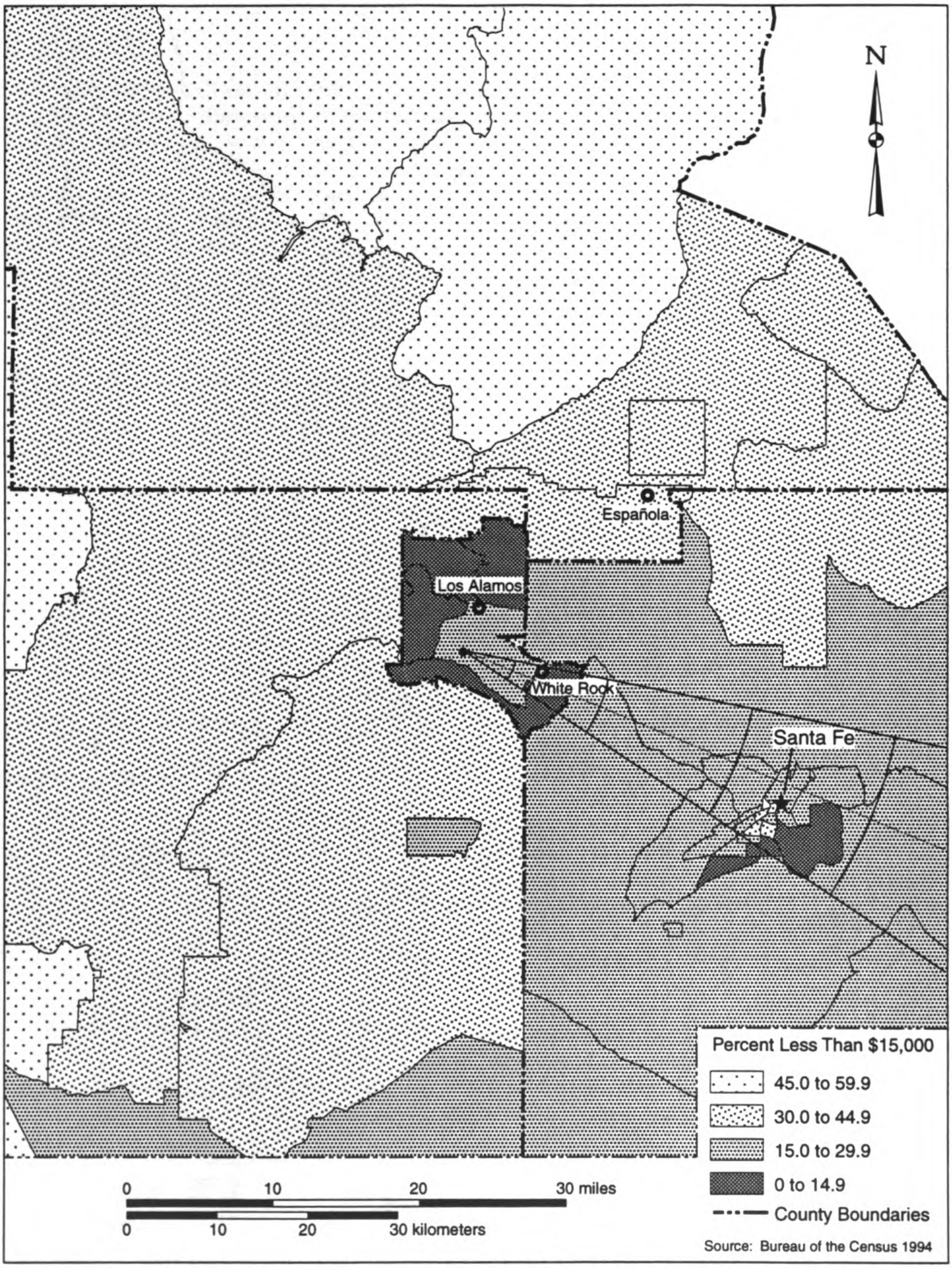

FIGURE 5-2.—*Maximally Exposed Population Sector Overlain on Distribution of Low-income Population within a 30-mi (48-km) Radius of the DARHT Site.*

5.1.9.2 Noninvolved Workers

For the bounding accident analysis, a noninvolved worker was assumed to be outside the facility hazard radius, at a distance of 2,500 ft (750 m), and exposed to the plume of material released from the detonation during the entire period of passage. This distance was based on a hazard radius that would typically be put in place for hydrodynamic tests. LANL implements this administrative exclusion area based on explosive safety principles (DOE 1994). This worker would receive a radiation dose of about 7×10^{-4} rem EDE. The maximum probability of LCF from this dose would be about 3×10^{-7}. The maximum probability of a beryllium-induced cancer would be about 5×10^{-10}. Toxicological effects would not be expected, as no more than 3.5×10^{-7} oz (0.01 mg) of any of the released constituents (uranium, beryllium, lead, lithium hydride) would be inhaled, and these inhalation intakes would be less than 0.1 percent of the applicable IDLH equivalent intake values. Additional results are presented in appendix I, Facility Accidents.

Potential impacts to noninvolved workers from hypothetical accidents involving plutonium were evaluated at 2,500 ft (750 m) and 1,300 ft (400 m) from both the inadvertent detonation and containment breach accidents. Potential impacts from the inadvertent detonation were estimated to be 90 rem and 160 rem at 2,500 ft (750 m) and 1,300 ft (400 m), respectively, with corresponding maximum probabilities of LCFs from these doses of 0.04 and 0.06. Potential impacts from the containment breach were estimated to be 20 rem and 60 rem at 2,500 ft (750 m) and 1,300 ft (400 m), respectively, with corresponding maximum probabilities of LCFs from these doses of 0.09 and 0.02. These are substantially less than the potential impacts to the public because the plutonium would largely disperse up and over noninvolved workers.

5.1.9.3 Workers

Workers may be subject to explosive, radiological, chemical, and industrial hazards while working at the PHERMEX Facility. These hazards are typically expected within normal industrial or laboratory workplaces and are controlled by worker protection programs in place at LANL. High explosives and radioactive material are not allowed in PHERMEX; therefore, only ordinary industrial and laboratory hazards are present inside the PHERMEX Facility. The firing site is where accidents outside the scope of normal industrial or laboratory accidents (that is, those involving high explosives and direct exposure to high levels of ionizing radiation) might occur.

Accidents on the PHERMEX firing site could range from those with trivial consequences to those that could be fatal to involved workers. Of greatest consequence would be the inadvertent detonation of high explosives on the firing site when workers are present, which, if it were to occur, might result in up to 15 worker fatalities. This accident is considered unlikely because of comprehensive training requirements, strict procedural control, physical interlocks and control of the fireset (detonating equipment), and limited personnel access. In the late 1950s, an explosives accident resulted in the deaths of four LANL workers (not associated with PHERMEX operations). That accident caused an extensive overhaul and upgrade of the explosive safety program. Since that accident, LANL has not experienced a high-explosive-related fatality, and such accidents are no longer considered reasonably foreseeable.

A possible second accident on the firing site with serious consequences outside the scope of ordinary industrial or laboratory hazards would be the direct exposure of a worker to the ionizing radiation pulse produced by the PHERMEX accelerator. Although this accident would be extremely unlikely, a worker could receive a very high acute radiation dose, delivered over a fraction of a microsecond, to a localized portion of the body. The potential for occurrence is reduced by physical lockout of accelerator controls when personnel are present on the firing site, high training requirements, strict procedural control, access control, and the fact that the accelerator beam pulse is very short-lived, lasting less than a microsecond. Direct exposure of workers to the accelerator beam has never occurred at LANL firing sites.

Impacts to workers from accidents involving plutonium would be essentially the same as those discussed above. An inadvertent detonation could result in up to 15 fatalities from blast effects, while no impacts would be expected from a containment breach, since all involved workers would be inside the facility and protected from material releases.

5.1.10 Waste Management

Wastes generated under the No Action Alternative would be subject to treatment, storage, and/or disposal in other LANL Technical Areas. Transportation of these wastes would be conducted following U.S. Department of Transportation (DOT) guidelines and using DOE- or DOT-approved containers carried on government vehicles using public roads between LANL facilities, as needed.

Mixed waste would consist of depleted uranium contaminated with lead. The amount of mixed waste to be stored would be small and not expected to exceed one 55-gal (0.2-m^3) drum or 220 lb (100 kg) per year. The volume of nonhazardous solid sanitary waste would be approximately one dumpster load per week.

During the two-year period from March 1992 through February 1994, the PHERMEX Facility disposed approximately 6,700 ft^3 (190 m^3) of low-level radioactive waste (LLW), representing up to four percent of the total LLW volume disposed at LANL during that period. Using depleted uranium usage as an indicator of overall program activity and LLW generation rates, estimates can be made of future waste generation levels. Since approximately 880 lb (400 kg) of depleted uranium were used at PHERMEX during this two-year period, approximately 1,800 ft^3 (50 m^3) LLW would be generated per 220 lb (100 kg) of depleted uranium used per year.

Yearly usage of depleted uranium under the No Action Alternative would be about 1,500 lb (700 kg). Applying the LLW generation rate of 1,800 ft^3 (50 m^3)/220 lb (100 kg), the estimated total LLW generated and disposed under the No Action Alternative would be about 12,500 ft^3 (350 m^3). The bulk of this waste would be the gravel and soil that is removed with the detonation debris. Total volume of waste generated would depend on the frequency of the firing-site detonations and periodic cleanup. Assuming the total LANL LLW disposal volume in future years will be 1.8×10^5 ft^3 (5,000 m^3)/yr (Bartlit et al. 1993), the No Action Alternative would contribute no more than seven percent of the total LANL LLW volume. (The *LANL Sitewide EIS* will address the near-term waste management matter at LANL. The long-term strategy for waste management throughout the DOE-complex, including LANL, will be analyzed in the Department's Draft Waste Management Programmatic EIS [DOE/EIS-0020D], to be released in September 1995.) Approximately 310 lb (140 kg) of solid hazardous waste and 2,500 lb (1,100 kg) of liquid hazardous waste would be disposed. This is based on estimated historical hazardous waste generation rates at the PHERMEX Facility of 220 lb (100 kg) of the solid hazardous waste and 1,800 lb (800 kg) of liquid hazardous waste disposed for every 1,100 lb (500 kg) of depleted uranium used in normal PHERMEX operations.

DOE estimates that up to two double-walled vessels per year would be used in support of the dynamic experiments involving plutonium that could be conducted at LANL. Two vessels would weigh approximately 26,000 lbs (11,820 kg); this steel may be contaminated to a level requiring handling and disposal as TRU waste. These vessels would either be cut into pieces for size reduction or disposed intact; however, the final waste configuration of the vessels has not been determined. The maximum volume of TRU waste would be equal to one TRUPACT-II container per year if the vessels are cut into pieces or two TRUPACT-II containers per year if the vessels are disposed intact.

5.1.11 Monitoring and Mitigation

5.1.11.1 Monitoring

Environmental monitoring currently performed at LANL would continue under the No Action Alternative. Existing stations for monitoring external penetrating radiation and radioactive and hazardous substances in air, water, soil, and sediment would be used to monitor the environmental impacts of the facility. Air-monitoring stations added in 1993 would serve as an enhanced air-monitoring network for the PHERMEX Facility.

5.1.11.2 Mitigation

Consequences of activities under the No Action Alternative were not considered to be of sufficient magnitude to warrant mitigation measures that would differ significantly from the measures currently applied as part of normal operations at PHERMEX. However, the DARHT Facility would be completed for other uses to be determined. Construction noise associated with the completion of the facility would be mitigated to minimize noise impacts on the surrounding environment as much as possible.

5.1.12 Decontamination and Decommissioning

After continued operations for an indefinite period, the PHERMEX facility would become a candidate for decommissioning. While a decontamination and decommissioning (D&D) plan and NEPA review would be conducted at that time, the activities and impacts associated with D&D can be summarized as:

- Conversion of about 15,200 ft^2 (1,400 m^2) of office and laboratory space, or its demolition and disposal of the rubble as sanitary waste
- Salvage of useable items of equipment, instruments, machined parts, etc. to other LANL uses
- Characterization of wastes and treatment, storage and disposal of nonhazardous solid waste, hazardous, radioactive, and/or mixed wastes from the facilities and support equipment, containment vessels, and testing instrumentation

Nonhazardous solid waste would be expected to be disposed at the Los Alamos County landfill. Appreciable waste volumes could result if buildings are demolished. Radioactive wastes are expected to be disposed in Los Alamos low-level waste facilities; however, the volumes would be expected to be negligible compared to LANL annual low-level waste volumes.

Hazardous and mixed-waste disposal requirements are expected to not exceed two to five times the annual PHERMEX generation rates, the higher value reflecting negotiated cleanup levels meeting RCRA "clean closure" criteria. These wastes would be treated and disposed in accordance with LANL RCRA permit requirements. It is not determined at this time whether onsite or offsite disposal would be chosen. The quantities would not be expected to appreciably impact existing treatment or disposal capacities.

5.2 DARHT BASELINE ALTERNATIVE

This section presents the expected environmental consequences associated with the DARHT Baseline Alternative.

5.2.1 Land Resources

5.2.1.1 Land Use

Dedication (facility is already partially constructed) of about 8 ac (3 ha) in TA-15 of the 28,000-ac (11,300-ha) LANL site for completion of construction and operation of the DARHT Facility would be consistent with current and past land uses at LANL and would have no reasonably foreseeable impact on established local land-use patterns. The disposition of the 11 ac (4 ha) associated with PHERMEX is unknown at this time.

5.2.1.2 Visual Resources

The DARHT Facility, partially constructed, would be an unobtrusive facility located in an isolated piñon/ponderosa pine forest area and would not be accessible or readily visible from offsite; therefore, its use should have no impact on visual resources.

5.2.1.3 Regional Recreation

Although a variety of recreational opportunities are available in the vicinity of LANL, only those individuals in areas relatively near TA-15 might be negatively impacted (startled) on occasion by noise associated with uncontained test firings at the DARHT site. Otherwise, no impacts on regional recreation would be expected.

5.2.2 Air Quality and Noise

Impacts on nonradiological air quality and the potential for noise impacts associated with the DARHT Baseline Alternative are discussed in this section.

5.2.2.1 Air Quality

Air quality impacts for the DARHT Baseline Alternative in this section are presented for the maximally impacted point of unrestricted public access. These impacts were determined using methods described in appendix C, Air Quality and Noise.

5.2.2.1.1 Construction

Air quality impacts for the DARHT Baseline Alternative were evaluated for emissions during both construction and operation phases of DARHT. Construction activities would emit NO_2, SO_2, and respirable particulates (PM_{10}). As a by-product of construction activities, PM_{10} would be emitted in the form of fugitive dust from moving earth. Table 5-5 presents air quality impacts from construction activities to complete the planned DARHT construction activities. It includes impacts from fugitive dust (PM_{10}) and construction equipment emissions (NO_2 and SO_2). Section 3.3.6 provides additional discussion of prior impacts associated with DARHT construction.

During the construction phase, the maximum offsite increases in ambient NO_2, SO_2, and PM_{10} from construction equipment would be very small, producing impacts well within the air quality standards. The offsite impact of fugitive dust emissions would also be small; the maximum increase in the 24-h average PM_{10} concentration would be about 10 percent of the Federal standard. The use of standard dust suppression measures would further lower projected impacts.

5.2.2.1.2 Operations

Impacts on air quality from routine operations in the DARHT Baseline Alternative would be substantially the same as in the No Action Alternative, described in section 5.1.2.1.2.

Although DOE estimates that the accelerators are pulsed about 25,000 times per year, the duration of the pulse is about 60 nsec. Hence, the total operating time would be less than about two thousandths of a second per year, suggesting that formation of ozone would be negligible. Even if the estimate of the number of pulses per year was low by a factor of ten, this conclusion would not change.

5.2.2.2 Noise

Noise in the DARHT Baseline Alternative would not be significantly different from that described for the No Action Alternative in section 5.1.2.2.

5.2.3 Geology and Soils

Impacts of the DARHT Baseline Alternative on geology and soils are described in the following subsections.

TABLE 5-5.—*Impacts on Air Quality from Construction Activities*

Pollutant	Averaging Time	Concentration at Maximally Impacted Point of Unrestricted Public Access ($\mu g/m^3$)	Percent of Regulatory Limit[a]
NO_2	Annual 24-h	0.04 4.8	0.06 3.3
PM_{10}	Annual 24-h	0.8 17	1.6 11
SO_2	Annual 24-h 3-h	0.003 0.3 22	0.007 0.1 2.2

[a] Uses the applicable regulatory limit shown in table 4-3.

Note: These impacts from construction activities apply to all alternatives except the No Action Alternative, which is assumed to have impacts about one-half of those listed. PM_{10} is a measure of fugitive dust while SO_2 and NO_2 are construction equipment emissions.

5.2.3.1 Geology

Geotechnical investigations (Sergent 1988) found no potential problems for the DARHT Facility. PHERMEX has over 30 years of operation history without site stability problems (see section 4.3.4, Site Stability). It is the best analogue for future DARHT operation.

5.2.3.2 Seismic

Seismically induced rockfalls could occur at the mesa rim, but the annual probability for earthquakes is low, and the DARHT Facility has sufficient setback from the mesa rim to be unaffected by these rockfalls during its design life (see section 4.3.4, Site Stability). Vibratory ground motion resulting from the detonation of high explosives is small, in general, being less than the ground motion pulse caused by the air wave from the same detonation.

Although seismic events that damage buildings would have an impact on mission goals, no scenarios were identified wherein a seismic event could trigger an action at the DARHT Facility that would result in any offsite environmental impacts.

5.2.3.3 Soils

Operating DARHT for the next 30 years at a moderately higher level of testing, as compared to that of the last 32 years of operating the PHERMEX Facility, is anticipated to result in soil contamination levels somewhat above, but not greatly above, those observed today at PHERMEX. Under the DARHT Baseline

Alternative, maximum average depleted uranium soil contamination in the vicinity of the firing point is not anticipated to be greater than about 5,000 ppm after 30 years of operation (see appendix D.6). The present PHERMEX firing site has a soils contamination circle around the firing point of about a 460-ft (140-m) radius. Inside this circle, soils are at or above the background concentration for uranium; outside this circle, soils exhibit background concentrations. Because the variety and magnitude of explosive charges to be used in future tests at DARHT will resemble those previously tested at PHERMEX, the area around the firing point where soils would exhibit uranium concentrations above background is anticipated to remain approximately the same, i.e., a circle with a 460-ft (140-m) radius. The area of land contaminated above background would be about 15 ac (6 ha). Soils sampling has shown that beryllium and lead contamination falls to background levels much closer to the firing point than uranium. Thus, the soil contamination circle defined for uranium would apply to the other metals of interest. Concentrations of metal contaminants in sediments within drainage channels are expected to be similar to those seen today in drainage channels at PHERMEX. Contaminants within the soil contamination circle would be available for migration in surface runoff to the canyons and deep drainage through the mesa.

5.2.4 Water Resources

Water resources examined for impact in the DARHT Baseline Alternative are:

- Surface water and sediment in Water Canyon, which discharges into the Rio Grande
- The main aquifer underlying Threemile Mesa

Stream losses to the bed of Water Canyon are analyzed for their potential to migrate through the vadose zone to the main aquifer. Infiltration is examined for its ability to carry metals in solution into the mesa top at the firing point and to communicate through the unsaturated zone to the main aquifer. Supporting information on deep drainage, the geochemistry of metals in LANL waters and sediments, surface water modeling, and vadose zone and ground water modeling as applied in this EIS can be found in appendix E.

A combination of data review and geochemical analysis was used to determine the solubility and sorption characteristics of several metals in the LANL water and soil/sediment environment (see appendix E2). Because they represent the largest fraction of expended materials in the tests to be conducted, depleted uranium, beryllium, lead, copper, and aluminum were all studied. The study revealed that a realistic value of solubility for beryllium in LANL waters was at its drinking water standard of 4 μg/L [40 CFR 141.62]. A realistic value for lead solubility in LANL waters was at its MCL of 50 μg/L [40 CFR 141.11] and approximately a factor of three above its action level of 15 μg/L [40 CFR 141.80]. Values of solubility for both copper and aluminum were both found to be substantially below their secondary drinking water standards. Thus, while the analysis examines the migration of beryllium and lead to gain insight into their migration and behavior in the environment, there is no need to simulate beryllium, copper, or aluminum. The solubility of uranium in LANL waters was found to be substantially above its proposed MCL value, and therefore its migration was modeled to estimate impact on the water resource.

5.2.4.1 Surface Water

The hydrology-sediment-contaminant transport modeling procedure described in appendix E3 was applied to assess the potential impacts of the DARHT Baseline Alternative. In this alternative, the transport by surface runoff during the next 30 years for releases of depleted uranium, beryllium, and lead from the DARHT site was analyzed. Table 5-6 shows the simulated peak concentration of contaminants in the infiltrated water in Water Canyon below the source. Details of the analysis and the treatment of runoff, storm water, and cooling water blowdown discharge at the DARHT site are described in appendix E3.

Because of their low solubility, the concentrations of beryllium and lead reach a plateau in their release to Water Canyon but still remain well below drinking water standards. Drinking water standards for beryllium and lead are 4 and 15 μg/L, respectively. Depleted uranium has a relatively high solubility in LANL surface and ground waters. Simulations reveal that concentrations of depleted uranium in surface waters released to Water Canyon immediately below DARHT could be slightly above the proposed MCL (20 μg/L). The Rio Grande is the nearest off-LANL access point for surface water carrying contamination from the firing point. As shown in table 5-6, the quality of surface water entering the Rio Grande is forecast to be more than an order-of-magnitude below the drinking water standard for uranium and several orders-of-magnitude below the drinking water standards for beryllium and lead.

5.2.4.2 Ground Water

Two analyses of depleted uranium, beryllium, and lead migration were conducted. Stream losses into the bed of Water Canyon were analyzed to estimate the migration of contaminants through the vadose zone to the main aquifer. Similarly, infiltration carrying metal in solution into the mesa top at the DARHT firing point was analyzed to estimate contaminant migration to the main aquifer.

The peak concentrations of contaminants in infiltration to Threemile Mesa and in surface water losses from the uppermost reach of Water Canyon opposite the DARHT Facility are shown in table 5-7. For those cases where the drinking water standards are exceeded (shown in bold), analyses are necessary. Only three cases were modeled: depleted uranium in the uppermost reach of Water Canyon, and depleted uranium and lead on the mesa top at the firing point. Releases of beryllium and lead from Water Canyon sediments and releases of beryllium from the mesa to the soil column were not analyzed in this case because the solution concentrations entering the soil column are at or below the drinking water standards. Similar releases to the uppermost reach of Water Canyon were analyzed in the No Action Alternative and were shown to be negligible (see section 5.1.4.2). Because of sorption and dispersion within the vadose zone, and solubility limits in Los Alamos waters, the metals beryllium, copper, and aluminum would not represent a hazard through the ground water pathway.

Analysis of depleted uranium migration through the vadose zone arising from releases to the stream bed of Water Canyon showed a peak concentration of about 0.02 μg/L after nearly 20,000 years in soil water being delivered to the main aquifer. Simulation of depleted uranium migration through the mesa to the main aquifer showed a peak concentration of about 80 μg/L after approximately 40,000 years. Water Canyon stream losses yield soil water entering the main aquifer at concentrations well below the proposed MCL for uranium (20 μg/L); however, releases from the firing point on the mesa top yield soil water concentrations approximately four times the MCL. Simulation of lead migration through the mesa to the main aquifer showed a peak concentration of approximately 6 μg/L in soil water entering the aquifer, less than half the action level of 15 μg/L in the drinking water standard. Upon entering the main aquifer, the small-scale and low-volume releases from the mesa top would be dispersed in the aquifer and further mixed either with ground water (if it were recovered in the municipal water supply well), or with the waters of the Rio Grande. The average yield of the Pajarito Field wells of 2.7 ft^3/s (0.07665 m^3/s) is

TABLE 5-6.—*Contaminant Concentrations and Time-to-peak for the DARHT Baseline Alternative*

Contaminant	Reach 12 (Water Canyon)	Reach 13 (Water Canyon)	Reach 14 (Water Canyon)	Reach 15 (Water Canyon)	Rio Grande (in solution)[a]	Rio Grande (on sediment)
Peak Concentration	(in µg/L)	(in µg/L)	(in µg/L)	(in µg/L)	(in µg/L)	(in µg/g)
Depleted Uranium	3.0×10^{1}	6.3	1.8	7.1×10^{-1}	**7.3×10^{-1}**	7.3×10^{-2}
Beryllium	3.2×10^{-3}	1.4×10^{-3}	6.0×10^{-4}	2.4×10^{-4}	2.4×10^{-4}	2.4×10^{-5}
Lead	7.7×10^{-3}	4.4×10^{-3}	1.0×10^{-3}	2.9×10^{-4}	2.9×10^{-4}	5.8×10^{-4}
Time (yr)						
Depleted Uranium	30	90	100	100	100	100
Beryllium	740	4,350	2,570	4,130	4,130	4,130
Lead	1,850	2,570	2,570	4,540	4,540	4,540

[a] Concentration of surface water entering Rio Grande; bold number in this column is basis for water resource number in tables S-1 and 3-3.

Note: Drinking Water Standards:
Uranium, 20 µg/L, [56 FR 33050]
Beryllium, 4 µg/L [40 CFR 141.62]
Lead, 15 µg/L [40 CFR 141.80]

TABLE 5-7.—*Peak Input Concentrations for the DARHT Baseline Alternative to Water Canyon Reaches and Threemile Mesa Predicted by Surface Runoff-sediment-contaminant Transport Model*

Location	Contaminant		
	Uranium (µg/L)	Beryllium (µg/L)	Lead (µg/L)
Drinking Water Standards	20 [56 FR 33050]	4 [40 CFR 141.62]	15 [40 CFR 141.80]
Threemile Mesa	**300,000**	**4**	**50**
Water Canyon Reach 12	**30**	0.003	0.008
Water Canyon Reach 13	6.3	0.001	0.004
Water Canyon Reach 14	1.8	0.0006	0.001
Water Canyon Reach 15	0.7	0.0002	0.0003

assumed to be representative of a water supply well which could be developed in the vicinity of Threemile Mesa (see appendix E4). The total flow rate of contaminated water from the mesa top firing point would be 1.1×10^{-3} ft^3/s (3.2×10^{-5} m^3/s). This gives a concentration reduction factor greater than 2,000, more than sufficient to reduce the concentration of depleted uranium in municipal water supplies to levels well below the proposed MCL. Based on the average annual flow rate of the Rio Grande [~1,500 ft^3/s (~42 m^3/s) at Otowi], the reduction factor would be even greater for ground water release to the Rio Grande.

Releases to the ground water pathway from operation under the DARHT Baseline Alternative do not adversely impact ground water quality.

5.2.5 Biotic Resources

Biotic resources examined for impacts under the DARHT Baseline Alternative include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species.

5.2.5.1 Terrestrial Resources

Both construction and operations impacts were evaluated for terrestrial resources.

5.2.5.1.1 Construction Impacts

Under the DARHT Baseline Alternative, further construction at the DARHT site would have little, if any, further impact on vegetation. Ground clearing and initial construction has already disturbed approximately 8 ac (3 ha) of mixed piñon-juniper/ponderosa pine habitat used by various species, and only about 0.25 ac (0.1 ha) would be further disturbed. Erosion control and revegetation of disturbed areas implemented during construction would be completed. These actions would minimize soil erosion. Section 3.3.6 provides additional details of the DARHT site.

Further construction at the DARHT site would have little, if any, further impact on the populations of small mammals that formerly inhabited the site. It is also likely that some small mammals, especially mice, would reinvade the disturbed area associated with the buildings.

Large mammals (deer, elk, coyote, bear, raccoon) use the DARHT site as habitat, mostly in a transient fashion, and it is unlikely that further construction would add to the present disruption of their use of this site (Risberg 1995).

Further construction at the DARHT site would not change the area of piñon-juniper/ponderosa pine habitat used by birds for roosting, feeding, and reproduction.

Some piñon-juniper/ponderosa pine habitat has already been disturbed by previous construction, and any reptiles and amphibians inhabiting the DARHT site have either been killed or displaced. Further impacts from completing the construction of DARHT would not be expected.

5.2.5.1.2 Operation Impacts

Further impacts to the DARHT site vegetation would be limited to effects from fires occurring during testing operations. These fires are quickly controlled by the firefighters who are stationed outside the exclusion fence at the time of the tests.

Impacts upon wildlife would be caused by repetitive, short-term disturbances from site activities. These impacts would be insignificant to overall population levels of common species, individuals, and thus populations of rare species such as the Mexican spotted owl, would not be adversely affected. DOE and the U.S. Fish and Wildlife Service (USFWS) have negotiated mitigation measures to reduce operational impacts to any threatened or endangered species in the vicinity of the DARHT and PHERMEX facilities (see section 5.11 and appendix K). Evidence from PHERMEX demonstrates that pollutant contamination of soil and plants outside the blast area is not above background levels.

5.2.5.2 Wetlands

Although floodplains lie at the bottom of Potrillo Canyon and Cañon de Valle, no wetlands lie within TA-15; thus, no impacts to wetlands would occur (Risberg 1995).

5.2.5.3 Aquatic Resources

No additional impacts to the aquatic resources located within the canyons surrounding TA-15 are expected.

5.2.5.4 Threatened and Endangered Species

It is unlikely that completion of DARHT construction would change the attractiveness of the area for potential use by threatened or endangered species. Completion of construction and operations of the DARHT Facility would not cause any adverse impacts to the nesting Mexican spotted owls in the vicinity. DOE and the USFWS have negotiated a plan to eliminate the potential for adverse impacts to these birds (see section 5.11 and appendix K).

5.2.6 Cultural and Paleontological Resources

Impacts on cultural and paleontological resources from the DARHT Baseline Alternative are described in the following subsections.

5.2.6.1 Archeological Resources

Archeological resources were evaluated from both construction and operations perspectives.

5.2.6.1.1 Construction

Completion of the DARHT Facility construction under the DARHT Baseline Alternative would not be expected to have any direct or indirect impacts on known archeological sites eligible for the National Register. Existing TA-15 security measures that restrict general access would continue to provide protection for possible intentional or incidental impacts from human activities.

5.2.6.1.2 Operations

Potential impacts related to detonation of high explosives at the designated firing point could result from 1) vibratory ground motion, 2) air waves, and 3) dispersal of metal fragments and other airborne debris.

Vibratory ground motion could induce structural instability to standing walls but would not affect other attributes of archeological sites which contribute to their research potential. Since none of the known archeological sites in the area of potential effects has standing walls, with the exception of Nake'muu, ground wave motion has the potential to affect only Nake'muu. This potential is minimal because the location of Water Canyon between the firing point and Nake'muu serves as a barrier which absorbs most of the motion. As stated, seismic tests conducted on March 11, 1995 (Vibronics 1995) indicated that potential impacts due to the air waves is a greater concern than vibratory ground motion.

