6

Environmental Impacts of Transportation

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6. ENVIRONMENTAL IMPACTS OF TRANSPORTATION

This chapter describes the potential environmental consequences of transporting the spent nuclear fuel and high-level radioactive waste described in Chapter 2 and Appendix A from 72 commercial and 5 U.S. Department of Energy (DOE, or the Department) sites to the Yucca Mountain site under the Proposed Action. This chapter also separately describes the potential impacts of transportation activities in the State of Nevada.

On a national basis DOE analyzed impacts of transporting spent nuclear fuel, including potential commercial spent mixed-oxide fuel containing surplus plutonium that originated from U.S. defense programs, and high-level radioactive waste, including high-level radioactive waste that could contain immobilized surplus plutonium from U.S. defense programs. These impacts include all activities necessary to transport these materials, from loading at the commercial and DOE facilities to delivery at the Yucca Mountain site. In addition, although DOE would prefer that most shipments be carried out by rail, the analysis addressed two scenarios—*mostly legal-weight truck* and *mostly rail*. These two scenarios allowed the analysis to encompass the range of potential impacts for any mix of truck and rail shipments that would actually occur. Because naval spent nuclear fuel would not be shipped by legal-weight truck (DIRS 101941-USN 1996, all) and not all of the generator sites can handle rail casks, the national scenarios involve the use of mostly legal-weight truck shipments (with only naval spent nuclear fuel being transported by rail) or mostly rail shipments (with transportation of some commercial spent nuclear fuel by truck). In addition, as part of the mostly rail scenario, the analysis assessed impacts of short hauls of commercial spent nuclear fuel in heavy-haul trucks or barges from some commercial sites to nearby railheads.

For the discussion of potential impacts of transportation by truck or rail in Nevada, such impacts would be a subset of the impacts of potential national impacts. They are discussed separately so they can be compared to a third mode of transportation, the use of heavy-haul trucks, for spent nuclear fuel and high-level radioactive waste that would arrive in Nevada by rail. Thus, the analysis considered three alternative modes of transportation for shipments once they would arrive in Nevada: (1) for those arriving by legal-weight truck, continuing the shipments by legal-weight truck to the Yucca Mountain site; (2) for those arriving by train, continuing the shipments by rail using a branch rail line in one of five candidate rail corridors to the site; or (3) for those arriving by rail, unloading the shipments from railcars and loading them on heavy-haul trucks at an intermodal transfer station for shipment to the site on one of five candidate highway routes. Figure 6-1 shows these three options. The candidate highway routes for heavy-haul trucks and rail corridors for a potential branch rail line are called *implementing alternatives*. Figure 6-2 shows the transportation implementing alternatives and their relationships to the national and Nevada transportation scenarios and to the mix of rail and legal-weight truck transportation modes that make up each scenario.

Section 6.1 summarizes both national and Nevada transportation activities. Chapter 2, Section 2.1.3, also describes national and Nevada transportation activities. Section 6.2 assesses the potential impacts of national transportation from the 77 sites to Yucca Mountain. Section 6.3 assesses potential impacts from transportation activities in Nevada. Chapter 2 describes the receipt and unloading of shipping casks at the repository (Section 2.1.2.1.1.1), the preparation of empty casks for reshipment (Section 2.1.2.1.1.3), and the potential construction and operation of a cask maintenance facility (Section 2.1.3.4). Chapter 4, Section 4.1.15, evaluates potential environmental impacts from the offsite manufacturing of shipping casks for commercial spent nuclear fuel and DOE spent nuclear fuel and high-level radioactive waste. Chapter 8, Section 8.4, discusses cumulative impacts of transportation for the Proposed Action and anticipated future radioactive material transportation activities. Appendix J contains details on transportation analysis methods and results. Appendix M provides information that is not needed to evaluate environmental impacts but that could be useful to readers to gain an understanding of nuclear waste transportation.

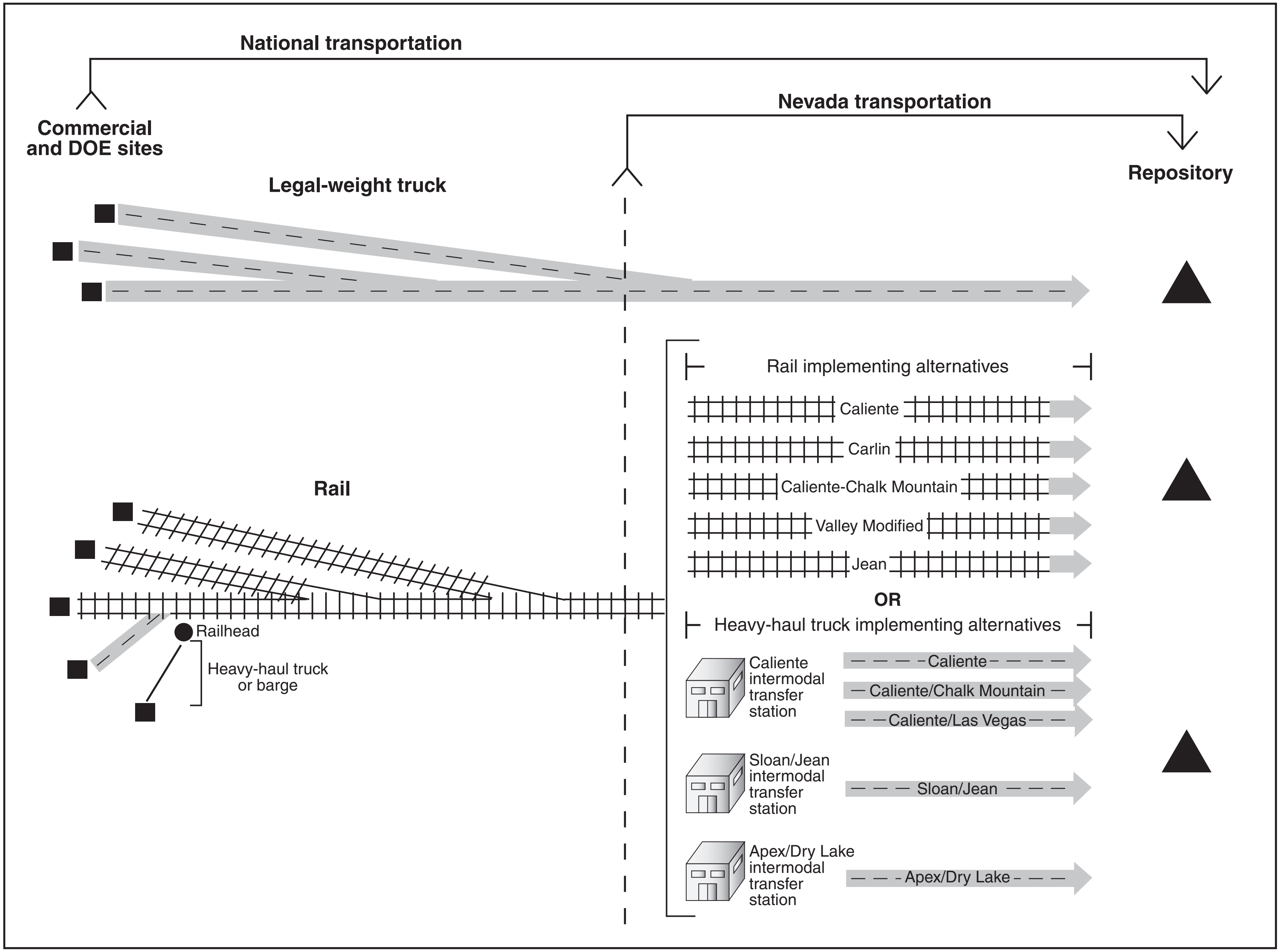
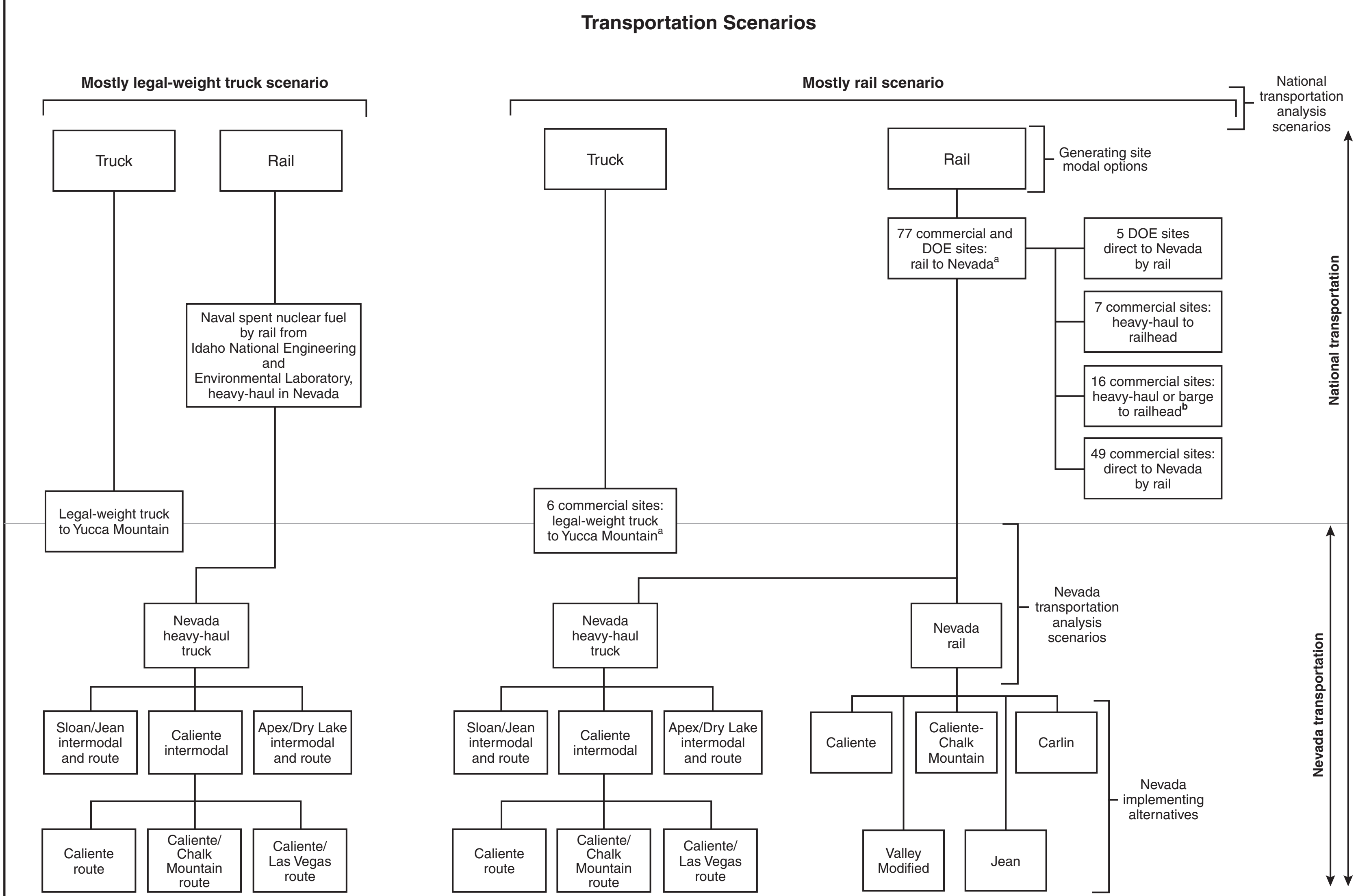


Figure 6-1. Relationship of Nevada and national transportation.



a. Six commercial sites would not have rail access until after reactor shutdown.
b. Salem and Hope Creek listed as one site.

Figure 6-2. Relationship between transportation modes, national and Nevada analytical scenarios, and Nevada transportation implementing alternatives.

CHANGES SINCE THE PUBLICATION OF THE DRAFT EIS

Changes in Information, Analytic Tools, and Assumptions

Since the publication of the Draft EIS, DOE has acquired new information and analytic tools that contribute to an improved understanding of interactions between the potentially affected environment and transportation activities necessary for the Proposed Action, including information and suggestions for improvements provided in public comments on the Draft EIS and on the Supplement to the Draft EIS. As a consequence, the impacts described in this chapter, Appendix J, and other transportation-related sections of this Final EIS differ from those described in the Draft EIS.

Notably, estimates of total impacts to public health and safety described in this chapter are smaller than those in the Draft EIS. With the exception of consequences of postulated acts of sabotage, estimates for radiological impacts of *incident-free transportation* and accidents and consequences of maximum reasonably foreseeable accidents are all smaller than the estimates in the Draft EIS. The nonradiological impacts reported in this Final EIS are approximately the same as those in the Draft EIS, including those in the Supplement to the Draft EIS. Differences in estimates of transportation-related impacts for land use; air quality; hydrology; biological resources and soils; cultural resources; socioeconomics; noise; aesthetics; waste management; utilities, energy, and materials; and environmental justice are principally the result of new information that enabled better representation of impacts that were, for the most part, identified in the Draft EIS and, for land use, changes in the affected environment that occurred after the publication of the Draft EIS. The following paragraphs describe the changes that had the most effect on the impact results, including comparisons with the results presented in the Draft EIS.

Estimated Numbers of Shipments. Estimates of the number of shipments of commercial spent nuclear fuel that would be made under the mostly legal-weight truck and mostly rail scenarios were based on a version of the CALVIN computer program (DIRS 155644-CRWMS M&O 1999, all) that has been updated from the version used for the Draft EIS. The updated version of CALVIN (Version 2.0) incorporates a number of changes, including: (1) revised estimates of future generation of commercial spent nuclear fuel; (2) revised estimates of the capabilities of commercial generator sites to handle and load large shipping casks; (3) revised estimates of the types and sizes of shipping casks that would be used; and (4) revised assumptions about how sites would select spent nuclear fuel assemblies for delivery to DOE.

The Final EIS analyses used a total of about 53,000 legal-weight truck shipments and 300 rail shipments of naval spent nuclear fuel for the mostly legal-weight truck scenario. This is an increase of about 3,000 shipments or 6 percent over the approximately 50,000 shipments reported in the Draft EIS. This increase is the result of slight changes in the assumed characteristics of spent nuclear fuel that commercial generators would deliver to DOE.

For the mostly rail scenario, the total number of shipments in the Final EIS analyses is about 10,700. About 1,100 of these shipments would be by legal-weight truck. The Draft EIS used a total of about 13,400 shipments (about 25 percent more), of which about 10,800 would be by rail and 2,600 by legal-weight truck. The reduced number of shipments is a result of changes in assumptions regarding the size of shipping casks and the capabilities of generator sites to handle and load rail casks. For this scenario, based on information available from industry sources following the publication of the Draft EIS, the updated CALVIN analysis assumed three generator sites previously considered capable of handling and loading only legal-weight truck casks could handle and load rail casks. In addition, the analysis assumed that the remaining truck-only sites would be capable of handling and loading rail casks following permanent shutdown of the sites' reactors.

Based solely on changes in the number of shipments, estimates of health and safety impacts nationally and in Nevada are 6 percent greater for the mostly legal-weight truck scenario and about 25 percent less for the mostly rail scenario than those reported in the Draft EIS. The change in the number of shipments would not cause discernible changes in impacts in other resource areas discussed in this chapter.

Characteristics of Commercial Spent Nuclear Fuel Used in Accident Analyses. The transportation analysis used the characteristics of representative spent nuclear fuel described in Appendix A, rather than the characteristics of typical (or average age) spent nuclear fuel used in the Draft EIS, to evaluate potential impacts and consequences of transportation accidents. Representative spent nuclear fuel is commercial spent nuclear fuel with a health and safety hazard that is the average of all the spent nuclear fuel that would be shipped to the proposed repository. Under this averaging, representative spent nuclear fuel would be (1) spent nuclear fuel from a pressurized-water reactor that had been discharged from a reactor for 15 years and had an average burnup of 50,000 megawatt-days per metric ton of heavy metal (MTHM), or (2) spent nuclear fuel from a boiling-water reactor that had been discharged for 14 years with a burnup of 40,000 megawatt-days per MTHM. Conversely, typical pressurized-water reactor spent nuclear fuel (also described in Appendix A) has been discharged from a reactor for 25.9 years with a burnup of almost 40,000 megawatt-days per MTHM. Typical boiling-water reactor spent nuclear fuel has been discharged from a reactor for 27.2 years with a burnup of about 32,000 megawatt-days per MTHM. DOE made the change to a representative fuel for accident analysis because it determined that estimates of accident risk using the characteristics of the typical spent nuclear fuel discussed in the Draft EIS underestimated the accident risk of shipments. This change in the analysis resulted in about a twofold increase in the estimated inventory of primary radionuclides in each shipping cask in comparison to the estimates in the Draft EIS. Primary radionuclides are those that contribute the most to impacts (see Appendix J, Section J.1.3.1).

Highway and Rail Routes. The analyses of transportation impacts in the Draft and Final EIS used the HIGHWAY (DIRS 104780-Johnson et al. 1993, all) and INTERLINE (DIRS 104781-Johnson et al. 1993, all) computer programs to identify routes that DOE could use for shipments from 77 generator sites to a Yucca Mountain Repository. DOE believes that the identified routes are representative of those that would be used if the Yucca Mountain site was approved and a repository was constructed and operated.

IDENTIFICATION OF TRANSPORTATION ROUTES

DOE has published proposed policy and procedures (63 *FR* 23756; April 30, 1998) "setting forth its revised plans for implementing a program of technical and financial assistance to states for training public safety officials of appropriate units of local government and to Indian tribes through whose jurisdictions the Department plans to transport spent nuclear fuel or high-level radioactive waste." The proposed policy and procedures state that DOE "plans to identify preliminary routes [that the Department] anticipates using within state and tribal jurisdictions when it notifies governors and tribal leaders of their eligibility." Notification would begin "approximately five years prior to transportation through" affected jurisdictions.

Most of the routes used for analyses in the Final EIS did not change from those used for the Draft EIS. However, railroad consolidations and alternative preferred routes designated by states for highway shipments resulted in changes in some of the routes identified by the computer programs and used in the analyses. For example, railroad consolidation led to a change in a potential *rail route* from the Monticello generator site in Minnesota. This caused the State of South Dakota, which was not included among the states crossed by routes analyzed in the Draft EIS, to become one of the states through which the analysis assumed shipments would travel.

In the case of highway shipments, new information published by the U.S. Department of Transportation (65 *FR* 75771; December 4, 2000) lists 14 states that have designated preferred routes for truck shipments of Highway Route-Controlled Quantities of Radioactive Materials. The Draft EIS listed 10 states based on information available at the time. The four added states are Delaware, Ohio, Texas, and Utah. Also listed for the first time in an integrated source are route restrictions and preferred route designations made by the State of Colorado that would preclude the use of Interstate Highway 70 west of Denver to the Utah border. The new information resulted in changes in the routing that the Draft EIS analysis assumed for some shipments.