Air waves would have no effect on those archeological sites whose eligibility for the National Register is based solely on their research potential. Air waves would have minimal effect on the structural stability of standing walls at Nake'muu. An air wave of 0.08 lb/in^2 (0.6 kPa) from a test blast at the PHERMEX firing point was measured at Nake'muu on March 11, 1995, from an explosion of 150 lb (70 kg) of TNT. This pressure is approximately one half of the air pressure required for window breakage (DOE 1992, table D.4-4). Although no structural damage resulted from this particular test, the cumulative impacts from similar air waves are unknown. In general, quantitatively assessing the effects air waves and ground motion could have on prehistoric structures is difficult because the baseline structural integrity of these sites is unknown. This site would be monitored for any adverse effects, and mitigation measures would be taken if necessary.

Flying debris would have no impact on those archeological sites whose eligibility for the National Register is based solely on their research potential. Flying debris, depending on the size and velocity, could impact those cultural resources which are eligible for the National Register for additional reasons (Criteria A, B, or C). No known prehistoric cultural resources in the area of potential effects have been identified as eligible under Criteria A or B (association with important events or people).

Because Nake'muu is eligible for the National Register under Criterion C based on its well-preserved standing walls, flying debris of sufficient size and velocity could result in an adverse effect. This potential was mitigated in the design stage of the project by aligning one wing of the DARHT building itself between the blast area and Nake'muu so that most blasting debris on a trajectory towards Nake'muu would be deflected away from Nake'muu. Using the height of the DARHT building alone as a barrier wall, some particles would be projected over that wall in the direction of Nake'muu. However, the only particles which would have the velocity to reach Nake'muu would be less than one inch in diameter. By the time they reach Nake'muu, they would no longer be propelled by the force of the blast itself, but would be falling to the ground by gravity alone. Based on the number of shots anticipated for the life of the DARHT Facility, the probability that any particles would reach Nake'muu was determined to be small and they would fall without sufficient force and size to affect the site. Constructing an additional barrier on top of the building would decrease even further the number of particles with the potential to reach Nake'muu. In a February 21, 1989, correspondence between the NM SHPO and the DOE, the SHPO concurred that "it is unlikely that the proposed activity will have any effect on the values for which LA 12655 [Nake'muu] is considered significant. However, I do agree that test activities should be monitored by a LANL Archaeologist, as discussed in your letter, to ensure that this assessment of effort is correct. If site damage to important site values is observed during the monitoring visits, further consultation will be necessary to determine appropriate measures to reduce adverse effects of test activities" (SHPO 1989).

The calculations above were made for explosions up to 150 lb (70 kg) of TNT originating specifically at the dual-axis firing point. Explosions exceeding this weight, anticipated to be about 500 lb (230 kg) TNT, require relocation of the firing point away from the dual-axis spot. In this situation, the shielding effect of the DARHT building would be reduced. The potential for blast debris from the larger explosions reaching Nake'muu would be mitigated by temporary construction of a sand bag revetment to create a blast shield. The blast overpressure measured during the March 11, 1995, tests scaled for 500 lb (230 kg) indicate a pressure of 0.12 lb/in^2 (0.8 kPa) at Nake'muu, which is still below the value of 0.2 lb/in^2 (1.4 kPa) required for window breakage (DOE 1992, table D.4-4). This overpressure, 0.12 lb/in^2 (0.8 kPa), is very conservative since the mitigating effects of the canyon are not included. Other data suggest that the canyon can reduce overpressure by as much as one half (Vibronics, Inc., 1995).

If determined to be desirable, additional characterization of the potential impact of DARHT operation on Nake'muu may be conducted. For example, options include design and implementation of a long-term monitoring procedure at Nake'muu and/or completion of a structural assessment of architectural elements. If necessary, several mitigation options are available, such as stabilization of standing masonry walls.

5.2.6.2 Historical Resources

No direct or indirect impacts on historic structures are anticipated.

5.2.6.3 Native American Resources

There would be essentially no impacts on Native American cultural resources.

5.2.6.4 Paleontological Resources

Because of the nature of the soil and geological substrate, it is unlikely that paleontological resources exist at the DARHT site; no potential effects are postulated.

5.2.7 Socioeconomic and Community Services

Environmental impacts on socioeconomics and community services for the DARHT Baseline Alternative are presented in the following subsections.

5.2.7.1 Demographic Characteristics

The DARHT Baseline Alternative would not have any significant impact on the existing demographic characteristics of communities in the region-of-interest, as described in section 4.7.1.

5.2.7.2 Economic Activities

The DARHT Baseline Alternative encompasses completing construction and operation of the dual-axis facility. The DOE would complete construction and begin operation of the first axis of the proposed DARHT Facility by FY 1999. At that time, the operating costs of DARHT would replace PHERMEX operating costs, although construction expenditures would continue until the completion of the second DARHT axis in FY 2001. For the purpose of estimating the economic impacts (employment, labor income, and output) of the DARHT Baseline Alternative, the analysis recognizes the incremental construction and operating expenditures associated with the DARHT Baseline Alternative, relative to ones associated with the No Action Alternative. The estimated capital construction expenditures, shown in table 5-8, do not include any site cleanup nor decommissioning and decontamination of the dual-axis facility at the end of its lifetime. The direct and indirect economic impacts of the proposed alternative are described below.

TABLE 5-8.—*Capital-funded Construction and Operating Costs for the DARHT Baseline Alternative (in millions of 1995 dollars)*

Year/Cost	1995	1996	1997	1998	1999	2000	2001	2002	Total
Capital	6.6	29.5	17.9	26.8	24.0	0.6	0	0	105.3
Operations and Maintenance	4.2	4.1	4.1	4.0	5.9	5.8	5.8	5.7	39.6

Over the period FY 1996 to FY 2002, the DARHT Baseline Alternative is estimated to generate 191 full-time equivalent jobs in the regional economy, 80 directly related to project construction and operating expenditures, and 111 indirectly generated by subsequent indirect spending and income generation within the regional economy. Over the same time period, the DARHT Baseline Alternative is estimated to generate an annual average of $4.1 million of regional labor income, $1.7 million directly related to the project, and $2.4 million indirectly generated through subsequent indirect spending in the regional economy. Finally, the DARHT Baseline Alternative is estimated to generate an annual average of $6.8 million of goods and services in the regional economy, $3.4 million directly generated by the project, and $3.4 million indirectly generated by subsequent indirect spending within the regional economy.

The underlying cost data were provided by LANL (Burns 1995a; Burns 1995b). The costs do not include any expenses associated with site cleanup nor decontamination and decommissioning at either the DARHT or PHERMEX facilities. These relevant data were adjusted using an escalation price change index for DOE defense-related construction projects (Pearman 1994; Anderson 1995).

5.2.7.3 Community Infrastructure and Services

The DARHT Baseline Alternative would not have any significant impact on the existing community infrastructure in the region-of-interest, as described in section 4.7.3.

5.2.7.4 Environmental Justice

Referring to other sections of the EIS, no significant adverse environmental impacts are identified with the construction or operation of the DARHT Facility under the DARHT Baseline Alternative. The impacts considered include air and noise emissions caused during facility construction and subsequent operations (section 5.2.2), and the potential for surface or ground water contamination (section 5.2.4). Any foreseeable impacts on air, noise, or water quality during the course of normal operations would not pose significant health impacts on human populations (section 5.2.8) and would fall within regulatory compliance requirements. Accordingly, DARHT Facility construction and planned operation under the DARHT Baseline Alternative would have no known disproportionate adverse health or environmental impact on minority or low-income populations in the region-of-interest [populations residing within 50 mi (80 km) of the site].

5.2.8 Human Health

Potential human health impacts under the DARHT Baseline Alternative would be essentially the same as for the No Action Alternative, described in section 5.1.8.

5.2.9 Facility Accidents

Potential impacts of facility accidents under the DARHT Baseline Alternative would be essentially the same as for the No Action Alternative, described in section 5.1.9.

5.2.10 Waste Management

Potential impacts of the DARHT Baseline Alternative on waste management would be essentially the same as for the No Action Alternative, described in section 5.1.10.

5.2.11 Monitoring and Mitigation

5.2.11.1 Monitoring

Potential impacts that would need to be monitored under the DARHT Baseline Alternative would be essentially the same as for the No Action Alternative, described in section 5.1.11.

5.2.11.2 Mitigation

Under normal operating conditions, two potential impacts would appear to warrant mitigation. Specific actions would be taken to minimize disturbance of the Mexican spotted owls inhabitating canyons near the DARHT site. Noise from construction equipment and activities would be minimized as much as possible. Operational noise from detonations would also be conducted to minimize disturbance. Facility lighting would be placed to direct illumination away from the canyons at night.

Protection of the Nake'muu archeological site might be necessary under certain detonation test configurations. Detonations would be shielded, if necessary, to avoid fragment impact to the site. No other archeological sites in the hazard radius have standing walls that would require mitigation activities. Other mitigation measures taken would not differ significantly from measures currently taken as part of normal operations at the PHERMEX Facility. Mitigation activities for cultural resources are presented in section 4.6. Construction noise associated with completing the facility would be mitigated to minimize noise impacts on the surrounding environment as much as possible.

5.2.12 Decontamination and Decommissioning

Potential impacts of decontamination and decommissioning under the DARHT Baseline Alternative would be similar to those described for the No Action Alternative in section 5.1.12. The following differences from D&D activities and impacts for the No Action Alternative would be expected:

- Increased salvage and conversion to other uses because of the presence of two accelerator facilities and their buildings
- Increased soil, gravel, and debris resulting from the repositioning of the firing site from the PHERMEX location

5.3 UPGRADE PHERMEX ALTERNATIVE

This section presents the expected environmental consequences associated with the Upgrade PHERMEX Alternative.

5.3.1 Land Resources

Potential impacts on land resources in the Upgrade PHERMEX Alternative would be essentially the same as those for the No Action Alternative, described in section 5.1.1.

5.3.2 Air Quality and Noise

5.3.2.1 Air Quality

Potential impacts of the Upgrade PHERMEX Alternative on air quality essentially would be the same as those for the No Action Alternative for operations, described in section 5.1.2.1.2, and the DARHT Baseline Alternative for construction activities, described in section 5.2.1.1.

5.3.2.2 Noise

Because the period of construction would be somewhat longer and some construction would probably take place to convert the existing DARHT Facility to other uses, construction noise would be generated for a period longer than in the DARHT Baseline Alternative. However, construction noise would not be expected to be noticeable away from the construction site. Disturbance of wildlife during operations would be about the same as with the No Action Alternative, described in section 5.1.2.2.

5.3.3 Geology and Soils

Potential impacts of the Upgrade PHERMEX Alternative on geology and soils would be essentially the same as those for the No Action Alternative, described in section 5.1.3.

5.3.4 Water Resources

Potential impacts of the Upgrade PHERMEX Alternative on surface and ground water would be essentially the same as those for the No Action Alternative, described in section 5.1.4.

5.3.5 Biotic Resources

Impacts on biotic resources in the Upgrade PHERMEX Alternative would be essentially the same as those for the No Action Alternative, described in section 5.1.5.

5.3.6 Cultural and Paleontological Resources

Potential impacts on cultural and paleontological resources in the Upgrade PHERMEX Alternative would be essentially the same as those for the No Action Alternative, described in section 5.1.6.

5.3.7 Socioeconomic and Community Services

Environmental impacts on socioeconomics and community services for the Upgrade PHERMEX Alternative are presented in this section. Potential impacts on demographic characteristics, community infrastructure and services, and environmental justice would be essentially the same as the No Action Alternative and are described in sections 5.1.7.1, 5.1.7.3, and 5.1.7.4, respectively. Potential impacts on economic activities are presented in the following paragraphs.

The Upgrade PHERMEX Alternative involves upgrading the present PHERMEX Facility to accommodate new technology developed for DARHT. Under this alternative, the DOE is expected to complete construction and begin operation of the upgraded PHERMEX Facility in FY 2002. During the upgrade of the PHERMEX Facility, construction costs would be incurred along with PHERMEX operating costs (see table 5-9). To estimate the regional economic impacts of the Upgrade PHERMEX Alternative, the analysis recognizes additional construction and operating expenditures under the Upgrade PHERMEX Alternative, relative to those associated with the No Action Alternative. The estimated capital construction expenditures do not include any site cleanup nor D&D of the dual-axis facility at the end of its lifetime.

Over the period FY 1996 to FY 2002, the Upgrade PHERMEX Alternative is estimated to generate 199 full-time equivalent jobs in the regional economy, 82 directly related to project construction and

TABLE 5-9.—*Capital-funded Construction and Operating Costs for Upgrade PHERMEX Alternative (in millions of 1995 dollars)*

Year/Cost	1995	1996	1997	1998	1999	2000	2001	2002	Total
Capital	6.6	36.6	33.7	21.7	14.8	10.2	3.1	0	126.7
Operations and Maintenance	4.2	4.1	4.1	4.0	4.0	4.0	3.9	6.0	34.3

operating expenditures, and 117 indirectly generated by consecutive rounds of spending and regional income generation. The Upgrade PHERMEX Alternative is also estimated to generate an annual average of $4.3 million of regional labor income, $1.8 million directly related to the project, and $2.5 million indirectly generated through consecutive rounds of spending in the regional economy. Finally, the Upgrade PHERMEX Alternative is estimated to generate an annual average of $6.9 million of goods and services in the regional economy, $3.3 million directly generated by the project, and $3.7 million indirectly generated by consecutive rounds of spending in the regional economy.

The underlying cost data were provided by LANL (Burns 1995a; Burns 1995b). The costs do not include any expenses associated with site cleanup nor D&D of either the proposed DARHT or PHERMEX facilities. These relevant data were adjusted using an escalation price change index for DOE defense-related construction projects (Pearman 1994; Anderson 1995).

5.3.8 Human Health

Potential impacts of the Upgrade PHERMEX Alternative on human health would be essentially the same as for the No Action Alternative, described in section 5.1.8.

5.3.9 Facility Accidents

Potential impacts of facility accidents under the Upgrade PHERMEX Alternative would be essentially the same as for the No Action Alternative, described in section 5.1.9.

5.3.10 Waste Management

Potential impacts of the Upgrade PHERMEX Alternative on waste management would be essentially the same as for the No Action Alternative, described in section 5.1.10.

5.3.11 Monitoring and Mitigation

Monitoring and mitigation measures taken under the Upgrade PHERMEX Alternative would be essentially the same as the No Action Alternative, described in section 5.1.11.

5.3.12 Decontamination and Decommissioning

Impacts of decontamination and decommissioning under the Upgrade PHERMEX Alternative would be essentially the same as in the No Action Alternative described in section 5.1.12; however, the buildings partially constructed for DARHT would also be subject to D&D evaluation.

5.4 ENHANCED CONTAINMENT ALTERNATIVE

This section presents the expected environmental consequences associated with the Enhanced Containment Alternative. Three options were analyzed under this Alternative, as described in section 3.7: the Building Containment, Vessel Containment, and Phased Containment (preferred alternative) options. No significant differences in potential environmental impacts were determined among the three options; in many cases (see tables S-1 and 3-3) potential impacts would be essentially identical. Minor differences were determined in impacts to, or caused by air quality operations, noise, soil contamination, biotic and cultural resources (without mitigation), socioeconomics, human health, low-level waste generation, and commitment of resources. These are discussed below.

5.4.1 Land Resources

5.4.1.1 Land Use

The Vessel Containment, Building Containment, and Phased Containment (preferred alternative) options under this alternative require a building addition for the cleanout facility. To accommodate all of these options, it is anticipated that 1 ac (0.4 ha) of land would have to be cleared for construction, in addition to the 8 ac (3 ha) of land previously disturbed by DARHT. Under the Vessel Containment and Phased Containment (preferred alternative) options, an existing 0.25-mi long (0.4-km long) firebreak road would be improved by widening, grading, and paving to provide access to the proposed vessel cleanout facility. This would lead to the potential for about 0.5 ac (0.2 ha) additional disturbance on either side of the existing road. Dedication of land for the cleanout facility or access road would be consistent with current and past land uses at LANL and would have no reasonably foreseeable impact on established local land-use patterns.

5.4.1.2 Visual Resources

The proposed DARHT Facility and the cleanout facility under any of the containment options would be unobtrusive and located in an isolated piñon/ponderosa pine forest area. The buildings would not be accessible or readily visible from offsite; therefore, they should have no impact on visual resources.

5.4.1.3 Regional Recreation

Although a variety of recreational opportunities are available in the vicinity of LANL, only those in areas relatively near TA-15 might be negatively impacted by noise associated with test firings at the proposed DARHT site. Test firings within the containment building would be expected to have no impacts on recreational resources. Under the Vessel Containment and Phased Containment (preferred alternative) options, it is possible that some tests would be conducted without using a containment vessel. These tests would have the same small potential for impacts on nearby recreation as other alternatives using uncontained test firing.

5.4.2 Air Quality and Noise

Impacts on nonradiological air quality and the potential for noise impacts associated with the Enhanced Containment Alternative are discussed in this section.

5.4.2.1 Air Quality

Air quality impacts for the Enhanced Containment Alternative are presented in this section for maximally impacted point of unrestricted public access. These impacts were determined using methods described in appendix C, Air Quality and Noise.

5.4.2.1.1 Construction

Pollutant emissions during the construction phase of all three options of the Enhanced Containment Alternative would be essentially the same as those for the DARHT Baseline Alternative. Pollutant emissions associated with constructing a containment structure (Building Containment Option) or the vessel cleanout facility under the Enhanced Containment Alternative have not been quantified. However, additional impacts from the construction of either structure would be expected to be minimal.

5.4.2.1.2 Operations

Potential air quality impacts from operations under the Enhanced Containment Alternative would be very similar for all three of the options analyzed. As shown in table 5-10, the calculated values for nitrogen dioxide and sulfur dioxide are essentially the same for all options and alternatives, while PM_{10} values vary slightly among alternatives. Annual PM_{10} air concentrations for the Enhanced Containment Alternative options are about the same among these options but are about 20 percent lower than those for other alternatives. The maximum short-term (24-h) of PM_{10} concentrations would differ among the enhanced containment options. The Vessel Containment and Phased Containment options would have short-term releases from uncontained detonations; potential short-term air quality impacts would be higher than the Building Containment Option and similar to those of the other alternatives analyzed.

Calculated values for beryllium, heavy metals, and lead for all of the enhanced containment options are essentially the same when analyzed over the 30-year project life because of the greater impact of containment releases on air quality. The Phased Containment Option would have less impact during the early years of the option because of the greater fraction of uncontained detonations. Although somewhat counter intuitive, the major reason for this is because uncontained detonations under these options allow for greater atmospheric dispersion with subsequently less air quality impact than releases from containment. The uncontained detonations were modeled as elevated releases [325 ft (99 m)] simulating

TABLE 5-10.—*Impacts on Air Quality from Operations under the Enhanced Containment Alternative*

Pollutant	Averaging Time	Concentration at Maximally Impacted Point of Unrestricted Public Access ($\mu g/m^3$)	Percent of Regulatory Limit[a]
NO_2	Annual	0.04	0.06
	24-h	2	1.4
PM_{10}	Annual	0.008	0.02
	24-h	0.4[c]	0.2[c]
		3.3[d]	2.2[d]
SO_2	Annual	2×10^{-4}	0.0005
	24-h	0.006	0.003
	3-h	0.03	0.003
Beryllium	30 days	2×10^{-5}	0.0002
Heavy Metals[b]	30 days	0.002	0.02
Lead	Calendar Quarter	1×10^{-4}	0.007

[a] Uses the applicable regulatory limit from table 4-3.
[b] Sum of the air concentration of uranium and lead.
[c] Building Containment Option
[d] Vessel Containment and Phased Containment options.

Note: NO_2 and PM_{10} are from hydrodynamic testing and boiler emissions.
SO_2 is from boiler emissions.
Beryllium, heavy metals, and lead are from hydrodynamic testing. Includes impacts from hydrodynamic testing and boiler emissions.

explosive dispersion, while containment releases were modeled as near ground level releases. Additional discussion of atmospheric releases and modeling is provided in appendix C1, Air Quality, and appendix H, Human Health.

5.4.2.2 Noise

Under all options of the Enhanced Containment Alternative, impacts associated with noise and blast pressure waves would be reduced compared to the No Action Alternative. Uncontained detonations under the Vessel Containment and Phased Containment options could potentially have noise and blast wave impacts of the same magnitude as for the No Action Alternative. The number of detonations would be reduced by 75 percent under the Vessel Containment Option and from 5 to 40 to 75 percent under the different phases of the Phased Containment Option.

Noise associated with construction and construction worker traffic would occur until completion of the DARHT Facility and the containment building or cleanout facility under all of the containment options. However, construction noise would not be expected to be noticeable away from the construction site.

Disturbance of wildlife during operations would be about the same as with the No Action Alternative (appendix C, Air Quality and Noise).

5.4.3 Geology and Soils

Impacts of the Enhanced Containment Alternative on geology and soils are described in the following subsections.

5.4.3.1 Geology

Geologic impacts under the Enhanced Containment Alternative would be similar to those under the DARHT Baseline Alternative, described in section 5.2.3.1.

5.4.3.2 Seismic

Seismic impacts under the Enhanced Containment Alternative would be similar to those under the DARHT Baseline Alternative, described in section 5.2.3.2.

Although seismic events that damage buildings would have an impact on mission goals, no scenarios were identified wherein a seismic event could trigger an action at the proposed DARHT Facility that would result in any offsite environmental impact.

5.4.3.3 Soils

The three options under the Enhanced Containment Alternative present lower soils contamination levels than the No Action and DARHT Baseline alternatives. The three options are the Vessel Containment Option, the Building Containment Option, and the Phased Containment Option (preferred alternative).

Under the Vessel Containment Option, an estimated maximum of 12 percent of the DARHT Baseline Alternative inventory could be released in the vicinity of the firing point if highly unlikely events were to occur. This 12 percent is made up of two types of releases. Under the Vessel Containment Option some uncontained detonations would be conducted, up to 25 percent of the total annual depleted uranium expenditures of 1,540 lb (700 kg) or a maximum of 385 lb (175 kg) per year. Of this depleted uranium inventory, 70 percent would be removed from the firing point during routine cleanup activities leaving 30 percent for migration in the environment. To be conservative, it is assumed no beryllium or lead would be removed from the firing point during routine cleanup. Of the remaining 75 percent of the inventory shot in containment, releases are assumed to occur in no more than 6 percent of the cases. Note that total release from these 6 percent of contained tests would be highly unlikely; however, to be conservative complete release is assumed. Thus, 7.5 percent (i.e., 0.25 x 0.30) release occurs during uncontained experiments and up to 4.5 percent (0.75 x 0.06) release occurs during contained experiments; a total of 12 percent. Assuming no cleanup of beryllium or lead, their percentage of inventory remaining in firing site soils is estimated to be no more than 29.5 percent of their original inventory. Thus, annual releases of depleted uranium, beryllium, and lead would be 185, 6.5, and 10 lbs (84, 3, and 4.4 kg), respectively. These annual releases would occur for 30 years.

Soil contamination under the Building Containment Option would be somewhat less than that under the Vessel Containment Option. Under the Building Containment Option, 6 percent of the annual inventory will be released to the environment under highly unlikely circumstances. It is further assumed that none of the contamination will be removed from the soils through routine cleanup activities. Thus, annual releases of depleted uranium, beryllium, and lead would be 92, 1.3, and 2 lbs (42, 0.6, and 0.9 kg), respectively. These annual releases would occur for 30 years.

Soil contamination under the Phased Containment Option would be somewhat more than under the Vessel Containment Option. Releases would be characterized by decreasing uncontained experiments in three phases over two 5-year periods, finally decreasing to about 25 percent uncontained experiments level after 10 years. For the three time periods (i.e., 5, 5, and 20 years), over the 30-year operation of the facility, the uncontained to containment percentages of annual inventory expended would be 95 and 5, 60 and 40, and 25 and 75. Under cleanup and operational assumptions identical to those under the Vessel and Building Containment Options, the percentages of annual inventory for depleted uranium deposited in the firing site soils for the three periods are 28.8, 20.4, and 12 percent. The percentages of annual inventory deposited in firing site soils for beryllium and lead for the three periods are 95.3, 62.4, and 29.5. During the first 5-year period, annual releases of depleted uranium, beryllium, and lead would be 444, 21, and 31 lbs (200, 9.5, and 14 kg), respectively. During the second 5-year period, the annual releases of depleted uranium, beryllium, and lead would be 315, 14, and 21 lbs (143, 6.2, and 9.4 kg), respectively. During the final 20-year period, the annual releases of depleted uranium, beryllium, and lead would be 185, 6.5, and 10 lbs (84, 3, and 4.4 kg), respectively.

For each of the options of the Enhanced Containment Alternative, the circle of contaminated soil at the firing point under the Enhanced Containment Alternative is assumed to be no greater than that for the No Action and DARHT Baseline alternatives. Thus, the circle of soil centered on the firing point exhibiting uranium concentrations above background would be no greater than a 460-ft (140-m) radius. The area of land contaminated above background for uranium, beryllium, and lead would be no greater than 15 acres (6 ha).

5.4.4 Water Resources

Water resources examined for impact in the Enhanced Containment Alternative are:

- Surface water and sediment in Water Canyon, which discharges into the Rio Grande
- The main aquifer underlying Threemile Mesa

Stream losses to the bed of Water Canyon are analyzed for their potential to release contaminants through the vadose zone to the main aquifer. Infiltration is examined for its ability to carry metals in solution into the mesa top at the firing point and to transport contaminants through the unsaturated zone to the main aquifer. Supporting information on deep drainage, the geochemistry of metals in LANL waters and sediments, surface water modeling, and vadose zone and ground water modeling as applied in this EIS can be found in appendix E.

A combination of data review and geochemical analysis was used to determine the solubility and sorption characteristics of several metals in the LANL water and soil/sediment environment (see appendix E2). Because they represent the largest fraction of expended materials in the tests to be conducted, depleted uranium, beryllium, lead, copper, and aluminum were all studied. The study revealed that a realistic value of solubility for beryllium in LANL waters was at its drinking water standard of 4 μg/L [40 CFR 141.62]. A realistic value for lead solubility in LANL waters was at its MCL of 50 μg/L [40 CFR 141.11] and approximately a factor of three above its action level of 15 μg/L [40 CFR 141.80]. Values of solubility for both copper and aluminum were both found to be substantially below their secondary drinking water standards. Thus, while the analysis examines the migration of beryllium and lead to gain insight into their migration and behavior in the environment, there is no need to simulate beryllium, copper, or aluminum because their solute concentrations at the source are at or below their respective drinking water standards. The solubility of uranium in LANL waters was found to be substantially above its proposed MCL value, and therefore its migration was modeled to estimate its potential impact on the water resource.

5.4.4.1 Surface Water

The hydrology-sediment-contaminant transport modeling procedure described in appendix E3 was applied to assess the potential impacts of the three options under the Enhanced Containment Alternative. In this alternative, the transport by surface runoff of the 30 years of future releases of depleted uranium, beryllium, and lead from the DARHT site was analyzed. Table 5-11 shows the simulated peak concentration of contaminants in the infiltrated water in Water Canyon below the source. Details of the analysis and treatment of runoff, storm water, and cooling water blowdown discharge at the DARHT site are described in appendix E3.

Because of their low solubility, the concentrations of beryllium and lead reach a plateau in their release to Water Canyon but still remain well below drinking water standards. Drinking water standards for beryllium and lead are 4 and 15 μg/L, respectively. Depleted uranium has a relatively high solubility in LANL surface and ground waters. Depleted uranium in surface water released to Water Canyon immediately below DARHT is slightly above the proposed MCL of 20 μg/L for the Vessel Containment and Phased Containment options, and slightly below the proposed MCL for the Building Containment Option. The Rio Grande is the nearest offsite access point for surface water carrying contamination from the firing point. As shown in table 5-11, the quality of surface water entering the Rio Grande under each of the options is forecast to be over an order-of-magnitude below the drinking water standard for uranium and several orders-of-magnitude below the drinking water standards for beryllium and lead.

5.4.4.2 Ground Water

Two analyses of depleted uranium, beryllium, and lead migration were conducted for the three options of the Enhanced Containment Alternative. The two analyses involved 1) infiltration carrying contaminants into the mesa top at the DARHT firing point and 2) infiltration of contaminants from the stream bed of Water Canyon. Both sources of infiltration and contamination were analyzed to estimate contaminant migration into the main aquifer.

The peak concentrations of contaminants in infiltration to Threemile Mesa and in surface water losses from the uppermost reach of Water Canyon opposite the DARHT Facility are shown in table 5-12. For

TABLE 5-11.—*Contaminant Concentrations and Time-to-peak for the Enhanced Containment Alternative*

Contaminant	Reach 12 (Water Canyon)	Reach 13 (Water Canyon)	Reach 14 (Water Canyon)	Reach 15 (Water Canyon)	Rio Grande (in solution)[a]	Rio Grande (on sediment)
Vessel Containment Option						
Peak Concentration	(in μg/L)	(in μg/L)	(in μg/L)	(in μg/L)	(in μg/L)	(in μg/g)
Depleted Uranium	2.5×10^{1}	4.8	1.4	5.4×10^{-1}	5.6×10^{-1}	5.6×10^{-2}
Beryllium	3.2×10^{-3}	1.4×10^{-3}	6.0×10^{-4}	2.4×10^{-4}	2.4×10^{-4}	2.4×10^{-5}
Lead	7.7×10^{-3}	4.4×10^{-3}	1.0×10^{-3}	2.9×10^{-4}	2.9×10^{-4}	5.7×10^{-4}
Time, years						
Depleted Uranium	17	90	100	100	100	100
Beryllium	740	4,350	2,570	4,130	4,130	4,130
Lead	1,850	2,570	2,570	2,640	2,640	2,640
Building Containment Option						
Peak Concentration	(in μg/L)	(in μg/L)	(in μg/L)	(in μg/L)	(in μg/L)	(in μg/g)
Depleted Uranium	17.6	3.28	9.4×10^{-1}	3.7×10^{-1}	3.8×10^{-1}	3.8×10^{-2}
Beryllium	3.2×10^{-3}	1.4×10^{-3}	6.0×10^{-4}	2.4×10^{-4}	2.4×10^{-4}	2.4×10^{-5}
Lead	6.2×10^{-3}	2.5×10^{-3}	4.4×10^{-4}	1.5×10^{-4}	1.5×10^{-4}	2.8×10^{-4}
Time, years						
Depleted Uranium	17	90	100	100	100	100
Beryllium	740	4,350	2,570	4,130	4,130	4,130
Lead	530	530	530	530	530	750
Phased Containment Option						
Peak Concentration	(in μg/L)	(in μg/L)	(in μg/L)	(in μg/L)	(in μg/L)	(in μg/g)
Depleted Uranium	26	4.9	1.4	5.6×10^{-1}	5.7×10^{-1}	5.7×10^{-2}
Beryllium	3.2×10^{-3}	1.4×10^{-3}	6.0×10^{-4}	2.4×10^{-4}	2.4×10^{-4}	2.4×10^{-5}
Lead	7.7×10^{-3}	4.4×10^{-3}	1.0×10^{-3}	2.9×10^{-4}	2.9×10^{-4}	5.8×10^{-4}
Time, years						
Depleted Uranium	17	90	100	100	100	100
Beryllium	740	4,350	2,570	4,130	4,130	4,130
Lead	1,850	2,570	2,570	2,640	2,640	2,640

[a] Concentration of surface water entering Rio Grande; basis for water resource number in tables and S-1 and 3-3.

Note: Drinking Water Standards:
- Uranium, 20 μg/L [56 FR 33050]
- Beryllium, 4 μg/L [40 CFR 141.62]
- Lead, 15 μg/L [40 CFR 141.80]

those cases where the drinking water standards are exceeded (shown in bold), analyses were conducted. Only three cases must be modeled – depleted uranium and lead on the mesa top at the firing point and depleted uranium in the uppermost reach of Water Canyon. Other metals and locations were not analyzed because sorption and dispersion within the vadose zone would only further reduce soil water concentrations that enter the soil column at concentrations at or below the drinking water standards.

TABLE 5-12.—*Peak Input Concentrations for the Enhanced Containment Alternative to Water Canyon Reaches and Threemile Mesa Predicted by Surface Runoff-sediment-contaminant Transport Model*

Location	Contaminant		
	Uranium (µg/L)	Beryllium (µg/L)	Lead (µg/L)
Drinking Water Standards	20 [56 FR 33050]	4 [40 CFR 141.62]	15 [40 CFR 141.80]
Vessel Containment Option			
Threemile Mesa	142,000	4	50
Water Canyon Reach 12	25.3	0.003	0.008
Water Canyon Reach 13	4.8	0.001	0.004
Water Canyon Reach 14	1.4	0.0006	0.001
Water Canyon Reach 15	0.5	0.0002	0.0003
Building Containment Option			
Threemile Mesa	71,000	4	50
Water Canyon Reach 12	17.6	0.003	0.006
Water Canyon Reach 13	3.3	0.001	0.003
Water Canyon Reach 14	0.9	0.0006	0.0004
Water Canyon Reach 15	0.4	0.0002	0.0002
Phased Containment Option			
Threemile Mesa	250,000	4	50
Water Canyon Reach 12	26	0.003	0.008
Water Canyon Reach 13	4.9	0.001	0.004
Water Canyon Reach 14	1.4	0.0006	0.001
Water Canyon Reach 15	0.6	0.0002	0.0003

For the Vessel Containment Option, analysis of depleted uranium migration through the vadose zone arising from releases to the stream bed of Water Canyon showed a peak concentration of about 0.05 µg/L after 18,000 years in soil water being delivered to the main aquifer. Analysis of the migration of depleted uranium and lead through the mesa to the main aquifer showed a peak concentration of 32 and 1×10^{-3} µg/L after approximately 42,000 and 100,000 years, respectively. Thus, while releases of lead in soil water are well below the drinking water standard action level of 15 µg/L, the release of depleted uranium from the mesa top yields soil water entering the main aquifer at concentrations less than twice the proposed MCL.

For the Building Containment Option, analysis of depleted uranium migration through the vadose zone arising from releases to the stream bed of Water Canyon showed a peak concentration of about 0.04 µg/L after 18,000 years in soil water being delivered to the main aquifer, well below the proposed MCL for uranium (20 µg/L). Analysis of the migration of depleted uranium and lead through the mesa to the main aquifer showed a peak concentration of 16.1 and 1.5×10^{-7} µg/L after approximately 42,000 and

100,000 years, respectively. Thus, the release of lead in soil water is well below the drinking water standard action level of 15 μg/L, and the release of depleted uranium from the mesa top yields soil water entering the main aquifer at concentrations below the MCL.

For the Phased Containment Option, analysis of depleted uranium migration through the vadose zone arising from releases to the stream bed of Water Canyon showed a peak concentration of about 0.06 μg/L after 18,000 years in soil water being delivered to the main aquifer. Analysis of the migration of depleted uranium and lead through the mesa to the main aquifer showed a peak concentration of 43 and 2×10^{-3} μg/L after approximately 42,000 and 100,000 years, respectively. Thus, while releases of lead in soil water are well below the drinking water standard action level of 15 μg/L, the release of depleted uranium from the mesa top yields soil water entering the main aquifer at concentrations about twice the proposed MCL.

Upon entering the main aquifer, the small-scale and low-volume releases from the mesa top would be dispersed in the aquifer and further mixed either with ground water (if it were recovered in the municipal water supply) or the waters of the Rio Grande. The average yield of the Pajarito Field wells of 2.7 ft^3/s (7.7×10^{-2} m^3/s) is assumed to be representative of a water supply well that could be developed in the vicinity of Threemile Mesa (see Appendix E4). The total flow rate of contaminated water from the mesa firing point would be 1.1×10^{-3} ft^3/s (3.2×10^{-5} m^3/s). This gives a concentration reduction factor greater than 2,000, more than sufficient to reduce the concentration of depleted uranium in municipal water supplies to levels well below the proposed MCL. Based on the average annual flow of the Rio Grande at Otowi (Graf 1993) between 1910 and 1985 of 1.1×10^6 ac-ft [1.5×10^3 ft^3/s (42 m^3/s)], the reduction factor would be even greater for ground water release to the Rio Grande.

Releases to the ground water pathway from operation under the Enhanced Containment Alternative would not adversely impact ground water quality.

5.4.5 Biotic Resources

Biotic resources examined for impacts under the Enhanced Containment Alternative include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species.

5.4.5.1 Terrestrial Resources

Both construction and operations impacts were evaluated for terrestrial resources.

5.4.5.1.1 Construction Impacts

All of the containment options under the Enhanced Containment Alternative would necessitate the construction of either a containment building or a vessel cleanout facility in TA-15. For the containment and cleanout buildings, an additional removal of piñon-juniper/ponderosa pine habitat of about 1 ac (0.4 ha) would be incurred with a resulting disturbance and displacement of associated wildlife. Under the Vessel Containment and Phased Containment (preferred alternative) options, an existing 0.25-mi long (0.4-km long) firebreak road would be improved by widening, grading, and paving to provide access to the proposed vessel cleanout facility. This would lead to the potential for about 0.5 ac (0.2 ha) additional disturbance on either side of the existing road. See section 5.1.5.1 for a description of these types of impacts.

5.4.5.1.2 Operation Impacts

Impacts would be essentially the same as the DARHT Baseline Alternative (section 5.2.5.1.2) except that disruption of wildlife from noise associated with detonations would likely be lessened, considerably so for the Building Containment Option. Noise associated with operation of the cleanout facility would be minimal.

5.4.5.2 Wetlands

Although floodplains lie at the bottom of Potrillo Canyon and Cañon de Valle, no wetlands lie within TA-15; thus, no impacts to wetlands would occur (Risberg 1995).

5.4.5.3 Aquatic Resources

No additional impacts to the aquatic resources located within the canyons surrounding TA-15 are expected.

5.4.5.4 Threatened and Endangered Species

Potential impacts on threatened and endangered species under the Enhanced Containment Alternative would be essentially the same as those for the DARHT Baseline Alternative, described in section 5.2.5.4.

5.4.6 Cultural and Paleontological Resources

Impacts on cultural and paleontological resources under the Enhanced Containment Alternative are described in the following subsections.

5.4.6.1 Archeological Resources

5.4.6.1.1 Construction

Completion of construction of the proposed DARHT Facility and the containment building, cleanout facility, or access road under any of the proposed containment options, would not be expected to have any direct or indirect impacts on known archeological sites eligible for the National Register. Existing TA-15 security measures that restrict general access would continue to provide protection for possible intentional or incidental impacts from human activities.

5.4.6.1.2 Operations

Any uncontained detonations conducted under the Vessel Containment or Phased Containment option would have impacts described under the DARHT Baseline Alternative in section 5.2.6.1.2. Potential impacts from contained detonations would be minimal, limited to vibratory ground motion.

5.4.6.2 Historical Resources

No direct or indirect impacts on historic structures are anticipated.

5.4.6.3 Native American Resources

There would be essentially no impacts on Native American cultural resources.

5.4.6.4 Paleontological Resources

Because of the nature of the soil and geological substrate, the occurrence of paleontological resources is not anticipated; no potential effects are postulated.

5.4.7 Socioeconomic and Community Services

Environmental impacts on socioeconomics and community services for the Enhanced Containment Alternative are presented in the following subsections.

5.4.7.1 Demographic Characteristics

The Enhanced Containment Alternative would not have any significant impact on the existing demographic characteristics of communities in the region-of-interest, as described in section 4.7.1.

5.4.7.2 Economic Activities

The Enhanced Containment Alternative would involve construction and operation of the DARHT Facility but with some modification to contain airborne emissions of fragments or other debris – either a containment vessel or a containment building. Under the Vessel Containment Option, the DOE would complete construction and begin operation of the dual-axis facility in FY 1999. At that time, DARHT operating costs would replace PHERMEX operating costs. Under the Building Containment Option, the DOE would complete construction and begin operation of the dual-axis facility in FY 2002, at which time DARHT operating costs would replace PHERMEX operating costs (table 5-13).

For the purpose of estimating the regional economic impacts of the two containment alternatives, the analysis illustrates their respective levels of construction and operating expenditures relative to those

TABLE 5-13.—*Capital-funded Construction and Operating Costs for the Enhanced Containment Alternatives (in millions of 1995 dollars)*

Cost/Option	1995	1996	1997	1998	1999	2000	2001	2002	Total
Capital									
Vessels	6.6	29.6	32.4	41.1	24.9	0.6	0	0	135.2
Building (150 lb)	6.6	28.7	27.7	31.3	16.5	15.0	0.9	0	121.9
Building (500 lb)	6.6	29.5	41.7	34.7	16.5	15.0	0.9	0	139.5
Phased	6.6	30.6	21.9	34.4	30.1	6.7	5.8	5.8	142
Operations and Maintenance									
Vessels	4.2	4.1	4.1	4.0	9.7	9.6	9.5	9.4	54.7
Building (150 lb)	4.2	4.1	4.1	4.0	4.0	4.0	3.9	9.4	37.7
Building (500 lb)	4.2	4.1	4.1	4.0	4.0	4.0	3.9	9.4	37.7
Phased	4.2	4.1	4.1	4.0	6.3	6.1	5.8	5.6	40.3

associated with the No Action Alternative. These estimated costs do not include any site cleanup, nor D&D of the dual-axis facility at the end of its lifetime.

Over the period FY 1996 to FY 2002, the Vessel Containment Option is estimated to generate 321 full-time equivalent jobs in the regional economy, 137 directly related to project construction and operating expenditures, and 185 indirectly generated by consecutive rounds of spending and income generation within the regional economy. This alternative is also estimated to generate an annual average of $6.8 million of regional labor income, $2.9 million directly related to the project, and $3.9 million indirectly generated through consecutive rounds of spending in the regional economy. The alternative is estimated to add an annual average of $12.0 million of goods and services to the regional economy, $6.2 million directly generated by the project, and $5.8 million indirectly generated by consecutive rounds of spending within the regional economy.

Alternatively, the 150-lb (70-kg) Building Containment Option is estimated to generate 209 full-time equivalent jobs in the regional economy, and the 500-lb (230-kg) Building Containment Option is estimated to generate 238 full-time equivalent jobs. Of these totals, for the smaller and larger buildings, respectively, 87 and 99 jobs would be directly accounted for by project construction and operating expenditures. The other 122 or 139 jobs for the two building sizes would be indirectly accounted for by consecutive rounds of regional spending and income generation.

Correspondingly, the Building Containment Option is estimated to add annual averages of $4.5 million and $5.1 million in regional labor income, with $1.9 million and $2.1 million directly related to the project, and $2.6 million and $3.0 million indirectly generated by consecutive rounds of spending in the regional economy. Relative to these impacts, the Building Containment Option is estimated to generate annual averages of $7.6 million [150 lb (70 kg)] and $8.4 million [500 lb (230 kg)] of goods and services in the regional economy, $3.6 million [150 lb (70 kg)] or $4.0 million [500 lb (230 kg)] directly generated by the project, and $4.0 million [150 lb (70 kg)] or $4.4 million [500 lb (230 kg)] indirectly generated through consecutive rounds of spending in the regional economy.

The Phased Containment Option (preferred alternative) involves construction and operation of the DARHT Facility, but with modifications to phase in the containment of airborne emissions of fragments or other debris. The DOE would be expected to complete construction and begin operation of the dual axis facility in FY 1999. During this phase, construction and operations and maintenance costs are similar to the vessel containment option and reflect those of the DARHT Baseline Alternative (table 5-13). These estimated costs do not include any site cleanup, decommissioning, or decontamination of the dual axis facility at the end of its lifetime.

In the period FY 1996 to FY 2002 the preferred alternative is estimated to generate 253 FTE-equivalent jobs in the regional economy, 106 being directly related to project construction and O&M expenditures and the other 147 being indirectly generated by consecutive rounds of spending and income generation within the regional economy.

Corresponding to these employment impacts, the Phased Containment Option (preferred alternative) is estimated to generate an annual average of $5.4 million dollars of regional labor income in the period FY 1996 to FY 2002: $2.3 million being directly related to the project and the other $3.1 million being indirectly generated through consecutive rounds of spending in the regional economy.

Finally, the Phased Containment Option (preferred alternative) is estimated to generate an annual average of $9.0 million dollars of goods and services in the regional economy during the period FY 1996 to FY 2002: $4.4 million of these being directly generated by the project, and the other $4.6 million being indirectly generated by consecutive rounds of spending within the regional economy.

The underlying cost data were provided by LANL (Burns 1995a; Burns 1995b). The costs do not include any expenses associated with site cleanup nor D&D of either the proposed DARHT or PHERMEX facilities. Those relevant data were adjusted using an escalation price change index for DOE defense-related construction projects (Pearman 1994; Anderson 1995).

5.4.7.3 Community Infrastructure and Services

The Enhanced Containment Alternative would not have any significant impact on the existing community infrastructure in the region-of-interest, as described in section 4.7.3.

5.4.7.4 Environmental Justice

Referring to other sections of the EIS, the construction and operation of the DARHT Facility under any of the containment options of the Enhanced Containment Alternative would pose no significant environmental impacts. The foreseeable impacts include fugitive air and noise emissions during facility construction and operations (section 5.3.2), and potential surface or underground water contamination (section 5.3.4). No significant human health impacts appear to exist from either radioactive or hazardous material released or from exposing receptors onsite (workers) or offsite (section 5.1.8). Accordingly, DARHT Facility construction and planned operations under the Enhanced Containment Alternative options would not pose a disproportionate adverse health or environmental impact on minority or low-income populations in the region-of-interest [populations residing within 50 mi (80 km) of the site].

5.4.8 Human Health

This section presents the impacts to the health of workers and the public from routine operations that would be conducted at the DARHT Facility under the Enhanced Containment Alternative. Impacts may potentially result from release and atmospheric transport of radioactive and hazardous material from the facility firing site as a result of planned detonations. Methods and assumptions used in calculating potential impacts are described in appendix H, Human Health.

Radiological impacts may result from exposure to depleted uranium and tritium released to the atmosphere from detonations at the DARHT site. Depleted uranium would be the principal contributor to radiation dose; tritium would contribute about 1×10^{-7} the dose of depleted uranium for chronic releases. The major exposure pathway would be inhalation of material released to the atmosphere, which would contribute more than 99 percent of the dose. Potential human health impacts may be *over estimated* by a factor of 100 because of the simplified, elevated point-source atmospheric dispersion model used rather than an explosive atmospheric dispersion model (see appendix H, Human Health). Potential impacts from any uses of plutonium would be essentially the same as for the No Action Alternative, described in section 5.1.8.

5.4.8.1 Public

Potential impacts to the MEI were evaluated at three locations in the vicinity of the DARHT site – Los Alamos, White Rock, and Bandelier. These locations are representative of the neighboring residential clusters in close proximity to LANL. Potential impacts to the surrounding population were also calculated. Potential radiological and nonradiological impacts are presented in the sections below.

5.4.8.1.1 Radiological Impacts

Estimated radiological impacts to the public under the three options would be very similar. The maximum annual dose to any nearby resident under the Vessel Containment, Phased Containment, and Building Containment options would be about 2×10^{-5} rem. Using a risk conversion factor of 5×10^{-4} LCFs per person-rem for members of the public, the estimated maximum probability of a latent fatal cancer would be less than 1×10^{-8} for all three options. The estimated cumulative dose to an individual over the anticipated 30-year life of the project would be about 6×10^{-4} rem under the Phased Containment Option, and about 5×10^{-4} rem under the Vessel Containment and Building Containment options. The estimated maximum probability of a LCF from this cumulative exposure would be about 3×10^{-7} under the Phased Containment Option, and about 2×10^{-7} under the Vessel Containment and Building Containment options.

The annual collective dose to the population of 290,000 individuals living within 50 mi (80 km) of DARHT from the Vessel Containment, Phased Containment, and Building Containment options would be about 0.44, 0.57, and 0.27 person-rem, respectively. No LCFs would be expected among the population from these population doses (2×10^{-4}, 2×10^{-4}, and 1×10^{-4} LCFs, respectively). Over the anticipated 30-year operating life of DARHT, the potential impacts for the Vessel Containment, Phased Containment, and Building Containment options would be about 13, 17, and 8 person-rem, respectively. LCFs would not be expected (6×10^{-3}, 8×10^{-3}, and 4×10^{-3} LCFs, respectively).

5.4.8.1.2 Nonradiological Impacts

Members of the public might also be exposed to heavy metals and other materials released during the detonation, including uranium, lead, beryllium, and lithium hydride. Potential impacts from these exposures would be very small under all three options. The maximum probability of a beryllium-induced cancer would be about 1×10^{-11}. Toxicological effects from releases of uranium, beryllium, lead, or lithium hydride would not be expected (maximum Hazard Index of 5×10^{-8}). The probability of a beryllium-induced cancer over the anticipated 30-year life of the project would be about 3×10^{-10}. The maximum Hazard Index expected in the first year immediately after 30 years of operations, accounting for any toxicological effects from buildup of hazardous material in soil, would not exceed 4×10^{-8}. Toxicological effects would not be expected.

Cancers would not be expected in the population in the surrounding 50 mi (80 km) from exposure to beryllium released during a year of normal operations under any of the enhanced containment options. The estimated total incidence would be about 1×10^{-7} under the Vessel Containment and Phased Containment options, and about 5×10^{-8} under the Building Containment Option.

5.4.8.2 Noninvolved Workers

A noninvolved worker is defined as a LANL employee who works in TA-15, but would not be directly involved with the proposed facility operations. Nearby workers not involved with the proposed DARHT detonation process would not likely be affected by detonations occurring within containment. It was assumed that access control would still be in place for the Enhanced Containment Alternative. Uncontained detonations could still occur under this alternative [Vessel Containment and Phased Containment (preferred alternative) options], as well as potential breaches of the containment vessels or releases from the containment building. To evaluate potential impacts from these occurrences, a noninvolved worker is assumed to work continuously 2,500 ft (750 m) distant from the firing site. This distance is based on a hazard radius that would typically be put in place for hydrodynamic test. LANL implements this administrative exclusion area based on explosive safety principles (DOE 1994).

The annual dose to a noninvolved worker is estimated to be about 2×10^{-5} rem EDE under the Vessel Containment and Phased Containment Options and 1×10^{-5} rem under the Building Containment Option. The maximum probability of an LCF from these doses would be about 6×10^{-9} and 5×10^{-9}, respectively. Over the 30-year anticipated operating life of the facility, a noninvolved worker's cumulative dose would be about 5×10^{-4} rem and 4×10^{-4} rem, respectively. The maximum probability of LCF from these doses would be about 2×10^{-7} for both.

A noninvolved worker could also be exposed to heavy metals and other materials released during the detonation, including uranium, lead, beryllium, and lithium hydride. The maximum probability of a beryllium-induced cancer would be about 2×10^{-11} under the Vessel Containment and Phased Containment options and 1×10^{-11} under the Building Containment Option. The probability of a beryllium-induced cancer from exposure over the anticipated 30-year life of the project would be about 5×10^{-10} and 3×10^{-10}, respectively. Toxicological effects from exposure to releases of uranium, beryllium, lead, or lithium hydride would not be expected (maximum Hazard Indexes of 9×10^{-8} and 6×10^{-8}, respectively).

5.4.8.3 Workers

Impacts to workers under the Enhanced Containment Alternative could be somewhat higher than those observed under previous PHERMEX operating experience or projected for the uncontained alternatives because cleanup of contained space (vessels or buildings) could involve exposure to greater quantities and concentrations of materials. The average annual worker dose would probably not exceed 0.020 rem. The maximum probability of LCF from this dose would be 8×10^{-6}. The annual collective worker dose, assuming a maximum of 100 workers, would probably not exceed 2 person-rem. Latent cancer fatalities would not be expected from this dose (8×10^{-4} LCFs). The cumulative worker dose over the assumed 30-year lifetime of the facility would probably not exceed 60 person-rem. Latent cancer fatalities would not be expected from this dose (2×10^{-2} LCFs).

Involved worker exposures to radiation and radioactive materials under normal operations would be controlled under established procedures that require doses to be kept as low as reasonably achievable. Any potential hazards would be evaluated as part of the radiation worker and occupational safety programs at LANL, and no impacts outside the scope of normal work activities would be anticipated.

5.4.9 Facility Accidents

This section presents the impacts from postulated facility accidents involving depleted uranium to individual members of the public, noninvolved workers nearby, and workers at the facility. The bounding accident evaluated under the Enhanced Containment Alternative differed for the Vessel Containment, Phased Containment, and Building Containment options. Under the Vessel Containment and Phased Containment options, the bounding accident is the catastrophic failure of a containment vessel. Under the Building Containment Option, the bounding accident is the cracking and loss of integrity of the containment walls or major failure of the HEPA-filtered overpressure release system. Both of these bounding accidents would result in greater potential consequences to members of the public and noninvolved workers than inadvertent uncontained detonation of a test assembly. This is because the hypothetical release of materials would be at ground level rather than at a higher elevation, resulting in a more dense dispersion plume closer to the ground. The inadvertent detonation would be the bounding accident for workers at the facility. Accident initiation events were not addressed; accidents were simply evaluated on a "what if" basis even though the likelihood of occurrence is very small.

Radiological impacts may result from exposure to depleted uranium and tritium released to the atmosphere from detonations at the DARHT site. Depleted uranium would be the principal contributor to radiation dose; tritium would contribute about 1×10^{-8} the dose of depleted uranium for acute releases. The major exposure pathway would be inhalation of material released to the atmosphere, which would contribute more than 99 percent of the dose.

More detailed results, identification of postulated facility accidents, and methods of analysis are described in greater detail in appendix I, Facility Accidents. Much of the technical basis for the health impact of the accident analysis is included in appendix H, Human Health. Transportation-related accidents are described in section 5.7.

In the past, DOE has conducted dynamic experiments at LANL with plutonium. Any future experiments with plutonium would always be conducted in double-walled containment vessels, and these experiments would not be expected to result in any release of plutonium to the environment. Potential impacts from facility accidents involving any use of plutonium would be essentially the same as for the No Action Alternative, described in section 5.1.9.

5.4.9.1 Public

As in the uncontained alternatives, potential impacts to members of the public were evaluated for three nearby points of public access: State Road 4, Pajarito Road, and the Bandelier National Monument. The MEI would be located at the State Road 4 location, approximately 0.9 mi (1.5 km) southwest of the site. An individual at this location under the assumed accident and exposure conditions would receive a radiation dose of about 0.01 rem EDE under the vessel containment failure scenario and about 0.001 rem under the building containment breach scenario. The maximum probability of a LCF from these doses would be about 6×10^{-6} and 6×10^{-7}, respectively. The maximum probability of beryllium-induced cancers would be about 8×10^{-9} and 8×10^{-10}, respectively. Toxicological effects would not be expected, as no more than 0.2 and 0.02 mg, respectively, of any of the released constituents (uranium, beryllium, lead, lithium hydride) would be inhaled. The intakes are less than 2 percent of the IDLH equivalent intake values. Additional results are presented in appendix I, Facility Accidents.

Maximum population dose would occur under the containment vessel breach scenario, in the east-through-southeast direction, with a population dose of about 17 person-rem. Population dose under the building containment breach scenario would be about 1.7 person-rem. Latent cancer fatalities among the population would not be expected from either of these doses (9×10^{-3} and 9×10^{-4} LCFs, respectively). Cancer would not be expected among the population from exposure to beryllium (total incidence of 1×10^{-5} cancers and 1×10^{-6} cancers, respectively).

5.4.9.2 Noninvolved Workers

As in the No Action Alternative, nearby workers not involved with the detonation process would be affected to a lesser extent than involved workers because of their distance from the firing point. Under the Vessel Containment and Phased Containment (preferred alternative) options, access control and other area restrictions would be maintained for planned uncontained detonations that could take place. Other precautions taken under the No Action Alternative would also be maintained. However, for contained detonations, it was assumed that the hazard radius would be lessened, to 1,300 feet (400 m), and that a noninvolved worker would be at this distance and exposed to the material released from the detonation during the entire period of passage.

A noninvolved worker would receive a radiation dose of about 0.05 rem EDE under the vessel containment failure scenario and a dose of about 0.005 rem under the building containment breach scenario. The maximum probability of an noninvolved worker contracting a fatal latent cancer from these doses would be about 2×10^{-5} and 2×10^{-6}, respectively. The maximum probability of beryllium-induced cancers would be about 3×10^{-8} and 3×10^{-9}, respectively. Toxicological effects would not be expected, as no more than 0.7 mg of any of the released constituents (uranium, beryllium, lead, lithium hydride) would be inhaled. The inhalation intakes for LiH is the largest fraction of IDLH equivalent intake values at less than 8 percent. Additional results are presented in appendix I, Facility Accidents.

5.4.9.3 Workers

Impacts to involved workers would differ little from those described under the No Action Alternative in section 5.1.9.3. During completion of DARHT construction and the associated containment building or vessel cleanout facility, normal construction-type hazards would be encountered. During operations, the accident of greatest consequence would be the inadvertent detonation of high explosive on the firing site or in the containment building when workers are present. This accident is considered unlikely, but it could result in the deaths of all workers (a maximum of 15) in the immediate area.

Also, like the No Action Alternative, another possible accident on the firing site with serious consequences outside the scope of normal industrial or laboratory hazards would be the direct exposure of a worker to the ionizing radiation pulse produced by the DARHT accelerator. Although this accident would be extremely unlikely, a worker could receive a very high acute radiation dose, delivered over a fraction of a micro-second, to a localized portion of the body.

5.4.10 Waste Management

Under this alternative, debris from the majority of detonations at the facility would be contained either by vessels or inside a containment building. Volumes of nonhazardous solid waste, solid and liquid hazardous waste, mixed waste, and TRU waste generated under the Enhanced Containment Alternative for the Vessel Containment, Building Containment, and Phased Containment options would be essentially the same as those for the No Action Alternative, described in section 5.1.10. Wastes generated under the Enhanced Containment Alternative, as for other alternatives, would be subject to treatment, storage, and/or disposal in other LANL Technical Areas. Transportation of these wastes would be conducted following DOT guidelines and using DOE- or DOT-approved containers carried on government vehicles using public roads between LANL facilities, as needed.

5.4.10.1 Vessel Containment Option LLW

Under the Vessel Containment Option, some uncontained detonations would be conducted, up to 25 percent of total annual depleted uranium expenditures of 1,540 lb (700 kg) or a maximum of 385 lb (175 kg) per year. The total estimated LLW generated and disposed from uncontained detonations would be less than 3,000 ft^3 (90 m^3), based upon a LLW generation rate of 1,800 ft^3 (50 m^3) LLW per 220 lb (100 kg) of depleted uranium used, as developed for the No Action Alternative (section 5.1.10). The bulk of this waste would be the gravel and soil that is removed with the detonation debris. Total volume of waste generated would depend on the number and frequency of the firing-site detonations and periodic cleanup.

For contained detonations, a reasonably predictable amount of waste would be generated each time. For contained major (hydrodynamic) detonation, the waste volume generated would be about 36 ft^3 (1 m^3) or up to five 55-gal drums. Some of the waste would be finely divided debris containing uranium, other metals, and occasionally lead. Much of this material would be separated out in the associated recovery facility and either recovered or disposed of separately, so that a reduced volume of LLW would remain for disposal. Assuming 50 percent recovery or separation of contained detonation material, and 20 major contained detonations per year, no more than 360 ft^3 (10 m^3) of LLW would be generated per year from contained detonations.

Total LLW generation is expected to be no more than 3,600 ft^3 (100 m^3) of LLW per year under the Vessel Containment Option. Assuming the total LANL LLW disposal volume in future years would be 180,000 ft^3yr (5,000 m^3/yr) (Bartlit et al. 1993), the Enhanced Containment Alternative, Vessel Containment Option would be projected to contribute no more than two percent of the total LANL LLW volume.

Given a bounding failure rate of five percent and 20 shots per year, one vessel may be projected to fail each year. The failed vessels would be decontaminated and decommissioned and reused as scrap metal so that they would not enter the waste management program.

5.4.10.2 Building Containment Option LLW

All detonations under the Building Containment Option would be conducted inside the containment building. Under this option, no uncontained detonations would occur, and therefore none of the large volumes of contaminated gravel and soil would be generated from cleaning the firing site of debris. LLW generation would be limited to that from contained detonations. As described above under the Vessel Containment Option, this would typically be no more than about 36 ft^3 (1 m^3) or up to five 55-gal drums per major hydrodynamic detonation. Assuming 50 percent recovery or separation of contained detonation material and 20 major contained detonations per year, no more than 360 ft^3 (10 m^3) of LLW would be generated per year under the Building Containment Option. Assuming the total LANL LLW disposal volume in future years would be 180,000 ft^3/yr (5,000 m^3/yr) (Bartlit et al. 1993), the Enhanced Containment Alternative, Building Containment Option would be projected to contribute no more than 0.2 percent of the total LANL LLW volume.

5.4.10.3 Phased Containment Option LLW

Under the phased Containment Option, the following three distinct phases would occur: 1) containment of 5 percent of the materials used during the first five years of operation, 2) containment of 40 percent of the materials used during the second five years of operation, and 3) beginning in the 11th year of operation, containment of at least 75 percent of the materials used. Under these distinct phases, there would be approximately 12,000 ft^3/yr (350 m^3/yr) of LLW generated during the first 5-year period, approximately 7,500 ft^3/yr (210 m^3/yr) in the second 5-year period, and 3,600 ft^3/yr (101 m^3/yr) during the last 20 years of the design life of the facility. The amount of LLW generated is reduced as the percentage of containment increases due to a lesser volume of soil removal.

Assuming the total LANL LLW disposed volume in future years would be 180,000 ft^3 (5,000 m^3/yr) (Bartlit et al. 1993) the volume of LLW generated under the Phased Containment Option would contribute 7 percent in each of the first five years, 4 percent in each of the second five years, and 2 percent in each of the last 20 years. Again, failed vessels would be decontaminated, decommissioned, and designated as scrap metal.

5.4.11 Monitoring and Mitigation

5.4.11.1 Monitoring

Monitoring under the Enhanced Containment Alternative would be essentially the same as that undertaken for the No Action Alternative, described in section 5.1.11.