Overall, the effects of changes in the routes used in the analysis on estimated impacts would be small for national transportation. However, DOE has added maps and tables that show the routes that were analyzed and the estimated health and safety impacts for each state through which shipments would pass if these routes were used (Appendix J, Section J.4).

Bureau of the Census Data. The analyses in the Draft and Final EIS used the HIGHWAY and INTERLINE computer programs to develop estimates of potentially affected populations along transportation routes. These programs use block group data from the 1990 Census. The Draft EIS used estimates of population along routes provided by these programs to estimate radiological impacts of transportation nationally and in Nevada. In a change from the Draft EIS, the Final EIS analysis used projections for each state made by the Bureau of the Census for population growth to 2025, results of the 2000 Census, and extrapolation to estimate populations along routes in 2035. These estimated population increases were used in estimating radiological health and safety impacts for national transportation.

In another change, estimates of populations along potential routes in the State of Nevada incorporate information developed using a geographic information system, 1990 Census data, and projections to 2035 obtained using the REMI computer program. Projections using REMI were based on forecasts provided to DOE by Clark County, Nye County, and the Nevada State Demographer, anchored to the results of the 2000 Census for Nevada counties. In addition, population estimates for routes that include the planned Las Vegas Beltway used a forecast for 2020 provided by a report prepared for the City of North Las Vegas (DIRS 155112-Berger 2000, all).

The overall effect of these changes is that estimated affected populations along national routes would be about 40 percent greater than the populations estimated with the use of 1990 Census data, as used in the Draft EIS. The Nevada population used in the analysis of transportation-related health and safety impacts in this Final EIS is about 100 percent greater than that used in the Draft EIS.

DOE conducted a limited sensitivity analysis of national transportation impacts using route population information based on projections provided by the TRAGIS computer program (DIRS 157136-Johnson and Michelhaugh 2000, all). The TRAGIS program, which DOE released in the Fall of 2001 to replace the HIGHWAY and INTERLINE computer codes used for the transportation analyses in this EIS, uses 2000 Census data to develop population estimates for routes. Based on the sensitivity analysis performed using TRAGIS in place of HIGHWAY, DOE determined that doses to the general public from incident-free transportation would be similar to (about 10 percent greater than) those reported in this chapter.

Performance of Shipping Casks in Transportation Accidents. DOE has revised the transportation accident analyses in the EIS to reflect new information. For example, since the publication of the Draft EIS, the Nuclear Regulatory Commission published *Reexamination of Spent Fuel Shipment Risk Estimates* (DIRS 152476-Sprung et al. 2000, all). Based on the analyses in that report, DOE concluded that the models used for analysis in the Draft EIS relied on assumptions about spent nuclear fuel and cask response to accident conditions that caused an overestimation of the resulting impacts. For example, the analyses in the Draft EIS were based on *Shipping Container Response to Severe Highway and Railway*

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Assessment of the Hazards of Transporting Spent Nuclear Fuel and High-Level Radioactive Waste to the Proposed Yucca Mountain Repository Using the Proposed Northern Las Vegas Beltway **(DIRS 155112-Berger 2000, all)**

The transportation analyses in the Final EIS used some information from this document. DOE considers this report to be the only available source of some information, but is in broad disagreement with the analyses and conclusions regarding the report's estimates of impacts.

Useful information not available elsewhere includes:

- An estimate of population along the Las Vegas Beltway—an area that is currently mostly uninhabited—although, as discussed below, DOE believes the estimate is high.
- New information regarding the expected cost to construct the beltway.
- A scenario for estimating dose to a maximally exposed individual along a highway route used by heavy-haul trucks in Nevada.

DOE disagrees with some aspects of the report for a variety of reasons, including:

- The projected population growth within 3.2 kilometers (2 miles) of the 21-kilometer (13-mile)-long Northern Beltway appears to be very high, accounting for 42 percent of population growth projected by a University of Nevada Las Vegas report (DIRS 156031-Riddel and Schwer 2000, Table 1) for all of Clark County during the same period.
- The report uses a very high accident rate as a basis for accident probabilities. This rate—4 times that reported to DOE by the State of Nevada for interstate trucks on all Nevada highways (see Appendix J, Section J.1.4.2.3.3)—is 17 times greater than the rate DOE used in the EIS, which is based on statistics compiled by the U.S. Department of Transportation. The rate could be higher in part because it was based on the State of Nevada definition of an accident rather than the Department of Transportation definition recommended by the National Governors Association (see Sections J.1.4.2.3 and J.1.4.2.3.3). In addition, the rate used in the report appears to be an intercity rate (urban interstate) that does not accurately reflect the accident rate for highways in Nevada that shipments to Yucca Mountain would use.
- The report projects economic impacts in the Northern Beltway area assuming that business location decisions would be made solely on whether shipments of spent nuclear fuel and high-level radioactive waste would use the Northern Beltway. The report did not consider many other factors commonly associated with such decisions.
- The report overestimates economic impacts to Clark County under the implied assumption that not only would some companies not locate near the Northern Beltway because of shipments of spent nuclear fuel and high-level radioactive waste, these companies would not locate anywhere in Clark County; and that existing Clark County companies that could move to the Northern Beltway area would actually leave Clark County. The report ignores statistics that show that many business relocations occur in the same county. In addition, the report fails to recognize that decisions to remain at the same location would have no economic impact on the county.

Accident Conditions, which estimated that 99.4 percent of accidents would not lead to a release of radioactive materials from a shipping cask (DIRS 101828-Fischer et al. 1987, pp. 4-8, 7-25, and 7-26). Based on the revised analyses, casks would continue to contain spent nuclear fuel fully in more than 99.99 percent of all accidents (DIRS 152476-Sprung et al. 2000, p. 7-73 to 7-76). In addition, based on that report, DOE has included impacts of an accident in which the radiation shielding of a shipping cask

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would be damaged—so-called *loss-of-shielding* accidents. DOE also included estimated impacts of 99.99 percent of accidents in which the cask's containment and shielding would not be damaged by the accident but where nearby populations could be exposed to low-level radiation during the time it would take for accident response and recovery. The analysis assumed the low-level radiation would be the maximum allowed by regulation for a cask transporting spent nuclear fuel or high-level radioactive waste. The Draft EIS did not include these evaluations.

The collective effect of these changes was a significant reduction in estimated consequences of maximum reasonably foreseeable accidents and estimates of accident risk from those presented in the Draft EIS. In addition, the use of information from the DIRS 152476-Sprung et al. (2000, all) report permits a better description of the maximum reasonably foreseeable accidents analyzed. For example, the characteristics of the maximum reasonably foreseeable accident analyzed in this chapter for rail transportation correspond closely to reported conditions in the Baltimore Tunnel train accident fire in July 2001 (DIRS 156753-Ettlin 2001, all; DIRS 156754-Rascovar 2001, all).

Model for Estimating Doses to the Public at Truck Stops. The Draft EIS used information reported in DIRS 101888-Neuhauser and Kanipe (1992, p. 3-29) to estimate the radiation dose that would be received by members of the public at rest stops used by trucks carrying spent nuclear fuel and high-level radioactive waste. The time allocated to stops in the report is equivalent to about 1 hour of stop per hour of travel—a significant overestimate of stop time in real truck transport operations involving team drivers. As a consequence, more than 90 percent of the dose to the general public reported for the mostly legal-weight truck scenario in the Draft EIS was based on this estimate of dose to persons at truck stops.

The analysis in this Final EIS used more recent data based on field observations of truck stop time (DIRS 152084-Griego, Smith, and Neuhauser 1996, all). In addition, the analysis estimated doses to populations in areas surrounding stops, including estimates of stop time for state inspections and periodic driver walk-around, which were not part of the analyses in the Draft EIS. The analysis concluded that the average time trucks would stop would be about 1 hour for every 10 hours of travel, which resulted in a much lower estimate for radiation dose to the general public. Appendix J, Section J.1.3.2.1 provides additional information.

RADTRAN. DOE used the RADTRAN 4 computer program in estimating the radiological incident-free and accident risk impacts in the Draft EIS. For this Final EIS, DOE used an updated version of the program, RADTRAN 5, which allowed more complex analyses of impacts, such as those involving models used to estimate doses to persons at truck stops. With the exception of the improvements in capabilities afforded by RADTRAN 5, the analytical methods used by the two programs to estimate impacts to populations are largely the same. This change had no effect on the results.

Health Effect Fatality Impacts of Vehicle Emissions. New information used to estimate fatalities from health effects of vehicle emissions (DIRS 151198-Biwer and Butler 1999, all) became available following the publication of the Draft EIS. DOE used this information in conjunction with information from the Environmental Protection Agency (DIRS 155780-EPA 1993, all; DIRS 155786-EPA 1997, all) to develop risk factors for the analysis in this Final EIS. Based on this new data, estimates of impacts from vehicle emissions are about 3 times greater than the estimates in the Draft EIS, which ranged from 0.2 to 0.6 fatalities over 24 years.

First Responder. The analyses of transportation impacts in this Final EIS included estimates of doses to maximally exposed individuals not identified in the Draft EIS. These included estimates of doses to a first responder at a transportation accident and individuals who resided close to highways or rail routes in the State of Nevada.

Socioeconomic Baseline for Nevada Counties. The analyses of socioeconomic impacts in the Draft and Final EIS used baseline data developed using the REMI computer program. However, input parameters to calculations performed using REMI were adjusted for the Final EIS so predicted results reflect similar forecasts provided by Clark and Nye Counties and the Nevada State Demographer. The resultant changes in estimated socioeconomic impacts are small.

Time to Construct a Branch Rail Line. After the publication of the Draft EIS, the estimated time to construct a branch rail line to the Yucca Mountain site changed from 2.5 years (30 months) to 40 to 46 months, depending on the corridor. However, engineering estimates of materials and labor required for construction did not change, and therefore the constant-dollar cost estimates did not change. The changes in projected construction schedules led to lower estimates for socioeconomic impacts of constructing and operating a branch rail line in Nevada than those in the Draft EIS.

Cost to Construct the Las Vegas Beltway. The EIS includes estimates of socioeconomic impacts of using heavy-haul trucks on three candidate routes that include the planned Las Vegas Beltway. The analysis in the Draft EIS assumed an expenditure of $40 million (1998 dollars) for the northern segment of the Beltway, occurring between 2007 and 2010 rather than between 2010 and 2020 as planned by Clark County. The Draft EIS analysis also assumed a corresponding total of $90 million (1998 dollars) for the southern and western segments of the Beltway. An estimate in a City of North Las Vegas-sponsored report suggests the cost of completing the Northern Beltway between 2010 and 2020 could be as much as $425 million in 1998 dollars (DIRS 155112-Berger 2000, p. 29) ($463 million in 2001 dollars). DOE adopted this estimate for use in estimating socioeconomic impacts for the Caliente/Las Vegas and Apex/Dry Lake routes for heavy-haul trucks evaluated in this chapter. Using the same information, the analysis in this chapter estimated socioeconomic impacts for a Jean route for heavy-haul trucks with the assumption that the corresponding costs to complete the southern and western segments of the Beltway could be as much as $790 million. Because it assumed these larger estimated costs, the estimated socioeconomic impacts in Clark County for the Jean, Apex/Dry Lake, and Caliente/Las Vegas routes for heavy-haul trucks are higher in this Final EIS than those in the Draft EIS, but remain low for the County.

Potential Land-Use Conflicts for Construction and Operation of a Branch Rail Line in Nevada. After the publication of the Draft EIS, changes occurred in ownership and use of lands that a branch rail line in the candidate rail corridors in Nevada could cross. Land that could be crossed by the Bonnie Claire Alternate of the Caliente and Carlin Corridors has been transferred by an Act of Congress to the Timbisha Shoshone Tribe; land at the junction of the Stateline Pass Option of the Jean Corridor and the Union Pacific Railroad has been transferred by an Act of Congress to Clark County for development of the Ivanpah Valley Airport; and land near the junction of the Valley Modified Corridor and the Union Pacific Railroad has been transferred by the Bureau of Land Management to Clark County for the Apex Industrial Park. These changes result in potential land-use impacts for the affected corridors.

Changes Due to Public Comments. In response to interest and suggestions by the public and to better describe potential impacts of transportation alternatives in Nevada, DOE has modified analyses and presentations of impacts. The following are examples of such modifications:

- *Land-use and ownership.* Added available descriptive details and assessed potential impacts to wilderness study areas; grazing allotments; rights-of-way; and Bureau of Land Management, private, Nellis Air Force Range (now called the Nevada Test and Training Range), Native American, and Nevada Test Site lands along Nevada rail corridors, including variations, and along routes for heavy-haul trucks.

- *Air quality (nonradiological).* Provided more complete quantitative estimates of carbon monoxide and PM_{10} emissions from transportation activities, particularly in the Las Vegas Valley nonattainment area.

- *Hydrologic resources.* Expanded flood zone, groundwater, and surface-water resources, and water demand analyses to incorporate information for variations of Nevada rail corridors and for routes for heavy-haul trucks.

- *Biological resources and soils.* Provided more details from existing information and analyses of disturbed areas, sensitive biological resources, management areas, and soil impacts.

- *Cultural resources.* Acquired and evaluated additional cultural, archeological, and Native American data and included evaluations of potential impacts of Nevada rail variations and heavy-haul truck routes.

- *Socioeconomics.* Updated socioeconomic baseline information to accommodate 2000 Census information as well as match population forecasts provided by Clark and Nye Counties and Nevada State Demographer.

- *Noise and vibration.* Added new data and developed additional analyses of impacts of ground vibration and noise on *sensitive structures*, populations, and communities along Nevada rail corridors and routes for heavy-haul trucks.

- *Aesthetics.* Incorporated field observations made after the publication of the Draft EIS for viewsheds along candidate rail corridors and routes for heavy-haul trucks and used additional detail available from existing information.

- *Environmental justice.* Added available detail, reanalyzed data on minority and low-income populations, and reevaluated impact assessments of other disciplines.

- *Utilities, energy, and materials.* Reanalyzed impacts based on new information for the repository flexible design and for variations in the candidate rail corridors.

- *Waste management.* Added new waste data, details of waste sources and shipments, and changes in waste management from changes in information regarding the repository flexible design.

Other Changes

In addition to the changes described above, DOE added Appendix M to provide general background information on transportation-related topics that are not addressed in detail in this chapter or Appendix J and are not directly related to potential impacts of the Proposed Action. This includes information on the Department's planning, under a draft Request for Proposal, to issue shipping contracts and discussion of in-transit procedures, emergency response plans, indemnification against damages from the potential release of spent nuclear fuel and high-level waste, and cask testing.

6.1 Summary of Impacts of Transportation

6.1.1 Overview of National Transportation Impacts

This section provides an overview of the potential impacts of using the Nation's highways and railroads to transport spent nuclear fuel and high-level radioactive waste from 72 commercial and 5 DOE sites to the repository at Yucca Mountain. Detailed discussions of national transportation impacts are in Section 6.2 and analytical methods are in Appendix J. All potential impacts are related to the health and safety of populations and hypothetical maximally exposed individual members of the general public and workers. This summary includes estimated impacts from loading operations, incident-free transportation, and accidents for the mostly legal-weight truck and mostly rail national transportation scenarios. (National transportation includes transportation in Nevada to Yucca Mountain.)

Estimated national transportation impacts are based on 24 years of transportation activities during the Proposed Action and average annual shipments of about 2,200 (2,200 truck, 13 rail) for the mostly legal-weight truck scenario and about 450 (400 rail, 45 truck) for the mostly rail scenario. From all causes, about 8 fatalities could occur in the nationwide general population from transportation activities of the mostly legal-weight truck scenario and about 5 fatalities from the mostly rail scenario during the 24-year transportation period (impacts of a maximum reasonably foreseeable accident are not included).

Impact analyses for the transport of spent nuclear fuel and high-level radioactive waste in Nevada using a branch rail line are based on the assumption that the branch rail line would be dedicated to activities related to the Proposed Action. There are other possible uses for such a branch rail line in Nevada including support of ranching, industrial, and commercial endeavors; support of Federal, state, tribal and local government activities; and transport of people, materials, and products into, out of, and across the state. However, DOE has not addressed any of these possibilities because there are no concrete proposals at this time for alternative uses, and insufficient information exists to evaluate such uses. Potential uses of a branch rail line are identified in Chapter 8, but the need or level of use and growth of use has not been defined or evaluated. If the Yucca Mountain Site was designated, DOE would consider any uses that were reasonably foreseeable at that time other than transporting radioactive materials to the site in selecting an alignment within any rail corridor selected.

Impacts of Loading Operations

All spent nuclear fuel and high-level radioactive waste would be loaded onto trucks or railcars at the 77 sites for transport to the Yucca Mountain site. Some health and safety impacts would be associated with these loading operations. There would be small (0.04 latent cancer fatality) impacts to members of the public from loading operations. Over the 24 years of the Proposed Action, an estimated 6 and 2 latent cancer fatalities could occur in involved worker populations from radiation exposure for the mostly legal-weight truck and mostly rail scenarios, respectively. The probability of a latent cancer fatality to the maximally exposed involved worker would be about 0.005 for both scenarios. No worker fatalities from industrial accidents would be expected. No or very small impacts to workers or members of the public would be expected from postulated loading accidents. About 0.4 traffic fatality could occur in the worker population from commuting under the mostly legal-weight truck scenario, while about 0.2 traffic fatality could occur under the mostly rail scenario. Loading operations and potential impacts are discussed further in Section 6.2.2.

Impacts of Incident-Free Transportation

Incident-free transportation is the expected norm for transportation of spent nuclear fuel and high-level radioactive waste to the Yucca Mountain site. Impacts of incident-free transportation would include those from external radiation emitted from transportation casks and vehicle exhaust emissions along the transportation routes.

Over the 24 years of the Proposed Action, an estimated 3 (2.5) latent cancer fatalities could occur in the general population along transportation routes from radiation exposure under the mostly legal-weight truck scenario and an estimated 1 latent cancer fatality could occur under the mostly rail scenario. Under the mostly legal-weight truck and mostly rail scenarios, the probability of a latent cancer fatality to the maximally exposed member of the public would be no more than 0.0012 and 0.0001, respectively. Under these same scenarios, about 1 (0.95 for the mostly legal-weight truck scenario and 0.77 for the mostly rail scenario) fatality from vehicle emissions could occur in the general population along transportation routes.

IMPLEMENTING ALTERNATIVES AND SCENARIOS

Implementing alternatives and scenarios are used to describe the range of reasonably foreseeable transportation actions with environmental impacts that could result from the Proposed Action.

Implementing alternatives represent feasible selections that DOE could make based in part on this EIS (for example, selecting a branch rail line corridor or an intermodal transfer station location and an associated route for heavy-haul trucks). Analytical scenarios, on the other hand, are feasible combinations of actions that DOE would have limited ability to direct (for example selecting the use of rail or truck casks for shipments from a specific nuclear powerplant). The scenarios are selected such that the analysis results bound the range of impacts that could result from the Proposed Action.

The transportation modes that make up the analytical scenarios and implementing alternatives include the following:

Legal-weight truck transportation: Legal-weight trucks have gross vehicle weights, including cargo, that do not exceed 80,000 pounds, which is the loaded weight limit for commercial vehicles operated on Interstate and U.S. highways without special state-issued permits. In addition, these vehicles have dimensions that are within the constraints of Federal and state regulation limits.

Permitted overweight, overdimension truck transportation: Semi- and tandem tractor-trailer trucks with gross vehicle weights over 80,000 pounds must obtain permits from state highway authorities to use public highways. States often permit vehicles that have gross weights above 80,000 pounds as *overweight, overdimension* vehicles with operating restrictions to protect public safety. Seven-axle tractor-trailer trucks (steering axle and three drive axles on the tractor and three axles on the trailer) with weights greater than 80,000 pounds that meet Federal bridge formulas and dimensional limits can carry payloads of 70,000 pounds.

Rail transportation: Rail transportation includes railroad transportation of spent nuclear fuel and high-level radioactive waste in large rail transportation casks (rail casks). The casks would be placed on railroad cars at commercial and DOE sites or at nearby intermodal transfer facilities for shipment on trains operated by commercial railroad companies over existing tracks. Because of the weight of the casks, only one cask would be transported on a railcar.

Heavy-haul truck transportation: Heavy-haul truck transportation includes the movement of large rail casks—both loaded and empty—on large heavy-haul trucks traveling on existing highways. For the transportation of spent fuel and high-level radioactive waste rail casks, these vehicles would weigh as much as 500,000 pounds; they would be more than 100 feet long and 10 to 12 feet wide, and would stand as high as 15 feet above the road surface. Heavy-haul trucks would require special permits issued by a state transportation agency. The permits would normally restrict the times of operation (typically daylight, non-rush-hour), operating speeds, and highways used.

Barge transportation: Barge transportation would be the transportation of loaded and empty rail casks between a commercial facility and a nearby railhead using navigable waterways. Barge terminals would have intermodal transfer capabilities sufficient to transfer casks from barges to railcars.

An estimated 12 (11.7) latent cancer fatalities could occur in the worker population from radiation exposure for the mostly legal-weight truck scenario, and an estimated 3 (3.5) latent cancer fatalities could occur for the mostly rail scenario. The probability of a latent cancer fatality to the maximally exposed involved worker would be approximately 0.02 for either the mostly legal-weight truck or mostly rail scenario. DOE expects impacts to noninvolved workers to be even lower than those to involved workers. To assess potential radiological impacts at generator facilities, the EIS analysis assumed that noninvolved workers would have no direct involvement in handling spent nuclear fuel and high-level radioactive waste.

The differences in incident-free impacts between the mostly legal-weight truck and mostly rail scenarios are due principally to (1) the difference in the number of shipments for the two scenarios, and (2) differences in analysis assumptions about the numbers of in-transit stops, the number of potentially exposed persons, and their proximity to shipping casks that could result in external radiation exposure.

DOE identified no national environmental justice concerns or air quality impacts for incident-free transportation. Incident-free national transportation and the potential impacts to workers and the public are discussed further in Section 6.2.3.

Impacts of Transportation Accidents

The analysis evaluated impacts to human health and safety, collectively including the health and safety of the public and transportation workers, from transportation accidents. Thus, impacts to populations from transportation accidents would include impacts to affected workers. Because the population of transportation workers would be small compared to the general population, radiological accident risks and consequences for the worker population would be a small fraction of those estimated for the public (that is, the total population).

TRANSPORTATION ACCIDENT RADIOLOGICAL DOSE RISK

The risk to the general public of radiological consequences from transportation accidents is called *dose risk* in this EIS. Dose risk is the sum of the products of the probabilities (dimensionless) and the consequences (in person-rem) of all potential transportation accidents.

The probability of a single accident is usually determined by historical information on accidents of a similar type and severity. The consequences are estimated by analysis of the quantity of radionuclides likely to be released, potential exposure pathways, potentially affected population, weather conditions, and other information.

As an example, the dose risk from a single accident that had a probability of 0.001 (1 chance in 1,000), and would cause a population dose of 22,000 person-rem in a population if it did occur, would be 22 person-rem. If that population was subject to 1,000 similar accident scenarios, the total dose risk would be 22,000 person-rem. Using the conversion factor of 0.0005 latent cancer fatality per person-rem, an analysis would estimate a health and safety risk of 11 latent cancer fatalities from this population dose risk.

Accident impacts include the consequences where shipping casks could be breached with subsequent release of radioactive material to nearby individuals and populations. In addition, there could be impacts to individuals from “normal” traffic accidents, in which there would be no release of radioactive material from shipping casks and only those directly involved in the accident would be affected. The analysis examined radiological consequences under the maximum reasonably foreseeable accident scenario, and also estimated overall accident risk. The maximum reasonably foreseeable accident scenario is the one with the greatest potential consequences that are reasonably foreseeable. The scenario must also have an occurrence likelihood of 1 in 10 million per year or greater to be considered “reasonably foreseeable.” Accident risk considers the potential consequences of all foreseeable accident scenarios and their occurrence likelihood, ranging from accident scenarios that are likely to occur but would have no release of radioactive material to those accident scenarios that are extremely unlikely to occur but could have large consequences (for example, the maximum reasonably foreseeable accident scenario).

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The overall radiological accident risk, as described in Appendix J, Section J.1.4.2.1, from all accident scenarios over the 24 years of transportation activities during the Proposed Action would be about 0.0002 latent cancer fatality for the mostly legal-weight truck scenario and about 0.0005 latent cancer fatality for the mostly rail scenario. These estimated latent cancer fatalities would occur in the hypothetically exposed population residing within 80 kilometers (50 miles) of the accident site.

The maximum reasonably foreseeable accident scenario for the mostly legal-weight truck scenario would result in about 1 latent cancer fatality in the exposed population. It is postulated to involve a release of radioactive material from a truck cask in an urbanized area under stable weather conditions. The probability of this accident scenario would be about 0.00000023 per year (a rate of about 2.3 in 10 million years). The maximum reasonably foreseeable accident scenario for the mostly rail scenario would result in about 5 latent cancer fatalities in the exposed population. It is postulated to involve a release of radioactive material from a rail cask in an urbanized area under stable weather conditions. The probability of this accident scenario would be about 0.00000028 per year (a rate of about 2.8 in 10 million years). The probability of a latent cancer fatality occurring in the hypothetical maximally exposed individual would be about 0.0015 for the mostly legal-weight truck scenario and about 0.015 for the mostly rail scenario.

DOE evaluated accidents involving the crash of a jet airliner into a legal-weight truck cask or rail cask (DIRS 157210-BSC 2001, all). Such an accident could result in up to 0.65 latent cancer fatality.

Nationwide, during the 24 years of the Proposed Action transportation activities, about 5 nonradiological fatalities could result from traffic accidents under the mostly legal-weight truck scenario. For the same time period, about 3 nonradiological fatalities could also result from traffic accidents under the mostly rail scenario. These fatalities would all be related to physical injuries associated with traffic accidents, not radiological impacts.

No environmental justice concerns were identified for transportation accident scenarios. Transportation accident scenarios and potential impacts are discussed further in Section 6.2.4.

Table 6-1 summarizes the national impacts of transporting spent nuclear fuel and high-level radioactive waste from 77 generator sites to the proposed Yucca Mountain Repository. The table lists impacts for the two transportation scenarios—mostly legal-weight truck and mostly rail. It includes impacts that would occur in Nevada among the national impacts. For the mostly rail scenario, Table 6-1 lists a range of impacts. Ten unique national impacts comprise the range—one for each of the five rail and five heavy-haul truck implementing alternatives in Nevada.

As listed in Table 6-1, impacts to the general population would be small for both scenarios. For example, impacts to individuals in a population of between 10 million and 17 million who lived within 800 meters (0.5 mile) of routes and to individuals who used the routes could range from about 0.12 millirem to as much as 0.5 millirem over the 24-year shipping campaign. These small doses would increase the risk of cancer for an average individual who lived along a route by 0.5 to 2.5 in 10 million over the individual's lifetime. This level of health and safety risk would not be discernible. A hypothetical maximally exposed individual who would live or work along transportation routes for 24 years would receive a dose of 2.4 rem (a truck stop worker for the mostly legal-weight truck scenario) or 0.29 rem (a person who lived near a rail stop for the mostly rail scenario). The estimated dose to the hypothetical truck stop worker would increase the risk of a latent cancer fatality by about 1 in 1,000 over the person's lifetime. For the maximally exposed individual who lived near a rail stop, the risk of a latent cancer fatality would increase by about 1 in 10,000 over the person's lifetime. The health and safety risks for these hypothetical individuals would not be discernible. For perspective, in the United States, about one in four deaths is caused by cancer from all causes.

Table 6-1. National transportation impacts for the transportation of spent nuclear fuel and high-level radioactive waste for the mostly rail and mostly legal-weight truck scenarios.[a,b]

Group	Impact	Mostly legal-weight truck scenario	Mostly rail scenario
Worker	*Incident-free health impacts, radiological*		
	Maximally exposed individual (rem)	48[c]	48[c]
	Individual latent cancer fatality probability	0.02	0.02
	Collective dose (person-rem)	29,000	7,900 - 8,800
	Latent cancer fatality incidence	11.7	3.2 - 3.5[d]
	Industrial safety (fatalities)	0.9	0.29
Public	*Incident-free health impacts, radiological*		
	Average exposed individual (rem)	0.0005	0.0001
	Maximally exposed individual (rem)	2.4[e]	0.29
	Individual latent cancer fatality probability	0.0012	0.00014
	Collective dose (person-rem)	5,000	1,200 - 1,600
	Latent cancer fatality incidence	2.5	0.61 - 0.81
	Incident-free vehicle emissions impacts (fatalities)	0.95	0.55 - 0.77
	Radiological impacts from maximum reasonably foreseeable accident scenario		
	Frequency (per year)	2.3 in 10,000,000	2.8 in 10,000,000
	Maximally exposed individual (rem)	3	29
	Individual latent cancer fatality probability	0.0015	0.015
	Collective dose (person-rem)	1,100	9,900
	Latent cancer fatality incidence	0.55	5
	Accident dose risk (person-rem)	0.46	0.89
	Accident risk (latent cancer fatalities)	0.00023	0.00045
Public and transportation workers	*Fatalities from vehicular accidents*	4.9	2.3 - 3.1

a. The assumed external dose rate is 10 millirem per hour at 2 meters (6.6 feet) from the vehicle for all shipments.
b. Totals for 24 years of operation, including impacts of loading.
c. Based on 2-rem-per-year dose limit.
d. Range for the 10 rail and heavy-haul truck implementing alternatives in Nevada.
e. Based on 100-millirem-per-year dose limit.

Radiological impacts of transportation accidents, which DOE estimated by summing the products of the probability of releases of radioactive materials from casks and the consequences of the releases if they occurred, would be very small. They would be small because accidents that could cause a release from a cask would be very unlikely and consequences from the small releases that could occur would generally be small. For example, Table 6-1 lists the consequences of maximum reasonably foreseeable accidents for the mostly rail and mostly legal-weight truck scenarios. In these accidents, which would have an annual likelihood of 2.3 in 10 million for the legal-weight truck scenario and 2.8 in 10 million for the mostly rail scenario, the estimated consequences would be 1,100 person-rem for a truck accident and 9,900 person-rem for a rail accident. The health and safety consequences of these doses would be about 0.55 latent cancer fatality for the truck accident and 5 latent cancer fatalities for the rail accident. The risk impacts of these accidents would be 2.3 in 10 million multiplied by 1,100 person-rem for the truck accident—about 0.00025 person-rem—and about 2.8 in 10 million multiplied by 9,900 person-rem for the rail accident—about 0.0028 person-rem. A *dose risk* of 0.0028 person-rem to a population is equivalent to a risk of 1 in 1 million of a single latent cancer fatality in the population. Thus, the radiological risks to health and safety from transportation accidents would be exceedingly small for both scenarios.

The radiological risks of accidents for the general public are not comparable with the risks of fatalities associated with immediate nonradiological consequences of transportation accidents. For the mostly legal-weight truck scenario, the analysis estimated there could be as many as 5 (4.9) fatalities over 24 years from vehicle collisions and other traffic accidents during the 53,000 legal-weight truck and 300 rail shipments. For the mostly rail scenario, which would involve as many as 9,600 rail and 1,100 legal-weight truck shipments, the analysis estimated there could be about 3 (2.5 to 3.3) fatalities over 24 years attributable to train operations; these could include fatalities from grade-crossing accidents and trespassers struck and killed by trains.

The analysis estimated long-term health effects fatalities that could be caused by the exhaust and fugitive dust emissions of the vehicles that would transport spent nuclear fuel and high-level radioactive waste. There would be 1 (0.95) fatality under the mostly legal-weight truck scenario and less than 1 (between 0.55 and 0.77) fatality under the mostly rail scenario as a consequence of 24 years of transportation. These fatalities would be latent, or would occur well after exposure to the vehicle exhaust and dust emissions.

Radiological doses to the workers who would load casks, drive trucks, operate trains, and inspect vehicles in transit would be higher than doses to the general public. Radiological protection programs would manage and limit doses to workers whose jobs would cause them to receive the greatest exposures. Even so, the analysis assumed a maximally exposed individual worker could receive a dose as high as 2 rem per year for each of the 24 years of the Proposed Action, for a total of 48 rem over 24 years. The analysis assumed that this dose, which is the maximum currently allowed under DOE administrative controls, would occur for both the mostly legal-weight truck and mostly rail scenarios. A dose of 48 rem would increase the worker's lifetime risk of a latent fatal cancer from an average of 23 percent from all causes to 25 percent.

The radiological impacts to all workers involved in shipping spent nuclear fuel and high-level radioactive waste to a Yucca Mountain Repository would be greatest for the mostly legal-weight truck scenario. For this scenario, the analysis estimated the workers would receive a total dose of 29,000 person-rem. Thus, the estimated lifetime impact to the worker population for the mostly legal-weight truck scenario would be 11.7 latent cancer fatalities from shipments over the 24 years of the Proposed Action. For the mostly rail scenario, the estimated lifetime impacts would be between 7,900 and 8,800 person-rem, or about one-third of the impacts for the mostly legal-weight truck scenario.

6.1.2 OVERVIEW OF NEVADA TRANSPORTATION IMPACTS

This section provides an overview of the environmental impacts associated with transportation of spent nuclear fuel and high-level radioactive waste in the State of Nevada. Although this section provides a more detailed, regional subset of some of the information gathered and analyses conducted for national transportation (see Section 6.1.1), it also includes information analyzed specifically for Nevada. This includes impacts from construction and operation of branch rail lines, routes for heavy-haul trucks and intermodal transfer stations, commuter transportation for construction and operations activities, and transportation of other materials in support of Yucca Mountain operations. Detailed discussions of potential impacts in Nevada are in Section 6.3 and Appendix J. The following areas were evaluated for potential impacts in Nevada from Yucca Mountain transportation activities:

- Transporting spent nuclear fuel and high-level radioactive waste by legal-weight truck in Nevada
- Constructing a branch rail line in Nevada and using it to transport spent nuclear fuel and high-level radioactive waste by rail to the repository
- Upgrading highways in Nevada for use by heavy-haul trucks to transport spent nuclear fuel and high-level radioactive waste to the repository
- Constructing and operating an intermodal transfer station in Nevada
- Transporting materials, consumables, supplies, equipment, waste, and people to support construction, operation and monitoring, and closure of the repository

Overviews are presented for the 12 environmental resource areas analyzed in this chapter and for the transportation of other materials and supplies, which is presented in further detail in Appendix J. Section 6.3 contains summaries that provide information for assessing the relative impacts in these resource areas from the mostly legal-weight truck transportation scenario, the five implementing alternatives for rail transportation, and the five implementing alternatives for heavy-haul truck transportation.

6.1.2.1 Land Use

Land-use impacts (land areas that would be disturbed or whose ownership or use would change) would be greatest for the mostly rail scenario. Land-use and ownership impacts based on a 60-meter- (200-foot)-wide rail right-of-way (land withdrawn) would affect from approximately 9.4 square kilometers (2,323 acres) for the Valley Modified route to 33.2 square kilometers (8,204 acres) for the Caliente route. Actual land disturbance in each 400-meter- (0.25-mile)-wide corridor for individual rail routes would range from approximately 5.1 square kilometers (1,260 acres) for the Valley Modified route to approximately 19.2 square kilometers (4,744 acres) for the Carlin route (see Figure 6-3). DOE based these estimated disturbances on anticipated construction activities (borrow areas, construction camps, soil areas) in the 400-meter corridor associated with the construction of a railroad and the projected width of the average construction disturbance for each rail bed. The average disturbance widths, for example, range from approximately 28 meters (91 feet) for the Caliente-Chalk Mountain Corridor to approximately 37 meters (120 feet) for the Jean Corridor. Land disturbance calculations do not include access roads. Existing roads would be used where possible. Due to possible variations along the rail corridors, land-use, ownership, and disturbances could vary from those discussed above (see Appendix J, Section J.3.1.2). Section 6.3.2.2 reports ranges due to these variations, as well as information on the representative corridor routes. No prime farmland would be affected by any of the transportation routes. The Carlin Corridor would affect the most private land [14 square kilometers (3,459 acres)]. Table 6-2 summarizes the land-use conflicts along the corridors. Selecting variations of a corridor, as described in Appendix J, Section J.3.1.2, could reduce some conflicts and increase or change conflicts in others. Overall impacts are generally proportional to the length of the corridor.

Disturbed land area for all of the heavy-haul truck implementing alternatives would range from 0.83 to 3.6 square kilometers (205 to 890 acres). No more than 0.2 square kilometer (50 acres) of private land would be affected for any route. There would be no land-use impacts from legal-weight trucks using existing highways. Land-use impacts are discussed for Nevada transportation rail implementing alternatives and for Nevada transportation heavy-haul truck implementing alternatives in Sections 6.3.2 and 6.3.3, respectively. None of the transportation implementing alternatives currently being considered would be affected by the flexible design evaluated for the proposed repository. Chapter 2, Table 2-7, summarizes the impacts to the various resource areas as the result of the repository operating modes. Section 6.3 contains summary information about the impacts in Nevada from the mostly legal-weight truck scenario and the rail and heavy-haul alternatives of the mostly rail scenario.