5.4.11.2 Mitigation

Under normal operating conditions, two potential impacts would appear to warrant mitigation. Specific actions would be taken to minimize disturbance of the Mexican spotted owls inhabitating Cañon de Valle and Water Canyon near the DARHT site. Noise from construction equipment and activities would be minimized as much as possible. Operational noise from detonations would also be conducted to minimize disturbance. Facility lighting would be placed to direct illumination away from the canyons at night.

Protection of the Nake'muu archeological site may be necessary under certain uncontained detonation test configurations of the Vessel Containment and Phased Containment (preferred alternative) options. Mitigating measures similar to those of the other alternatives (e.g., blast shielding) may be necessary to avoid fragments reaching the site. No other archeological sites in the hazard radius have standing walls that would require mitigation activities. The containment structures used in this alternative would reduce the environmental consequences of operating DARHT and the need for mitigation for detonations performed in containment. Mitigation activities for cultural resources are presented in section 4.6 and 5.11.

5.4.12 Decontamination and Decommissioning

Decontamination and decommissioning under the Enhanced Containment Alternative would be essentially the same as described for the DARHT Baseline Alternative in section 5.2.12. In addition to those D&D activities and impacts, this alternative would result in decommissioning of a containment building and/or an undetermined number of vessels used for a 20- to 30-year design life. However, the amount of soil cleanup would be substantially less (25 to 90 percent) because of containment of wastes within the vessels or building.

5.5 PLUTONIUM EXCLUSION ALTERNATIVE

This section presents the expected environmental consequences associated with the Plutonium Exclusion Alternative.

5.5.1 Land Resources

Potential impacts of the Plutonium Exclusion Alternative on land resources would be essentially the same as for the DARHT Baseline Alternative, described in section 5.2.1.

5.5.2 Air Quality and Noise

Potential impacts of the Plutonium Exclusion Alternative on air quality essentially would be the same as those for the No Action Alternative for operations, described in section 5.1.2.1.2, and the DARHT Baseline Alternative for construction activities, described in section 5.2.1.1. Potential noise impacts would be essentially the same as for the DARHT Baseline Alternative, described in section 5.2.2.

5.5.3 Geology and Soils

Potential impacts of the Plutonium Exclusion Alternative on geology and soils would be essentially the same as for the DARHT Baseline Alternative, described in section 5.2.3.

5.5.4 Water Resources

Potential impacts of the Plutonium Exclusion Alternative on surface and ground water would be essentially the same as for the DARHT Baseline Alternative, described in section 5.2.4.

5.5.5 Biotic Resources

Potential impacts of the Plutonium Exclusion Alternative on biotic resources would be essentially the same as for the DARHT Baseline Alternative, described in section 5.2.5.

5.5.6 Cultural and Paleontological Resources

Potential impacts of the Plutonium Exclusion Alternative on cultural and paleontological resources would be essentially the same as for the DARHT Baseline Alternative, described in section 5.2.6.

5.5.7 Socioeconomic and Community Services

Environmental impacts of socioeconomics and community services for the Plutonium Exclusion Alternative are presented in sections 5.5.7.1 through 5.5.7.4.

5.5.7.1 Demographic Characteristics

The Plutonium Exclusion Alternative would not have any significant impacts on the existing demographic characteristics of communities in the region-of-interest, as described in section 4.7.1.

5.5.7.2 Economic Activities

Under the Plutonium Exclusion Alternative, the DOE would continue operating the PHERMEX Facility on a full-time basis while construction is completed on the DARHT Facility. Once construction of the dual-axis facility is completed, the DOE would begin operating the DARHT Facility on a full-time basis and operate the PHERMEX Facility on only a standby basis. The DOE expects to complete construction and begin operation of the DARHT Facility in FY 1999. At that time the present analysis assumes full-time operation of the DARHT Facility would begin, while full-time operation of the PHERMEX Facility would be scaled back to half time.

Table 5-14 illustrates the combined costs of operating and maintaining PHERMEX along with constructing, operating, and maintaining the DARHT Facility. These combined costs are expressed relative to ones that would be incurred under the No Action Alternative. The estimated costs do not include any site cleanup or D&D of the DARHT or PHERMEX Facilities at the end of their lifetimes. The economic impacts of these expenditures are described in terms of the number of regional jobs, labor income, and goods and services produced in the regional economy.

TABLE 5-14.—*Capital-funded Construction and Operating Costs for the Plutonium Exclusion Alternative (in millions of 1995 dollars)*

Year/Cost	1995	1996	1997	1998	1999	2000	2001	2002	Total
Capital	6.6	29.5	17.9	26.8	24.0	0.6	0	0	105.3
Operations and Maintenance	4.2	4.1	4.1	4.0	7.9	7.8	7.8	7.6	47.4

The Plutonium Exclusion Alternative would generate 233 FTE jobs in the regional economy. Of this total, 99 would be directly accounted for by project construction and varying levels of operation and maintenance of the PHERMEX and DARHT Facilities. The remaining 134 FTE jobs would be indirectly accounted for by consecutive rounds of regional spending and income generation.

Correspondingly, the Plutonium Exclusion Alternative is estimated to generate an annual average of $4.9 million in regional labor income. Of this total, $2.1 million is directly related to project construction and facility operation and maintenance. The remaining $2.9 million is indirectly generated by consecutive rounds of spending in the regional economy.

Meanwhile, the Plutonium Exclusion Alternative is estimated to generate a total of $8.6 million of goods and services in the regional economy, with $4.5 million directly accounted for by project construction and facility operations and maintenance. The remaining $4.1 million is indirectly accounted for by consecutive rounds of regional spending and income generation.

5.5.7.3 Community Infrastructure and Services

The Plutonium Exclusion Alternative would not have any significant impact on the existing community infrastructure in the region-of-interest, as described in section 4.7.3.

5.5.7.4 Environmental Justice

The construction and operation of the DARHT and PHERMEX facilities under the Plutonium Exclusion Alternative would pose no significant environmental impacts. The foreseeable impacts include fugitive air and noise emissions during facility construction and operations (section 5.2.2), and potential surface or underground water contamination (section 5.2.4). No significant human health impacts appear to exist from either radioactive or hazardous material release or from exposing receptors onsite (workers) or offsite (section 5.1.8). Accordingly, DARHT Facility construction and planned operations under the Plutonium Exclusion Alternative would not pose a disproportionate adverse health or environmental impacts on minority or low-income populations in the region-of-interest [populations residing within 50 mi (80 km) of the site].

5.5.8 Human Health

Potential impacts of the Plutonium Exclusion Alternative on human health would be essentially the same as for the No Action Alternative, described in section 5.1.8.

5.5.9 Facility Accidents

Potential impacts of facility accidents under the Plutonium Exclusion Alternative would be essentially the same as for the No Action Alternative, described in section 5.1.9.

5.5.10 Waste Management

Potential impacts of the Plutonium Exclusion Alternative on waste management would be essentially the same as for the No Action Alternative, described in section 5.1.10.

5.5.11 Monitoring and Mitigation

Potential impacts that would need to be monitored or mitigated under the Plutonium Exclusion Alternative would be essentially the same as for the DARHT Baseline Alternative, described in section 5.2.11.

5.5.12 Decontamination and Decommissioning

Impacts of D&D under the Plutonium Exclusion Alternative would be essentially the same as for the DARHT Baseline Alternative, described in section 5.2.12.

5.6 SINGLE AXIS ALTERNATIVE

This section presents the expected environmental consequences associated with the Single Axis Alternative.

5.6.1 Land Resources

Potential impacts on land resources in the Single Axis Alternative would be essentially the same as those for the DARHT Baseline Alternative, described in section 5.2.1.

5.6.2 Air Quality and Noise

Potential impacts of the Single Axis Alternative on air quality essentially would be the same as the No Action Alternative for operations, described in section 5.1.2.1.2, and the DARHT Baseline Alternative for construction activities, described in section 5.2.1.1.

Potential noise impacts would be essentially the same as for the DARHT Baseline Alternative, described in section 5.2.2.

5.6.3 Geology and Soils

Potential impacts of the Single Axis Alternative on geology and soils would be essentially the same as those for the DARHT Baseline Alternative, described in section 5.2.3.

5.6.4 Water Resources

Potential impacts of the Single Axis Alternative on surface and ground water would be essentially the same as those for the DARHT Baseline Alternative, described in section 5.2.4.

5.6.5 Biotic Resources

Impacts on biotic resources in the Single Axis Alternative would be essentially the same as those for the DARHT Baseline Alternative, described in section 5.2.5.

5.6.6 Cultural and Paleontological Resources

Impacts on cultural and paleontological resources from the Single Axis Alternative would be essentially the same as those for the DARHT Baseline Alternative, described in section 5.2.6.

5.6.7 Socioeconomic and Community Services

Environmental impacts on socioeconomics and community services for the Single Axis Alternative are presented in this section. Potential impacts on demographic characteristics, community infrastructure and services, and environmental justice would be essentially the same as the DARHT Baseline Alternative and are described in sections 5.2.7.1, 5.2.7.3, and 5.2.7.4, respectively. Potential impacts on economic activities are presented below.

5.6.7.1 Economic Activities

Under the Single Axis Alternative, the DOE is expected to complete construction of the facility by FY 1999. At that time, DARHT operating costs would replace PHERMEX operating costs (see table 5-15). For purposes of estimating the impacts of the Single Axis Alternative on the regional economy (employment, labor income, and output), the analysis shows the construction and operating expenditures under the Single Axis Alternative relative to those under the No Action Alternative. The estimated capital construction expenditures do not include any site cleanup nor D&D of the dual-axis facility at the end of its lifetime.

TABLE 5-15.—*Capital-funded Construction and Operating Costs for the Single Axis Alternative (in millions of 1995 dollars)*

Year/Cost	1995	1996	1997	1998	1999	2000	2001	2002	Total
Capital	6.6	29.5	17.9	5.7	0	0	0	0	59.6
Operations and Maintenance	4.2	4.1	4.1	4.0	5.3	5.2	5.2	5.1	37.2

Over the period FY 1996 to FY 2002, the Single Axis Alternative is estimated to generate 104 FTE jobs in the regional economy, 44 directly related to project construction and operating expenditures, and the other 60 indirectly generated by consecutive rounds of spending and income generation within the regional economy. The Single Axis Alternative is also estimated to generate an annual average of $2.2 million of regional labor income, $0.9 million directly related to the project, and $1.3 million indirectly generated through consecutive rounds of spending. Finally, the Single Axis Alternative is estimated to generate an annual average of $3.8 million of goods and services in the regional economy, $1.9 million of these directly generated by the project, and $1.9 million indirectly generated by consecutive rounds of spending in the regional economy.

The underlying cost data were provided by LANL (Burns 1995a; Burns 1995b). The costs do not include any expenses associated with site cleanup, nor D&D of either the DARHT or PHERMEX facilities. These relevant data were adjusted using an escalation price change index for DOE defense-related construction projects (Pearman 1994; Anderson 1995).

5.6.8 Human Health

Potential impacts of the Single Axis Alternative on human health would be essentially the same as those for the No Action Alternative, described in section 5.1.8.

5.6.9 Facility Accidents

Potential impacts of facility accidents under the Single Axis Alternative would be essentially the same as those for the No Action Alternative, described in section 5.1.9.

5.6.10 Waste Management

Potential impacts of the Single Axis Alternative on waste management would be the same as those for the No Action Alternative, described in section 5.1.10.

5.6.11 Monitoring and Mitigation

5.6.11.1 Monitoring

Potential impacts that would need to be monitored under the Single Axis Alternative would be the same as those for the No Action Alternative, described in section 5.1.11.

5.6.11.2 Mitigation

Mitigation measures taken under the Single Axis Alternative would be the same as those for the DARHT Baseline Alternative, described in section 5.2.11.2.

5.6.12 Decontamination and Decommissioning

Potential impacts of D&D under the Single Axis Alternative would be essentially the same as under the DARHT Baseline Alternative, described in section 5.2.12, except that there would be only one accelerator hall and support equipment for D&D evaluation.

5.7 TRANSPORTATION OF MATERIALS

This section presents the results of an analysis of incident-free (routine operations) and accident consequences associated with transportation of materials, details of which are given in appendix J, Transportation of Materials. For purposes of this EIS, one transportation analysis applies to the No Action Alternative and the Upgrade Alternative (associated with PHERMEX); another analysis applies to the remaining alternatives (associated with DARHT).

All transportation would be in LANL-controlled areas. The analysis presented in appendix J is based on the assumption that the test device would be secured to a flat-bed truck and transported to the receiving facility. The assembled test device would be transported from TA-16-410 to the PHERMEX or the DARHT Facility using roads internal to TA-16 and TA-15 (see figure 3-1). The truck would be loaded at TA-16-410 and transported nonstop approximately 4.7 mi (7.5 km) to the magazine (Building R–242). From the magazine, the test device would be transported nonstop approximately 1.2 mi (2 km) to the PHERMEX gate or 0.9 mi (1.5 km) to the DARHT gate. At each of the facilities, the test device would be transported approximately 1,000 ft (300 m) from the facility gate to the firing site. Because the total distances are so similar, less than 0.3 mi (0.5 km) difference, the longer distance to PHERMEX is used for data presented here.

For purposes of this analysis, 20 shipments per year were assumed. Although 150 lb (70 kg) high explosive is the normal maximum at the firing points, three hypothetical test devices were assumed for analysis to cover a range of high explosive content, including the maximum sizes for the firing points, 500 lb (230 kg) (see sections 3.4.2 and 3.5.2). The three hypothetical test devices are: Test Device 1 with 22 lb (10 kg) high explosive, Test Device 2 with 500 lb (230 kg) high explosive, and Test Device 3 with 1,010 lb (460 kg) high explosive.

Contrary to intuition, Test Device 1 would produce the worst-case worker doses because the device materials would be less dispersed in an accidental explosion. The worst-case results, Test Device 1, are presented in this section unless otherwise stated.

5.7.1 Incident-free Transportation

Potential impacts of routine transportation are discussed in the following sections.

5.7.1.1 Nonradiological Impacts

Nonradiological impacts of routine transportation would result principally from pollutants emitted from the vehicles. The estimated number of fatalities due to vehicle emissions from routine transportation was found to be essentially zero (2.4×10^{-4} LCFs over the life of the project).

5.7.1.2 Radiological Impacts

Radiological doses to the truck crew, onsite workers, and the public, resulting from transportation activities, were calculated using methods described in appendix J, Transportation of Materials. Results of the analysis are provided in table 5-16. The calculated dose is based on 20 shipments per year. The dose to truck crews over the life of the project would be about 1×10^{-4} person-rem. The calculated dose to the public over the life of the project would be less than 3×10^{-9} person-rem. The total dose to the onsite worker population over the life of the project for the No Action Alternative would be about 0.004 person-rem.

The potential LCFs were calculated using dose conversion factors given in ICRP 60 (ICRP 1991), i.e., 0.0004 LCFs/person-rem to the onsite worker and truck crew and 0.0005 LCFs per person-rem to the general public, respectively. Cancer would not be expected to occur for the life of the project (workers and crew, 2×10^{-6} LCFs; onsite worker, 5×10^{-5} LCFs; public, less than 4×10^{-11} LCFs).

5.7.2 Impacts of Transportation of Materials Under Accident Conditions

Potential impacts of transportation of materials under accident conditions are discussed in the following subsections. If an accident occurs, the resulting debris and contamination, if any, would be removed and taken to appropriate LANL facilities as is done for firing-point debris.

TABLE 5-16.—*Summary of Analyses for Routine Transportation for the No Action Alternative and DARHT Baseline Alternative*

Population Group[a]	Per Shipment		Annually	
	Radiological Dose (person-rem)	Health Effects (LCFs)	Radiological Dose (person-rem)	Health Effects (LCFs)
Radiological Impacts[b]				
Truck Crew	6×10^{-6}	2×10^{-9}	1×10^{-4}	4×10^{-8}
Onsite Worker	2×10^{-4}	7×10^{-8}	3×10^{-3}	1×10^{-6}
Total	2×10^{-4}	7×10^{-8}	4×10^{-3}	1×10^{-6}
Nonradiological Impacts				
Onsite Worker		4×10^{-7}		8×10^{-6}
Total Radiological and Nonradiological Impacts				
Truck Crew	6×10^{-6}	2×10^{-9}	1×10^{-4}	4×10^{-8}
Onsite Worker	2×10^{-4}	5×10^{-7}	3×10^{-3}	9×10^{-6}

[a] The calculated dose to the public is less than 1×10^{-10} person-rem and for this analysis is considered essentially zero.

[b] The maximum individual in-transit dose is 6×10^{-9} person-rem per shipment. Truck crew doses for the DARHT Baseline Alternative are slightly lower.

5.7.2.1 Nonradiological Impacts

Transport vehicle speed is limited to 35 mph; therefore, vehicle collisions with other vehicles on the transportation route are not considered severe enough to cause fatalities to the truck occupants or occupants of the other vehicles involved in the accident. For the purposes of the analysis in appendix J, the transport vehicle is assumed to impact a stationary object with sufficient force to detonate the high explosive.

Impacts due to explosions are modeled based on accidental detonation of high explosive in each of the hypothetical test devices. Assuming that a peak overpressure of 30 psi (186 kpa) is fatal, all individuals within an approximate radius of 15 ft (5 m), 43 ft (13 m), and 53 ft (16 m) for test devices 1, 2, and 3, respectively, would be subjected to potentially fatal overpressures. The truck crews are assumed to be located within 30 ft (10 m) of the accident. Additionally, approximately 50 percent of the individuals at distances up to 80 ft (24 m) might be killed because of the blast wave. Injuries and fatalities to bystanders from flying shrapnel have not been estimated. There have been no such transportation accidents during more than 30 years of firing activities at TA-15.

In addition to evaluating the impacts from a detonation of the high explosives, an assessment of the consequences of a release of the hazardous materials associated with the devices was performed. It was assumed that 10 percent of the material released would be respirable (see appendix C). The results, based on the meteorological data for the LANL site, are shown in table 5-17. For comparison, although plume passage times are very short in duration, the IDLH exposure limits are also provided in table 5-17.

TABLE 5-17.—*Nonradiological Transportation Accident Impacts to the Public*

Population Group	Beryllium (mg/m^3)	Lead (mg/m^3)	Lithium Hydride (mg/m^3)
Allowable Limit[a]	10	700	55
Onsite Worker[b]	1.2×10^{-4}	1.9×10^{-4}	1.2×10^{-3}
Offsite Individual[c]	1.1×10^{-4}	1.7×10^{-4}	1.1×10^{-3}

[a] IDLH limits taken from NIOSH 1990.
[b] Assumed to be located 0.5 mi (0.75 km) northwest.
[c] Assumed to be located 1 mi (1.5 km) southwest.

5.7.2.2 Radiological Impacts

The analyses of radiological impacts evaluates the impacts to MEI and the public because of a release of radioactive material. The analysis is based on the assumption that the transport vehicle would impact a stationary object, and the high explosive would be detonated. The accident rate used, about 4 accidents per 10 million mi (2 accidents per 10 million km) (Saricks and Kvitek 1994), is a combination of accident rates for rural and urban federally aided highway systems.

Radiological doses were calculated for two population densities of interest [i.e., laboratory open space, about 5 workers/0.4 mi^2 (1 km^2); and occupied buildings, about 360 workers/0.4 mi^2 (1 km^2)]. It was assumed that 10 percent of the material aerosolized was respirable. The calculated dose, on a per shipment basis, to the two populations is estimated to be 0.2 person-rem and 17 person-rem, respectively. The integrated risk to the public (i.e., consequences times accident frequency integrated over the entire shipping distance) was estimated to be less than 1×10^{-4} person-rem.

Radiological doses were also calculated for the MEI, located about 300 ft (100 m) from the release, the onsite MEI, located at the nearest occupied facility, and the offsite MEI, located at the site boundary. For this analysis, based on the location of the site boundary and the nearest public roadway, and the meteorological data, the offsite MEI was assumed to be located approximately 0.9 mi (1.5 km) to the northwest. The onsite MEI is assumed to be located 2,500 ft (0.75 km) to the northwest. The results of the radiological analyses for the MEI are presented in table 5-18.

The largest dose among the groups investigated was calculated to be to the onsite worker and amounted to 4.1×10^{-4} rem. The dose to the offsite MEI would be 3.7×10^{-4} rem. The maximum probability of LCF from this dose would be about 2×10^{-7} for both the onsite worker and the offsite individual. The dose to the individual at 300 ft (100 m) was calculated to be essentially zero; the radioactive cloud was lofted well above and over the individual.

TABLE 5-18.—*Radiological Accident Impacts to the Maximally Exposed Individuals*

Receptor	Radiological Dose per Accident (rem)
Maximum Onsite Worker[a]	4.1×10^{-4}
Maximum Offsite Individual[b]	2.4×10^{-4}

[a] Assumed to be located 0.5 mi (0.75) km northwest.
[b] Assumed to be located 1 mi (1.5) km northwest.

5.8 UNAVOIDABLE ADVERSE IMPACTS AND IRREVERSIBLE AND/OR IRRETRIEVABLE COMMITMENT OF RESOURCES

The following subsections address unavoidable adverse environmental impacts and irreversible and/or irretrievable commitment of resources.

5.8.1 Unavoidable Adverse Impacts

Potentially unavoidable adverse impacts associated with the No Action Alternative, DARHT Baseline Alternative, Upgrade PHERMEX Alternative, Plutonium Exclusion Alternative, and Single Axis Alternative were identified as follows:

- Contaminating soils with various materials, including depleted uranium, beryllium, lead, copper, aluminum, and other metals within approximately 460 ft (140 m) of the firing point during testing
- Disturbing wildlife as a result of blast noise from detonation of high explosives. DOE and the USFWS have negotiated to reduce noise impacts to any threatened or endangered species in the vicinity of the DARHT and PHERMEX facilities (see section 5.11).
- Initiating small fires as a result of explosives testing.

Unavoidable adverse impacts identified with the Enhanced Containment Alternative would be limited to destruction of a small amount [about 0.25 ac (0.1 ha)] of piñon/ponderosa pine forest habitat for the construction of the cleanup/recycle facility. Any tests which are uncontained may result in the same unavoidable adverse impacts listed above.

5.8.2 Irretrievable and/or Irreversible Commitment of Resources

Irretrievable and/or irreversible commitment of resources associated with the various alternatives are presented in table 5-19.

5.9 CUMULATIVE IMPACTS

The following discussion of cumulative impacts addresses the potential for impacts that are insignificant, when viewed separately, but may become significant when viewed together. Cumulative impacts include impacts on the affected environment of the proposed activities over the life of the project, in addition to past and reasonably foreseeable future activities, whether onsite or offsite and public or private. The only measurable cumulative impacts are those discussed in this section.

As currently projected for the foreseeable future, concentrations of metal contaminants (depleted uranium, beryllium, lead, and other metals) in soil would approximately double for the TA-15 PHERMEX test area under the No Action Alternative or the Upgrade PHERMEX Alternative. For the DARHT Baseline Alternative, Plutonium Exclusion Alternative, and the Single Axis Alternative, an area equivalent to that of the PHERMEX test area would be contaminated at the DARHT test site to approximately the current level of the PHERMEX test area. In the Enhanced Containment Alternative, if the vessel approach were used

TABLE 5-19.—*Irreversible and/or Irretrievable Commitment of Resources*

Factor	No Action[a] Alternative	DARHT Baseline Alternative	Upgrade PHERMEX[e] Alternative	Enhanced Containment Alternative			Plutonium Exclusion Alternative	Single Axis Alternative
				Vessels[b]	Building[c]	Phased[d]		
CONSTRUCTION								
Construction Materials								
Concrete (yd^3)	15,000	15,000	28,000	16,000	22,000	16,000	15,000	15,000
Cement (tons)	4,500	4,500	9,000	5,100	7,100	5,100	4,900	4,900
Rebar (tons)	600	600	1,000	600	900	600	600	600
Fuel								
Diesel (gal)	9,500	11,500	17,000	12,500	18,500	12,500	11,500	11,500
Gasoline (gal)	9,500	11,500	17,000	12,500	18,500	12,500	11,500	11,500
Propane (lb)	9,500	11,500	17,000	12,500	18,500	12,500	11,500	11,500
Electricity (kWh)	365,000	365,000	750,000	365,000	450,000	365,000	365,000	365,000
Work Force (worker years)								
Craft	50	59	120	74	140	74	59	59
Noncraft	12	14	29	18	26	18	14	14
Project Management (people)	max. 15/day	max. 15/day	max. 15/day	max. 15/day	max. 15/day	max. 15/day	max. 15/day	max. 15/day
Waste Disposal Costs ($ thousands)	14.5	14.5	14.5	14.5	30.0	14.5	14.5	14.5
TOTAL COSTS ($ millions) (construction and equipment)	49	123	145	154	159	154	123	85
OPERATIONS								
Materials Used (Annual)								
Water (gal)	40,000	70,000	70,000	110,000	110,000	100,000	100,000	60,000
Helium (ft^3)	6,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000
Sulfur Hexafluoride (ft^3)	3,100	0	0	0	0	0	0	0
Energy (Annual)								
Natural Gas (ft^3)	8,700	10,400	13,000	13,300	14,800	12,600	10,400	10,400
Electricity (kWh)	550,000	2,250,000	2,500,000	2,600,000	2,900,000	2,520,000	2,250,000	1,350,000

TABLE 5-19.—*Irreversible and/or Irretrievable Commitment of Resources – Continued*

Factor	No Action[a] Alternative	DARHT Baseline Alternative	Upgrade PHERMEX[e] Alternative	Enhanced Containment Alternative			Plutonium Exclusion Alternative	Single Axis Alternative
				Vessels[b]	Building[c]	Phased[d]		
Work Force, (worker years)								
Radiation-trained workers	9	15	15	24	24	22	20	13
Support staff	5	5	5	5	5	5	5	5
Operating Costs per Year ($ millions)	4.2	6.5	6.5	10.4	10.4	7.5[g] 9.5[h] 10.4[i]	6.5	5.4
Material Usage								
Depleted Uranium (lb)	1,540	1,540	1,540	1,540	1,540	1,540	1,540	1,540
Beryllium (lb)	20	20	20	20	20	20	20	20
Lead (lb)	30	30	30	30	30	30	30	30
Copper (lb)	220	220	220	220	220	220	220	220
Other Metals (lb)[f]	440	440	440	440	440	440	440	440
High Explosive (lb)	3,300	3,300	3,100	3,300	3,300	3,300	3,300	3,300
Tritium (Ci)	3	3	3	3	3	3	3	3
Lithium Hydride (lb)	220	220	220	220	220	220	220	220

[a] No construction at PHERMEX; however, construction at proposed DARHT site to complete building for nonhydrodynamic testing purposes.
[b] DARHT Facility plus vessel cleanout facility.
[c] DARHT Facility plus vessel cleanout facility and containment building.
[d] For operations, represents the annual average over the 30-year operating life. The Phased Containment Option of the Enhanced Containment Alternative is divided into three distinct phases of operation: 1) the first five years of operation are marked by 5 percent containment, 2) the second five years of operation are marked by 40 percent containment, and 3) the final phase beginning in the 11th year of operation is marked by 75 percent containment.
[e] New-construction at PHERMEX plus DARHT construction noted in footnote a.
[f] When referring to PHERMEX, "other metals" means the sum of all aluminum, boron, brass, iron, inconel, niobium, nickel, silver, tin, tantalum, titanium, tungsten, and vanadium used during each year.
[g] FY 1999 – 2002
[h] FY 2003 – 2007
[i] FY 2008 and beyond

for uncontained tests, the DARHT test site would be contaminated to approximately 10 percent of the current contamination level of the PHERMEX test area. All of these areas could in time (centuries to millennia) contribute to contamination of ground water; however, the contamination levels were estimated through model simulations over 30 years and were found to be lower than drinking water standards. LANL has contaminated soils in other areas that might contribute to ground water contamination. Although these other potential sources have not been quantified, the contribution of any of the alternatives is not expected to increase the cumulative effects to ground water.

Collective worker dose for the LANL site for 1993 amounted to 239 person-rem, with approximately 0.3 person-rem attributable to testing at the PHERMEX Facility. Because the future testing program is expected to be roughly the same under all alternatives, and worker dose is related to operations, worker dose would be expected to be roughly the same 0.1 percent regardless of the alternative analyzed. Testing at PHERMEX or DARHT would be expected to contribute the same, about 0.1 percent, to LANL worker dose and would be inconsequential in terms of cumulative impacts.

Collective dose for the population within 50 miles (80 km) of the LANL site was 1.4 person-rem for 1992. Under the various hydrodynamic testing alternatives addressed here, the collective dose would be expected to range from 0.13 to 0.32 person-rem/yr. Thus, at a maximum for foreseeable conditions, hydrodynamic testing at TA-15 would continue to contribute roughly 10 to 25 percent of the reported collective population dose from LANL operations. Assuming the last 32 years of hydrodynamic testing to have resulted in about 10 person-rem and that an additional 30 years would double that, the cumulative collective dose from hydrodynamic testing at LANL would be about 20 person-rem out of an approximate 90 person-rem for all site sources (based on constant 1992 level). Cancer would not occur from such a cumulative collective dose since the calculated risk is 0.05 LCFs. The annual collective population dose for the same population from natural background radiation would be about 110,000 person-rem/yr. Hence, over the 30-year period, the collective population dose from natural background radiation would be about 3,200,000 person-rem, for which, using the same conversion factor, about 1,600 LCFs would be inferred.

5.10 IMPACTS ON LONG-TERM PRODUCTIVITY

This section addresses the relationship between short-term uses of the environment and the maintenance of its long-term productivity.

Based on the analyses performed in this EIS, impacts on long-term productivity at Area III of TA-15 would be limited to consequences of deposition of depleted uranium and other metals on the soils of the site from continued testing and the potential of such metals for affecting the piñon/ponderosa pine forest habitat. However, no adverse effects on the piñon/ponderosa pine forest habitat over the last 32 years of operations similar to those proposed have been observed. Therefore, no impacts are expected on long-term productivity of the site from implementation of any of the alternatives.

5.11 MITIGATION MEASURES

One purpose of an EIS is to identify measures that could be taken to mitigate any adverse impacts that are disclosed through the impact analysis. Mitigation measures can be those that are required by law or regulation, those that are built into a project from the start, or those that are developed in response to adverse effects identified in the impact analysis. This section summarizes the mitigation measures that might be applied for any alternative analyzed in this EIS. Mitigation measures required by law or regulation are not discussed in this section. Routine mitigation measures that would be taken as part of standard operating practices for construction or operation, such as providing silt fences around the construction site to reduce soil transport or operating sirens to warn personnel and wildlife of tests, are not included.

The mitigation measures discussed here are of three types. Some are common to all alternatives analyzed. Others are engineered design features that have been made part of the DARHT Facility, and would be common to all alternatives that would use that facility (all alternatives except the No Action and Upgrade PHERMEX alternatives). The third type are those that were identified for a specific alternative. Although these are included earlier in this chapter under each alternative, they are summarized here.

5.11.1 Mitigation Common to All Alternatives

Some mitigation measures would apply to all alternatives, regardless of what course of action the DOE would select. References to the DARHT Facility would apply to actions taken to complete the building for other uses as well as actions taken to complete the DARHT Facility for the proposed use.