There are potential land-use conflicts for the Nevada implementing alternatives. The Carlin, Caliente, and Valley Modified Corridors encroach on the western and southern boundaries of the Nellis Air Force Range (also known as the Nevada Test and Training Range), and the Caliente-Chalk Mountain rail corridor and Caliente/Chalk Mountain heavy-haul truck route travel through the Range from north to south, essentially bisecting it. The U.S. Air Force has stated to DOE that the construction and use of routes through the Nellis Air Force Range would seriously affect sensitive and classified programs, would severely reduce Air Force training capabilities, and would impair the ability to comply with international testing and training obligations on the Range. In response to these concerns, DOE has identified the Caliente-Chalk Mountain Corridor and Caliente/Chalk Mountain heavy-haul route as nonpreferred alternatives. In addition, the Air Force noted the potential for safety risks of using other routes that could cross lands that are hazard areas and encompass weapons safety footprints for live weapons deployment. Although DOE is unaware of specific safety risks, the Caliente, Carlin, and Valley Modified rail corridors

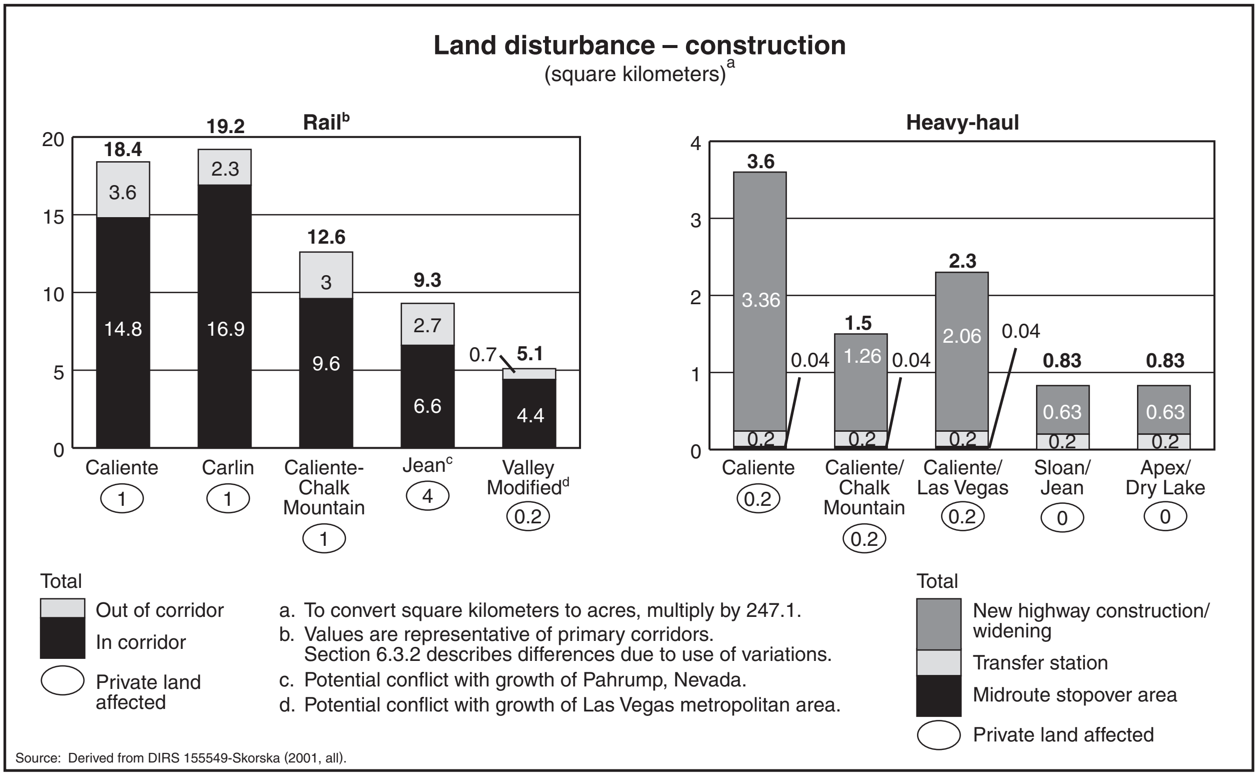

Figure 6-3. Land disturbed for construction of branch rail lines and upgrades to Nevada highways for heavy-haul use.

include sections that would encroach on the Range for short distances. For the Caliente Corridor, Carlin Corridor, and one section of the Valley Modified Corridor, DOE has identified variations that would avoid entering the Range. A short segment of the Valley Modified Corridor for which there is no currently identified variation would cross the southern Range boundary. If DOE selected this corridor, it would consult with the Air Force to determine avoidance or mitigation measures.

The Steiner Creek Alternate of the Carlin Corridor passes just west of the Simpson Park Wilderness Study Area and might encroach slightly into the Wilderness Study Area. The Caliente Corridor passes close to the Weepah Springs and Kawich Wilderness Study Areas, and passes inside and along the western boundary of the South Reveille Wilderness Study Area. The Wilson Pass Option of the Jean Corridor passes through Bureau of Land Management Visual Resource Management Class II lands in the vicinity of Wilson Pass in the Spring Mountains. The Jean and Valley Modified Corridors could have conflicts with the future community growth of Pahrump and Las Vegas, respectively. The Valley Modified Corridor passes near the Las Vegas Paiute Indian Reservation. The Valley Modified Corridor and its Sheep Mountain Alternate cross Nellis Wilderness Study Areas A, B, and C; the Quail Mountain Wilderness Study Area; and penetrates the Desert National Wildlife Refuge. The routes for heavy-haul trucks pass through the Las Vegas Paiute Indian Reservation along U.S. Highway 95 northwest of Las Vegas and approximately 4.8 kilometers (3 miles) west of the Moapa Indian Reservation. The rail origination location for the Stateline Pass Option is on lands to be used for the construction of the Ivanpah Valley Airport (Ivanpah Valley Airport Public Lands Transfer Act, Public Law 106-362, 114 Stat. 1404). The Bonnie Claire Alternate of the Carlin and Caliente Corridors passes through the newly established Timbisha Shoshone trust lands near Beatty.

Table 6-2. Land-use conflicts of rail corridor variations.[a,b]

Corridor[c]	Forest Service land	Fish and Wildlife Service land/ range	Desert Land Entry Program/ withdrawal area	Right-of-way/ road	Wilderness Study Area	Private land	Grazing allotments	Nellis Air Force Range	BLM[d]/ Nevada Test Site land	Native American Reservation
Caliente										
Caliente Corridor with Eccles Option	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Eccles Option	No	No	No	No	No	Yes	Yes	No	Yes	No
Caliente Option	No	No	No	Yes	No	Yes	No	No	Yes	No
Crestline Option	No	No	No	Yes	No	Yes	No	No	Yes	No
White River Alternate	No	No	No	No	No	Yes	No	No	Yes	No
Garden Valley Alternate	No	No	No	Yes	No	Yes	No	No	Yes	No
Mud Lake Alternate	No	No	No	No	No	No	Yes	No	Yes	No
Goldfield Alternate	No	No	No	No	No	Yes	Yes	No	Yes	No
Bonnie Claire Alternate	No	No	No	Yes	No	Yes	Yes	No	Yes	Yes
Oasis Valley Alternate	No	No	No	No	No	Yes	Yes	No	Yes	No
Beatty Wash Alternate	No	No	No	No	No	No	Yes	No	Yes	No
Carlin										
Carlin Corridor with Big Smoky Valley Option	No	No	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Big Smoky Valley Option	No	No	Yes	Yes	No	No	Yes	No	Yes	No
Crescent Valley Alternate	No	No	No	Yes	No	Yes	Yes	No	Yes	No
Wood Spring Alternate	No	No	No	No	No	No	Yes	No	Yes	No
Rye Patch Alternate	No	No	No	Yes	No	No	Yes	No	Yes	No
Steiner Creek Alternate	No	No	No	No	Yes	No	Yes	No	Yes	No
Monitor Valley Option	No	No	Yes	Yes	No	No	Yes	No	Yes	No
Mud Lake Alternate	No	No	No	No	No	No	Yes	No	Yes	No
Gold Field Alternate	No	No	No	No	No	Yes	Yes	No	Yes	No
Bonnie Claire Alternate	No	No	No	Yes	No	Yes	Yes	No	Yes	Yes
Oasis Valley Alternate	No	No	No	No	No	Yes	Yes	No	Yes	No
Beatty Wash Alternate	No	No	No	No	No	No	Yes	No	Yes	No
Caliente-Chalk Mountain										
Caliente-Chalk Mountain Corridor with Eccles Option	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Eccles Option	No	No	No	No	No	Yes	Yes	No	Yes	No
Caliente Option	No	No	No	Yes	No	Yes	No	No	Yes	No
Crestline Option	No	No	No	Yes	No	Yes	No	No	Yes	No
White River Alternate	No	No	No	No	No	Yes	No	No	Yes	No
Garden Valley Alternate	No	No	No	Yes	No	Yes	No	No	Yes	No
Orange Blossom Road Option	No	No	No	Yes	No	No	No	No	Yes	No
Mercury Highway Option	No	No	No	No	No	No	No	No	Yes	No
Topopah Option	No	No	No	No	No	No	No	No	Yes	No
Mine Mountain Alternate	No	No	No	No	No	No	No	No	Yes	No
Area 4 Alternate	No	No	No	Yes	No	No	No	No	Yes	No
Jean										
Jean Corridor with Wilson Pass Option	No	No	No	Yes	No	Yes	Yes	No	Yes	No
Wilson Pass Option	No	No	No	Yes	No	Yes	Yes	No	Yes	No
North Pahrump Alternate	No[e]	No	No	Yes	No	Yes	No	No	Yes	No
Stateline Pass Option	No	No	Yes	Yes	No	Yes	Yes	No	Yes	No
Valley Modified										
Valley Modified Corridor	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Indian Hills Alternate	No	Yes	Yes	Yes	No	No	No	No	Yes	No
Sheep Mountain Alternate	No	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No
Valley Connection	No	No	No	No	No	Yes	No	No	Yes	No

a. Sources: Derived from DIRS 101504-BLM (1979, all), DIRS 103077-BLM (1983, all), DIRS 101523-BLM (1994, all), DIRS 103079-BLM (1998, all), DIRS 104993-CRWMS M&O (1999, all), DIRS 155549-Skorska (2001, all).

b. For definition and illustration of Corridor, Option, Variation, and Alternative terms, see Chapter 3, Section 3.2.2. For additional explanation, see Appendix J, Section J.3.1.2.

c. The first line under each corridor indicates land-use conflicts for the entire corridor with the use of that particular variation. Further listings indicate conflicts only along the length of the particular variation.

d. BLM = Bureau of Land Management.

e. Route abuts Toiyabe National Forest.

6.1.2.2 Air Quality

The main air pollutants would be fugitive dust (PM_{10}) and equipment emissions (carbon monoxide, nitrogen dioxide, and sulfur dioxide) from construction or upgrade activities associated with the rail and heavy-haul truck implementing alternatives, and vehicle emissions associated with legal-weight truck, heavy-haul truck, and rail transportation.

Because the Las Vegas air basin is in nonattainment of air quality regulations for PM_{10} and carbon monoxide, more restrictive regulations are applied to these criteria pollutants within the Las Vegas air basin. Construction activities are a major source of PM_{10} emissions (DIRS 155557-Clark County 2001, all). Vehicle emissions are the major source of carbon monoxide emissions (DIRS 156706-Clark County 2000, all). The transportation air quality analyses focused on these pollutants and sources within the Las Vegas air basin. Annual emissions were estimated and compared to the General Conformity threshold levels established in EPA regulations implementing the Clean Air Act.

The PM_{10} emissions during construction activities would result primarily from earthmoving operations, but also from construction vehicle fuel combustion. Dust control measures are required for activities in the Las Vegas air basin (DIRS 155557-Clark County 2001, all). These measures include water application and limiting activity on windy days. Construction activities would occur under the rail and heavy-haul transportation implementing alternatives in Nevada. The General Conformity threshold level for PM_{10} (63,500 kilograms per year) would be exceeded under the mostly rail scenario for total estimated emissions of the Valley Modified Corridor (190 percent of threshold). Construction activities in other corridors would not exceed the PM_{10} threshold. The General Conformity threshold level for PM_{10} would be exceeded under the heavy-haul scenario for the Caliente-Las Vegas route (100 percent of threshold). Construction activities of other heavy-haul routes would not exceed the PM_{10} threshold.

Carbon monoxide emissions would largely be a result of vehicle emissions. The greatest vehicle emissions under all three transportation scenarios would result not from radioactive material transport to Yucca Mountain, but from commuter and materials transportation to the site. Transport of personnel and materials results indicate maximum emissions during the operations and monitoring phase (67 percent of the carbon monoxide threshold). Vehicle emissions from transportation of radioactive materials would be, at most, 14 percent of the threshold level for the Valley Modified Corridor. During the construction phase, current estimates of fuel use for construction vehicles would result in exceedances of the General Conformity threshold levels for construction of the Valley Modified Corridor (110 percent of threshold).

Section 6.1.3 discusses air quality impacts from the transportation of personnel and materials. Section 6.3.1 discusses air quality impacts for Nevada legal-weight truck transportation. Sections 6.3.2 and 6.3.3 discuss rail and heavy-haul truck implementing alternatives, respectively.

DOE has conducted a separate conformity review for the Nevada transportation implementing alternatives that could result in the release of pollutants to the Las Vegas air basin, which is in nonattainment for carbon monoxide and PM_{10} (DIRS 101826-FHWA 1996, pp. 3-53 and 3-54). Sections 6.3.1.1, 6.3.2.1, and 6.3.3.1 summarize the results of conformity reviews for legal-weight truck, rail, and heavy-haul truck transportation, respectively, in Nevada.

6.1.2.3 Hydrology

Surface-water resources are most prevalent among the Caliente and Carlin Corridors and could be affected by construction activities. The potential Caliente intermodal transfer station is about 0.19 kilometer (0.12 mile) from a perennial stream, and the Caliente, Caliente/Chalk Mountain, and Caliente/Las Vegas routes for heavy-haul trucks would pass within 1 kilometer (0.6 mile) of water resources. Surface-water impacts during construction would be avoided by implementing good management practices to prevent and mitigate spills of pollutants and would avoid, minimize, or otherwise mitigate possible changes to stream flows. Therefore, DOE does not anticipate impacts to surface waters from the construction of a rail or heavy-haul truck implementing alternative. In addition, surface-water impacts would be unlikely from legal-weight truck, rail, or heavy-haul truck operations or the operation of an intermodal transfer station.

Potential for groundwater impacts would be limited. There would be the potential for temporary withdrawals of water from groundwater sources during the construction of a branch rail line or upgrades to highways and construction of an intermodal transfer station. Estimated water use would be greater for construction of branch rail lines than for upgrades for routes for heavy-haul trucks (see Figure 6-4). Such withdrawals would require temporary permits from the State of Nevada or possibly leases of temporary water rights from individuals along the route. If groundwater could not be withdrawn for construction, water would be transported from permitted sources to the construction sites by truck.

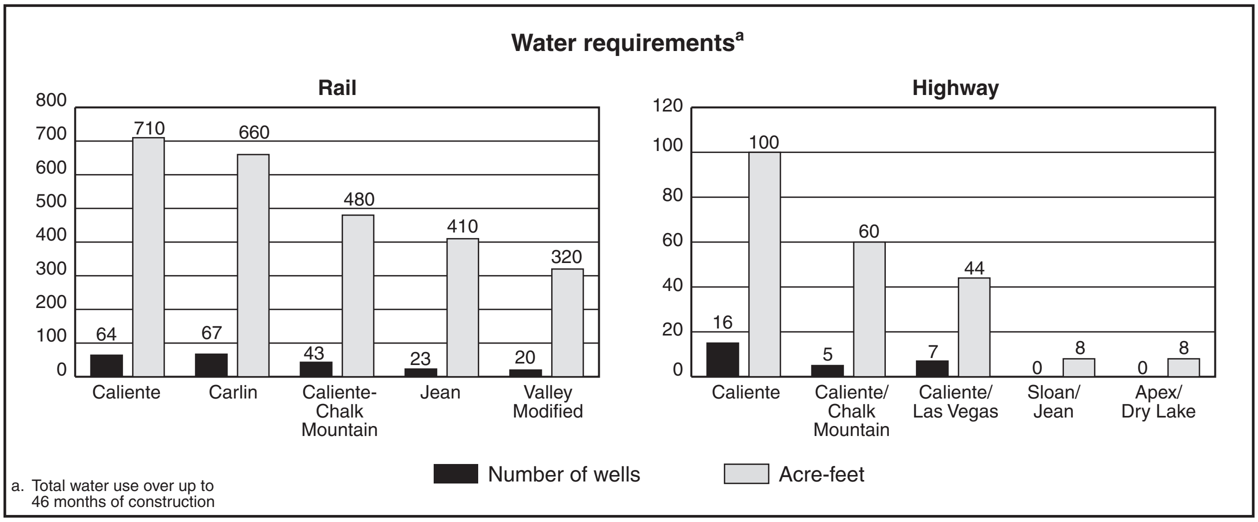

Figure 6-4. Water and number of wells required for construction of branch rail lines and upgrades to Nevada highways for heavy-haul use.

Legal-weight truck shipments, operations of a branch rail line, or operations of heavy-haul trucks, including the operation of an intermodal transfer station, would not affect groundwater resources. Water needs for these operations would be minor, and there would be little potential for contaminant releases to occur, particularly releases of a magnitude that could affect groundwater. Hydrology impacts are discussed for Nevada transportation rail implementing alternatives and for Nevada transportation heavy-haul truck implementing alternatives in Sections 6.3.2 and 6.3.3, respectively.

6.1.2.4 Biological Resources and Soils

Loss of habitat from construction of a branch rail line would be the greatest potential impact to biological resources (vegetation, habitat, threatened and endangered species, small animals, birds, game animals, wild horse and wild burro herds, and soils), potentially affecting the desert tortoise, a threatened species. Loss of desert tortoise habitat would be approximately 2.4 square kilometers (590 acres) for the Caliente/Chalk Mountain route, 3 square kilometers (740 acres) for the Caliente and Carlin routes, 5 square kilometers (1,200 acres) for the Valley Modified route (which is within the range of the desert tortoise along its entire length), and more than 11 square kilometers (2,700 acres) for the Jean route. All of these potential routes have low abundance of desert tortoises with the exception of some limited areas of the Jean route where abundance is higher.

In general, the number of herd management areas crossed by each route is related to the length of the route (as described in Section 3.2.2.1.4). Therefore, the potential for impacts to game animals or horses and burros through disruption of movement patterns or from loss of individual animals would be greater for the longer routes. The Valley Modified route does not cross any herd management areas, but passes through the Desert National Wildlife Range. The Carlin route passes through or near the greatest number of herd management areas or other areas that provide habitat for important biological resources (such as sage grouse strutting grounds). The adverse impact that loss of an individual animal could have on a particular herd would depend on the particular individual that was lost and the size of the herd. Small herds could be affected to a greater degree than large herds. Noise from passing trains could disturb game animals, horses, or burros until those animals became acclimated to the presence of the trains. DOE anticipates that two trains could pass by each day, so this disruption should be minimal.

Other features of the particular routes could affect the potential for impacts to biological resources along each route. Fencing along portions of a route could affect the number of individual animals lost because animals could be blocked from escape routes in fenced areas. Tunnels along the Jean route could be used by wildlife for shelter. Animals seeking shelter in a tunnel might not be able to escape if a train passed through while they were in the tunnel.

The potential for impacts from upgrading Nevada highways for heavy-haul truck use would be small because modifications to roads would occur in previously disturbed rights-of-way. An intermodal transfer station constructed in association with a heavy-haul truck implementing alternative would potentially disturb only about 0.2 square kilometer (50 acres) of potential desert tortoise habitat. The activities associated with constructing a branch rail line, building an intermodal transfer station, or upgrading and maintaining a heavy-haul truck route to Yucca Mountain would be likely to adversely affect a few individual desert tortoises. However, based on review of past experience and available information, DOE believes it could mitigate the impacts of these activities such that they would not negatively affect regional populations of desert tortoises, jeopardize the continued existence of the species, or result in adverse modification of designated critical habitat. Individuals of other special status species could be affected based on the route chosen. Impacts from operations, with the exception of infrequent wildlife kills by vehicles, would be unlikely. Although the proposed routes for heavy-haul trucks pass near or through herd management areas and other areas containing sensitive biological resources, adverse impacts to those resources would be small because the heavy-haul trucks would use existing roads and would represent a very small percentage of the traffic along those roads. [See DIRS 156930-NDOT (2001, all) for traffic counts along Nevada highways.] As with heavy-haul trucks, legal-weight truck shipments that used existing highways would cause only very small impacts to biological resources.

For highway upgrades, DOE or the State of Nevada would reduce concerns about soil contamination or erosion by incorporating appropriate mitigation measures during construction. These measures would include the proper control of hazardous materials and use of dust suppression and other control techniques to reduce erosion. As a result, the implementing alternatives for transportation in Nevada would be unlikely to have impacts on soil. Impacts to biological resources and soils are discussed for Nevada transportation rail implementing alternatives and for Nevada transportation heavy-haul truck implementing alternatives in Sections 6.3.2 and 6.3.3, respectively.

6.1.2.5 Cultural Resources

A comprehensive review of existing literature and many discussions with responsible Federal and State of Nevada agencies and Native American groups has identified many archaeological and cultural sites and features. Pertinent information is presented in Chapter 3, Sections 3.1.6, 3.2.2.1.5, and 3.2.2.2.5. Much of the information has been confirmed and additional information acquired during field observations.

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Based on this extensive review of available information and recent field observations, the construction and operation of a branch rail line in any of the candidate corridors could present the potential for direct or indirect impacts (such as crushing or disturbing of sites; soil erosion exposing or covering sites) to archaeological and historic resources, including those related to Native American culture. None of the five rail corridors passes through presently established reservation lands, but the Bonnie Claire Alternate (for either the Carlin or Caliente Corridor) passes directly through the recently established Timbisha Shoshone Trust Lands at Scottys Junction. In some cases, proposed corridors cross historic linear sites (such as the Pony Express Trail) (see Chapter 3, Section 3.2.2.1.5). In these cases potential impacts could be identified during field studies that would evaluate the current condition of the resources at particular locales, the overall character of the impacts, and the effort required to mitigate the impacts. If a rail corridor was selected, DOE would conduct additional archaeological surveys and ethnographic studies as part of additional National Environmental Policy Act reviews to determine potential impacts of alternative alignments within a corridor.

The determination of the potential for impacts to archaeological resources and Native American cultural values from the upgrading and use of existing Nevada highways for heavy-haul truck shipments could require study. Although the widening of roadways and development of turnouts would occur within existing rights-of-way, disturbance of cultural resources near the roadway and, in some cases, within existing rights-of-way could occur. The American Indian Writers Subgroup has commented that ethnographic field studies will be needed to determine specific potential impacts to Native American cultural properties and values for candidate rail corridors (DIRS 102043-AIWS 1998, p. 4-6).

6.1.2.6 Occupational and Public Health and Safety

Impacts to occupational and public health and safety include industrial safety impacts to workers from construction and operations, radiological impacts to workers and the general public from external radiation exposure and exposure to vehicle emissions during normal operations and incident-free transportation, radiological impacts from transportation accident scenarios, radiological impacts from hypothetical severe accident scenarios that would breach shipping casks, and impacts from traffic accidents.

Potential industrial safety impacts to workers from construction and operations are listed in Table 6-3. Estimated impacts from industrial accidents would be higher for rail than for heavy-haul trucks, but in all cases there would be less than 1 industrial safety-related fatality during construction for any of the five branch rail line or five heavy-haul truck implementing alternatives. No industrial safety-related fatalities would be expected to occur during operations.

Table 6-3. Industrial safety impacts to workers from construction and operation of Nevada transportation implementing alternatives.[a]

Impact	Branch rail line				
	Caliente	Carlin	Caliente-Chalk Mountain	Jean	Valley Modified
Total recordable cases	220	210	180	150	110
Lost workday cases	110	110	95	76	58
Fatalities (industrial accidents)	0.4	0.4	0.4	0.3	0.2
	Heavy-haul truck[b]				
	Caliente	Caliente/Chalk Mountain	Caliente/Las Vegas	Sloan/Jean	Apex/Dry Lake
Total recordable cases	370	320	330	210	210
Lost workday cases	190	170	180	110	110
Fatalities (industrial accidents)	0.9	0.8	0.8	0.5	0.5

a. Impacts are totals for 24 years of operations. There are no impacts for the legal-weight truck scenario.
b. Includes impacts to workers at an intermodal transfer station.

Potential radiological impacts and vehicle emissions-related impacts from normal operations and incident-free transportation in Nevada for each of the rail and heavy-haul truck implementing alternatives and for the mostly legal-weight truck scenario are presented in Table 6-4. Radiological impacts to members of the public from external radiation exposure and risks from exposure to vehicle emissions during incident-free transportation would be lowest for rail, intermediate for heavy-haul trucks, and highest for legal-weight truck transportation, where an estimated 0.3 latent cancer fatalities could occur over 24 years. Impacts from vehicle emissions would be low in all cases (0.001 or fewer fatalities).

Table 6-4. Worker and public health and safety impacts from Nevada transportation implementing alternatives.[a]

Impact	Legal-weight truck[b]	Branch rail line: Caliente	Branch rail line: Carlin	Branch rail line: Caliente-Chalk Mountain	Branch rail line: Jean	Branch rail line: Valley Modified
Workers						
Maximally exposed individual probability of LCF[c]	0.02	0.02	0.02	0.02	0.02	0.02
Worker population LCFs	0.75	0.34	0.39	0.3	0.3	0.28
Public						
Maximally exposed individual probability of LCF	0.0016	0.00015	0.00015	0.00015	0.00015	0.00015
General population LCFs	0.17	0.009	0.019	0.009	0.08	0.013
Vehicle emissions-related health effects (fatalities)	0.09	0.25	0.25	0.2	0.23	0.13
Accident risk[d]						
Population LCFs	0.000026	0.000001	0.000001	0.000001	0.000004	0.000001
Maximum reasonably foreseeable accident scenario						
Population LCFs	0.5	5	5	5	5	5
Maximally exposed individual probability of LCF	0.0015	0.02	0.02	0.02	0.02	0.02
Traffic accident fatalities	0.49	1.93	1.85	1.57	1.27	0.94

Impact	Heavy-haul truck[b]: Caliente	Heavy-haul truck[b]: Caliente-Chalk Mountain	Heavy-haul truck[b]: Caliente/Las Vegas	Heavy-haul truck[b]: Sloan/Jean	Heavy-haul truck[b]: Apex/Dry Lake
Workers					
Maximally exposed individual probability of LCF[c]	0.02	0.02	0.02	0.02	0.02
Worker population LCFs	0.76	0.61	0.66	0.59	0.57
Public					
Maximally exposed individual probability of LCF	0.00016	0.00016	0.00016	0.00016	0.00016
General population LCFs	0.04	0.03	0.11	0.17	0.08
Vehicle emissions-related health effects (fatalities)	0.47	0.32	0.46	0.42	0.29
Accident risk[d]					
Population LCFs	0.000005	0.000001	0.000028	0.00006	0.000028
Maximum reasonably foreseeable accident scenario					
Population LCFs	5	5	5	5	5
Maximally exposed individual probability of LCF	0.02	0.02	0.02	0.02	0.02
Traffic accident fatalities	4.1	2.76	3.47	1.98	1.93

a. Impacts are totals for 24 years of operations.
b. Includes impacts to workers at an intermodal transfer station.
c. LCF = latent cancer fatality.
d. In this table, radiological accident dose risk is the sum of the products of the probabilities (dimensionless) and consequences (in person-rem) of all potential transportation accidents. This sum is converted to latent cancer fatalities using the conversion factor of 0.0005 latent cancer fatality per person-rem.

The overall radiological accident risk from all accidents over the 24 years of transportation activities in Nevada would be no higher than about 0.003 latent cancer fatality in the potentially exposed population within 80 kilometers (50 miles). Accident risk would be highest for the heavy-haul implementing alternatives and lower for the mostly legal-weight truck scenario and rail implementing alternatives. The Jean rail and Sloan/Jean heavy-haul truck implementing alternatives would have higher accident risks than other implementing alternatives. The estimated accident risks are presented in Table 6-4.

The Nuclear Regulatory Commission published a draft Addendum 1 (DIRS 148185-NRC 1999, all) to NUREG-1437, Volume 1, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (DIRS 101899-NRC 1996, all) to provide a technical basis to amend Commission regulations with the objective of improving the efficiency of renewing nuclear plant operating licenses well-understood environmental impacts to avoid repetitive reviews. The addendum addresses two aspects of spent nuclear fuel transportation that the original Commission analysis did not address—the cumulative impacts of transportation of commercial spent nuclear fuel in the vicinity of the proposed repository at Yucca Mountain, and the impacts of transporting higher-burnup fuel. The results of this DOE EIS analysis appear to be consistent with the Nuclear Regulatory Commission conclusion in the addendum, which is that "radiological and accident risks of SNF [spent nuclear fuel] transport in the vicinity of Las Vegas are within regulatory limits and small."

6.1.2.7 Socioeconomics

Socioeconomic impacts of transportation (changes in the level of employment, population, real disposable income, Gross Regional Product, and State of Nevada and local government expenditures) would occur from the construction and operation of a branch rail line, from upgrading a heavy-haul truck route, from transporting large shipping casks using heavy-haul trucks, and from constructing and operating an intermodal transfer station. Figures 6-5 through 6-8 show total regional employment changes in the peak year of construction, and average total employment in the region of influence from operations activities. Because of the large population and employment in the socioeconomic region of influence (principally in Clark County), impacts from construction activities would generally be less than 3 percent of the baseline for each socioeconomic measure in all three counties in the region of influence, for the rail or heavy-haul truck implementing alternatives. Changes in Lincoln County (the two rail corridors and three routes for heavy-haul trucks originating in Caliente) would be more visible, but still generally less than 3 percent of the applicable baseline and would not be greater than historic short-term socioeconomic changes in the county over the past two decades. The operational period for either a branch rail line or a heavy-haul truck route probably would generate relatively constant employment levels. Changes to the baseline regional populations and employment from construction or operation of a rail or heavy-haul truck implementing alternative would be unlikely to have consequences greater than 3 percent of the population baseline. DOE anticipates that the changes in the economic measures of Gross Regional Product, real disposable income, and State of Nevada and local government expenditures would be less than 3 percent of the baselines in each county. Changes in employment and subsequent changes in population would be the principal cause of the changes in these measures. Figures 6-5 through 6-8 show the changes in employment and population expected during construction and operations if DOE implemented one of the five rail or five heavy-haul truck implementing alternatives.

DOE performed detailed analyses for the corridors of the five branch rail line implementing alternatives and the five heavy-haul truck implementing alternatives. The results of these analyses, which are driven by the length of the rail corridors or the cost of construction and upgrades for the proposed routes for heavy-haul trucks, are representative of the variations (options and alternates) of each corridor listed in Appendix J, Section J.3.1.2. The lengths of the variations for each corridor are similar, as listed in Section 6.3.2.2.

In light of public comments received on the Draft EIS concerning perception-based and stigma-related impacts, DOE examined relevant studies and literature on perceived risk and stigmatization of communities to determine whether the state of the science in predicting future behavior based on perceptions had advanced sufficiently since scoping to allow DOE to quantify the impact of public risk perception on economic development or property values in potentially affected communities. Of particular interest were those scientific and social studies carried out in the past few years that directly relate to either Yucca Mountain or to DOE actions such as the transportation of foreign research reactor spent nuclear fuel. DOE also reevaluated the conclusions of previous literature reviews such as those

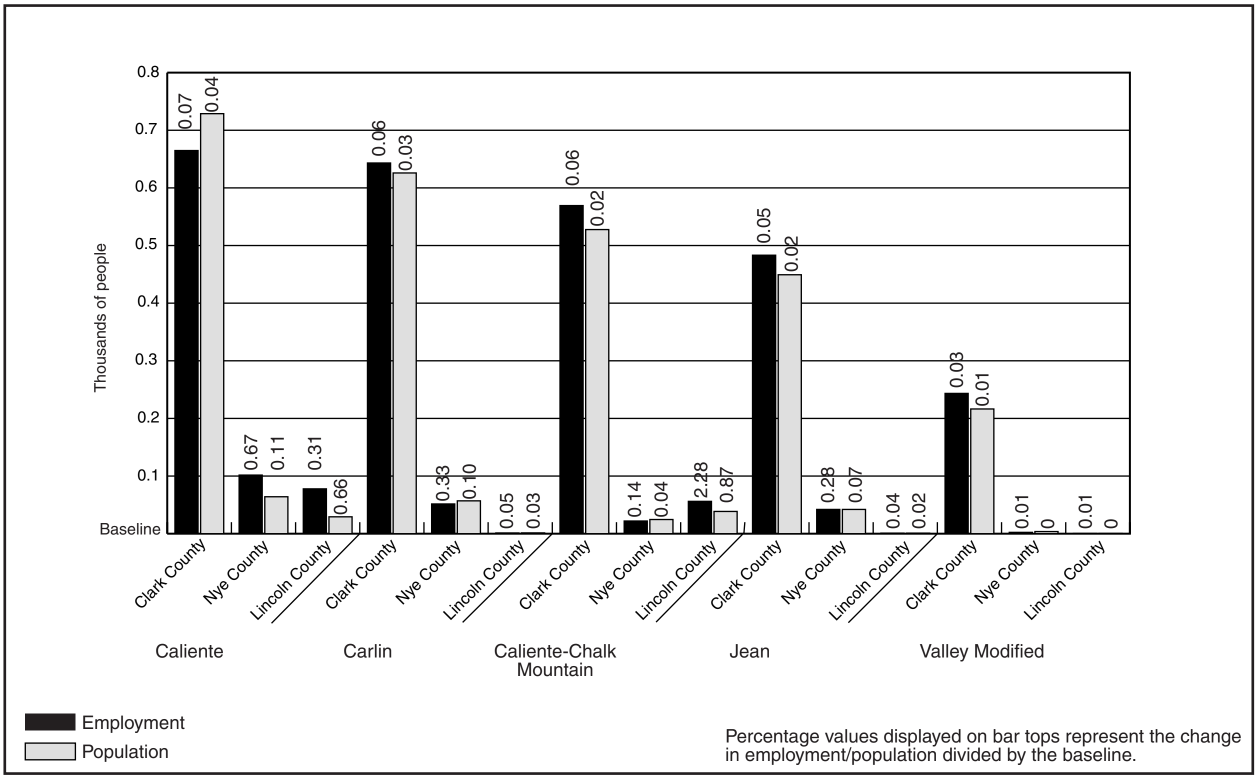

Figure 6-5. Population and employment for branch rail line implementing alternatives, construction (peak years).

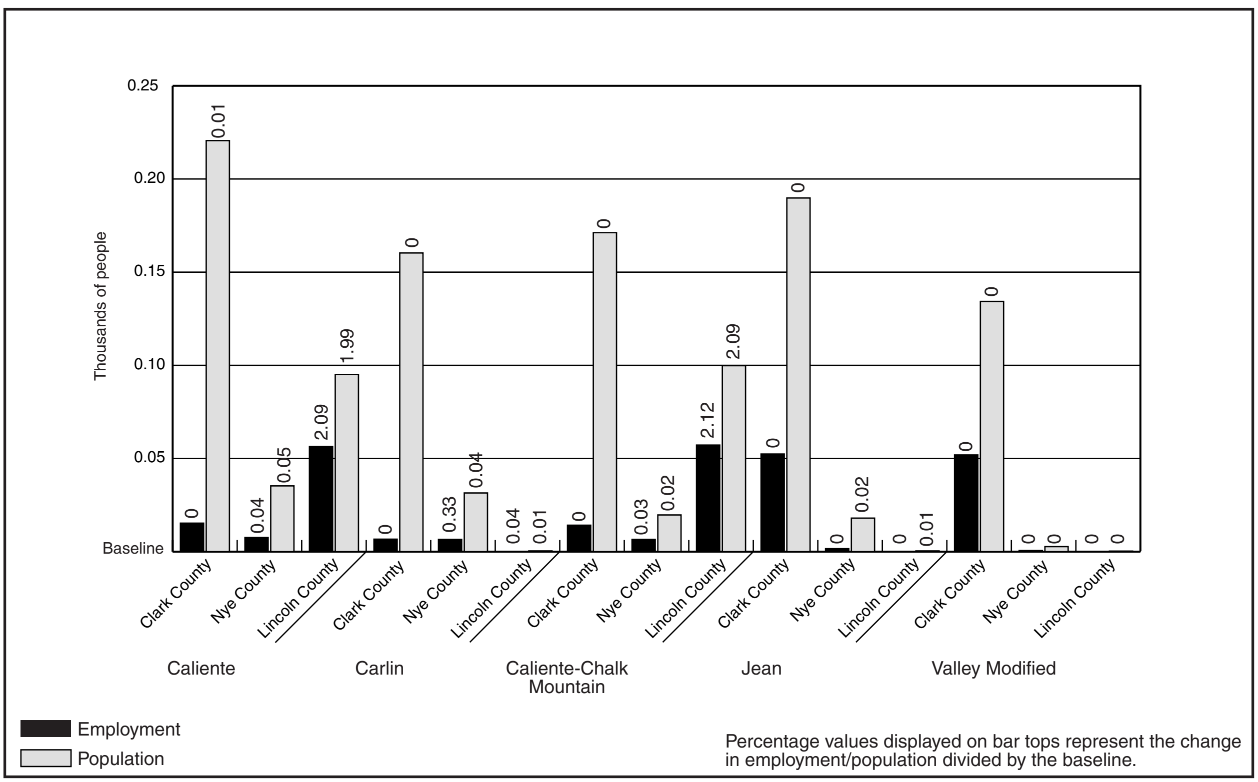

Figure 6-6. Population and employment for branch rail line implementing alternatives, operations (average years).