- DOE will continue to consult with the four Accord tribes (Cochiti, Jemez, Santa Clara and San Ildefonso Pueblos) to ensure protection of cultural resources in the vicinity of the DARHT and PHERMEX sites (section 4.6.3), and will periodically (at least once a year) arrange for Tribal officials to visit cultural resource sites within TA-15 that are of particular interest to the Tribes.
- Evaluation of cultural resources in the vicinity of TA-15 will be coordinated with the New Mexico State Historic Preservation Officer for concurrence of eligibility determinations and potential effects (see section 4.6.1).
- DOE will periodically (at least once a year) pick up metal fragments in the area, and will invite the local tribes to participate so that they can observe whether there has been damage to any cultural resource sites.
- DOE will develop a way, possibly in conjunction with the State Historic Preservation Officer, the National Park Service, or the local Tribal governments, to periodically photograph or otherwise record the condition of the Nake'muu ruin to determine if activities at TA-15 are causing any structural changes to the ruin over time.
- DOE and LANL have developed a Storm Water Pollution Prevention Plan for the DARHT Facility which was implemented before construction activities began. The plan includes measures for erosion control, sedimentation control, surface restoration and revegetation, storm water retention, and a general housekeeping plan (see appendix K).
- DOE and LANL will develop a habitat management plan for all threatened and endangered species occurring throughout LANL. This plan would be used to determine long-range mitigation actions to protect the habitat for these species (see appendix K).
- DOE and LANL will take specific mitigation actions to protect the nesting habitat of the Mexican spotted owl, such as not disturbing habitat within 0.25 mi (0.4 km) of known nesting habitat (see appendix K).

- Construction activities will be restricted at the DARHT site during the breeding season for the Mexican spotted owl (March 1 to August 31). These measures include limits on light sources, noise, and restricted access for personnel and equipment (see appendix K).
- To protect the habitat for many wildlife species, including Mexican spotted owls, raptors, and salamanders, DOE will not remove trees or dead snags without contacting the LANL ecological studies team (see appendix K).
- To protect the habitat for many wildlife species, including threatened and endangered species, LANL ecological studies team will conduct field surveys to check for the presence of these species prior to site activities such as collecting metal fragments; an appropriate vegetation buffer zone will be maintained between facilities and the canyon rims to minimize erosion from site activities (see appendix K).
- Native trees will be planted, as appropriate, for erosion control and landscaping to provide additional wildlife habitat (see appendix K).
- Waterflow from the facilities will be monitored to ensure compliance with permitted outfalls (see appendix K).
- Any permanent or temporary fencing or other barriers will be constructed so as to minimize the effects on large mammal and predator species movements (see appendix K).
- The LANL ecological studies team will collect baseline data on any contaminants present, and will monitor contaminants by sampling soils, plants, animals, and roadkill at the TA-15 facilities.
- Construction noise would be minimized as much as possible to mitigate adverse impacts to site workers and the general public.

5.11.2 Mitigation by Engineered Design Features

These mitigation measures have been engineered into the DARHT Facility. The facility was designed and (partially) constructed to incorporate many features that would limit potential adverse environmental impacts.

- Orienting the two accelerator halls of the DARHT Facility to provide a "blast shadow" to minimize the possibility of flying fragments reaching the Nake'muu ruin.
- Providing radiation shielding around the accelerators to limit radiation exposure to workers in the facility.
- Construction of an earthen berm to limit radiation exposure beyond the firing site.
- Providing spill containment (physical barriers or sills) inside the facility, with sufficient capacity to contain all hazardous material spills that could conceivably occur in the facility.
- The DARHT site layout includes mitigation to specific cultural resource sites. The access road was routed to avoid two cultural resource sites, and the sites were fenced to protect them from disturbance during construction. At the request of the San Ildefonso Pueblo, a third site was capped and covered by the earthen radiation shielding berm instead of excavating the site. See section 4.6.1.

5.11.3 Mitigation By Alternatives

For the DARHT Baseline Alternative and all alternatives that would involve operating the DARHT Facility (all alternatives except the No Action Alternative and the Upgrade PHERMEX Alternative), glass plates, sandbags, or other shielding material would be used for mitigation during large uncontained shots to:

- Deflect metal fragments and protect cultural resource sites from being reached by flying shrapnel
- Break up fragments, buffer noise, and limit contaminant releases to the Mexican spotted owl habitat

For the Enhanced Containment Alternative the following mitigation measures would apply.

- The method of enhanced containment, under the Building Containment, Vessel Containment, or Phased Containment options, would mitigate soils contamination and other adverse impacts from flying shrapnel for those tests that would be contained.
- Under any option, the cleanout facility would mitigate adverse impacts from cleaning out the containment vessel or building by means of recycling materials and the processes used. See section 3.7.1.3.

5.12 REFERENCES CITED IN CHAPTER 5

Anderson, A.B., 1995, *EIS Information,* LANL Memorandum No. DX-11:95-74, February 15, Los Alamos National Laboratory, Los Alamos, New Mexico.

Bartlit, et al., 1993, *A Fresh Perspective on the Proposed Expansion of Area G at TA-54,* October, Los Alamos National Laboratory, Los Alamos, New Mexico.

Burns, M.J., 1995a, *Response to Initial DARHT EIS Data Request,* LANL Memorandum No. DX-DO:DARHT-95-16, January 30, Los Alamos National Laboratory, Los Alamos, New Mexico.

Burns, M.J., 1995b, *Revised Cost Estimates and Suggested Text Revisions for the Final DARHT EIS,* LANL Memorandum No. DX-DO: DARHT-95-100, August 16, Los Alamos National Laboratory, Los Alamos, New Mexico.

DOE (U.S. Department of Energy), 1994, *DOE Explosives Safety Manual,* DOE/EV/06194, Revision 7, August, Washington, D.C.

DOE (U.S. Department of Energy), 1993, *1992 LANL Dose* [Annual Air Emissions Report for the calendar year 1992], June, Los Alamos, New Mexico.

DOE (U.S. Department of Energy), 1992, *Final Environmental Impact Statement and Environmental Impact Report for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore,* DOE/EIS-0157, August, Albuquerque, New Mexico.

Fong, S., 1993, Letter to L. Gay (New Mexico Environment Department), May 21, Department of Energy, Los Alamos, New Mexico.

Gay, L., 1993, Letter to S. Fong (U.S. Department of Energy), May 27, New Mexico Environment Department, Santa Fe, New Mexico.

Graf, W.L., 1993, *Geomorphology of Plutonium in the Northern Rio Grande*, LA-UR-93-1963, March, Los Alamos National Laboratory, Los Alamos, New Mexico.

ICRP, 1991, "1990 Recommendations of the International Commission on Radiological Protection," *Annals of the ICRP*, ICRP Publication 60, Vol. 21, No. 1-3, ISSN-0146-6453, Pergamon Press, Oxford England.

Korecki, N.T., 1988, *Geotechnical Investigation Report Dual-Axis Radiographic Hydrotest Facility Los Alamos National Laboratories Los Alamos, New Mexico SHB Job. No. E88-1154,* Sergent, Hauskins and Beckwith Consulting Geotechnical Engineers, Albuquerque, New Mexico.

Merlan, T.W., 1989, *Dual-Axis Radiographic Hydrotest (DARHT) Facility,* Letter to H.E. Valencia, February 21, SHPO (State Historic Preservation Officer), State of New Mexico Office of Cultural Affairs, Santa Fe, New Mexico.

Pearman, D.W., 1994, *Economic Escalation Indices for Department of Energy (DOE) Construction, Environmental Restoration and Waste Management Projects,* DOE Memorandum to Distribution, February 22, U.S. Department of Energy, Washington, D.C.

Risberg, D., 1995, *Draft Biological and Floodplain Wetland Assessment for the Dual-Axis Radiographic Hydrodynamics Test Facility (DARHT),* LA-UR-95-647, February, Los Alamos National Laboratory, Los Alamos, New Mexico.

Saricks, C., and T. Kvitek, 1994, *Longitudinal Review of State-Level Accident Statistics for Carriers of Interstate Freight,* ANL/ESD/TM-68, March, Argonne National Laboratory, Argonne, Illinois.

Sutcliffe, W.G., et al., 1995, *A Perspective on the Dangers of Plutonium*, April 14, UCRL-ID-118825, Center for Security and Technology Studies, Lawrence Livermore National Laboratory, Livermore, California.

Vibronics, Inc., 1995, *Acoustic and Seismic Testing at the PHERMEX Facility Conducted For: Environmental Impact Statement for DARHT Facility Los Alamos National Laboratory (March 10, 1995 – March 11, 1995)* Evansville, Indiana.

Chapter 6
Regulatory Requirements

CHAPTER 6
REGULATORY REQUIREMENTS

This section discusses the significant Federal, State, and local permit and approval requirements required for construction and operation of the DARHT Baseline Alternative and the other analyzed alternatives. Names of outside agencies and individuals contacted during preparation of the draft EIS are also included.

6.1 RADIOACTIVE AIR EMISSIONS

Radioactive emissions from LANL facilities are subject to the Environmental Protection Agency (EPA) National Emission Standards for Hazardous Air Pollutants at 40 CFR Part 61. In particular, Subpart A, "General Provisions," and Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities," are applicable. Emissions of radionuclides to the ambient air from a DOE facility are not to exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr [40 CFR 61.92]. DOE submitted an application to construct the DARHT Facility, as described in the DARHT Baseline Alternative, to the Region VI Office of EPA in 1988. In a letter to DOE, dated August 2, 1988, that approved the construction, EPA determined the projected dose to the nearest offsite resident from DARHT operations and other activities conducted at LANL would be well within the 10 mrem/yr standard.

Subpart H of 40 CFR Part 61 [40 CFR 61.93] prescribes emission monitoring and test procedures to determine compliance with the 10 mrem/yr standard at DOE facilities. By letter dated June 25, 1991, DOE informed EPA that LANL was not in full compliance with Subpart H. Although DOE monitors LANL's radionuclide emissions, LANL's monitoring program does not meet the requirements of Subpart H. EPA subsequently issued a Notice of Noncompliance to DOE on November 27, 1991. Shortly thereafter DOE and EPA entered into discussions to execute a Federal Facilities Compliance Agreement to bring LANL into compliance. The EPA issued the draft agreement for public comments on June 5, 1995 [60 FR 29594]; the comment period closed on August 4, 1995. Although the Agreement has not yet been finalized, DOE has been working in the interim to bring sources which emit radionuclides into compliance. The source that emits 95 percent of the radionuclides at LANL, the Los Alamos Meson Physics Facility, is in full compliance, and DOE anticipates full compliance for all sources by the end of 1997. On September 13, 1994, the Concerned Citizens for Nuclear Safety brought a civil action against DOE under the Clean Air Act to enforce the 40 CFR Part 61 requirements at LANL. That matter is still in litigation.

6.2 NONRADIOACTIVE AIR EMISSIONS

Nonradioactive emissions from LANL facilities are subject to the regulatory requirements of the New Mexico Environment Department (NMED) established under the New Mexico Air Quality Control Act. The NMED Air Quality Control Regulation requires a permit for constructing stationary sources or modifying existing sources in the event that the source would have potential emission rates greater than 10 lb/h (4.54 kg/h) or 25 ton/yr (22.67 metric ton/yr) of any regulated air contaminant subject to a Federal or New Mexico ambient air quality standard [NMED Air Quality Control Regulations §702 Part

Two.A(1)]. The PHERMEX Facility has not been subject to this requirement because its construction and operation preceded the effective date of §702 Part Two. The DARHT Baseline Alternative and the alternatives other than the No Action Alternative could be subject to the §702 Part Two permit requirement if they are classified as new stationary sources or modified stationary sources. The NMED regulations give a research facility, such as LANL, the opportunity to group its sources for the purposes of §702 at NMED's discretion [NMED Air Quality Control Regulations §702 Part One.33]. Consequently, the DARHT Facility could potentially be grouped with PHERMEX and not classified as a new stationary source. The DARHT Facility would be a "modification" to the PHERMEX Facility if 1) potential emissions of any regulated air contaminant increase in the event that DARHT became operational and PHERMEX were closed, or 2) new contaminants would be emitted by the DARHT Facility [NMED Air Quality Control Regulations §702 Part One.19].

NMED regulations also require a permit prior to the construction of new or modified sources with potential emissions of toxic air pollutants exceeding specified quantities [NMED Air Quality Control Regulations §702 Part Three.C]. The term *new source* is defined to be any source for which construction commenced after 1988, but not including any new source which is integrally related with and connected to the process of an existing source [NMED Air Quality Control Regulations §702 Part Three.B.(4)]. All alternatives analyzed except the No Action and PHERMEX Upgrade alternatives are, consequently, potentially subject to the permit requirement. However, the rule exempts from the permitting requirements activities such as those analyzed in this EIS (except for the Enhanced Containment Alternative) which are classified as "non-process fugitive emissions of toxic air pollutants from stationary sources" [NMED Air Quality Control Regulations §702 Part Two.C(3)(j)]. The Enhanced Containment Alternative, if implemented, would not be automatically exempt from the air toxic permit requirements since emissions from containment structures would pass through a vent and, therefore, not be classified as *fugitive emissions* under the definition of this term in §702 Part One.16. Appendix A to §702 Part Three of the NMED Air Quality Control Regulations contains the threshold quantity emission limits that would trigger the need for a toxic air emissions permit. The air pollutants from the alternatives under consideration with the greatest likelihood of triggering the permit requirement are uranium and lithium hydride. Appendix A specifies that a permit would be needed if emissions of natural uranium exceed 0.0133 lb/h (6 g/h) and emissions of lithium hydride exceed 0.00167 lb/h (0.76 g/h). (The DARHT Baseline Alternative and the alternatives use depleted uranium; however, the toxicity of depleted uranium is similar to natural uranium.)

If the Enhanced Containment Alternative were to be implemented, a vessel cleanout facility would be built to handle the debris resulting from cleaning the containment structure or vessels after each use. Air emissions for this facility are not currently defined. The need for an emissions permit under §702 will be evaluated when information becomes available.

NMED regulations require owners of sources with potential emissions greater than 10 ton/yr (9.1 metric tons/yr) of any regulated contaminant or 1 ton/yr (0.91 metric tons/yr) of lead to file a Notice of Intent with NMED, whether or not a permit is required, as a condition of construction [NMED Air Quality Control Regulations §703.1 Part Two.A]. Emissions from the DARHT Baseline Alternative or the other alternatives would be within these levels; consequently, a Notice of Intent would not be needed.

All of Los Alamos County has attainment status for the National Ambient Air Quality Standards listed at 40 CFR Part 50. Consequently, a written determination indicating that implementing any alternative analyzed in this EIS would conform to the New Mexico State Implementation Plan does not need to be prepared [20 New Mexico Administrative Code 2.98(2)]. Major new sources of pollutants in attainment areas are subject to prevention of significant deterioration (PSD) permit requirements. None of the alternatives analyzed would by themselves trigger the need for a PSD permit because they are not *major stationary sources* (as that term is defined in the NMED Air Quality Control Regulations §707.P.26) of regulated air pollutants. Projected emissions from any alternative selected for implementation would be combined with other emissions from LANL to determine whether total sitewide emissions would trigger the need for a sitewide PSD.

The DARHT Baseline Alternative and the other alternatives would not be included within the source categories subject to new source performance standards [NMED Air Quality Control Regulations §750].

Emissions of hazardous air pollutants from the DARHT Baseline Alternative or its alternatives would be less than 10 tons/yr (9.1 metric tons/yr) for a single hazardous air pollutant and 25 tons/yr (22.7 metric tons/yr) for any combination of two or more hazardous air pollutants. Consequently, the DARHT Baseline Alternative and the other alternatives would not be major sources of hazardous air pollutants subject to the requirements covering the construction or modification of major sources of hazardous air pollutants at 20 New Mexico Administrative Code 2.83.

Nonradioactive emissions from implementing the DARHT Baseline Alternative or another alternative would eventually be covered in an operating permit issued under NMED Air Quality Control Regulations §770 for the entire LANL site. DOE expects to submit an operating permit application to NMED in late 1995.

6.3 LIQUID DISCHARGES TO SURFACE WATER AND THE GROUND

The three sources of liquid discharges from the DARHT Baseline Alternative and all but the No Action Alternative are cooling tower blowdown, septic tank sanitary waste effluent, and storm water runoff. Although these sources would discharge to the ground, the discharges may enter Water Canyon, an ephemeral tributary to the Rio Grande. The State of New Mexico Environmental Improvement Division issued DOE a septic tank permit (number SF890589) for the DARHT Facility on October 30, 1989. Other septic tank permits have been issued for the Radiographic Support Laboratory and the PHERMEX Facility. EPA issued to LANL on December 29, 1994, a National Pollutant Discharge Elimination System (NPDES) permit (number NMR10A236) covering storm water discharges from construction activity at the DARHT site. A storm water pollution prevention plan for the construction activity was completed and implemented. The cooling tower blowdown from the DARHT Baseline Alternative would have an average flow of 2,000 gal/d (7,600 L/d). This discharge is incorporated into the LANL sitewide NPDES permit (permit number NM0028355) issued to DOE and LANL by EPA Region VI on June 24, 1994.

6.4 CHEMICAL AND MATERIAL STORAGE

Chemical and material storage at a LANL facility would be conducted according to DOE Orders and Manuals. In particular, DOE Orders 5480.4 (Environmental Protection, Safety, and Health Protection Standards) and 5480.7A (Fire Protection) require compliance by DOE and its contractors with National Fire Protection Association Codes and Standards, the Occupational Safety and Health Standards at 29 CFR Part 1910 established by the Occupational Safety and Health Administration (OSHA), and the DOE

Explosives Safety Manual. In addition, DOE rules in 10 CFR Part 835 establish radiation protection standards and program requirements to protect occupational workers at DOE facilities.

6.5 WASTE MANAGEMENT

If implemented, the DARHT Baseline Alternative or the other alternatives would produce five categories of regulated waste: solid waste, hazardous waste, mixed radioactive and hazardous waste (mixed waste), low-level radioactive waste, and TRU waste.

Solid waste that is not classified under Subtitle C of the Resource Conservation and Recovery Act (RCRA) as a hazardous waste would be disposed at the LANL Area J landfill in TA-54 or sent offsite to an approved disposal facility. The Area J landfill is operated according to the requirements in Subtitle D of RCRA, the New Mexico Solid Waste Act, and regulations issued under each Act.

Waste that is classified as hazardous waste under Subtitle C of RCRA would be taken to TA-54 for temporary storage. Ultimate treatment and disposal would occur at RCRA interim status or permitted facilities at LANL or offsite. Hazardous waste storage areas in TA-54 are operated according to the requirements of Subtitle C of RCRA, the New Mexico Hazardous Waste Act, and regulations issued under each Act.

Mixed waste would be treated and disposed according to the site treatment plan for LANL developed in response to the Federal Facility Compliance Act [42 U.S.C. 6939c(b)]. The availability of proposed site treatment plans for various DOE sites, including LANL, was announced April 5, 1995 [60 FR 17346].

Low-level radioactive waste would be disposed at the LANL low-level radioactive waste disposal site in TA-54. This site is operated according to the requirements in chapter III of DOE Order 5820.2A (Radioactive Waste Management).

Materials required to be disposed as TRU waste would be size reduced, as appropriate, to minimize volumes of waste sent to the Waste Isolation Pilot Plant (WIPP). TRU waste would be stored at LANL Area G in TA-54 prior to packaging and certification for shipment to the WIPP.

6.6 NOISE

If implemented, the DARHT Baseline Alternative or the other alternatives would create substantial noise during those times when explosions occur as discussed in section 5.2.3.

Federal efforts to regulate noise largely derive from the Noise Control Act of 1972 [42 U.S.C. 4901-4918]. Under the Act, Federal agencies such as DOE are to carry out their programs to further the Act's purpose of promoting an environment for all Americans that is free from noise that jeopardizes health or welfare [42 U.S.C. 4903(a)]. DOE seeks to meet this obligation by placing high explosives test areas, such as PHERMEX or the DARHT Facility, away from populated areas, localizing the noise impacts to the extent practicable, and conducting operations involving explosives during hours when most people within hearing distance are not sleeping. Beyond the general obligation in the Noise Control Act, no specific requirements in the Noise Control Act or in any regulations implemented under the Act prohibit or regulate the activities conducted at the DARHT Baseline Alternative and its alternatives [42 U.S.C. 4309].

OSHA has established regulations to regulate the noise exposure of occupational workers [29 CFR 1910.95]. DOE Order 5480.4 specifies that DOE contractor operations, such as those to be conducted under the DARHT Baseline Alternative or an alternative, are to meet all OSHA standards in 29 CFR Part 1910.

The Noise Control Act requires Federal agencies to meet State and local requirements relating to the abatement of noise [42 U.S.C. 4903(b)]. No State requirements would prohibit or regulate the noise associated with operation of the DARHT Baseline Alternative or the other alternatives. The Los Alamos County Code does have noise restrictions. It is a violation of the code to cause noise levels exceeding 65 dBA in residential areas of the county between 7 a.m. and 9 p.m. and 53 dBA between 9 p.m. and 7 a.m. (Los Alamos County Code, Ch. 8.28.030). Between 7 a.m. and 9 p.m., the permissible noise level can be increased to 75 dBA in residential areas provided the noise is limited to 10 minutes in any 1 hour. Persons who cannot meet the preceding requirements can request a permit from the county for noise-generating activities of a temporary nature [Los Alamos County Code, Ch. 8.28.060(d)].

6.7 FLOODPLAINS AND WETLANDS

DOE's policy is to avoid, to the extent possible, the long- and short-term adverse impacts associated with the destruction of wetlands and the occupancy and modification of floodplains and wetlands [10 CFR 1022.3]. Executive Order 11988, issued by President Carter in 1977, requires Federal agencies to avoid direct or indirect support of floodplain development when there is a practicable alternative. Executive Order 11990, also issued by President Carter in 1977, directs Federal agencies to minimize the detrimental impact of their actions on wetland areas and avoid new construction on wetlands unless no practicable alternative exists. DOE has determined no floodplains or wetlands are present on land which would be affected by the DARHT Baseline Alternative or the other alternatives.

6.8 THREATENED AND ENDANGERED SPECIES AND MIGRATORY BIRDS

The Endangered Species Act of 1973 requires that Federal agencies not take any action that is likely to jeopardize the continued existence of any endangered species or threatened species or result in destruction or adverse modification of their habitat [16 U.S.C. 1536]. Unless otherwise permitted by regulation, the Migratory Bird Treaty Act makes it unlawful to pursue, hunt, take, capture, kill (or to attempt any of the preceding) any migratory bird or nest or eggs of such bird [16 U.S.C. 703]. The Bald and Golden Eagle Protection Act [16 U.S.C. 668] protects bald and golden eagles. The Fish and Wildlife Coordination Act [16 U.S.C. 661] provides other requirements for protecting wildlife. DOE has reviewed the preceding authorities and has determined that construction and operation of the DARHT Baseline Alternative or another alternative would be consistent with the authorities through implementation of appropriate mitigating measures.

DOE has determined, and the U.S. Fish and Wildlife Service (USFWS) has concurred, that the preferred alternative analyzed in the EIS will not adversely affect any threatened or endangered species or their habitat. DOE and the USFWS have completed informal consultation under Section 7 of the Endangered Species Act; see appendix K. Mitigation measures have been negotiated and are discussed in section 5.11 and appendix K.

6.9 NATIVE AMERICAN, ARCHEOLOGICAL, AND HISTORIC PRESERVATION

DOE's American Indian Tribal Government Policy is in DOE Order 1230.2, issued April 8, 1992. DOE commits in the Order to consult with Tribal governments to assure that Tribal rights and concerns are considered prior to DOE taking actions that may affect Tribes. DOE also has committed to avoiding unnecessary interference with traditional Tribal religious practices.

The August 11, 1978, American Indian Religious Freedom Act (AIRFA) [42 U.S.C. 1996] establishes that it is United States policy to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise their traditional religions, including access to sites, use and possession of sacred objects, and the freedom to worship through ceremonies and traditional rites. The Native American Graves Protection and Repatriation Act provides that Tribal descendants shall own Native American human remains and cultural items discovered on Federal lands after November 16, 1990 [25 U.S.C. 3002]. When items are discovered during an activity on Federal lands, the activity is to cease, and appropriate Tribal governments are to be notified. Work on the activity can resume 30 days after receipt of certification that notice has been received by the Tribal governments.

During the NEPA process for DARHT, DOE has consulted with local American Indian Tribes regarding sites in the vicinity of DARHT and PHERMEX. These consultations are summarized in section 4.6.3, and they are expected to continue in a similar manner through the life of testing activities at DARHT and PHERMEX.

During May, June, and July of 1995, DOE consulted with representatives of the four Accord Tribes, Cochiti, Jemez, Santa Clara and San Ildefonso Pueblos, which have identified themselves as the Tribes most affected by activities at LANL. Meetings included discussions concerning AIRFA matters, on a government-to-government basis following the publication of the draft EIS. Based on general and specific comments provided by Tribal government representatives, DOE has made changes in the content of the final EIS with respect to traditional cultural properties and mitigation measures to protect cultural resource sites. DOE will continue regular consultations with Tribal governments throughout the life of the DARHT project to ensure protection of traditional properties.

The Archaeological Resources Preservation Act prohibits the excavation of material remains of past human life that have archeological interest and are at least 100 years old without a permit from the appropriate Federal land manager or an exemption [16 U.S.C. 470bb, 470ee]. The Federal land manager for LANL is DOE.

The National Historic Preservation Act authorizes the Secretary of the Interior to maintain a National Register of Historic Places [16 U.S.C. 470a(a)(1)]. Federal agencies cannot approve projects that would affect properties listed, or eligible for listing, on the Register without considering the effect on the listed or eligible properties [16 U.S.C. 470f]. For proposed actions at LANL, DOE consults with the New Mexico State Historic Preservation Office and the Advisory Council on Historic Preservation, as necessary. DOE consulted with these offices and with the San Ildefonso Pueblo prior to initiating construction at the DARHT site, and employed the mitigation measures agreed to at that time to protect archeological sites.

DOE has reviewed the preceding authorities and has determined that construction and operation of the DARHT Baseline Alternative or another alternative would be consistent with the authorities through implementation of appropriate mitigating measures.

6.10 SITING AND PLANNING

All of the alternatives under consideration, including the No Action Alternative, involve land in TA-15 at LANL. The *LANL Site Development Plan* provides that existing and planned land uses for TA-15 are for high explosives research, development, and testing (LANL 1994). All alternatives analyzed in the EIS are consistent with the planned land uses for TA-15.

6.11 OTHER AGENCIES AND INDIVIDUALS CONSULTED

In addition to the agencies discussed above, during the preparation of the draft EIS the following outside governmental agencies and individuals were consulted:

John L. Temple, Assistant Director, Bureau of Business and Economic Research, University of New Mexico, 1920 Lomas NE, Albuquerque, NM 87131-6021 (505-277-2216).

Karma A. Shore, Economist, Bureau of Business and Economic Research Data Bank, University of New Mexico, 1920 Lomas NE, Albuquerque, NM 87131-6021 (505-277-8300).

Gerry Bradley, Labor Economist Supervisor, New Mexico Department of Labor, Economic Research and Analysis, P.O. Box 1928, Albuquerque, NM 87103 (505-841-8645).

Jim Greenwood, Los Alamos Economic Development Corporation, 901 18th St., Los Alamos, NM 87544 (505-662-0001).

6.12 REFERENCE CITED IN CHAPTER 6

LANL (Los Alamos National Laboratory), 1994, *Environmental Surveillance at Los Alamos During 1992*, LA-12764-ENV, Los Alamos, New Mexico.