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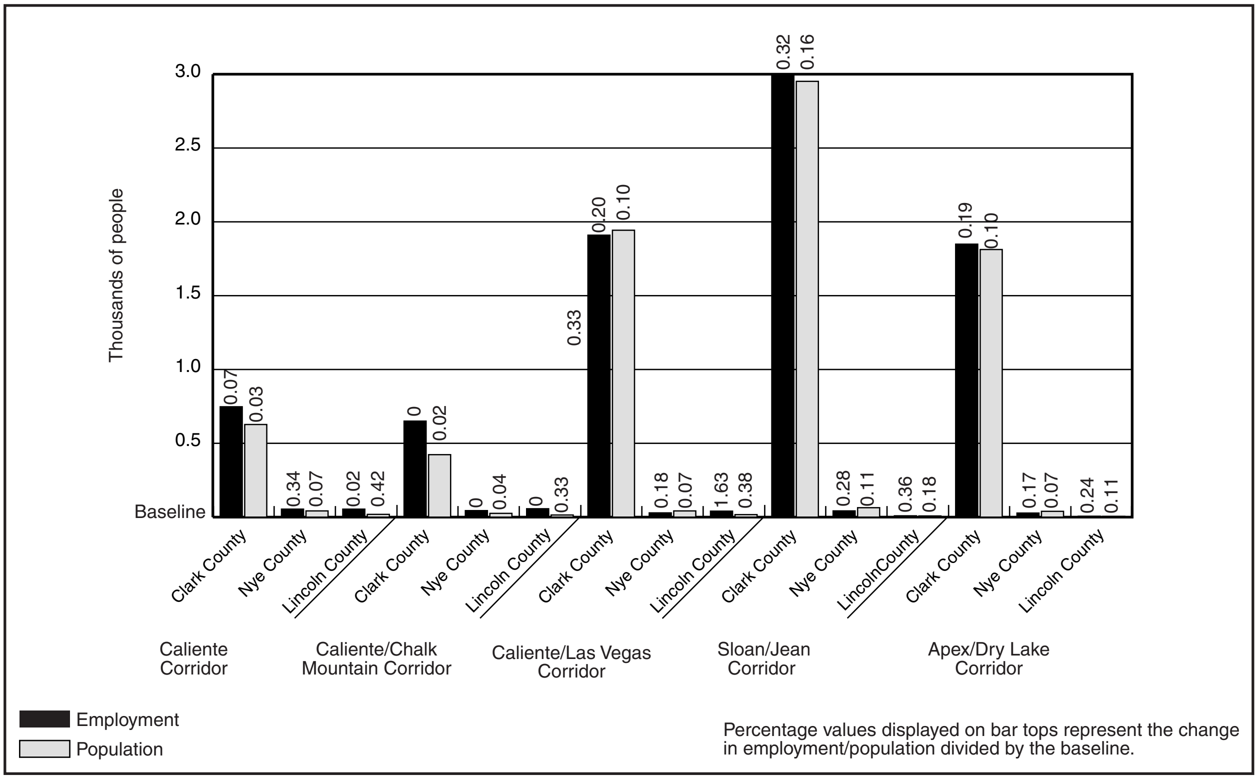

Figure 6-7. Population and employment for heavy-haul implementing alternatives, construction (peak years).

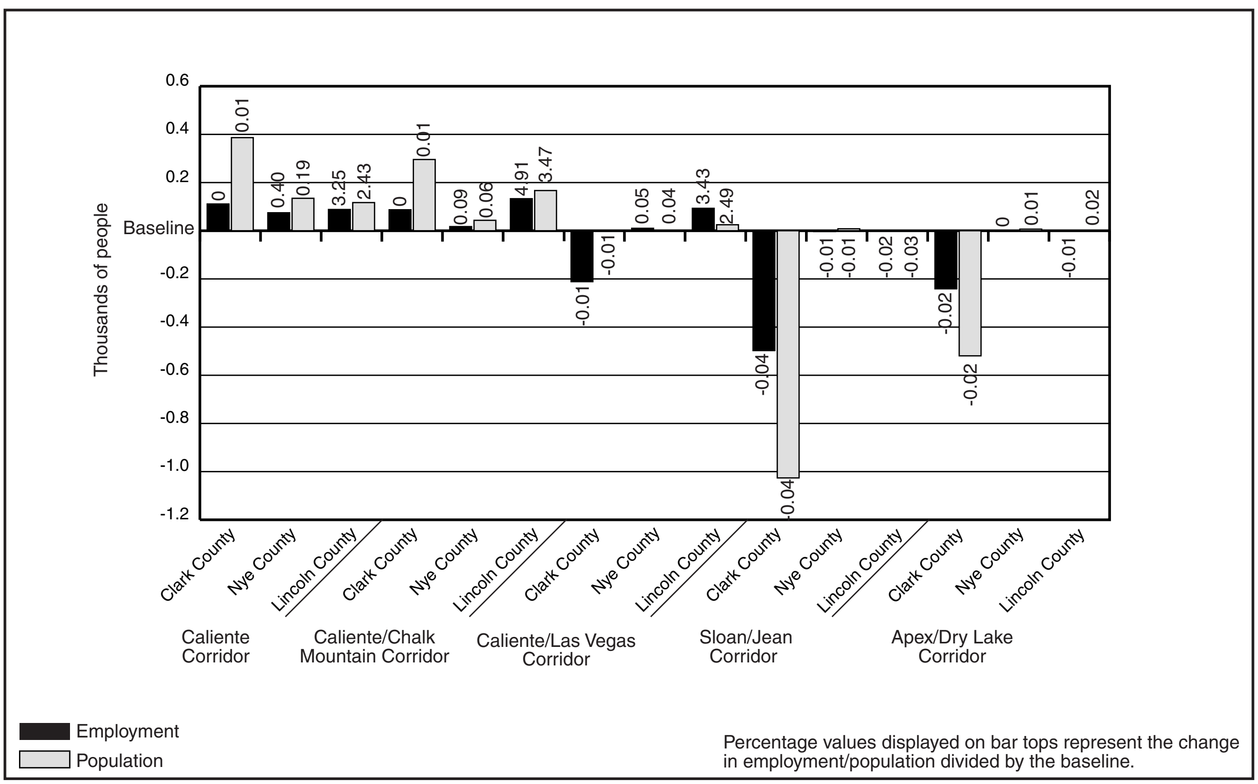

Figure 6-8. Population and employment for heavy-haul implementing alternatives, operations (average years).

conducted by the Nuclear Waste Technical Review Board and the State of Nevada, among others. DOE has concluded that:

- While in some instances risk perceptions could result in adverse impacts on portions of a local economy, there are no reliable methods whereby such impacts could be predicted with any degree of certainty
- Much of the uncertainty is irreducible, and
- Based on a qualitative analysis, adverse impacts from perceptions of risk would be unlikely or relatively small.

While stigmatization of southern Nevada can be envisioned under some scenarios, it is not inevitable or numerically predictable. Any such stigmatization would likely be an aftereffect of unpredictable future events, such as serious accidents, which may not occur. As a consequence, DOE did not attempt to quantify any potential for impacts from risk perceptions or stigma in this Final EIS. Chapter 2, Section 2.5.4 contains further detail.

6.1.2.8 Noise and Vibration

Noise from the construction of a branch rail line or upgrades to highways for heavy-haul trucks would be transient and not excessive. In addition, noise from trains, which would occur during as many as five weekly round trips, would not be excessively disruptive. Heavy-haul truck operations would use existing highways that already have traffic, including semi-trailer trucks. The American Indian Writers Subgroup identified noise from transportation as a concern because of its effects on ceremonies and the solitude necessary for healing and praying (DIRS 102043-AIWS 1998, all).

Construction upgrades of heavy-haul truck routes and construction of branch rail lines would be unlikely to cause vibration damage to historic buildings because of the distance of potentially sensitive buildings from construction sites. Upgrading of roads where they pass through or near communities would have the most potential for noise or vibration to affect buildings or be a nuisance to residents.

Train Operations. Ground vibration from trains using a branch rail line in Nevada to transport spent nuclear fuel and high-level radioactive waste to Yucca Mountain would be well below levels that would contribute to damage to historic buildings or structures.

Because DOE would place the candidate branch rail lines in areas away from communities, and because development and construction and most operations would occur during daylight hours, the potential for noise or vibration impacts from rail line construction and operation is low.

Heavy-Haul Truck Operation. Because they would use air-filled rubber tires with loads distributed to over 100 wheels and would operate on improved roadways having compacted foundation soils, ground vibration from heavy-haul trucks would be much less than that from trains. In addition, DOE assumes that speeds near communities with sensitive historic structures and buildings would be limited for safety, further ensuring that vibration criteria were not exceeded.

6.1.2.9 Aesthetics

Four of the five candidate rail corridors would not have large or lasting aesthetic impacts. The upgrades of existing highways would present short-term aesthetic impacts during construction but these would be temporary and transient, resulting largely from widening the highways. Routes originating in Caliente could cause impacts on the Class II lands of Kershaw Ryan State Park, the entrance of which is on the east side of the Meadow Valley Wash across from a potential location for an intermodal transfer station. However, the character of this area of the Meadow Valley Wash has been modified by the Union Pacific rail line, the City of Caliente water treatment facility, and agricultural uses of lands in the vicinity. Studies have identified a potential visual resource impact for the northeastern portion of the Jean Corridor that passes through the Spring Mountains. The character of Class II lands (defined in Chapter 3, Section 3.1.10) in that part of the corridor would change, possibly in conflict with visual resource management goals. All routes for heavy-haul trucks and all branch rail lines except Carlin would pass through Class III lands. Aesthetic conditions would not be affected by legal-weight trucks on existing, well-traveled highways.

6.1.2.10 Utilities, Energy, and Materials

Impacts to utility, energy, and material resources from the construction and operation of any of the rail or heavy-haul truck implementing alternatives would be small compared to usage in Nevada. For example, Nevada fossil-fuel consumption during 1996 was about 3.8 billion liters (1 billion gallons) (DIRS 148081-BTS 1999, Table MF-21). By comparison, the largest fossil-fuel use for any of the implementing alternatives would be less than 50 million liters (13 million gallons) over the construction period, or less than 0.5 percent of the Nevada annual use. Similarly, concrete use for the largest implementing alternative would be about 460,000 metric tons (200,000 cubic meters), also less than 2 percent of the Nevada annual use of 7.4 million metric tons (3.2 million cubic meters) (DIRS 104926-Bauhaus 1998, all). Figures 6-9 and 6-10 compare the use of resources for construction of the rail and heavy-haul truck implementing alternatives, respectively.

6.1.2.11 Wastes

Construction and operation of a branch rail line or use of heavy-haul trucks would produce small amounts of construction debris, sanitary solid waste, and sanitary wastewater and possibly a small amount of hazardous waste. Under the heavy-haul truck alternative, a small amount of low-level radioactive waste could be generated at an intermodal transfer station. Nonradioactive wastes would be recovered for recycling, placed in permitted landfills, reused, or in the case of sanitary sewage, treated and disposed of on the site. All waste would be managed in accordance with applicable environmental, occupational safety, and public health and safety requirements to minimize the possibility of adverse impacts to animals, vegetation, air quality, soil, and water resources.

There would be minimal impacts on the capacity of facilities to treat or dispose of wastes from Nevada transportation. For example, branch rail line construction camps with running water would generate about 37 million liters (10 million gallons) of sanitary sewage that could be treated and disposed of in permitted septic systems and about 940 metric tons (1,000 tons) of sanitary solid waste during the peak year of employment. For comparison, the waste volume from Nevada transportation would be small in relation to the volumes disposed of in the State in 2000 [3.5 million metric tons (3.9 million tons) of sanitary solid waste] (DIRS 155565-NDEP 2001, Section 2.1), so the rail construction camps would add about 0.027 percent. The estimated construction debris from an intermodal transfer station would be 23 metric tons (26 tons). Approximately 750,000 metric tons (820,000 tons) of construction debris was disposed of in Nevada in 2000 (DIRS 155565-NDEP 2001, Section 2.1), so the construction of an intermodal transfer station would add less than approximately 0.01 percent to the total. About 1,400 kilograms (3,000 pounds) of tires and drained oil filters (industrial and special wastes) would be generated during truck maintenance activities at an intermodal transfer station. About 83,000 metric tons (91,000 tons) of this type of waste was disposed of in Nevada in 2000 (DIRS 155565-NDEP 2001, Section 2.1), so the truck maintenance waste would add less than about 0.01 percent. Hazardous and low-level radioactive waste would have a small impact on the ability of facilities to treat and dispose of the waste. According to the Environmental Protection Agency, treatment and disposal capacity in the western states for hazardous waste would be above the expected demand (by 7 times for incineration and

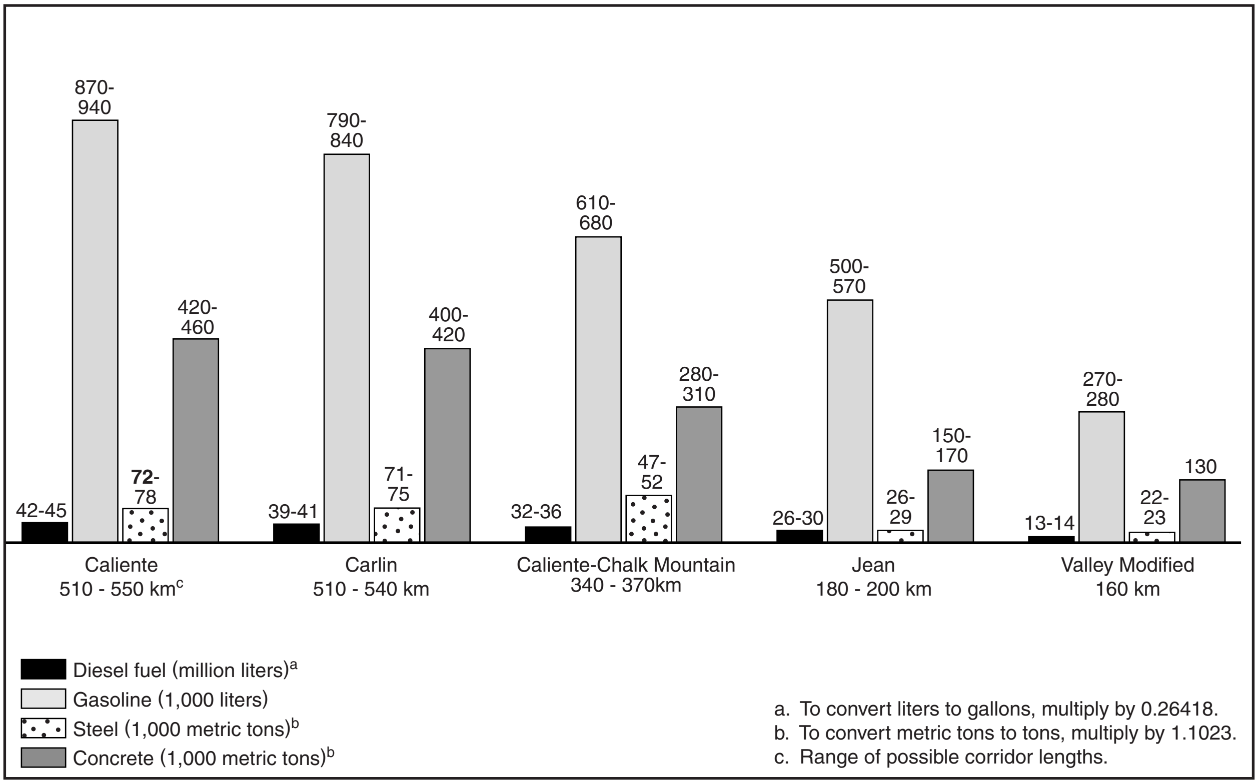

Figure 6-9. Utility, energy, and material use for construction of a branch rail line in Nevada.

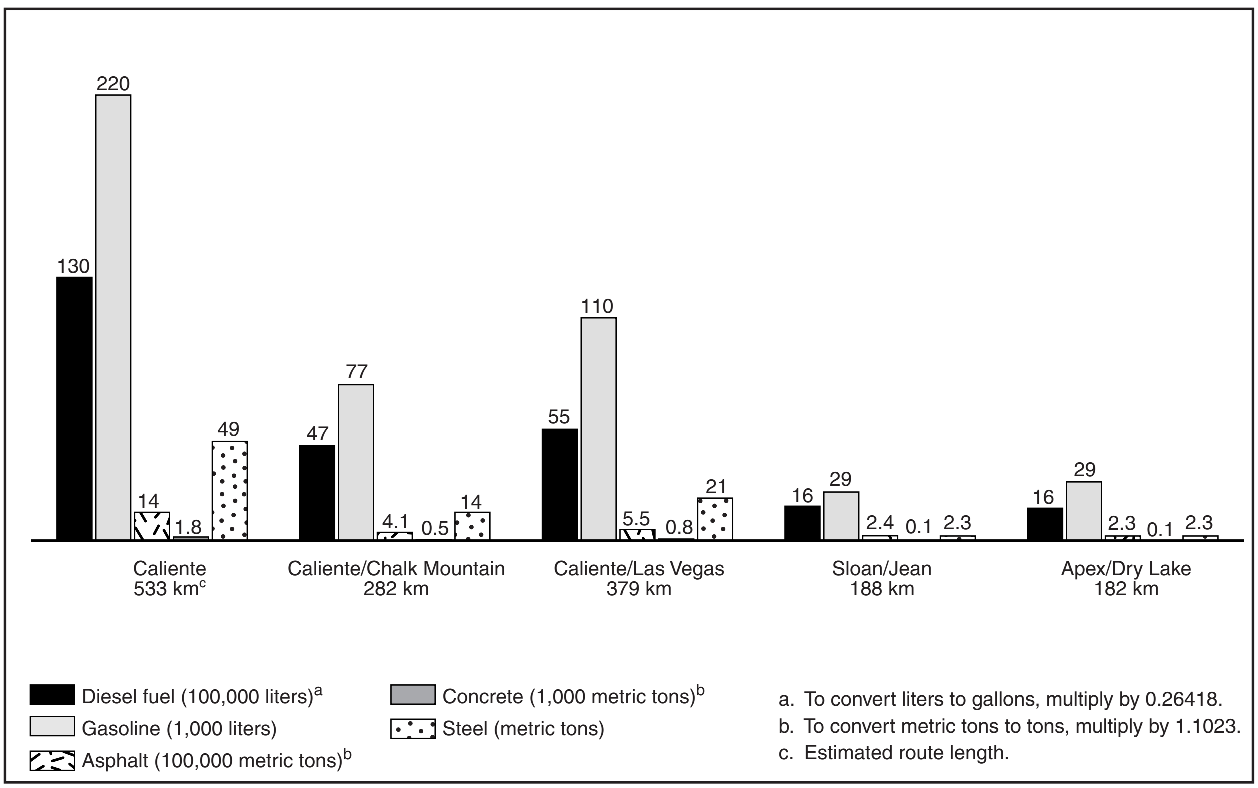

Figure 6-10. Utility, energy, and material use for upgrading of Nevada highways for heavy-haul truck use.