Glossary

GLOSSARY

Access Control Office	LANL office that monitors activities and controls access within TA-15.
aerosolize	The process of converting a solid or a liquid into a gaseous suspension of fine particles (an aerosol).
air quality	A measure of the quantity of pollutants in the air.
air quality standards	The prescribed quantity of pollutants in the outside air that cannot be exceeded legally during a specified time in a specified area.
alluvium	Clay, silt, sand, and/or gravel deposits found in a stream channel or in low parts of a stream valley that is subject to flooding.
ambient air	The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures. It is not the air in immediate proximity to emission sources.
aquifer	Geologic material that contains sufficient saturated permeable material to conduct ground water and to yield worthwhile quantities of ground water to wells and springs.
aqueous	Containing or dissolved in water.
atmosphere	The layer of air surrounding the earth.
background radiation	Normal radiation present in the lower atmosphere from cosmic rays and earth sources. Background radiation varies with location, depending on altitude and natural radioactivity present in the surrounding geology.
beryllium (Be)	A rare metal (average atomic mass of about 9 atomic mass units) used most commonly in the manufacture of beryllium-copper alloys for numerous industrial and scientific applications. It is on the EPA's list of priority metals for hazardous air pollutants.
bound, bounding	A description of the evaluation process that provides a reasonable upper limit to potential consequences or impacts.
breccia	A coarse-grained rock composed of angular broken rock fragments held together by a naturally occurring mineral cement.
°C	Degree Celsius. °C = 5/9 x (°F - 32).
cancer	Any malignant new growth of abnormal cells or tissue.

capable (fault)	A term defined by the Nuclear Regulatory Commission to indicate that a fault is a hazard to be considered in safety analyses.
carcinogenic	Adjective describing an agent that is capable of producing or inducing cancer.
cavate	A hand-dug cavity in the tuff cliff face.
collective dose	The sum of the individual doses to all members of a specific population.
community	A group of people or a site within a spatial scope exposed to risks that potentially threaten health, ecology, or land values, or exposed to industry that stimulates unwanted noise, smell, industrial traffic, particulate matter, or other nonaesthetic impacts (environmental justice definition).
concentration	The amount of a substance contained in a unit quantity (mass or volume) of a sample.
conglomerate	A coarse-grained sedimentary rock composed of rounded fragments larger than 2 mm in diameter set in fine-grained sand or silt. It is commonly cemented naturally by a mineral cement.
control and accountability	Continuing control and accountability, particularly of special nuclear materials such as plutonium and highly enriched uranium.
criteria pollutants	Six pollutants (ozone, carbon monoxide, total suspended particulates, sulfur dioxide, lead, and nitrogen oxide) known to be hazardous to human health and for which the EPA sets National Ambient Air Quality Standards under the Clean Air Act.
criticality	A state in which a self-sustaining nuclear chain reaction is achieved.
cumulative effects	Additive environmental, health, and socioeconomic effects that result from a number of similar activities in an area or over time.
cumulative impacts	The sum of environmental, health, and socioeconomic impacts that result from a number of activities in an area or over time.
curie (Ci)	A unit of radioactivity equal to 37,000,000,000 (3.7×10^{10}) decays per second.
dBA	Decibel on the A-weighted scale (*see also decibel and decibel, A-weighted*).
decay, radioactive	The spontaneous transformation of an unstable atom to a lower, more stable energy state, often with the emission of particulate or electromagnetic radiation (alpha, beta, gamma, or x-radiation).

decibel	An expression of sound pressure level that is referenced to a pressure of 20 micropascals expressed on a logarithmic scale, 1 dB = 20 $\log_{10}$ (p/20) where p is the sound pressure in micropascals. Twenty micropascals approximates the minimum audible sound pressure level in humans (*see also decibel, A-weighted*).
decibel, A-weighted (dBA)	The A-weighted decibel (dBA) is an expression of adjusted pressure levels by frequency that accounts for human perception of loudness. Consequently, dBA is most often used when evaluating human noise disturbance. For example, at a frequency of 500 Hz, 60 dB are reduced by 3.2 dB to give an A-weighted pressure level of 56.8 dBA. Lower frequencies are reduced more because they are less of an annoyance to humans, and higher frequencies are reduced less because they are more of an annoyance (*see also decibel*).
decommissioning	The removal from service of facilities such as processing plants, waste tanks, and burial grounds, and the reduction or stabilization of radioactive contamination, if present.
depleted uranium	A mixture of uranium isotopes where uranium-235 represents less than 0.7 percent of the uranium by mass.
design life	The estimated period of time that a component or system is expected to perform within specifications before the effects of aging result in performance deterioration or a requirement to replace the component or system.
detonation	*See explosion.*
disablement	A means to render a nuclear weapon so that it cannot be detonated.
dose rate	The radiation dose delivered per unit time (e.g., rad/h).
dynamic experiment	An experiment to provide information regarding changes in materials under conditions caused by the detonation of high explosives.
E/Q (E over Q)	A measure of atmospheric dispersion for short-term (acute) atmospheric releases using Gaussian dispersion plume modeling, with units of s/m^3. For a given point or location at some distance from the source, it represents the time-integrated air concentration ($Ci \cdot s/m^3$) divided by the total release from the source (Ci). Integrated air concentrations used are usually plume centerline values. E/Qs are typically used for release lasting no longer than 8 to 24 hours.
ecology	The science dealing with the relationship of all living things with each other and with the environment.

ecosystem	A complex of the community of living things and the environment forming a functioning whole in nature.
ecotone	A transition zone that exists between two ecologic communities.
Ector	An existing x-ray diagnostic machine scheduled to be moved to PHERMEX in mid-1995.
effective dose equivalent	A concept used to estimate the biological effect of ionizing radiation. It is the sum over all body tissues of the product of absorbed dose, the quality factor (to account for the different penetrating abilities of the various types of radiation), and the tissue weighing factor (to account for the different radiosensitivity of the various tissues of the body).
effluent	Liquid or airborne material released to the environment. In common usage, however, the term "effluent" implies liquid release.
effluent standards	Defined limits of effluent in terms of volume, content of contaminants, temperature, etc.
EIS	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.
electron accelerator	A device which uses intense electrical and magnetic energy to increase the velocity of electrons, thereby increasing their energy.
element	One of the known chemical substances that cannot be divided into simpler substances by chemical means. All isotopes of an element have the same atomic number (number of protons) but have a different number of neutrons, and thus different atomic weights.
emission standards	Legally enforceable limits on the quantities and kinds of air contaminants that can be emitted into the atmosphere.
endangered species	Plants and animals that are threatened with extinction, serious depletion, or destruction of critical habitat. Requirements for declaring a species endangered are contained in the Endangered Species Act.
energy	The capacity to produce heat or do work.
enhanced radiography	A radiography technique for producing extremely high-resolution, time-phased, photographic images of an opaque object (*see also radiography*).
environment	The sum of all external conditions and influences affecting the life, development, and ultimately the survival of an organism.

environmental monitoring	The act of measuring, either continuously or periodically, some quantity of interest, such as radioactive material in the air.
ephemeral stream	A stream channel which carries water only during and immediately after periods of rainfall or snowmelt.
epicenter	The point on the earth's surface directly above the focus of an earthquake.
equation-of-state	A mathematical expression which defines the physical state of a homogeneous substance by relating volume to pressure and absolute temperature for a given mass of the material.
erosion	A general term for the natural processes by which earth materials are loosened, dissolved, or worn away and moved from one place to another. Typical processes are wind and water as they carry away soil.
evapotranspiration	Loss of water from the earth's surface to the atmosphere by evaporation from the soil, lakes, streams, and by transpiration from plants.
exclusion zone	The area surrounding the firing point that is cleared of all personnel for a test shot. The radius of this area is determined by the size of the shot.
explosion	An extremely fast chemical reaction producing high temperatures and a large amount of gas. The terms explosion and detonation (also explode and detonate) are used interchangeably here; but to a specialist, they are distinct terms and depend on reaction rates.
exposure to radiation	The incidence of radiation on living or inanimate material by accident or intent. Background exposure is the exposure to natural background ionizing radiation. Occupational exposure is the exposure to ionizing radiation that occurs during a person's working hours. Population exposure is the exposure of a number of persons who inhabit an area.
°F	Degree Fahrenheit. F = (°C x 9/5) + 32.
fallout	Radioactive material that has been produced and distributed through the atmosphere as a result of aboveground testing of nuclear devices.
fault	A fracture or a zone of fractures within a rock formation along which vertical, horizontal, or transverse slippage of the earth's crust has occurred in the past.
fissionable	Atoms capable of being split or divided (fissioned) by the absorption of thermal neutrons. The most common fissionable materials are uranium-233, uranium-235, and plutonium-239.

fission	The splitting of a heavy nucleus into two approximately equal parts, which are nuclei of lighter elements, accompanied by the release of energy and generally one or more neutrons. Fission can occur spontaneously or can be induced by nuclear bombardment.
forb	A general term for a weed or broad leaf flowering plant as distinguished from grasses and sedges.
formation	A body of rock identified by lithic characteristics and stratigraphic position. Formations may be combined into groups or subdivided into members.
fugitive emission	Those emissions which could not reasonably pass through a stack, chimney, vent, or other fundamentally equivalent opening.
GENII	A computer program used to estimate doses to individuals and populations from releases of radioactive materials.
geology	The science that deals with the earth; the materials, processes, environments, and history of the planet, especially the lithosphere, including the rocks, their formation, and structure.
ground water	All subsurface water, especially that part that is in the zone of saturation.
group	The geological term for the rock layer next in rank above formation.
habitat	The part of the physical environment in which a plant or animal lives.
half-life (radiological)	The time in which half the atoms of a radioactive substance disintegrate to another nuclear form. Half-lives vary from millionths of a second to billions of years.
Hazard Index (HI)	An indicator of the potential toxicological hazard from exposure to a particular substance. The HI is equal to an individual's estimated exposure divided by the U.S. EPA's substance-specific reference dose. An HI of 1.0 would indicate an expectation of the health effect upon which the reference dose is based. No toxicological effects would be expected where the HI is less than 1.0.
hazard zone	A circular area in which personnel are not allowed outside the control rooms during tests involving high explosives. The area is centered on the firing point and its radius is determined from the amount of explosives to be used.
He-Ne Laser	A device which uses a gaseous mixture of helium (He) and Neon (Ne) to produce an intense beam of light.

HEPA filter	High-efficiency particulate air filter designed to remove greater than 99.9 percent of particles from a flowing air stream. Efficiency is determined at 0.3 μ; efficiency increases for particles larger and smaller than 0.3 μ.
historic resources	The sites, districts, structures, and objects considered limited and nonrenewable because of their association with historic events, persons, or social or historic movements.
Horizon A (soil)	The top-most layer of soil distinguishable by color, texture, or structure.
hydrodynamic test	A dynamic integrated systems test of a mock-up nuclear package during which the high explosives are detonated and the resulting motions and reactions of materials and components are measured. The explosively generated high pressures and temperatures cause some of the materials to behave hydraulically (like a fluid).
hydrodynamic testing facility	A facility in which to conduct dynamic and hydrodynamic testing for nuclear and conventional weapons research and assessment. Fast diagnostic systems that are available include radiographic, electrical, optical, laser, and microwave.
hydronuclear experiment	Very-low-yield experiment (less than a few pounds of nuclear energy released) to assess primary performance and safety with normal detonation.
intensity (earthquake)	A numerical rating used to describe the effects of earthquake ground motion on people, structures, and the earth's surface. The numerical rating is based on an earthquake intensity scale such as the modified Mercalli Scale commonly used in the United States.
interbed	A typically thin bed of one kind of rock material occurring between or alternating with beds of another material.
interfingers	The combination of markedly different rocks through vertical succession of thin interlocking or overlapping of wedge-shaped layers.
interflow breccias	A breccia that occurs in or between volcanic flows.
ion	An atom or molecule that has gained or lost one or more electrons to become electrically charged.
ionization	The process that creates ions. Nuclear radiation, x-rays, high temperatures, and electric discharges can cause ionization.
ionizing radiation	Radiation capable of displacing electrons from atoms or molecules to produce ions.

irradiation	The process of exposing a material to radiation.
ISC2	A computerized dispersion program used to calculate ground-level concentrations of air pollutants.
isotope	An atom of a chemical element with a specific atomic number and atomic weight. Isotopes of the same element have the same number of protons but different numbers of neutrons. Isotopes are identified by the name of the element and the total number of protons and neutrons in the nucleus. For example, uranium-238 is a uranium atom with 238 protons and neutrons.
laser	An active electronic device that converts input power into a very narrow, intense beam of light.
latent cancer fatalities (LCFs)	Deaths that were ultimately caused by a radiation-induced cancer. The cancer became evident years after the radiation exposure. LCFs can be calculated for the public by using the risk conversion factor of 5×10^{-4} deaths per person-rem and for the worker by using the risk conversion factor of 4×10^{-4} deaths per person-rem.
lineament	A geological term for straight or gently curved alignments of topographic features such as depressions, streams, or changes in surface slope.
linear accelerator	A device in which atomic particles travel in a straight line as their velocity is increased. A particle accelerator that accelerates electrons, protons, or heavy ions in a straight line by the action of alternating voltages.
lithic	The description of rocks on the basis of such characteristics as color, mineralogic composition, and grain size.
low-income communities	A community where 25 percent or more of the population is identified as living in poverty.
low-level waste	Radioactive waste not classified as high-level waste or TRU waste; for DARHT and PHERMEX it would consist mainly of solid material contaminated with low levels of depleted uranium.
lystric fault	The fault that is steep at the ground surface and becomes less and less steep as its depth increases. It eventually becomes horizontal or nearly horizontal.
mass balance error	The difference between two estimates of the change in water stored; the difference between influent and effluent, and the difference between initial and final stored water.

maximum contaminant levels (MCLs)	The maximum permissible level of a contaminant in water that is delivered to a user of a public water system.
maximally exposed individual (MEI)	A real or hypothetical person located to receive the maximum possible dose from a given hazardous material release.
member	A geological term for a layer of rock that includes some specially developed part of a formation.
MEPAS	Computer code used to estimate the toxicological hazards resulting from releases of hazardous materials.
migration	The movement of a material through the soil or ground water.
mitigate	To take practicable means to avoid or minimize environmental harm from a selected alternative.
National Register of Historic Places	A list maintained by the National Park Service of architectural, historic, archeological, and cultural sites of local, State, or national importance.
natural background radiation	Radiation that is ubiquitous and generated in naturally occurring materials or through naturally occurring processes. Principal sources of background radiation are primordial radionuclides such as uranium, thorium, and potassium-40 and cosmic radiation. In contrast, radiation may be produced or enhanced by man-made means such as activation or nuclear fission.
noninvolved worker	For this EIS, a worker who is not involved in the operation of a facility when a radioactive release occurs, and who is assumed to be 2,500 ft (750 m) or 1,300 ft (400 m) from the point of release, depending on the exposure scenario and alternative.
NEPA	National Environmental Policy Act of 1969 as amended; it requires the preparation of an EIS for Federal projects that could present significant impacts to the environment.
nonproliferation	The restriction of ability to easily access fissile material in concentrations sufficient to assemble a nuclear weapon.
NO_x	Oxides of nitrogen, primarily nitrogen oxide (NO) and nitrogen dioxide (NO_2). These are produced in the combustion of fossil fuels, and can constitute an air pollution problem.
nuclear radiation	*See radiation.*

nuclear reaction	An interaction between a photon, particle, or nucleus and a target nucleus, leading to the emission of one or more particles and photons.
nuclear stockpile	The total aggregation of the Nation's nuclear weapons that are in the custody of the Department of Defense. This quantity is defined in the nuclear weapons stockpile memorandum.
nuclear weapon	The general name given to any weapon in which an explosion can result from the energy released by reactions involving atomic nuclei, either fission, fusion, or both.
nuclear weapons primaries	Those components of a nuclear weapon involved in the reaction up to the point where nuclear criticality is achieved.
nuclide	A species of atom, characterized by its nuclear constitution (number of protons and number of neutrons).
organic compounds	Carbon compounds which are, or are similar to, compounds produced by living organisms.
outfall	Place where liquid effluents enter the environment and are monitored.
oxide	A compound in which an element chemically combines with oxygen.
ozone	A molecule of oxygen in which three oxygen atoms are chemically attached to each other.
particulates	Solid particles and liquid droplets small enough to become airborne.
passive safety system	A system that provides safety features requiring no human intervention or adverse condition to actuate.
perennial stream	A stream that contains water at all times except during extreme drought.
perched aquifer	A body of ground water separated from an underlying body of ground water by an unsaturated zone.
people of color communities	A population classified by the U.S. Bureau of the Census as Black, Hispanic, Asian and Pacific Islander, American Indian, Eskimo, Aleut, and other nonwhite persons, the composition of which is at least equal to or greater than the state minority average of a defined area or jurisdiction.
permeability	Ability of liquid to flow through rock, ground water, soil, or other substance.
person-rem	Unit of radiation dose to a given population; the sum of the individual doses received by a collection of individuals.

pH	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.
physiographic	Pertaining to the physical features of the earth's surface, such as land forms or bodies of water.
plutonium (Pu)	A transuranic, heavy (average atomic mass ranging from about 237–244 atomic mass units), silvery metallic element with 15 isotopes that is produced by the neutron irradiation of natural uranium.
PM_{10}	Particulate matter with a 10 micron or less aerodynamic diameter.
pollution	The addition of an undesirable agent to the environment in excess of the rate at which natural processes can degrade, assimilate, or disperse it.
progeny	Stable or radioactive elements formed by the radioactive decay of another nuclide, which is the "parent."
pulse width	The duration of a brief burst of energy, such as x-rays or direct current electricity.
Puye Formation	A stratigraphic unit composed of basalts, interflow breccias, conglomerates, sandstones, and siltstones that underlies Los Alamos National Laboratory.
radiation	The emitted particles or photons from radioactive atoms.
radioactive waste	Materials from nuclear operations that are radioactive or are contaminated with radioactive materials and for which there is no practical use or for which recovery is impractical (*see low-level waste*).
radioactivity	The process of radioactive decay (*see decay, radioactive*)
radiography	The technique of producing a photographic image of an opaque specimen by transmitting a beam of x-rays or gamma rays through it onto an adjacent photographic film; the image results from variations in thickness, density, and chemical composition of the specimen.
radionuclide	A nuclide that emits radiation.
reach	A continuous and unbroken expanse or surface of water (used in hydrologic contexts).
recharge	The processes involved in the absorption and addition of water to an aquifer.
rem	The unit of effective dose equivalent.

render safe	A means to make a nuclear weapon secure from unwanted detonation.
Richter Scale	A numerical scale of earthquake magnitude that represents the size of an earthquake at its source.
risk	In accident analysis, the probability weighted consequence of an accident, defined as the accident frequency per year multiplied by the dose. The term "risk" is also used commonly to describe the probability of an event occurring.
runoff	The portion of rainfall, melted snow, or irrigation water that flows across the ground surface and eventually returns to streams.
Santa Fe Group	The name applied to a sequence of geologic formations that have been deposited mostly in the Rio Grande rift. These deposits are primarily sediments with some limestones, volcanic tuffs, and basalts.
Stockpile Stewardship and Management Program	The DOE program to develop a new approach, based on scientific understanding and expert judgement, to ensure continued confidence in the safety, performance, and reliability of the nuclear weapons stockpile.
seismicity	The way earthquakes of various sizes occur geographically and temporally.
shield	Material used to reduce the intensity of radiation that would irradiate personnel or equipment.
short-lived	A designation for radionuclides with relatively short half-lives.
solid state laser	A device which uses a semiconductor to produce an intense beam of light. This term is often used to distinguish a device from gas lasers.
spallation products	Products that result from a nuclear reaction in which the energy of the incident particle is so high that more than two or three particles are ejected from the target nucleus, and both its mass number and atomic number are changed.
stabilization	The action of making a nuclear material more stable by converting its physical or chemical form or placing it in a more stable environment.
static testing	Using radiographic equipment to make an x-ray image of a test assembly before other testing is done.
stockpile management	Maintenance, evaluation, repair, or replacement of weapons in the existing stockpile.

stockpile stewardship	A program of activities to maintain the technical competence and capability for the Nation to continue to have confidence in the safety, reliability, and performance of our nuclear weapons.
strata	Layers of rock usually in a sequence.
stratum	A single layer of rock, usually one of a sequence.
stratigraphy	The science of rock strata, or the characteristics of a particular set of rock strata.
surface water	All bodies of water on the Earth's surface (e.g., streams, lakes, reservoirs), as distinguished from ground water.
threatened species	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
transuranic elements	Elements that have atomic numbers greater than 92; all are radioactive, and are products of artificial nuclear changes.
tritium	A radioactive isotope of hydrogen; its nucleus contains one proton and two neutrons.
TRU waste	Material contaminated by alpha-emitting radionuclides, which are heavier than uranium, with half-lives greater than 20 years and in concentrations greater than 100 nCi/g of material.
Tshirege member	Layer of volcanic rock that is a member of the Bandelier tuff. It is composed of multiple flow units of tuff.
tuff	A type of rock formed of compacted volcanic fragments.
uranium (U)	A heavy (average atomic mass of about 238 atomic mass units), silvery-white metal with 14 radioactive isotopes.
welding	Consolidation of sediments by pressure resulting from weight of material or from earth movement.
$\bar{\chi}/Q'$	(*Chi-bar over Q-prime*) A measure of the average atmospheric dispersion for long-term (chronic) atmospheric releases using gaussian dispersion plume modeling, with units of s/m^3. For a given point or location at some distance from the source, it represents the average air concentration in Ci/m^3 divided by the release rate in Ci/s. Typically the concentration used $\bar{\chi}/Q'$ is the average centerline value for individuals and is averaged over a specific sector of a polar grid surrounding the release point for populations. is used for long-term (chronic) releases, often on the order of months or years.

x-ray	**A penetrating electromagnetic radiation, which may be generated by accelerating electrons to high velocity and suddenly stopping them by collision with a target material.**

List of Preparers and Contributors

LIST OF PREPARERS AND CONTRIBUTORS

This list identifies individuals who were principal preparers and contributors to this environmental impact statement (EIS). Many other individuals contributed to the preparation and review of the EIS. M. Diana Webb of the Los Alamos Area Office of the Department of Energy (DOE) directed the preparation of the EIS. David E. Rosson, Jr., of DOE's Albuquerque Operations Office is the Director of the DOE/AL *Environmental Impact Statement* Program Office. Glen T. Hanson of Battelle's Albuquerque Office provided overall project management, as well as technical and document preparation support. E. B. Moore provided management of the technical support from participating staff from DOE's Pacific Northwest Laboratory (managed and operated by Battelle).

Name:	**ROSANNE L. AABERG**
Affiliation:	Battelle – Pacific Northwest Laboratory
Education:	• B.S., Chemical Engineering, University of Washington, 1976
Technical Experience:	Nineteen years of experience in the fields of environmental health physics, nuclear fuel cycle analysis, and RCRA compliance.
EIS Responsibility:	Contributed monitoring information for chapter 5.

Name:	**SAMUEL T. ALEXANDER**
Affiliation:	Los Alamos National Laboratory
Education:	• M.S., Applied Mathematics, University of Wisconsin, 1968 • B.S., Applied Mathematics, University of California at Berkeley, 1965
Technical Experience:	Twenty-three years of experience in facility and project management for explosives firing sites, facility support, and radiographic analyses.
EIS Responsibility:	Co-preparer of chapter 3 and provided baseline data for appendix B, coordinated DX-Division information for the EIS.

Name:	**KURT ANAST**
Affiliation:	Los Alamos National Laboratory
Education:	• B.S., Metallurgical Engineering, Colorado School of Mines, 1979
Technical Experience:	Sixteen years of experience in process design, construction, and operation in the chemical, metallurgical, and waste treatment areas.
EIS Responsibility:	Contributed to development of Enhanced Containment Alternative.

Name: ALLAN B. ANDERSON

Affiliation: Los Alamos National Laboratory

Education:
- Ph.D., Solid State Physics, Colorado State University, 1976
- B.S., Physics, Western Illinois University, 1970

Technical Experience: Eighteen years of experience in high explosives research and development.

EIS Responsibility: Contributed to appendix B.

Name: DAVID M. ANDERSON

Affiliation: Battelle – Pacific Northwest Laboratory

Education:
- M.S., Forest Economics, Oregon State University, 1991
- B.S., Forest Resources, Oregon State University, 1989

Technical Experience: Five years of experience with regional socioeconomic modeling using various regional impact assessment codes.

EIS Responsibility: Contributed to the socioeconomics section.

Name: JAY K. BOETTNER

Affiliation: Los Alamos National Laboratory

Education:
- M.S., Engineering, Texas Technological University, 1980
- B.S., Electrical Engineering, University of Missouri, 1966

Technical Experience: Twenty-nine years of engineering and testing experience, with particular expertise in weapons testing. Participated in design and acquisition of new confinement and safety vessels.

EIS Responsibility: Provided information for chapter 3 and appendix B.

Name: MICHAEL J. BURNS

Affiliation: Los Alamos National Laboratory

Education:
- M.S., Mechanical Engineering, University of California at Berkeley, 1984
- B.S., Mechanical Engineering, New Mexico State University, 1983

Technical Experience: Ten years of experience in design, fabrication, and testing of linear induction accelerator systems for electron-beam and radiographic research.

EIS Responsibility: Co-preparer of chapter 3, provider of baseline data for appendix B, contributed to description of technical alternatives.

Name:	**DAVID C. CHASTAIN**
Affiliation:	Los Alamos National Laboratory
Education:	• M.A.E., Architectural Engineering, Oklahoma State University, 1977 • B.S., Architectural Studies, Oklahoma State University, 1975
Technical Experience:	Eighteen years of experience in facility design and construction with the last ten years in project management.
EIS Responsibility:	Co-preparer of chapter 3 and provider of baseline data for appendix B and construction data on the DARHT Facility.
Name:	**COLBERT E. CUSHING**
Affiliation:	Battelle – Pacific Northwest Laboratory
Education:	• Ph.D., Limnology, University of Saskatchewan, 1961 • M.S., Limnology, Colorado State University, 1956 • B.S., Fisheries Management, Colorado State University, 1952
Technical Experience:	Thirty-four years of experience in freshwater ecological research in streams and radioecology, and over 20 years of experience in EIS preparation.
EIS Responsibility:	Prepared biotic resources consequence section of chapter 5.
Name:	**SALVATORE DIMARIA**
Affiliation:	Battelle – Albuquerque
Education:	• M.A., Geography, University of New Mexico, 1988 • B.S., Biology, University of New Mexico, 1972
Technical Experience:	Seven years of experience with geographical, biological, and quantitative methods research.
EIS Responsibility:	Prepared the biotic resources section in chapter 4, and assisted with the overall review. Prepared appendix F.
Name:	**MICHAEL J. FAYER**
Affiliation:	Battelle – Pacific Northwest Laboratory
Education:	• Ph.D., Soil Physics, University of Massachusetts, 1984 • M.S., Plant and Soil Science, University of Maine, 1980 • B.S., Plant and Soil Science, University of Maine, 1976
Technical Experience:	Eleven years of experience in water, energy, mass transport in porous media, and recharge measurement and modeling.
EIS Responsibility:	Contributed to geohydrological analyses for chapter 5 and determined the deep drainage rate beneath the DARHT site.

Name: **NANCY FOOTE**

Affiliation: Battelle – Pacific Northwest Laboratory

Education:
- B.A., Sociology and English, University of Missouri, 1952

Technical Experience: Nineteen years of experience in technical writing and editing.

EIS Responsibility: Assisted in technical editing of chapter 5.

Name: **CHRISTIAN J. FOSMIRE**

Affiliation: Battelle – Pacific Northwest Laboratory

Education:
- M.S., Meteorology, Pennsylvania State University, 1993
- B.S., Meteorology, Pennsylvania State University, 1990

Technical Experience: One year of experience in computer programming and data collection and analysis in the area of atmospheric diffusion modeling and risk assessment.

EIS Responsibility: Prepared criteria air pollutant sections of chapter 5 and appendix C1.

Name: **BRUCE GALLAHER**

Affiliation: Los Alamos National Laboratory

Education:
- M.S., Hydrology, University of Arizona, 1979
- B.S., Mathematics, Eastern New Mexico University, 1972

Technical Experience: Seventeen years of experience in the field of contaminant hydrology.

EIS Responsibility: Provided input to water resources sections in chapter 4.

Name: **GARIANN GELSTON**

Affiliation: Battelle – Pacific Northwest Laboratory

Education:
- B.S., Applied Mathematics, Mesa State College, 1991

Technical Experience: One year of experience in environmental assessment modeling.

EIS Responsibility: Modeled nonradiological chronic/cumulative exposure analyses for human health sections of chapter 5 and appendix H.

Name: **BARBARA A. GEORGITSIS**

Affiliation: Battelle – Albuquerque

Education:
- B.S., Civil Engineering, University of New Mexico, 1994

Technical Experience: One year of experience in data management, quality assurance, and NEPA compliance.

EIS Responsibility: Assembled and prepared sections of chapter 4.

Name:	**CLIFFORD S. GLANTZ**
Affiliation:	Battelle – Pacific Northwest Laboratory
Education:	• M.S., Physics and Atmospheric Sciences, University of Washington, 1982 • B.S., Physics and Atmospheric Sciences, State University of New York–Albany, 1979
Technical Experience:	Twenty-seven years of experience in research in the fields of environmental risk assessment and risk management, air pollution meteorology, and multipathway pollutant transport modeling.
EIS Responsibility:	Contributed to the air quality sections of chapter 5 and appendix C1.
Name:	**PHILIP D. GOLDSTONE**
Affiliation:	Los Alamos National Laboratory
Education:	• Ph.D., Physics, State University of New York at Stony Brook, 1975 • M.S., Physics, Polytechnic Institute of Brooklyn, 1972 • B.S., Physics, Polytechnic Institute of Brooklyn, 1971
Technical Experience:	Twenty years of experience in nuclear and plasma physics and weapons science, and five years of experience with nuclear weapons issues, including stockpile stewardship in the absence of underground nuclear testing.
EIS Responsibility:	Provided information for chapters 2 and 3.
Name:	**GLEN T. HANSON**
Affiliation:	Battelle – Albuquerque
Education:	• M.A., Anthropology/Archaeology, Arizona State University, 1976 • B.S., Anthropology/Archaeology, Grand Valley State College, 1971
Technical Experience:	Twenty-four years of experience in environmental and resource management, regulatory compliance, environmental assessment and impact analyses for NEPA documentation, facility siting, site characterization, cultural resource assessment and management, and environmental program management.
EIS Responsibility:	Project Manager - Battelle – Albuquerque. Technical and management reviewer.
Name:	**PAUL L. HENDRICKSON**
Affiliation:	Battelle – Pacific Northwest Laboratory
Education:	• J.D., Law, University of Washington, 1971 • M.S., Industrial Management, Purdue University, 1972 • B.S., Chemical Engineering, University of Washington, 1968
Technical Experience:	Twenty-two years of experience in energy and environmental studies with special emphasis on regulatory issues.
EIS Responsibility:	Prepared sections on land use impacts in chapter 5 and chapter 6 regulatory requirements.

Name:	**RUTH A. HENDRICKSON**
Affiliation:	Battelle – Columbus
Education:	• Ph.D., English, The Ohio State University, 1988 • M.A., English, Marshall University, 1982 • B.A., English, Marshall University, 1980
Technical Experience:	Thirteen years of experience in technical writing, editing, and publications management, and ten years of university-level teaching experience in the fields of writing and communications.
EIS Responsibility:	Technical editor/writer.
Name:	**JAMES A. HILEMAN**
Affiliation:	Battelle – Albuquerque
Education:	• Ph.D., Seismology, California Institute of Technology, 1977 • M.S., Seismology, California Institute of Technology, 1971 • Geophysical Engineer, Colorado School of Mines, 1960
Technical Experience:	Thirty years of experience in exploration, research, management, and review, particularly in siting critical facilities and assessing geologic hazards.
EIS Responsibility:	Lead preparer of chapter 3 and sections on geological environment (chapter 4) and geological consequences (chapter 5).
Name:	**TRACY A. IKENBERRY**
Affiliation:	Battelle – Pacific Northwest Laboratory
Education:	• M.S., Radiology & Radiation Biology, Colorado State University, 1982 • B.A., Biology, McPherson College, 1979
Technical Experience:	Thirteen years of experience in radiological assessment, operational and environmental health physics. Diplomate, American Board of Health Physics, 1988.
EIS Responsibility:	Task Manager for chapter 5 environmental consequences. Technical reviewer and contributor to chapter 5 and associated appendixes.
Name:	**JOYCE B. JOHNSON**
Affiliation:	Battelle – Columbus
Education:	• M.A., English, Ball State University, 1971 • B.A., English, Hanover College, 1967
Technical Experience:	Twenty-four years of experience in preparing and managing publications, writing, editing, and training, and ten years of experience managing groups of publications specialists.
EIS Responsibility:	Technical editor/writer.

Name:	**EDWARD L. JOLLY**
Affiliation:	Butler Service Group (Subcontractor to Los Alamos National Laboratory)
Education:	• M.S., Nuclear Engineering, University of New Mexico, 1968 • B.S., Physics, New Mexico Institute of Mining and Technology, 1961
Technical Experience:	Thirty-four years of experience in pulsed power, explosives testing, and accelerator technology.
EIS Responsibility:	Co-preparer of chapter 3 and provided baseline data for appendix B, provided input to containment alternative; technical reviewer.

Name:	**DAVID C. KELLER**
Affiliation:	Los Alamos Naitonal Laboratory
Education:	• B.S., Biology, University of New Mexico, 1988.
Technical Experience:	Ten years of experience in research biology, specializing in bird research.
EIS Responsibility:	Conducted endangered species surveys and prepared the biological assesment for DARHT.

Name:	**CHARLES T. KINCAID**
Affiliation:	Battelle – Pacific Northwest Laboratory
Education:	• Ph.D., Engineering, Utah State University, 1979 • B.S., Civil Engineering, Humboldt State College, 1970
Technical Experience:	Sixteen years of experience in the area of water flow and contaminant transport in the subsurface environment.
EIS Responsibility:	Lead preparer for water resources and soils sections of chapter 5 and appendixes D and E.

Name:	**BEVERLY M. LARSON**
Affiliation:	Los Alamos National Laboratory
Education:	• M.A., Anthropology, Wichita State, 1980 • B.A., Anthropology, Wichita State, 1976
Technical Experience:	Twenty years of experience in archeological research and cultural resource management in the southwest and plains states.
EIS Responsibility:	Assisted in the preparation of the cultural and archeological sections of chapter 4.

Name: JAY C. LAVENDER

Affiliation: Battelle – Pacific Northwest Laboratory

Education:
- B.A., Industrial Technology, Washington State University, 1984

Technical Experience: Ten years of experience in risk, safety, reliability, and statistical analysis techniques and in the preparation of safety analysis documents for a wide variety of nonnuclear and nuclear operations, facilities, and transportation systems.

EIS Responsibility: Prepared transportation section for chapter 5 and appendix I.

Name: DONALD A. McCLURE

Affiliation: The Delphi Group, Inc. (Subcontractor to Los Alamos National Laboratory)

Education:
- Ph.D., Nuclear Physics, University of Missouri at Rolla, 1970
- M.S., Physics/Mathematics, University of Missouri at Rolla, 1966
- B.A., Physics/Mathematics, Nebraska Wesleyan University, 1964

Technical Experience: Twenty-five years of professional teaching and research experience in the areas of reactor safety, personnel dosimetry, environmental monitoring, licensing, emergency response, facility safety, order compliance, operational readiness, and environmental impact analysis.

EIS Responsibility: Co-preparer of chapter 3, provided baseline data for appendix B, coordinator and developer of technical, management, and administrative information for chapter 3, and contributed to the classified supplement.

Name: EMMETT B. MOORE

Affiliation: Battelle – Pacific Northwest Laboratory

Education:
- Ph.D., Physical Chemistry, University of Minnesota, 1956
- B.S., Chemistry, Washington State University, 1951

Technical Experience: Twenty years of experience in environmental regulation, and participation in and management of the preparation of environmental permits and documentation.

EIS Responsibility: Project Manager of technical support provided by Battelle – Pacific Northwest Laboratory.

Name: MARK T. MURPHY

Affiliation: Battelle – Pacific Northwest Laboratory

Education:
- Ph.D., Geology, Johns Hopkins University, 1989
- M.S., Geology, University of New Mexico, 1985
- B.S., Earth Science, University of California at Santa Cruz, 1977

Technical Experience: Fourteen years of professional experience in environmental geology and geological engineering.

EIS Responsibility: Contributed to seismic impact section of chapter 5 and appendix D.

Name: ELIZABETH A. NAÑEZ

Affiliation: Battelle – Albuquerque

Education:
- M.S., Environmental Engineering, University of New Mexico, in progress
- B.S., Industrial Engineering, Texas Tech University, 1990

Technical Experience: Five years of experience in engineering, including three years' concentration in environmental engineering.

EIS Responsibility: Prepared sections of chapter 3, appendix K, and assisted in data collection.

Name: IRAL C. NELSON

Affiliation: Battelle – Pacific Northwest Laboratory

Education:
- M.A., Physics, University of Oregon, 1955
- B.S., Mathematics, University of Oregon, 1951

Technical Experience: Forty years of experience in various aspects of health physics (radiation protection) and 24 years of experience in conducting NEPA reviews and preparing NEPA documentation. Diplomate, American Board of Health Physics, 1962.

EIS Responsibility: Deputy Project Manager of technical support provided by Battelle – Pacific Northwest Laboratory; technical reviewer and contributor to chapter 5.

Name: WILLIAM E. NICHOLS

Affiliation: Battelle – Pacific Northwest Laboratory

Education:
- M.S., Civil Engineering, Oregon State University, 1990
- B.S., Agricultural Engineering, Oregon State University, 1987

Technical Experience: Five years of experience in hydrologic and hydrothermal vadose zone modeling for performance assessment of waste isolation and disposal issues.

EIS Responsibility: Prepared ground water transport modeling for water resources section of chapter 5.

Name: PAUL NICKENS

Affiliation: Battelle – Pacific Northwest Laboratory

Education:
- Ph.D., Anthropology, University of Colorado, 1974
- M.A., Anthropology, University of Colorado, 1972
- B.A., Anthropology, University of Colorado, 1969

Technical Experience: Twenty-one years of experience in southwestern archeology and cultural site protection and preservation.

EIS Responsibility: Prepared the cultural resources sections of chapter 5.

Name:	**ROBERT T. NIEHOFF**
Affiliation:	Battelle – Columbus
Education:	• B.S., Chemistry, Xavier University, 1960
Technical Experience:	Thirty-one years of experience in information research, document management, and technical editing.
EIS Responsibility:	Technical editor/writer.
Name:	**YASUO ONISHI**
Affiliation:	Battelle – Pacific Northwest Laboratory
Education:	• Ph.D., Mechanics and Hydraulics, University of Iowa, 1972 • M.S., Mechanical Engineering, University of Osaka Prefecture, 1969 • B.S., Mechanical Engineering, University of Osaka Prefecture, 1967
Technical Experience:	Twenty years of experience in fluid mechanics and hydrology with expertise in transport and chemical interactions of sediment and contaminants.
EIS Responsibility:	Obtained solubility and adsorption properties of potential contaminants for water resources section of chapter 5.
Name:	**TED M. POSTON**
Affiliation:	Battelle – Pacific Northwest Laboratory
Education:	• M.S., Fisheries, Central Washington University, 1978 • B.A., Fisheries, Central Washington University, 1973
Technical Experience:	Twenty years of experience in research, environmental assessment, and noise analysis.
EIS Responsibility:	Prepared noise analysis sections of chapter 5 and appendix C2.
Name:	**RANDY F. REDDICK**
Affiliation:	Battelle – Albuquerque
Education:	• M.S., Environmental Health Engineering, University of Kansas, 1983 • B.S., Civil Engineering, University of Kansas, 1982
Technical Experience:	Twelve years of experience with NEPA compliance, NEPA document preparation, and safety studies.
EIS Responsibility:	Deputy Project Manager - Battelle – Albuquerque. Prepared portions of chapters 3 and 4.

Name: **MARSHALL C. RICHMOND**

Affiliation: Battelle – Pacific Northwest Laboratory

Education:
- Ph.D., Civil and Environmental Engineering, University of Iowa, 1987
- M.S., Civil and Environmental Engineering, Washington State University, 1983
- B.S., Civil and Environmental Engineering, Washington State University, 1982

Technical Experience: Eight years of experience in the development and application of hydrodynamic and contaminant transport models for surface water flow systems.

EIS Responsibility: Modeled water transport for chapter 5 and appendix E.

Name: **DEBORAH RISBERG**

Affiliation: Los Alamos National Laboratory

Education:
- B.S., Biology, University of New Mexico, 1990

Technical Experience: Ten years of experience in many areas of environmental biology, including research, environmental compliance, and environmental protection.

EIS Responsibility: Conducted endangered species surveys and prepared the biological assesment for DARHT.

Name: **ALAN C. ROHAY**

Affiliation: Battelle – Pacific Northwest Laboratory

Education:
- Ph.D., Geophysics, University of Washington, 1982
- B.S., Geology, Massachusetts Institute of Technology, 1974

Technical Experience: Fifteen years of experience in seismic and volcanic hazards, structure of the earth, earthquake, explosion, and noise signal analysis.

EIS Responsibility: Supported the sections on seismic hazard and facility noise consequences in chapter 5.

Name: **STEVEN B. ROSS**

Affiliation: Battelle – Albuquerque

Education:
- M.S., Nuclear Engineering, University of New Mexico 1987
- B.S., Nuclear Engineering, University of New Mexico 1985

Technical Experience: Nine years of experience in safety analysis, risk assessment, regulatory analysis, and fire risk assessment.

EIS Responsibility: Provided technical review of chapters 3, 4, 5, and appendixes.

Name: DAVID E. ROSSON, JR.

Affiliation: U.S. Department of Energy

Education:
- B.S., Metallurgical Engineering, University of Tennessee, 1963

Technical Experience: Thirty-five years of government service with increasing responsibilities in program and project management, including five years' experience in the safety and environmental area.

EIS Responsibility: Director, DOE/Albuquerque Operations, EIS Project Office.

Name: NANCY N. SAUER

Affiliation: Los Alamos National Laboratory

Education:
- Ph.D., Inorganic Chemistry, Iowa State University, 1986
- B.S., Chemistry, University of Idaho, 1981

Technical Experience: Twelve years of experience in metal ion coordination chemistry and four years' experience in development of waste treatment technologies.

EIS Responsibility: Contributed to development of Enhanced Containment Alternative in chapter 3.

Name: SANDRA F. SNYDER

Affiliation: Battelle – Pacific Northwest Laboratory

Education:
- M.S.P.H., Radiological Hygiene, University of North Carolina, 1991
- B.S., Environmental Resource Management, Pennsylvania State University, 1986

Technical Experience: Seven years of experience in modeling of environmental releases of radioactive materials.

EIS Responsibility: Prepared human health section of chapter 5. Prepared appendixes H and I.

Name: LISSA STAVEN

Affiliation: Battelle – Pacific Northwest Laboratory

Education:
- M.S., Health Physics, Colorado State University, 1990
- B.S., Environmental Conservation, University of New Hampshire, 1984

Technical Experience: Five years of experience in environmental health physics and low-level waste disposal management practices.

EIS Responsibility: Contributed to decontamination and decommissioning sections and prepared waste management sections of chapter 5.

Name:	**T. J. TRAPP**
Affiliation:	Los Alamos National Laboratory
Education:	• Ph.D., Nuclear Engineering, Oregon State University, 1977 • M.S., Nuclear Engineering, Mississippi State University, 1974 • B.S., Nuclear Engineering, Mississippi State University, 1973
Technical Experience:	Twenty years of experience in plutonium science and nuclear technology.
EIS Responsibility:	Provided information for chapter 3 and classified supplement to the EIS.
Name:	**CARLOS A. ULIBARRI**
Affiliation:	Battelle – Pacific Northwest Laboratory
Education:	• Ph.D., Economics, University of New Mexico, 1992 • B.A., Economics and Spanish Literature, University of New Mexico, 1984
Technical Experience:	Five years of experience in natural resource and environmental economics.
EIS Responsibility:	Prepared sections on socioeconomics and environmental justice in chapters 4 and 5. Prepared appendix G.
Name:	**JANIS L. VOMACKA**
Affiliation:	Battelle – Albuquerque
Education:	• Graduate, American Business College, 1964
Technical Experience:	Twenty-eight years of experience in publication preparation and management, including technical editing, graphics design and production, desktop publishing, and printing.
EIS Responsibility:	Technical editor, graphics designer, and production coordinator.
Name:	**DAVE WARD**
Affiliation:	Battelle –Albuquerque
Education:	• B.S., Engineering Physics, University of Maine, 1957
Technical Experience:	Thirty-eight years of nuclear engineering and safety analysis experience.
EIS Responsibility:	Assisted in data collection for chapter 3.
Name:	**M. DIANA WEBB**
Affiliation:	Department of Energy, Los Alamos Area Office
Education:	• M.L.A., Landscape Architecture, University of Illinois, 1975 • B.F.A., Fine Arts, University of Illinois, 1966
Technical Experience:	Twenty-eight years of experience in the areas of environmental planning and NEPA compliance.
EIS Responsibility:	DOE NEPA Document Manager and contributed to various sections of the EIS.

Name:	**MARK WIGMOSTA**
Affiliation:	Battelle – Pacific Northwest Laboratory
Education:	• Ph.D., Environmental Engineering, University of Washington, 1991 • M.S., Geological Sciences, University of Washington, 1983 • B.S., Geological Sciences, University of Washington, 1981
Technical Experience:	Twelve years of experience in the areas of surface water hydrology, erosion processes, and sediment transport.
EIS Responsibility:	Contributed to water resources section of chapter 5 in areas of surface runoff and sediment and contaminant transport in chapter 5 and appendix E.
Name:	**SANDRA K. WISE**
Affiliation:	Battelle – Albuquerque
Education:	• B.S., Environmental Health, Colorado State University, 1995
Technical Experience:	Eight years of experience in data management, quality assurance and one year experience in NEPA compliance.
EIS Responsibility:	Prepared sections of appendix K.
Name:	**DONALD C. WOLKERSTORFER**
Affiliation:	Los Alamos National Laboratory
Education:	• Ph.D., Applied Physics, Stanford University, 1971 • M.S., Applied Physics, Stanford University, 1967 • B.S., Physics, Marquette University, 1965
Technical Experience:	Twenty-two years of experience in nuclear design and nuclear weapons program management.
EIS Responsibility:	Provided information for chapter 2 and the classified supplement to the EIS.

Distribution List

DARHT EIS

DISTRIBUTION LIST

UNITED STATES SENATE

The Honorable Jeff Bingaman
Santa Fe, NM

The Honorable Jeff Bingaman
Washington, DC

The Honorable Pete V. Domenici
Santa Fe, NM

The Honorable Pete V. Domenici
Washington, DC

The Honorable Pete V. Domenici
Subcommittee on Energy and Water Development
Committee on Appropriations
Washington, DC

The Honorable J.J. Exon
Subcommittee on Strategic Forces
Committee on Armed Forces
Washington, DC

The Honorable J.B. Johnston
Subcommittee on Energy and Water Development
Committee on Appropriations
Washington, DC

The Honorable Trent Lott
Subcommittee on Strategic Forces
Committee on Armed Forces
Washington, DC

UNITED STATES HOUSE OF REPRESENTATIVES

The Honorable Tom Bevill
Subcommittee on Energy and Water Development
Committee on Appropriations
Washington, DC

The Honorable Duncan Hunter
Subcommittee on Military Procurement
Committee on National Security
Washington, DC

The Honorable John T. Myers
Subcommittee on Energy and Water Development
Committee on Appropriations
Washington, DC

The Honorable Bill Richardson
Santa Fe, NM

The Honorable Bill Richardson
Washington, DC

The Honorable Steve Schiff
Albuquerque, NM

The Honorable Steve Schiff
Washington, DC

The Honorable Joe Skeen
Las Cruces, NM

The Honorable Joe Skeen
Washington, DC

The Honorable Ike Skelton
Subcommittee on Military Procurement
Committee on National Security
Washington, DC

FEDERAL AGENCIES

Don Klima
Advisory Council on Historic Preservation
Washington, DC

Alan Pacham
Centers for Disease Control, ATSDR
Atlanta, GA

John T. Conway
Defense Nuclear Facilities Safety Board
Washington, DC

Jonathan Medalia
Library of Congress
Congressional Research Service (CRS/F)
Washington, DC

Robert M. Bernero
Nuclear Regulatory Commission
Nuclear Material Safety and Safeguards
Washington, DC

Harold Balbok
U.S. Army Corps of Engineers
CERL
Washington, DC

A.F. Einarsen
U.S. Army Corps of Engineers
Office of Environmental Policy
Washington, DC

Robert Fairweather
Office of Management and Budget
Environmental Branch
Washington, DC

John W. Zavitz
Office of U.S. Attorney for the District of New Mexico
Albuquerque, NM

Charles Cartwright
U.S. Department of Agriculture
Forest Service
Albuquerque, NM

Lori Osterstock
U.S. Department of Agriculture
Forest Service
Santa Fe National Forest
Espanola, NM

Loretta L. Dunn
U.S. Department of Commerce
Legislative and Intergovernmental Affairs
Washington, DC

Harold P. Smith, Jr.
U.S. Department of Defense
Washington, DC

Everet Beckner
U.S. Department of Energy, DP-2
Washington, DC

Carol Borgstrom
U.S. Department of Energy, EH-42
Office of NEPA Policy and Assistance
Washington, DC

Howard Canter
U.S. Department of Energy, MD-2
Washington, DC

David Crandall
U.S. Department of Energy, DP-16
Washington, DC

Richard Crowe
U.S. Department of Energy, DP-13
Germantown, MD

Jim Daniel, EH-422
U.S. Department of Energy
Washington, DC

Carlton H. Darnell
U.S. Department of Energy, DP-32
Germantown, MD

William Dennison
U.S. Department of Energy, GC-51
Washington, DC

Robert DeWitt
U.S. Department of Energy, DP-11
Germantown, MD

Roger Dintaman
U.S. Department of Energy, DP-34
Germantown, MD

Patrick Edgerton
U.S. Department of Energy, DP-42
Germantown, MD

Arnold Epstein
U.S. Department of Energy, DP-32
Germantown, MD

Steve Ferguson
U.S. Department of Energy, GC-51
Washington, DC

Roger Fisher
U.S. Department of Energy, DP-10
Washington, DC

James Van Fleet
U.S. Department of Energy, DP-14
Washington, DC

Henry Garson
U.S. Department of Energy, DP-34
Germantown, MD

Richard Hahn
U.S. Department of Energy, DP-22
Germantown, MD

Robert Hamby
U.S. Department of Energy, DP-32
Germantown, MD

Harold Harris
U.S. Department of Energy, DP-10
Washington, DC

Clarence Hickey
U.S. Department of Energy, ER-8.2
Germantown, MD

Ted Hines
U.S. Department of Energy, EH-422
Washington, DC

Loveless Johnson III
U.S. Department of Energy, EM-5
Washington, DC

Marc Johnston
U.S. Department of Energy, GC-30
Washington, DC

Robert A. Jones
U.S. Department of Energy, DP-11
Germantown, MD

Mark Kasischke
U.S. Department of Energy, GC-32
Washington, DC

Michael Kleinrock
U.S. Department of Energy, EM-22
Washington, DC

Jim Landers
U.S. Department of Energy, DP-4
Washington, DC

Allen Levy
U.S. Department of Energy, DP-16
Washington, DC

Stan Lichtman
U.S. Department of Energy, EH-421
Washington, DC

Kenneth Luongo
U.S. Department of Energy, NN-40
Washington, DC

Janet Masters
U.S. Department of Energy, GC-32
Washington, DC

Robert Nordhaus
U.S. Department of Energy, GC-1
Washington, DC

Jay Norman
U.S. Department of Energy, NN-40
Washington, DC

Tara O'Toole
U.S. Department of Energy, EH-1
Washington, DC

John Ordaz
U.S. Department of Energy, DP-13
Germantown, MD

Gary Palmer
U.S. Department of Energy, DP-34
Washington, DC

John Rabb
U.S. Department of Energy, CI-61
Washington, DC

Dan Reicher
U.S. Department of Energy, S
Washington, DC

Victor Reis
U.S. Department of Energy, DP-1
Washington, DC

Joan Rohlfing
U.S. Department of Energy, DP-1
Washington, DC

Eric Schweitzer
U.S. Department of Energy, DP-25
Washington, DC

Elizabeth Sellers
U.S. Department of Energy
Richland, WA

Raj Sharma
U.S. Department of Energy, NE-433
Germantown, MD

Marshall Sluyter
U.S. Department of Energy, DP-11
Germantown, MD

Steve Sohinki
U.S. Department of Energy, DP-25
Washington, DC

John C. Stewart
U.S. Department of Energy, EM-22
Germantown, MD

Bob Strickler
U.S. Department of Energy, EH-422
Washington, DC

Mary Anne Sullivan
U.S. Department of Energy, GC-50
Washington, DC

Kim Tully
U.S. Department of Energy
Center for Environmental Management Support, EM-5
Washington, DC

Anna Bachica
U.S. Department of Energy, OIEA
Albuquerque Operations Office
Albuquerque, NM

Rex Borders
U.S. Department of Energy, OSHD
Albuquerque Operations Office
Albuquerque, NM

Corey Cruz
U.S. Department of Energy, EISPO
Albuquerque Operations Office
Albuquerque, NM

Nick Dienes
U.S. Department of Energy, OESH
Albuquerque Operations Office
Albuquerque, NM

Shiv Goel
U.S. Department of Energy, EPD
Albuquerque Operations Office
Albuquerque, NM

Steve Guidice
U.S. Department of Energy, OEST
Albuquerque Operations Office
Albuquerque, NM

Bob Henderson
U.S. Department of Energy, SNSD
Albuquerque Operations Office
Albuquerque, NM

Gloria Inlow
U.S. Department of Energy, OIEA
Albuquerque Operations Office
Albuquerque, NM

Tracy Loughead
U.S. Department of Energy
Albuquerque Operations Office
Albuquerque, NM

Karen McAda
U.S. Department of Energy, EPD
Albuquerque Operations Office
Albuquerque, NM

Jeff Robbins
U.S. Department of Energy, EPD
Albuquerque Operations Office
Albuquerque, NM

Ivan Rose
U.S. Department of Energy, PMB
Albuquerque Operations Office
Albuquerque, NM

David E. Rosson
U.S. Department of Energy, EISPO
Albuquerque Operations Office
Albuquerque, NM

Connie Soden
U.S. Department of Energy, EPD
Albuquerque Operations Office
Albuquerque, NM

Bruce Twinning
U.S. Department of Energy, OOM
Albuquerque Operations Office
Albuquerque, NM

Robert Walston
U.S. Department of Energy, OSHD
Albuquerque Operations Office
Albuquerque, NM

George Werkema
U.S. Department of Energy, WQD
Albuquerque Operations Office
Albuquerque, NM

Earl Whiteman
U.S. Department of Energy, WQD
Albuquerque Operations Office
Albuquerque, NM

Dean Triebel
U.S. Department of Energy
Amarillo Area Office
Amarillo, TX

Harold Johnson
U.S. Department of Energy
Carlsbad Area Office
Carlsbad, NM

Lisa Cummings
U.S. Department of Energy, OC
Los Alamos Area Office
Los Alamos, NM

Steve Fong
U.S. Department of Energy
Los Alamos Area Office
Los Alamos, NM

Juan L. Griego
U.S. Department of Energy
Los Alamos Area Office
Los Alamos, NM

Mathew Johansen
U.S. Department of Energy
Los Alamos Area Office
Los Alamos, NM

Larry Kirkman
U.S. Department of Energy
Los Alamos Area Office
Los Alamos, NM

Joyce Laeser
U.S. Department of Energy
Los Alamos Area Office
Los Alamos, NM

Herman LeDoux
U.S. Department of Energy
Los Alamos Area Office
Los Alamos, NM

Jon Mack
U.S. Department of Energy
Los Alamos Area Office
Los Alamos, NM

Bill Mullen
U.S. Department of Energy
Los Alamos Area Office
Los Alamos, NM

James Nunz
U.S. Department of Energy
Los Alamos Area Office
Los Alamos, NM

Ted Taylor
U.S. Department of Energy
Los Alamos Area Office
Los Alamos, NM

Ivan Trujillo
U.S. Department of Energy
Los Alamos Area Office
Los Alamos, NM

Gilberto Valenzuela
U.S. Department of Energy
Los Alamos Area Office
Los Alamos, NM

Joe Vozella
U.S. Department of Energy
Los Alamos Area Office
Los Alamos, NM

Diana Webb
U.S. Department of Energy
Los Alamos Area Office
Los Alamos, NM

Elizabeth Withers
U.S. Department of Energy
Los Alamos Area Office
Los Alamos, NM

Ken Zamora
U.S. Department of Energy
Los Alamos Area Office
Los Alamos, NM

Robert J. Agonia
U.S. Department of Energy
Nevada Operations Office
Las Vegas, NV

Don Elle
U.S. Department of Energy
Nevada Operations Office
Las Vegas, NV

John Leppert
U.S. Department of Energy
Nevada Operations Office
Las Vegas, NV

Anthony Adduci
U.S. Department of Energy
Oakland Operations Office
Oakland, CA

Leanne Morrow
U.S. Department of Energy
Oakland Operations Office
Livermore, CA

Tricia Powell
U.S. Department of Energy
Rocky Flats
Golden, CO

Nancy Ben
U.S. Department of Energy
Rocky Flats Public Reading Room
Westminster, CO

Drew Grainger
U.S. Department of Energy
Savannah River Operations Office
Aiken, SC

Arthur Blazer
U.S. Department of the Interior
Bureau of Indian Affairs
Albuquerque, NM

Fred Lujan
U.S. Department of the Interior
Bureau of Indian Affairs, Southern Pueblos Agency
Albuquerque, NM

Velma Mason
U.S. Department of the Interior
Bureau of Indian Affairs, Northern Pueblos Agency
Espanola, NM

William R. Calkins
U.S. Department of the Interior
Bureau of Land Management
New Mexico State Office
Santa Fe, NM

Joseph Hesbrook
U.S. Department of the Interior
Bureau of Land Management
Native American Program Office
Santa Fe, NM

Bryan Jacobs
U.S. Department of the Interior
National Park Service
Los Alamos, NM

Mark Mendoza
U.S. Department of the Interior
National Park Service
Santa Fe, NM

Roy Weaver
U.S. Department of the Interior
National Park Service
Los Alamos, NM

Jonathan P. Deason
U.S. Department of the Interior
Office of Environmental Project Review
Washington, DC

Libby Stone
U.S. Department of the Interior
Office of Environmental Project Review
Washington, DC

Willie R. Taylor
U.S. Department of the Interior
Office of Environmental Project Review
Washington, DC

Edward Stern
U.S. Department of Labor
Office of Regulatory Analysis
Occupational Safety and Health Administration
Washington, DC

Sam Coleman
U.S. Environmental Protection Agency, Region 6
Air, Pesticides and Toxics Division
Dallas, TX

Susan Offerdal
U.S. Environmental Protection Agency
Office of Federal Activities
Washington, DC

Richard Sanderson
U.S. Environmental Protection Agency
Office of Federal Activities
Washington, DC

Allyn M. Davis
U.S. Environmental Protection Agency, Region 6
Hazardous Waste Management Division
Dallas, TX

Barbara Driskoll
U.S. Environmental Protection Agency, Region 6
Dallas, TX

Hank D. May
U.S. Environmental Protection Agency, Region 6
Dallas, TX

Jane Saginaw
U.S. Environmental Protection Agency, Region 6
Dallas, TX

Lynda F. Carroll
U.S. Environmental Protection Agency, Region 6
Dallas, TX

Mike Jansky
U.S. Environmental Protection Agency, Region 6
Dallas, TX

Karen Cathey
U.S. Fish and Wildlife Service
New Mexico Ecological Services State Office
Albuquerque, NM

Jennifer Fowler-Propst
U.S. Fish and Wildlife Service
New Mexico Ecological Services State Office
Albuquerque, NM