50 times for landfill) until 2013 (DIRS 103245-EPA 1996, pp. 32, 33, 36, 46, 47, and 50). Disposal capacity for a broad range of low-level radioactive wastes would be available at two currently licensed facilities (DIRS 152583-NRC 2000, section on U.S. Low-level Radioactive Waste Disposal).

6.1.2.12 Environmental Justice

Section 6.3 discusses the methods used in the analysis of potential environmental justice concerns. No potentially disproportionately high and adverse impacts to minority or low-income populations were identified in areas of land use; air quality; hydrology; biological resources and soils; socioeconomics; aesthetics; and occupational and public health and safety for construction or operations under the mostly legal-weight truck scenario in Nevada or any of the 10 rail and heavy-haul truck transportation implementing alternatives. Potential visual resource (aesthetic) impacts were identified for the Jean Corridor but these were not determined to be disproportionate. However, no potentially disproportionately high and adverse impacts would occur in these areas for legal-weight truck transportation that would use existing highways. If DOE identified potentially high and adverse impacts for a corridor or route, it would mitigate them (as discussed in Chapter 9).

Because impacts to humans and other impacts that could affect minority or low-income populations or populations of American Indians would not be disproportionately high and adverse, including mitigation as needed, an additional environmental justice analysis is not required. Chapter 4, Section 4.1.13.4, contains an environmental justice discussion of a Native American perspective on the Proposed Action.

6.1.3 TRANSPORTATION OF OTHER MATERIALS AND PERSONNEL

Other types of transportation activities associated with the Proposed Action would involve the transportation of personnel and of materials other than the spent nuclear fuel and high-level radioactive waste discussed above. These other materials include construction materials and consumables for repository construction and operation, including repository components (for example, disposal containers, drip shields, etc.); waste including low-level waste, construction and demolition debris, sanitary and industrial solid waste, and hazardous waste; and office and laboratory supplies, mail, and laboratory samples.

The quantities of construction materials, consumables, site-generated waste, laboratory samples, and supplies, would differ for the range of repository operating modes. The number of commuting employees would also differ. Therefore, the transportation impacts listed in Table 6-5 are ranges, from the least to the greatest impact. Appendix J, Section J.3.6, provides additional detail.

Table 6-5. Impacts related to repository transportation activities.

Factor	Impact
Total kilometers traveled (millions)	610 - 1,100
Total nonradiological latent fatalities[a]	0.9 - 1.6
Total nonradiological traffic fatalities[b]	6.3 - 11.4
Total nonradiological commuting worker traffic fatalities	2.4 - 4.2

a. From commuter and materials transportation.
b. From materials transportation and public fatalities from commuter transportation.

Additional traffic in the Las Vegas air basin would result in emissions of carbon monoxide, most significantly during the repository phases of construction and operation and monitoring. The Las Vegas air basin is in nonattainment status for carbon monoxide, which is largely a result of vehicle emissions (DIRS 156706-Clark County 2000, Appendix A, Table 1-3). As part of the conformity review DOE conducted using the guidance in DIRS 155566-DOE (2000, all), it was determined that the transportation of personnel, materials, and supplies through the Las Vegas air basin would not exceed the carbon monoxide General Conformity threshold level [91 metric tons (100 tons) per year; 40 CFR 93.153] for serious nonattainment status. The highest total emissions for personnel, materials, and supplies would be 50 tons per year during the construction phase and 67 tons per year during the operations and monitoring phase; emissions would contribute a maximum of an additional 0.07 percent to the estimated 2000 daily carbon-monoxide levels in the nonattainment area (DIRS 156706-Clark County 2000, Appendix A, Table 1-3).

Impacts in other environmental resource areas would be unlikely to occur.

6.2 National Transportation

This section describes the estimated national transportation impacts from shipping spent nuclear fuel and high-level radioactive waste from 72 commercial and 5 DOE sites throughout the United States to the proposed Yucca Mountain Repository. This section includes the following:

- Definition and an overview of the analysis scenarios (Section 6.2.1)
- Impacts to workers and the public from spent nuclear fuel and high-level radioactive waste loading operations at commercial and DOE sites (Section 6.2.2)
- Potential incident-free (routine) radiological impacts and vehicle emission impacts (Section 6.2.3)
- Potential accident scenario impacts (Section 6.2.4).

National transportation of spent nuclear fuel and high-level radioactive waste, which would use existing highways and railroads, would average 7.8 million truck kilometers (4.9 million miles) per year for the mostly truck case and 1.6 million railcar kilometers (1 million miles) per year for the mostly rail case. Barges used to ship rail casks to nearby railheads from commercial sites not served by a railroad could average as much as 6,500 kilometers (4,000 miles) per year. The national yearly average for total highway and railroad traffic is 186 billion truck kilometers (116 billion miles) and 49 billion railcar kilometers (30 billion miles) (DIRS 150989-BTS 1998, pp. 5 and 6)]. Spent nuclear fuel and high-level radioactive waste transportation would represent a very small fraction of the total national highway and railroad traffic (0.004 percent of truck kilometers and 0.003 percent of railcar kilometers). Domestic waterborne trade in 1995 accounted for about 1 billion metric tons (910 million tons) (DIRS 148158-MARAD 1998, all). This represents about 1 million barge shipments per year. Thus, shipments of spent nuclear fuel by barge would only be a very small fraction of the total annual domestic waterborne commerce.

With the exception of occupational and public health and safety impacts, which are evaluated in this section, the environmental impacts of this small fraction of all national transportation would be very small in comparison to the impacts of other nationwide transportation activities. Thus, the national transportation of spent nuclear fuel and high-level radioactive waste would have very small impacts on land use and ownership; hydrology; biological resources and soils; cultural resources; socioeconomics; noise and vibration; aesthetics; utilities, energy, and materials; or waste management.

To determine if pollutants of concern from national transportation vehicles (truck and rail) would degrade air quality in nonattainment areas, DOE reviewed traffic volumes in these areas. This review determined that the numbers of shipments of Yucca Mountain-destined vehicles through these areas would be very small in relation to normal traffic volumes. Therefore, the impact to air quality in these areas, except Nevada (see Section 6.1.3), would be very small.

Radiological impacts of accidents on biological resources would be extremely unlikely. The analysis focused the impacts from accidents on human health and safety. A severe accident scenario, such as the

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maximum reasonably foreseeable accident scenarios discussed in Section 6.2.4.2, that would cause a release of contaminated materials would be very unlikely. The probabilities of the severe accident scenarios discussed in Section 6.2.4.2 are less than 3 in 10 million per year for both the mostly legal-weight truck and mostly rail transportation scenarios. Because of the low probability of occurrence, an accident scenario during the transport of spent nuclear fuel and high-level radioactive waste would be unlikely to cause adverse impacts to any endangered or threatened species, and impacts to other plants and animals would be small. Therefore, the analysis did not evaluate the impacts for these environmental parameters for national transportation activities further.

This chapter does not evaluate the risks of economic loss or resultant environmental consequences from potential transportation accidents that could cause releases of radioactive materials. DOE did not perform these analyses because estimating economic risks and environmental consequences would depend on many factors associated with accidents that cannot be known in advance. Therefore, the information that would be needed for such an analysis is not available. Section J.1.4.2.5 of Appendix J presents a review and analysis of studies by the U.S. Nuclear Regulatory Commission, the National Aeronautics and Space Administration, DOE, and others that discusses cost factors and provides estimates of the range of costs and environmental consequences of cleaning up contamination following hypothetical accidental releases of radioactive materials.

6.2.1 ANALYSIS SCENARIOS AND METHODS

Under the mostly legal-weight truck scenario for national transportation, DOE would transport shipments (with the exception of naval spent nuclear fuel and possibly some DOE high-level radioactive waste) by legal-weight truck to Nevada. Naval spent nuclear fuel would be shipped by rail from the Idaho National Engineering and Environmental Laboratory. Under the mostly-legal weight truck scenario, DOE assumed that some shipments of DOE high-level radioactive waste would use *overweight trucks*. With the exception of permit requirements and operating restrictions, the vehicles for these shipments would be similar to legal-weight truck shipments but might weigh as much as 52,200 kilograms (115,000 pounds). States routinely issue special permits for trucks weighing up to 58,500 kilograms (129,000 pounds).

Figure 6-11 shows the highway routes (mostly Interstate Highways) that the analysis used to estimate transportation-related impacts, along with the locations of the commercial and DOE sites and Yucca Mountain. The routes selected for analysis are representative of routes that DOE could use for truck shipments if the Yucca Mountain site was approved. In addition, the highway routes shown would conform to the routing requirements in 40 CFR 397.101 (see Appendix J, Section J.1.2).

Although DOE cannot be certain of the actual mix of rail and truck shipments that would occur, it expects that the mostly rail scenario best represents the mix of modes it would use. This belief is based on analyses the Department has done to assess generator site capabilities to handle larger (rail) casks, distances to suitable railheads, and historic experience in actual shipments of fuel, waste, or large reactor-related components. In addition, DOE considered relevant information published by knowledgeable sources such as the Nuclear Energy Institute, which provided information on capabilities of generator sites to handle large rail casks (DIRS 155777-McCullom 2000). Although DOE believes the mostly rail scenario best represents what would be likely for the transportation of spent nuclear fuel and high-level radioactive waste to a Yucca Mountain Repository, Appendix J, Section J.1.2.1.4 describes an analysis that illustrates how changes in the mix of rail and truck modes would change estimated health and safety impacts for national transportation. The results of the analysis indicated how a mix between the limits represented by the mostly legal-weight truck and mostly rail scenarios would result in health and safety impacts that would be between those estimated for the two scenarios and would not be greater than the impacts from either scenario.

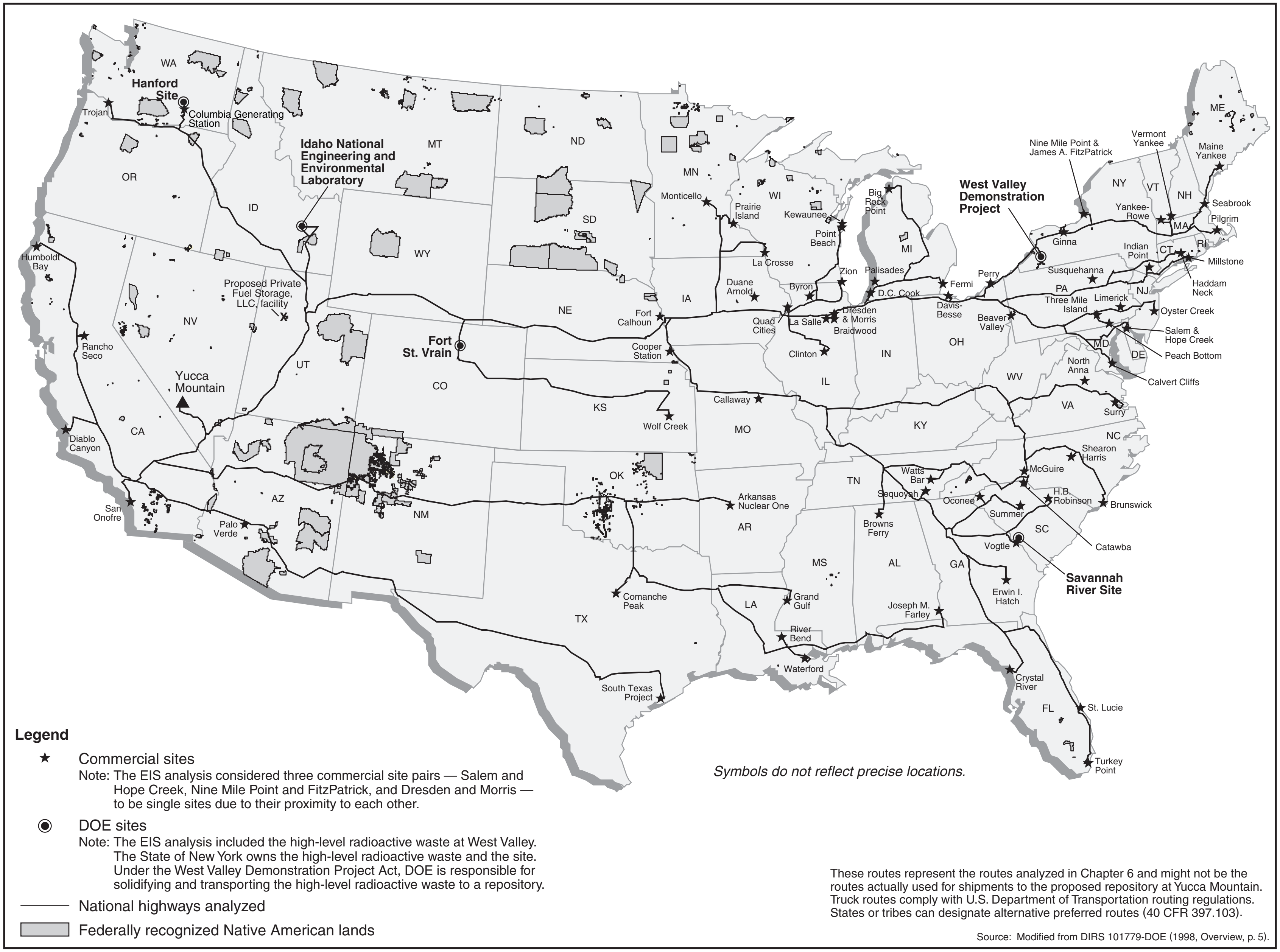

Figure 6-11. Representative truck routes from commercial and DOE sites to Yucca Mountain analyzed for the Proposed Action.

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MOSTLY LEGAL-WEIGHT TRUCK AND MOSTLY RAIL SCENARIOS

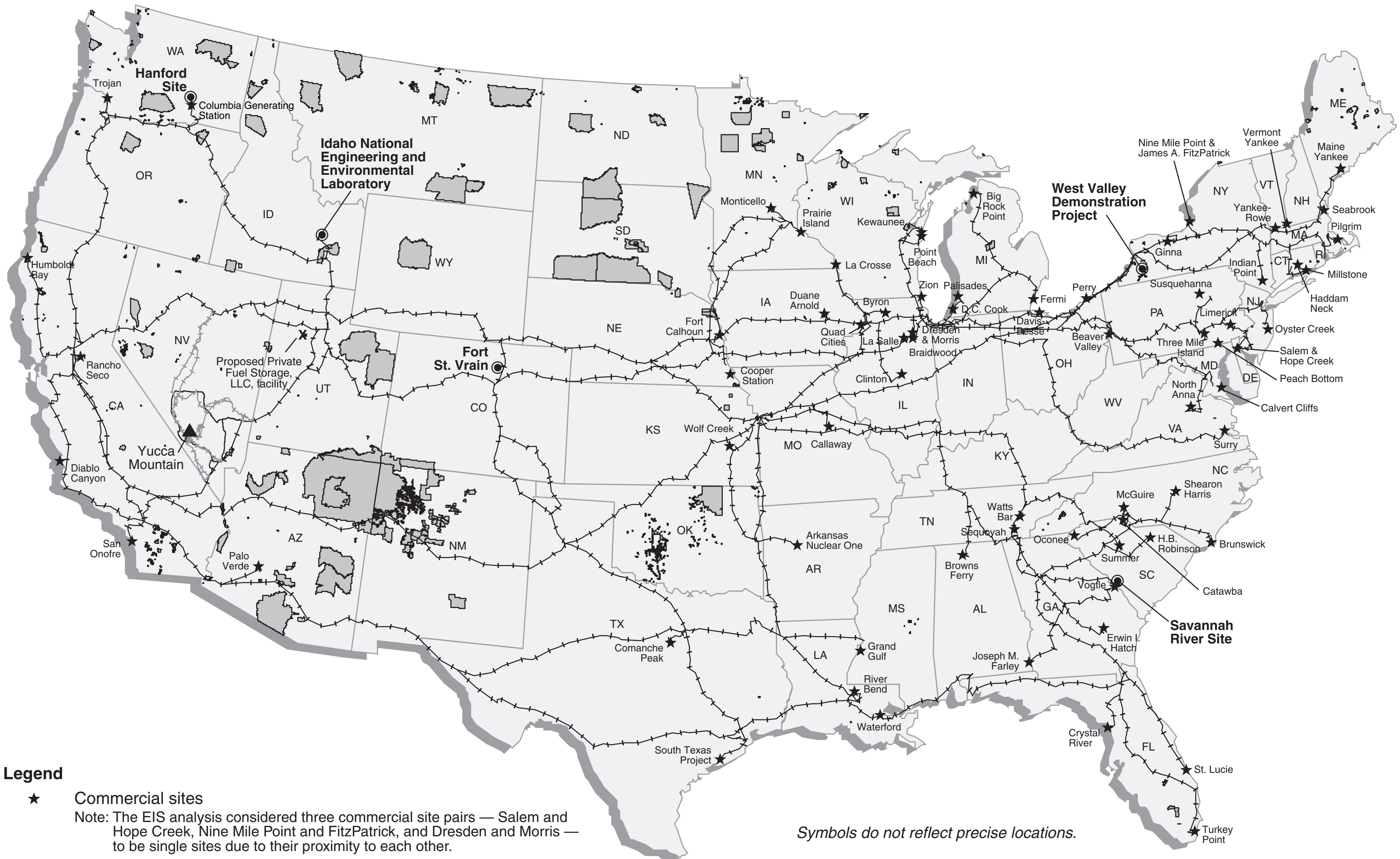
The Department would prefer most shipments to a Yucca Mountain repository be made using rail transportation. It also expects that the mostly rail scenario described in this EIS best represents the mix of rail and truck transportation that would be used. However, it cannot be certain of the actual mix of rail and truck transportation that would occur over the 24 years of the Proposed Action. Consequently, DOE used the mostly legal-weight truck and mostly rail scenarios as a basis for the analysis of potential impacts to ensure the analysis addressed the range of possible transportation impacts. The estimated number of shipments for the mostly legal-weight truck and mostly rail scenarios represents the two extremes in the possible mix of transportation modes, thereby covering the range of potential impacts to human health and safety and to the environment for the transportation modes DOE could use for the Proposed Action.

Under the national transportation mostly rail scenario, DOE would transport shipments (with the exception of commercial spent nuclear fuel at six sites that do not have the capability to load a rail cask) by rail to Nevada. In addition, this scenario assumes that 24 commercial sites that have the capability to handle and load rail casks, but that do not have railroad service, would make shipments to nearby railheads by barge or heavy-haul truck. Barge shipments of rail casks containing spent nuclear fuel could be possible from 17 commercial sites that are on or near navigable waterways. Figure 6-12 shows the railroad routes that the analysis used to estimate transportation-related impacts, along with the locations of the commercial and DOE sites and Yucca Mountain. The routes selected for analysis are representative of routes that could be used for rail shipments if the Yucca Mountain site was approved. The analysis estimated that these routes would most closely follow current railroad industry practices and the system-wide capability to ship hazardous materials safely. These routes would reduce time in transit, reduce the number of interchanges between railroads, and use mainline tracks to the maximum practical extent.