GOVERNMENT LABORATORIES

Tony Dvorak
Argonne National Laboratory
Washington, DC

Marsha Goldberg
Argonne National Laboratory
Washington, DC

Michael Lazaro
Argonne National Laboratory
Woodridge, IL

Bruce Verhaaren
Argonne National Laboratory
Argonne, IL

Mike Anastasio
Lawrence Livermore National Laboratory
Washington, DC

C.F. Baker
Lawrence Livermore National Laboratory
Livermore, CA

Diane Meyer
Lawrence Livermore National Laboratory
Germantown, MD

Holly Miller
Lawrence Livermore National Laboratory
Livermore, CA

Lloyd Multhauf
Lawrence Livermore National Laboratory
Livermore, CA

Carolyn Pura
Lawrence Livermore National Laboratory
Livermore, CA

Ken Zahn
Lawrence Livermore National Laboratory
Livermore, CA

Ellen Taylor
Lawrence Livermore National Laboratory
Germantown, MD

James Aldrich
Los Alamos National Laboratory
Los Alamos, NM

Mike Alexander
Los Alamos National Laboratory
Los Alamos, NM

Thomas Alexander
Los Alamos National Laboratory
Los Alamos, NM

Allan Anderson
Los Alamos National Laboratory
Los Alamos, NM

Leroy Apodaca
Los Alamos National Laboratory
Los Alamos, NM

Gian Bacigalupa
Los Alamos National Laboratory
Los Alamos, NM

Jody Benson
Los Alamos National Laboratory
Los Alamos, NM

Jim Bland
Los Alamos National Laboratory
Los Alamos, NM

Jay Boettner
Los Alamos National Laboratory
Los Alamos, NM

Fred Bolton
Los Alamos National Laboratory
Los Alamos, NM

Rhondda Bradbury
Los Alamos National Laboratory
Los Alamos, NM

Karl Braithwaite
Los Alamos National Laboratory
Los Alamos, NM

Katherine Brittin
Los Alamos National Laboratory
Los Alamos, NM

Jay Brown
Los Alamos National Laboratory
Los Alamos, NM

Richard Browning
Los Alamos National Laboratory
Los Alamos, NM

Michael Burns
Los Alamos National Laboratory
Los Alamos, NM

George Chandler
Los Alamos National Laboratory
Los Alamos, NM

David Chastain
Los Alamos National Laboratory
Los Alamos, NM

Donald Cobb
Los Alamos National Laboratory
Los Alamos, NM

Greg Cunningham
Los Alamos National Laboratory
Los Alamos, NM

Jim Danneskiold
Los Alamos National Laboratory
Los Alamos, NM

Bob Day
Los Alamos National Laboratory
Los Alamos, NM

Robin DeVore
Los Alamos National Laboratory
Los Alamos, NM

Jean Dewart
Los Alamos National Laboratory
Los Alamos, NM

Dan Dunham
Los Alamos National Laboratory
Los Alamos, NM

Eric Edmonds
Los Alamos National Laboratory
Los Alamos, NM

Carl Ekdahl
Los Alamos National Laboratory
Los Alamos, NM

Jack Ellvinger
Los Alamos National Laboratory
Los Alamos, NM

Dennis Erickson
Los Alamos National Laboratory
Los Alamos, NM

Eric M. Ferm
Los Alamos National Laboratory
Los Alamos, NM

Kathy Firestone
Los Alamos National Laboratory
Los Alamos, NM

Teralene Foxx
Los Alamos National Laboratory
Los Alamos, NM

Bernard Foy
Los Alamos National Laboratory
Los Alamos, NM

Phil Fresquez
Los Alamos National Laboratory
Los Alamos, NM

Candace Frostenson
Los Alamos National Laboratory
Los Alamos, NM

Nicole Gaedecke
Los Alamos National Laboratory
Los Alamos, NM

Bruce Gallaher
Los Alamos National Laboratory
Los Alamos, NM

Doris Garvey
Los Alamos National Laboratory
Los Alamos, NM

Arlin Givens
Los Alamos National Laboratory
Los Alamos, NM

Ernie Gladney
Los Alamos National Laboratory
Los Alamos, NM

Roger Goldie
Los Alamos National Laboratory
Los Alamos, NM

Phil Goldstone
Los Alamos National Laboratory
Los Alamos, NM

Nancy Greene
Los Alamos National Laboratory
Los Alamos, NM

Todd Haagenstad
Los Alamos National Laboratory
Los Alamos, NM

Kenneth Hanson
Los Alamos National Laboratory
Los Alamos, NM

Barbara Hargis
Los Alamos National Laboratory
Los Alamos, NM

Sig Hecker
Los Alamos National Laboratory
Los Alamos, NM

Hillard Howard
Los Alamos National Laboratory
Los Alamos, NM

John Huchton
Los Alamos National Laboratory
Los Alamos, NM

Reggie Hughes
Los Alamos National Laboratory
Los Alamos, NM

John Immele
Los Alamos National Laboratory
Los Alamos, NM

David Jardine
Los Alamos National Laboratory
Los Alamos, NM

George Jennings
Los Alamos National Laboratory
Los Alamos, NM

Ed Jolly
Los Alamos National Laboratory
Los Alamos, NM

Donald J. Keigher
Los Alamos National Laboratory
Los Alamos, NM

Michelle Kirsch
Los Alamos National Laboratory
Los Alamos, NM

Mike Kolb
Los Alamos National Laboratory
Los Alamos, NM

Dave Kraig
Los Alamos National Laboratory
Los Alamos, NM

Beverly Larson
Los Alamos National Laboratory
Los Alamos, NM

Elaine Larson
Los Alamos National Laboratory
Los Alamos, NM

Dan Macdonell
Los Alamos National Laboratory
Los Alamos, NM

Carolyn Mangeng
Los Alamos National Laboratory
Los Alamos, NM

Joan March
Los Alamos National Laboratory
Los Alamos, NM

Paula Mattys
Los Alamos National Laboratory
Los Alamos, NM

Don McClure
Los Alamos National Laboratory
Los Alamos, NM

Gail McFarlane
Los Alamos National Laboratory
Los Alamos, NM

James Mercer-Smith
Los Alamos National Laboratory
Los Alamos, NM

Karl Mueller
Los Alamos National Laboratory
Los Alamos, NM

Kent N Musgrave
Los Alamos National Laboratory
Los Alamos, NM

Sally Olguin
Los Alamos National Laboratory
Los Alamos, NM

Harry Otway
Los Alamos National Laboratory
Los Alamos, NM

Ghazar R. Papazian
Los Alamos National Laboratory
Los Alamos, NM

Bill Partain
Los Alamos National Laboratory
Los Alamos, NM

Ann Pendergrass
Los Alamos National Laboratory
Los Alamos, NM

Gene Peterson
Los Alamos National Laboratory
Los Alamos, NM

Kathy Pfeufer
Los Alamos National Laboratory
Los Alamos, NM

Ed Pogue
Los Alamos National Laboratory
Los Alamos, NM

Doniven Porterfield
Los Alamos National Laboratory
Los Alamos, NM

Steve Rae
Los Alamos National Laboratory
Los Alamos, NM

Tom Ribe
Los Alamos Community Reading Room
Los Alamos, NM

Debbie Risberg
Los Alamos National Laboratory
Los Alamos, NM

Carolyn Robinson
Los Alamos National Laboratory
Los Alamos, NM

Carmen M. Rodriguez
Los Alamos National Laboratory
Los Alamos, NM

Evan Rose
Los Alamos National Laboratory
Los Alamos, NM

Pat Rose
Los Alamos National Laboratory
Los Alamos, NM

Mike Saladen
Los Alamos National Laboratory
Los Alamos, NM

Robert Sander
Los Alamos National Laboratory
Los Alamos, NM

Robin Shaw
Los Alamos National Laboratory
Los Alamos, NM

Jacie Siino
Los Alamos National Laboratory
Los Alamos, NM

Caroline Spaeth
Los Alamos National Laboratory
Los Alamos, NM

Doug Stavert
Los Alamos National Laboratory
Los Alamos, NM

Vai Stewart
Los Alamos National Laboratory
Los Alamos, NM

Jay Stimmel
Los Alamos National Laboratory
Los Alamos, NM

Barbara Stine
Los Alamos National Laboratory
Los Alamos, NM

Jim Straight
Los Alamos National Laboratory
Los Alamos, NM

Gil Suazo
Los Alamos National Laboratory
Los Alamos, NM

Carol Sutcliffe
Los Alamos National Laboratory
Los Alamos, NM

T.J. Trapp
Los Alamos National Laboratory
Los Alamos, NM

Bruce Trent
Los Alamos National Laboratory
Los Alamos, NM

Patricia Trujillo-Oviedo
Los Alamos National Laboratory
Los Alamos, NM

Archie Velarde
Los Alamos National Laboratory
Los Alamos, NM

Douglas Venable
Los Alamos National Laboratory
Los Alamos, NM

Ernie Vigil
Los Alamos National Laboratory
Los Alamos, NM

Anne & Chuck Walthers
Los Alamos National Laboratory
Los Alamos, NM

Scott Watson
Los Alamos National Laboratory
Los Alamos, NM

Michael Whalen
Los Alamos National Laboratory
Los Alamos, NM

Lloyd Wheat
Los Alamos National Laboratory
Los Alamos, NM

Jim White
Los Alamos National Laboratory
Los Alamos, NM

Neil Williams
Los Alamos National Laboratory
Los Alamos, NM

Don Wolkerstorfer
Los Alamos National Laboratory
Los Alamos, NM

Paul Hendrickson
Pacific Northwest Laboratory
Richland, WA

Tracy Ikenberry
Pacific Northwest Laboratory
Richland, WA

Charley Kincaid
Pacific Northwest Laboratory
Richland, WA

Emmett Moore
Pacific Northwest Laboratory
Richland, WA

Iral Nelson
Pacific Northwest Laboratory
Richland, WA

Robert Quinn
Pacific Northwest Laboratory
Richland, WA

Sandi Snyder
Pacific Northwest Laboratory
Richland, WA

Carlos Ulibarri
Pacific Northwest Laboratory
Richland, WA

Don Cook
Sandia National Laboratories
Albuquerque, NM

Jim Gerardo
Sandia National Laboratories
Washington, DC

John Maenchen
Sandia National Laboratory
Albuquerque, NM

TRIBAL GOVERNMENT

Fred Peso
Mescalero Apache Tribe
Mescalero, NM

The Honorable Ron Shutiva
Governor, Pueblo of Acoma
Acoma, NM

Stanley Paytiamo
Pueblo of Acoma
Environmental Protection Office
Acomita, NM

The Honorable Isaac P. Herrera
Governor, Pueblo of Cochiti
Cochiti Pueblo, NM

Andrew Quintana
Pueblo of Cochiti
Cochiti Pueblo, NM

The Honorable Alvino Lucero
Governor, Pueblo of Isleta
Isleta Pueblo, NM

The Honorable Paul Chinana
Governor, Pueblo of Jemez
Jemez Pueblo, NM

The Honorable Roland Johnson
Governor, Pueblo of Laguna
Laguna Pueblo, NM

The Honorable Tony Vigil
Governor, Nambe Pueblo
Santa Fe, NM

The Honorable Gerald Nailor
Governor, Picuris Pueblo
Penasco, NM

The Honorable Jacob Viarrial
Governor, Pueblo of Pojoaque
Santa Fe, NM

The Honorable Calvin Garcia
Governor, Pueblo of San Felipe
San Felipe Pueblo, NM

The Honorable Elmer C. Torres
Governor, Pueblo of San Ildefonso
Santa Fe, NM

Randy Sanchez
Lt. Governor, Pueblo of San Ildefonso
Santa Fe, NM

Eric Fender
Pueblo of San Ildefonso
Environmental Office
Santa Fe, NM

Gilbert Sanchez
Pueblo of San Ildefonso
Los Alamos Pueblo Project
Santa Fe, NM

The Honorable Joe A. Garcia
Governor, San Juan Pueblo
San Juan Pueblo, NM

Charles Lujan
San Juan Pueblo, Office of Environmental Affairs
San Juan Pueblo, NM

The Honorable Alex Lujan
Governor, Pueblo of Sandia
Bernalillo, NM

The Honorable Ernest Lujan
Governor, Pueblo of Santa Ana
Bernalillo, NM

The Honorable Edwin Tafoya
Governor, Pueblo of Santa Clara
Española, NM

Walter Dasheno
Pueblo of Santa Clara
Española, NM

The Honorable Bennie Starr
Governor, Pueblo of Santo Domingo
Santo Domingo Pueblo, NM

The Honorable Mike Concha
Governor, Taos Pueblo
Taos, NM

The Honorable Herman Vigil
Governor, Tesuque Pueblo
Santa Fe, NM

Judy Knight-Frank
Ute Mountain
Tawaoc, CO

The Honorable Stanley Pino
Governor, Pueblo of Zia
San Ysidro, NM

The Honorable Donald F. Eriacho
Governor, Pueblo of Zuni
Zuni, NM

NEW MEXICO STATE GOVERNMENT

Governor Gary Johnson
Santa Fe, NM

Lt. Governor Walter D. Bradley
Santa Fe, NM

Karen Lightfoot
New Mexico Energy, Mineral, and Natural Resources Department
Forestry and Resources Conservation Division
Santa Fe, NM

Bill Blankenship
New Mexico Environment Department
Air Pollution and Control Bureau
Santa Fe, NM

Debbie Brinkerhoff
New Mexico Environment Department
Air Pollution and Control Bureau
Santa Fe, NM

Jackie Calligan
New Mexico Environment Department
Library
Santa Fe, NM

Gedi Cibas
New Mexico Environment Department
Office of the Secretary
Santa Fe, NM

Michael Dale
New Mexico Environment Department
Los Alamos, NM

Robert S. Dinwiddie
New Mexico Environment Department
Santa Fe, NM

Benito Garcia
New Mexico Environment Department
Hazardous and Radioactive Material Bureau
Santa Fe, NM

John Parker
New Mexico Environment Department
DOE Oversight Bureau
Santa Fe, NM

Mary M. Perkins
New Mexico Environment Department
DOE EM Oversight Bureau
Los Alamos, NM

Jim Piatt
New Mexico Environment Department
Surface Water Quality Bureau
Santa Fe, NM

Neil Weber
New Mexico Environment Department
DOE Environmental Monitoring & Oversight
Santa Fe, NM

Mark E. Weidler
New Mexico Environment Department
Santa Fe, NM

Stephen Yanicak
New Mexico Environment Department
DOE Environmental Monitoring & Oversight
Los Alamos, NM

Jerry Maracchini
New Mexico Game and Fish Department
Santa Fe, NM

Joseph L. Carraro
New Mexico State Legislature
Albuquerque, NM

Max Coll
New Mexico State Legislature
Santa Fe, NM

Roberto J. Gonzales
New Mexico State Legislature
Taos, NM

Gary K. King
New Mexico State Legislature
Moriarty, NM

Edward J. Lopez
New Mexico State Legislature
Santa Fe, NM

Ben Lujan
New Mexico State Legislature
Santa Fe, NM

Roman M. Maes, III
New Mexico State Legislature
Santa Fe, NM

Vince Martinez
New Mexico State Legislature
Rio Rancho, NM

Emilio Naranjo
New Mexico State Legislature
Espanola, NM

Robert A. Perls
New Mexico State Legislature
Corrales, NM

Virgil O. Rhodes
New Mexico State Legislature
Corrales, NM

Debbie A. Rodella
New Mexico State Legislature
San Juan Pueblo, NM

Nick L. Salazar
New Mexico State Legislature
San Juan Pueblo, NM

Elizabeth T. Stefanics
New Mexico State Legislature
Santa Fe, NM

Sandra L. Townsend
New Mexico State Legislature
Aztec, NM

Patsy G. Trujillo
New Mexico State Legislature
Santa Fe, NM

Leonard Tsosie
New Mexico State Legislature
Crownpoint, NM

Luciano Varela
New Mexico State Legislature
Santa Fe, NM

Jeannette O. Wallace
New Mexico State Legislature
Los Alamos, NM

Regis Pecos
New Mexico State Office of Indian Affairs
Santa Fe, NM

Tom Udall
Office of the Attorney General
Santa Fe, NM

Allan C. Lloyd
South Coast Air Quality Management District
Diamond Bar, CA

Michael R. Taylor
State of New Mexico Office of Cultural Affairs
Santa Fe, NM

MUNICIPAL & LOCAL GOVERNMENT

Ross Chavez
City of Espanola
Espanola, NM

Debbie Jaramillo
City of Santa Fe
Santa Fe, NM

Marian A. Shirin
City of Santa Fe Planning Department
Santa Fe, NM

Alex Georgieff
Acting County Administrator
Los Alamos County
Los Alamos, NM

Lawry Mann
Los Alamos County Council
Los Alamos, NM

Jim Anderson
Los Alamos Public Schools
Los Alamos, NM

Lorenzo Valdez
Rio Arriba County
Espanola, NM

Ray Tafoya
Rio Arriba County Commission
Espanola, NM

Patti J. Bushee
Santa Fe City Council
Santa Fe, NM

Larry Delgado
Santa Fe City Council
Santa Fe, NM

Steve Farber
Santa Fe City Council
Santa Fe, NM

Chris Moore
Santa Fe City Council
Santa Fe, NM

Betty Platts
Santa Fe County Council
Santa Fe, NM

John B. Tillery
Town of Red River
Red River, NM

Tony Gonzales
Village of Chama
Chama, NM

COMPANIES AND INSTITUTIONS

John Fleck
Albuquerque Journal
Albuquerque, NM

Gio Nguyen
ARDI Corporation
Minneapolis, MN

Beatrice Brown
Beta Corporation
Albuquerque, NM

Harry A. Bryson
Camber Corporation
Oak Ridge, TN

P.M. Guggino
Coleman Research Corporation
Albuquerque, NM

J.L. Butler
Dames & Moore
Albuquerque, NM

D. Lynn Coursen
Dynatec Explosive Consultants
Española, NM

Beverley Ramsey
EASI
Woodsboro, MD

George Lobsenz
Energy Daily
Washington, DC

Lionel Vargas
First National Bank of Santa Fe
Los Alamos, NM

Joel Runes
Florida Power and Light
Miami, FL

Mike Palmer
Foley Co.
Kansas City, MO

Ann Strickland
Foster Wheeler Environmental
Santa Fe, NM

Dr. Robert L. Long
GPU Nuclear Corporation
Parsipanny, NJ

David Ball
GRAM Inc.
Albuquerque, NM

Ricky Waters
Health Food Shop
Los Alamos, NM

Cindy Darcy
Hobbs, Straus, Dean, and Walker
Washington, DC

Don Hossink
IBM
Albuquerque, NM

Sidney Drell
JASON
Menlo Park, CA

Patrick Armijo
Journal North News
Santa Fe, NM

Tami Wiggins
Keystone Environmental & Planning
Albuquerque, NM

Bernadette Boullea
KRSN/KNLA Radio
Los Alamos, NM

Nancy Rae Stapp
KTAO
Taos, New Mexico

Roger Scott
Lamb Associates, Inc.
Albuquerque, NM

Eric Cole
LATA
Los Alamos, NM

Frederic March
LATA
Los Alamos, NM

Dave Lechel
Lechel, Inc.
Albuquerque, NM

Steven Shankland
Los Alamos Monitor
Los Alamos, NM

Evelyn Vigil
Los Alamos Monitor
Los Alamos, NM

Ross & Ron Van Lyssel
Los Alamos Shell
Los Alamos, NM

Masoud Zarraby
Merrick & Co.
Los Alamos, NM

Jeffrey E Stuermer
Merrill Lynch
Santa Fe, NM

Mesa Public Library
Los Alamos, NM

Gaurav Rajen
Mission Research Inc.
Albuquerque, NM

Susan Dover
Parsons Brinkerhoff
Denver, CO

Susie Galt
Parsons Brinkerhoff
Denver, CO

Andrea Rosenthal
Parsons Brinkerhoff
New York, NY

Mike Kaemper
Rio Grande Sun
Espanola, NM

Stanley E. Logan
S.E. Logan & Associates, Inc.
Santa Fe, NM

Dana Dominey
SAIC
Washington, DC

Mark J. Duff
SAIC
Albuquerque, NM

Keith Easthouse
Santa Fe New Mexican
Santa Fe, NM

Jay Shelton
Santa Fe Prep School
Santa Fe, NM

Santa Fe Public Library
Santa Fe, NM

Robert Enz
Scientech
Los Alamos, NM

Tony Ladino
Scientech
Los Alamos, NM

William R. Winkler
Stone & Webster Engr.
Denver, CO

Tom Switlik
Switlik & Associates
Espanola, NM

Andy Andrs
Systematic Management Services
Germantown, MD

David I. Chanin
Technadyne Engineering Consultants, Inc.
Albuquerque, NM

John Nash
Tetra Tech
Falls Church, VA

R.D. Gauny
The Delphi Group, Inc.
Austin, TX

Kent Waterman
TRK Management
Los Alamos, NM

W.F. Kirk
UNC Naval Products
Uncasville, CT

David H. Vomacka
Woolpert Consultants
Dayton, OH

ORGANIZATIONS

John Bradley
Acequia de Las Joyas
Santa Fe, NM

Claudia Nissley
Advisory Council on Historic Preservation
Golden, CO

Dorelen Bunting
Albuquerque Center for Peace & Justice
Albuquerque, NM

Harry Early
All Indian Pueblo Council, Inc.
Albuquerque, NM

Lloyd Suina
All Indian Pueblo Council, Inc.
Office of Environmental Protection
Albuquerque, NM

Susan Diane
All People's Coalition
Albuquerque, NM

Angela Wiebalk
All Peoples Coalition
Albuquerque, NM

American Friends Service Committee
Colorado Office
Denver, CO

American Friends Service Committee
New Mexico Project Office
Espanola, NM

American Friends Service Committee
Pacific Southwest Regional Office
Pasadena, CA

Ladonna Harris
Americans for Indian Opportunity
Bernalillo, NM

Sawnie Morris
Amigos Bravos
Taos, NM

Brian Shields
Amigos Bravos
Taos, NM

Archdiocese of Santa Fe
Albuquerque, NM

Ian F. Devereux
Atomic Weapons Establishment
Reading, UK

Ken Silver
Boston University School of Public Health
Boston, MA

Don Timmerman
Casa Maria Catholic Worker House of Hospitality
Milwaukee, WI

Laurie Pares
CCC
Chimayo, NM

Joe F. Trujillo
Chamita Mutual Domestic Water Association
San Juan Pueblo, NM

Citizens Alert
Reno, NV

Janet Greenwald
Citizens for Alternatives to Nuclear Dumping
Albuquerque, NM

Garland Harris
Citizens for Alternatives to Radioactive Dumping
Albuquerque, NM

Mildred McClain
Citizens for Environmental Justice
Savannah, GA

Paul Schwartz
Clean Water Action Project
Solid Waste Program
Washington, DC

Dwayne Anderson
Clean Water Action Project, Southwest Region
Austin, TX

Carl Rupert
Clean Water Fund of North Carolina
Raleigh, NC

Fred C. Schmidt
Colorado State University, Documents Department
Fort Collins, CO

J.G. Lefebvre
Commissariat a l'Energie Atomique
Centre d'Etudes de Vaujours-Moronvillers
Mexico

David Coss
Communications Workers of America Local 7037
Santa Fe, NM

Steve Israel
Communications Workers of America Local 7037
Santa Fe, NM

Matthew Albright
Community Development Committee
Los Alamos, NM

Margaret Carde
Concerned Citizens for Nuclear Safety
Santa Fe, NM

Jay Coughlan
Concerned Citizens for Nuclear Safety
Santa Fe, NM

Susan Hirshberg
Concerned Citizens for Nuclear Safety
Santa Fe, NM

David Lester
Council of Energy Resource Tribes
Denver, CO

Peter Shemitz
Eco Action KC
Kansas City, MO

Alice Slater
Economists Allied for Arms Reduction (ECAAR)
New York, NY

Herman Agoyo
Eight Northern Indian Pueblos Council, Inc.
San Juan Pueblo, NM

Victor O. Lujan
Eight Northern Indian Pueblos Council, Inc.
San Juan Pueblo, NM

El Rito Community United Methodist Church
Alcalde, NM

Denise Smith
Energy Communities Alliance
Los Alamos, NM

Brian Costner
Energy Research Foundation
Columbia, SC

Frederick Krupp
Environmental Defense Fund, Inc.
National Headquarters
New York, NY

Christine Shaver
Environmental Defense Fund, Inc.
Rocky Mountain Office
Boulder, CO

Environmental Defense Fund
Capitol Office
Washington, DC

Federation of American Scientists
Washington, DC

William Weahkee
Five Sandoval Indian Pueblos Inc.
Bernalillo, NM

Bruce Gagon
Florida Coalition for Peace and Justice
Gainesville, FL

Sam Hitt
Forest Guardians
Santa Fe, NM

Tom Clements
Greenpeace
Washington, DC

Peggy Prince
Greenpeace
Santa Fe, NM

Chris Zimmer
Greenpeace
Washington, DC

Hospital and Health Care Workers, District 1199
New Mexico AFL-CIO
Albuquerque, NM

Tom Zamora-Collina
Institute for Science and International Security
Washington, DC

International Union of Operating Engineers
Albuquerque, NM

Morton Corn
Johns Hopkins University
Baltimore, MD

Virginia Jaramillo
La Casa
Los Alamos, NM

Jean Nichols
La Communidad
Peñasco, NM

Joanie Berde
La Communidad Citizen Group
Carson Forest Watch
Llano, NM

Alice Roos
LANL 2000 Task Force A
The Sanctuary Foundation
Santa Fe, NM

Las Clinicas del Norte
Ojo Caliente, NM

League of Women Voters
Washington, DC

Carlotta McInteer
League of Women Voters
Los Alamos, NM

Kathleen Tolman
League of Women Voters
Santa Fe, NM

Bonnie Bonneau
Legions of Living Light
El Prado, NM

Steve Brownell
Los Alamos Chamber of Commerce
Los Alamos, NM

Carolyn Shipley
Los Alamos Community Development Committee
Los Alamos, NM

Diane Albert
Los Alamos Pathways Association
Los Alamos, NM

Stan and Rose Mary Crawford
Los Alamos Study Group
Dixon, NM

Greg Mello
Los Alamos Study Group
Santa Fe, NM

Mary Riseley
Los Alamos Study Group
Santa Fe, NM

John Stroud
Los Alamos Study Group
Santa Fe, NM

Janie O'Rourke
Los Alamos Trails & Pathways
Los Alamos, NM

Eberhard Gerth
Luwa U.S. Office
Bethesda, MD

Maureen Eldridge
Military Production Network
Washington, DC

David Henderson
National Audubon Society
Santa Fe, NM

Dede Armentrout
National Audubon Society, Southwest Region
Austin, TX

Jerry Pardilla
National Tribal Environmental Council
Albuquerque, NM

National Wildlife Federation
Washington, DC

Andrew P. Caputo
Natural Resources Defense Council
Washington, DC

Ashok Gupta
Natural Resources Defense Council
National Headquarters
New York, NY

Natural Resources Defense Council
San Francisco Office
San Francisco, CA

Teresa Juarez
New Mexico Alliance
Albuquerque, NM

New Mexico Conference of Churches
Albuquerque, NM

Hilario Romero
New Mexico Education Opportunity Center
Española, NM

Doug Meiklejohn
New Mexico Environmental Law Center
Santa Fe, NM

Michael Collins
New Mexico Green Party
Santa Fe, NM

Steven Schmidt
New Mexico Green Party
Santa Fe, NM

Kevin Bean
New Mexico Public Interest Research Group
Albuquerque, NM

Sara Sharer
New Mexico Public Interest Research Group
Albuquerque, NM

Karen Young
Northern New Mexico Community College
Espanola, NM

Suchi Solomon
Nuclear Free Nation
Santa Fe, NM

Charlotte Cooke
Nuclear Guardianship Project
Santa Fe, NM

Frances Harwood
Nuclear Guardianship Project
Santa Fe, NM

Nuclear Information Resource Service
Washington, DC

Ralph Hutchinson
Oak Ridge Environmental Peace Alliance
Oak Ridge, TN

Doris Smith
Panhandle Area Neighbors and Landowners (PANAL)
Panhandle, TX

June Fisher
Pax Christi
Santa Fe, NM

Mary G.P. Hall
Peace and Justice League
Santa Fe, NM

Virgina J. Miller
People for Peace
Santa Fe, NM

Ellen Roddick
People For Peace
Santa Fe, NM

Dan Kerlinsky
Physicians for Social Responsibility
Albuquerque, NM

Daryl Kimball
Physicians for Social Responsibility
Washington, DC

Janna Rolland
Physicians for Social Responsibility
Albuquerque, NM

Vina Colley
Portsmouth-Piketon Residents for Environmental Safety and Security (PRESS)
McDermott, OH

Rosemary Johnson
Regional Environmental Council
Westborough, MA

Gwen Wardwell
Rio Grande Chapter Sierra Club
Santa Fe, NM

Pat D'Andrea
Rio Grande/Rio Bravo
Santa Fe, NM

Irv Rosenthal
Risk and Decision Processes Center
The Wharton School
University of Pennsylvania
Philadelphia, PA

LeRoy Moore
Rocky Mountain Peace Center
Boulder, CO

Juan Montes
Rural Alliance for Military Accountability
Questa, NM

Beverly Gattis
Serious Texans Against Nuclear Dumping (STAND) of Amarillo, Inc.
Amarillo, TX

Brian Lambourn
SHR, AWE, Aldermaston
Reading, UK

Penelope McMullen
Sisters of Loretto
Santa Fe, NM

Beatrice Brailsford
Snake River Alliance
Pocatello, ID

John Ussery
Solar Park Development Group
El Rito, NM

Michael Guerrero
Southwest Organizing Project
Albuquerque, NM

Richard Moore
Southwest Organizing Project
Albuquerque, NM

Don Hancock
Southwest Research & Information Center
Albuquerque, NM

William Paul Robinson
Southwest Research & Information Center
Albuquerque, NM

Testing Alert Network
Las Vegas, NV

Joey Natseway
Tewa Women United
Santa Fe, NM

John W. Poston, Sr.
Texas A&M University
Nuclear Engineering Department
College Station, TX

William J. Weida
The Colorado College
Colorado Springs, CO

The Sierra Club
Washington, DC

Bruce Hamilton
The Sierra Club, National Headquarters
San Francisco, CA

Rob Smith
The Sierra Club, Southwest Office
Phoenix, AZ

Barbara Deaux
TRADE
Santa Fe, NM

Marylia Kelley
Tri-Valley Citizens Against the Radioactive Environment (CARES)
Livermore, CA

Bruce Berlin
Trinity Forum
Santa Fe, NM

William Kastenberg
University of California at Berkeley
Nuclear Engineering Department
Berkeley, CA

Dean Baker
University of California at Irvine
Irvine Occupational Health Center
Irvine, CA

Elaine Stamman
University of California
Office of the President
Oakland, CA

Carlos Ramirez
University of New Mexico/Los Alamos
Los Alamos, NM

Ron K Bhada
Waste Management Education and Research Consortium
Las Cruces, NM

Denise D. Fort
Water Resources Administration Program
Albuquerque, NM

Jackie Cabasso
Western States Legal Foundation
Oakland, CA

Andrew Lichterman
Western States Legal Foundation
Oakland, CA

Amadea Morningstar
Wildfire-Action for the Environment
Tesuque, NM

INDIVIDUALS

Ian Aeby
Espanola, NM

Peter Allan
Short Hills, NJ

Duane Allen
Arco, ID

Robert Anderson
Albuquerque, NM

David Arnpriester
Los Alamos, NM

John Bartlit
Los Alamos, NM

Jerry Beery
Los Alamos, NM

Robert Benjamin
Los Alamos, NM

C.S. Bennett
Espanola, NM

Roy G. Biscamp
Santa Fe, NM

Pat Blewett
Los Alamos, NM

Keith Bowers
Albuquerque, NM

Sallie Bunglian
Santa Fe, NM

Amy Bunting
Santa Fe, NM

Peter Chestnut
Albuquerque, NM

Arthur B. Clark
Santa Fe, NM

Sanford Clarke
Santa Fe, NM

Janet S. Cohen
Santa Fe, NM

Jim & Judy Corbin
White Rock, NM

Eloy Cordova
Taos, NM

Kip & Helen Corneli
Santa Fe, NM

Abbie Ben Cortez
Santa Fe, NM

Irwin and Florence Cromwell
Santa Fe, NM

C. Cusick
Santa Fe, NM

Randy Dalice
Las Vegas, NV

Ann Dasburg
Santa Fe, NM

Shirley G. Davis
Santa Fe, NM

Ted Davis
Albuquerque, NM

Janet Degan
Santa Fe, NM

Richard Deyo
Santa Fe, NM

John F. Doherty
Providence, RI

Craig Dunning
Boulder, CO

Matt Eilert
Los Alamos, NM

Paul Fenimore
Los Alamos, NM

Charles Fenstermacher
Los Alamos, NM

Dr. Jack Frenkel
Santa Fe, NM

Mr. & Mrs. Cesabio H. Gallegos
Santa Fe, NM

Josephine Giddens
Santa Fe, NM

Carol Gish
Santa Fe, NM

Martin, Martha, and Judith Gursky
Los Alamos, NM

Yvonne Hager
Santa Fe, NM

Beth Hale
Albuquerque, NM

Willard Hamsing
Los Alamos, NM

James F. Harnson
Los Alamos, NM

J.R. Heineman
Los Alamos, NM

John F. Hepler
Los Alamos, NM

Linda Hibbs
Santa Fe, NM

Marilyn G. Hoff
Santa Fe, NM

R.W. Honsinger, MD
Los Alamos, NM

John Hopkins
Los Alamos, NM

Candace S Hughes
Phoenix, AZ

Margie Hughes
Santa Fe, NM

Rod Hurder
Espanola, NM

Mahavir Jain
Los Alamos, NM

Carla C. Javier
Las Vegas, NV

Jeanelle Jeanperrin
Los Alamos, NM

James Kniola
Española, NM

Ralph Kopansky
Espanola, NM

Judy Kowalski
Santa Fe, NM

Lawrence Lack
Los Ojos, NM

John and Joan Leahigh
Albuquerque, NM

Milton G. Lockhart
Los Alamos, NM

John Lyles
Los Alamos, NM

John Magee
Santa Fe, NM

Joe Masco
Albuquerque, NM

John A. Mattson
Santa Fe, NM

Wally McCorkle
White Rock, NM

Don McCormick
Los Alamos, NM

Ed McGovern
Santa Fe, NM

John W. McMullen
Las Vegas, NV

Chris Mechels
Santa Fe, NM

Tyler Mercier
Santa Fe, NM

Julie Meredith
Santa Fe, NM

Steve Michael
Santa Fe, NM

Marian Morgan
Los Alamos, NM

Alva Morrison
Tres Piedras, NM

L. Morrison
Los Alamos, NM

Linda Mulka
Los Alamos, NM

Lynda Muller
Los Alamos, NM

Al Ogard
Santa Fe, NM

Antonio Pares
Chimayo, NM

Jeff Petraglia
Amarillo, TX

B. Phillips
Santa Fe, NM

D.W. Reade
Santa Fe, NM

Deborah Rikoon
Santa Fe, NM

Louis Rosen
Los Alamos, NM

Karin Salzmann
Santa Fe, NM

Corinne Sanchez
Española, NM

Ed Sandlin
Los Alamos, NM

Al Shapolia
Santa Fe, NM

Sid Singer
Los Alamos, NM

E. Mott Skinner
Santa Fe, NM

Fran Smith
Parkersburg, WV

Gordon Spingler
Los Alamos, NM

B.J. Stallings
Los Alamos, NM

Edward S. Syrjala
Centerville, MA

Dyanna Taylor
Santa Fe, NM

Mike Terrill
Los Alamos, NM

Marilyn & Charles Thomas, Jr.
Santa Fe, NM

David B. Thomson
Los Alamos, NM

David G. Ussery
Arvada, CO

Allen Valentine
Los Alamos, NM

Andy Vigil
Las Vegas, NM

George Vigil
Los Alamos, NM

Mary Ann Vigil
Santa Fe, NM

Lee Ann Ward
Los Ojos, NM

Jim Weber
Santa Fe, NM

Barbara Weintrab
Los Alamos, NM

Frank & Ginger Welch
Los Alamos, NM

Steve Wells
Los Alamos, NM

Norman G. Wilson
Los Alamos, NM

Jon Yatabe
Pleasanton, CA

Luis Zamora
Taos, NM

Index

INDEX