The railroad routes shown in Figure 6-12 could also be used by generators to transport spent nuclear fuel to a proposed Private Fuel Storage facility near Skull Valley in northwestern Utah (DIRS 152001-NRC 2000, all). Rail routes from that facility to connections with potential branch rail lines or to an intermodal transfer station in Nevada would be essentially the same as the western sections of rail routes analyzed in this chapter. Thus, impacts presented in this chapter for five candidate routes for heavy-haul trucks and five candidate rail corridors in Nevada would be about the same whether shipments were directly from 72 commercial and 5 DOE generator sites to a Yucca Mountain Repository or from a Private Fuel Storage facility in Skull Valley, Utah. Chapter 8, Section 8.4, discusses potential cumulative impacts of transporting commercial spent nuclear fuel to a Private Fuel Storage facility and then to a Yucca Mountain Repository (see Appendix J, Section J.1.2).

This section evaluates radiological and nonradiological impacts to workers and the public from routine transportation operations and from accidents. DOE used a number of computer models and programs to estimate these impacts; Appendix J describes the analysis assumptions and models.

The CALVIN model (DIRS 155644-CRWMS M&O 1999, pp. 2 to 22) was used to estimate the number of shipments of commercial spent nuclear fuel for both the mostly legal-weight truck and mostly rail scenarios. The CALVIN program used commercial spent nuclear fuel inventories and characteristics from the *Report on the Status of the Final 1995 RW-859 Data Set* (DIRS 104848-CRWMS M&O 1996, all) and the *Calculation Method for the Projection of Future SNF Discharges* (DIRS 156305-CRWMS M&O 2001, all) (see Appendix A) to estimate the number of shipments. For DOE spent nuclear fuel and high-level radioactive waste, the analysis used inventories and characteristics for materials to be shipped under the Proposed Action that were reported by the DOE sites in 1998 (see Appendix A) to estimate the number of shipments. Chapter 2, Section 2.1.3, and Appendix J discuss the number of shipments.



Legend

★ Commercial sites

Note: The EIS analysis considered three commercial site pairs — Salem and Hope Creek, Nine Mile Point and FitzPatrick, and Dresden and Morris — to be single sites due to their proximity to each other.

◉ DOE sites

Note: The EIS analysis included the high-level radioactive waste at West Valley. The State of New York owns the high-level radioactive waste and the site. Under the West Valley Demonstration Project Act, DOE is responsible for solidifying and transporting the high-level radioactive waste to a repository.

+++++++ National rail lines anaylzed

+++++++ Nevada rail corridors

▭ Federally recognized Native American lands

These routes represent the routes analyzed in Chapter 6 and might not be the routes actually used for shipments to the proposed repository at Yucca Mountain. Rail routes are based on maximizing the distance on mainline track and minimizing the overall distance and number of interchanges between railroads.

Source: Modified from DIRS 101779-DOE (1998, Overview, p. 5).

Figure 6-12. Representative rail routes from commercial and DOE sites to Yucca Mountain analyzed for the Proposed Action.

The transportation analyses used the following computer programs:

- HIGHWAY (DIRS 104780-Johnson et al. 1993, all) to identify the highway routes that it could use to transport spent nuclear fuel and high-level radioactive waste. All of the routes would satisfy U.S. Department of Transportation route selection regulations.
- INTERLINE (DIRS 104781-Johnson et al. 1993, all) to identify rail and barge routes for the analysis.
- RADTRAN 5 (DIRS 150898-Neuhauser and Kanipe 2000, all; DIRS 155430 Neuhauser, Kanipe, and Weiner 2000, all) to estimate radiological dose risk to populations and transportation workers during routine operations. The analyses also used this program to estimate radiological dose risks to populations and transportation workers from accidents.
- RISKIND (DIRS 101483-Yuan et al. 1995, all) to estimate radiological doses to the maximally exposed individuals and to the population during routine transportation. This program also estimated radiological doses to the maximally exposed individuals and to the population from transportation accidents.

6.2.2 IMPACTS FROM LOADING OPERATIONS

This section describes potential impacts from loading spent nuclear fuel and high-level radioactive waste in transportation casks and on transportation vehicles at the 72 commercial and 5 DOE sites. It also describes methods for estimating radiological and industrial hazard impacts from routine loading operations and radiological impacts of loading accidents to workers and members of the public. During loading operations, radiological impacts to workers could occur from normal operations and accidents. In addition, workers could experience impacts from industrial hazards. Members of the public could experience radiological impacts if a loading accident occurred but would not experience impacts from industrial hazards, including hazards associated with nonradioactive hazardous materials. Nonradioactive hazardous materials would be used only in small quantities, if at all, in loading operations. Chapter 4 addresses impacts from unloading operations at the repository.

6.2.2.1 Radiological Impacts of Routine Operations

Radiological impacts to members of the public from routine operations would be very small. An earlier DOE analysis estimated that public dose from loading operations (primarily due to atmospheric effluents) would be less than 0.001 person-rem per metric ton of uranium loaded (DIRS 104731-DOE 1986, Volume 2, p. E.6) (see Appendix J for more information). Therefore, to be conservative this analysis estimated the dose to the public from loading operations by multiplying the value of 0.001 person-rem per metric ton of uranium by the 70,000 metric tons (77,000 tons) of spent nuclear fuel and high-level radioactive waste DOE would transport under the Proposed Action. [DIRS 104731-DOE (1986, Volume 2, all) uses the term "metric ton uranium," which is essentially the same as metric tons of heavy metal for commercial spent nuclear fuel.] The resulting population dose would be 70 person-rem, which, based on conversion factors recommended by the International Commission on Radiological Protection, would result in 0.04 latent cancer fatality. The Commission recommends 0.0004 and 0.0005 latent cancer fatality per person-rem for involved worker populations and the general public, respectively (DIRS 101836-ICRP 1991, p. 22).

Table 6-6 lists estimated involved worker impacts from loading spent nuclear fuel at commercial sites and loading DOE spent nuclear fuel and high-level radioactive waste at DOE facilities for shipment to the Yucca Mountain site under the Proposed Action. The impacts assume worker rotation and other administrative actions at commercial sites would follow guidance similar to that in *DOE Standard - Radiological Control Manual* (DIRS 156764-DOE 1999, Article 211). Although the guidance that the

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annual dose received by an individual worker could be as high as 2 rem per year, DOE policy is to limit doses to individual workers to no more than 500 millirem per year. The maximum individual dose would be 12 rem over the 24 years of loading operations for individuals who worked the entire duration of repository operations. The estimated probability of a latent cancer fatality for an involved worker from this dose would be about 0.005 (5 chances in 1,000).

Table 6-6. Estimated radiological impacts to involved workers from loading operations.[a]

Impact	Mostly rail	Mostly legal-weight truck
Maximally exposed individual		
Dose (rem)	12[b]	12[b]
Probability of LCF[c]	0.005	0.005
Involved worker population[d]		
Dose (person-rem)	4,200	15,000
Number of LCFs	1.7	6.1

a. Numbers are rounded.
b. Based on 500-millirem-per-year administrative dose limit.
c. LCF = latent cancer fatality.
d. All involved workers at all facilities, preparing about 11,000 shipments under the mostly rail scenario and about 53,000 shipments under the mostly legal-weight truck scenario over 24 years.

As many as 2 latent cancer fatalities from the mostly rail scenario and about 6 latent cancer fatalities from the legal-weight truck scenario could result in the involved worker population over 24 years. The mostly legal-weight truck scenario would result in more potential impacts than the mostly rail scenario because of the increased exposure time needed to load more transportation casks.

To assess potential radiological impacts at generator facilities, the EIS analysis assumed that noninvolved workers would have no direct involvement with handling spent nuclear fuel or high-level radioactive waste. DOE expects radiological impacts to noninvolved workers to be even smaller than those to involved workers.

6.2.2.2 Impacts from Industrial Hazards

Table 6-7 lists estimated impacts to involved workers from industrial hazards over 24 years of loading operations at the 77 sites. Fatalities from industrial hazards would be unlikely from loading activities under either national transportation scenario. The mostly legal-weight truck scenario would have about three times the estimated number of total recordable cases and lost workday cases of the mostly rail scenario because there would be more shipments and more work time (full-time equivalent worker years). Using the assumption that the noninvolved workforce would be 25 percent of the number of involved workers, the analysis determined that impacts to noninvolved workers would be about 25 percent of those listed in Table 6-7.

Table 6-7. Impacts to involved workers[a] from industrial hazards during loading operations.[b]

Impact	Mostly rail	Mostly legal-weight truck
Total recordable cases[c]	130	380
Lost workday cases[d]	67	200
Fatalities[e]	0.29	0.9

a. Includes all involved workers at all facilities during 24 years of repository operations. During the 24 years of shipments to the proposed repository, these workers would put in 1,300 worker years (2,080 hours per worker year) preparing about 11,000 shipments under the mostly rail scenario and 3,700 worker years preparing about 53,000 legal-weight truck shipments and 300 naval spent nuclear fuel rail shipments under the mostly legal-weight truck scenario. Industrial safety impacts in the noninvolved workforce would be about 25 percent of those listed.
b. Numbers are rounded to two significant digits.
c. Total recordable cases (injury and illness) based on a 1998 loss incident rate of 0.08.
d. Lost workday cases based on a 1998 loss incident rate of 0.05.
e. Fatalities based on a 1998 loss incident rate of 0.000218.

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To assess potential industrial safety impacts at generator facilities, the EIS analysis assumed that noninvolved workers would be persons with office-based administrative duties associated with loading operations. In addition to industrial safety impacts, traffic fatality and vehicle emissions impacts as a result of commuting workers associated with loading operations were estimated. Traffic involving commuting workers could result in 0.4 fatality under the mostly legal-weight truck scenario and 0.2 fatality under the mostly rail scenario. Estimated vehicle emissions impacts from commuting could result in 0.06 latent fatalities for the mostly legal-weight truck scenario and 0.02 for the mostly rail scenario.

6.2.3 NATIONAL TRANSPORTATION IMPACTS

The following sections discuss the impacts of transporting spent nuclear fuel and high-level radioactive waste to the proposed Yucca Mountain Repository under the mostly legal-weight truck and mostly rail scenarios. The analysis in this section addresses the impacts of incident-free transportation. Section 6.2.4 discusses accidents, and Appendix J contains the details of the analysis and its assumptions.

6.2.3.1 Impacts from Incident-Free Transportation – National Mostly Legal-Weight Truck Transportation Scenario

This section addresses radiological and nonradiological impacts to populations and maximally exposed individuals for incident-free transportation of spent nuclear fuel and high-level radioactive waste for the mostly-legal weight truck scenario.

Incident-Free Radiological Impacts to Populations. Table 6-8 lists the incident-free population dose and latent cancer fatalities to workers and the public for the mostly legal-weight truck scenario. The impacts include those for the shipment of naval spent nuclear fuel by rail to Nevada, intermodal transfer of rail casks to heavy-haul trucks, and subsequent heavy-haul transportation to the proposed repository. Section 6.3.3 and Appendix J contain additional information on worker impacts from intermodal transfer operations. Worker impacts would include radiological exposures of security escorts for legal-weight truck, rail, and heavy-haul truck shipments and from the transfer of naval spent nuclear fuel shipments from rail to heavy-haul truck. The collective dose to the security escorts traveling in separate vehicles would be about 6 person-rem for legal-weight truck shipments. Doses to escorts of rail shipments of naval spent nuclear fuel, who would travel in railcars in sight of but separated from the cask cars, followed by escorted heavy-haul truck shipments in Nevada would be about 0.4 person-rem.

Table 6-8. Population doses and impacts from incident-free transportation for national mostly legal-weight truck scenario.[a]

Category	Legal-weight truck shipments	Rail shipments of naval spent nuclear fuel[b]	Totals[d]
Involved workers			
Collective dose (person-rem)	14,000	29	14,000
Estimated LCFs[c]	5.6	0.01	5.6
Public			
Collective dose (person-rem)	5,000	20	5,000
Estimated LCFs	2.5	0.01	2.5

a. Impacts are totals for shipments over 24 years.
b. Includes impacts from intermodal transfer operations (see Section 6.3.3.1).
c. LCF = latent cancer fatality.
d. Totals might differ from sums of values due to rounding.

If escorts accompanied legal-weight truck shipments over the full length of their shipment routes, rather than only in highly populated urban areas as required by Federal regulations (10 CFR 73.37), the estimated doses to escorts over 24 years would be 360 person-rem (a 0.14 probability of a latent cancer fatality in the population of escorts).

In addition, as is recommended by the Commercial Vehicle Safety Alliance (DIRS 155863-CVSA 2000, all), the analysis assumed state safety inspections of shipments would occur only in originating and destination states. If inspections were conducted for every shipment in each state through which the shipment would pass, inspectors would receive an additional dose of 7,000 person-rem (about 2.8 latent cancer fatalities) over 24 years.

Appendix J, Section J.1.3.2.2.2 contains additional information about the analysis of impacts to escorts and inspectors.

The estimated radiological impacts would be 6 (5.6) latent cancer fatalities for workers and 3 (2.5) latent cancer fatalities for members of the public for the 24 years of operation. The population within 800 meters (0.5 mile) of routes would be about 10 million based on projections to 2035. About 2.3 million members of this population would be likely to incur fatal cancers from all other causes not associated with the Proposed Action (DIRS 153066-Murphy 2000, p. 5).

Incident-Free Radiological Impacts to Maximally Exposed Individuals. Table 6-9 lists estimates of doses and radiological impacts for maximally exposed individuals for the legal-weight truck scenario (which considers drivers and security escorts). The risks are calculated for the 24 years of shipment activities. Appendix J discusses analysis methods and assumptions. State inspectors who conducted frequent inspections of shipments of spent nuclear fuel and high-level radioactive waste and transportation vehicle operating crews would receive the highest annual radiation doses.

Table 6-9. Estimated doses and radiological impacts to maximally exposed individuals for national mostly legal-weight truck scenario.[a,b]

Individual	Dose (rem)	Probability of latent fatal cancer
Involved workers		
Crew member (including driver)	48[c]	0.02
Inspector	48[c]	0.02
Railyard crew member	0.13	0.00005
Public		
Resident along route	0.006	0.000003
Person in traffic jam	0.016[d]	0.000008
Person at service station	2.4[e]	0.0012
Resident near rail stop	0.009	0.000005

a. The assumed external dose rate is 10 millirem per hour at 2 meters (6.6 feet) from the vehicle for all shipments.
b. Totals for 24 years of operations.
c. Based on 2-rem-per-year administrative dose limit. If a lower dose limit, for example 500 millirem per year, was imposed for transportation workers or state inspectors, maximally exposed individual doses would be lower. See DIRS 156764-DOE (1999, Article 211) for DOE guidance on occupational dose limits.
d. Person in a traffic jam is assumed to be exposed one time only.
e. Assumes the person works at the service station for all 24 years of operations. Mitigation would be required to reduce impacts to members of the public to below 100 millirem per year.

Impacts to the maximally exposed individuals in the general public would be very low. The highest impacts would be to a service station employee who worked at a station where the analysis assumed all truck shipments would stop under the mostly legal-weight truck scenario (Table 6-9). The analysis estimated that this employee would receive a dose of 2.4 rem over 24 years, which corresponds to the maximum that would be allowed (100 millirem per year) for a member of the general public under regulations in 10 CFR Part 20. The estimate assumes that measures would be taken by DOE to reduce the dose to the employee from 130 millirem per year (3.2 rem over 24 years)—the dose estimated by the analysis if dose reduction measures were not implemented. The estimate of 3.2 rem over 24 years conservatively assumed the person would be exposed to 450 truck shipments each year for 24 years. For perspective, under the mostly legal-weight truck scenario, which assumes an average of 2,200 legal-weight truck shipments per year, about 450 truck shipments would pass through the Mercury, Nevada, gate to the Nevada Test Site in 1,800 hours. A worker at a truck stop along the route to Mercury would work about 1,800 hours per year. Thus, if every shipment stopped at that truck stop, the maximum number of shipments the worker would be exposed to in a year would be 450.

Impacts from Vehicle Emissions. Using data published by DIRS 151198-Biwer and Butler (1999, p. 1165 to 1166), DIRS 155786-EPA (1997, all), and DIRS 155780-EPA (1993, Section 13.2.13) (see Appendix J, Section J.1.3.2.3), DOE estimated the number of fatalities that vehicle emissions from shipments to Yucca Mountain could cause (Table 6-10). These potential impacts would result principally from exposure to increases in levels of pollutants, where the additional pollutants would come from vehicles transporting spent nuclear fuel and high-level radioactive waste and the accompanying escort vehicles. In the context of the number of vehicle kilometers from shipments to the Yucca Mountain site, these emissions would be very small in comparison to the emissions from other vehicles.

Table 6-10. Population health impacts from vehicle emissions during incident-free transportation for national mostly legal-weight truck scenario.[a]

Category	Legal-weight truck shipments	Rail shipments of naval spent nuclear fuel	Total[b]
Estimated vehicle emission-related fatalities	0.93	0.01	0.95

a. Impacts are totals for shipments over 24 years.
b. Total differs from sums of values due to rounding.

This section addresses radiological and nonradiological impacts to populations and maximally exposed individuals from the incident-free transportation of spent nuclear fuel and high-level radioactive waste for the mostly rail national transportation scenario. In addition, it identifies impacts of legal-weight truck shipments that would occur under the mostly rail scenario for the six commercial sites that do not have the capability to load rail casks (about 1,079 legal-weight truck shipments over 24 years). Of these six sites, two have direct rail access and four have indirect access. Of the four sites with indirect access, three have barge access. The analysis assumed that the six legal-weight truck sites would upgrade their crane capacities and ship by rail after reactor shutdown.

6.2.3.2 Impacts from Incident-Free Transportation – National Mostly Rail Transportation Scenario

For this analysis, DOE assumed that it would use either a branch rail line or heavy-haul trucks in Nevada to transport rail casks to and from the repository. Accordingly, the results indicate the range of impacts for the rail and heavy-haul truck implementing alternatives that DOE could use for transportation to the repository after rail shipments arrived in Nevada. Section 6.3 and Appendix J present more information on the analysis of the environmental impacts of the Nevada rail and heavy-haul implementing alternatives. Appendix J, Section J.2, also presents a comparison of the effects of using dedicated trains or general freight services for rail shipments.

The mostly rail scenario assumes that the 24 commercial sites not served by a railroad but with the capability to handle rail casks would use heavy-haul trucks to transport the casks to railheads for transfer to railcars. In addition, 17 of the 24 sites are adjacent to navigable waterways. At some of the 17 sites on navigable waterways, barges could be used for the initial trip segments (see Appendix J, Section J.2.1). The impacts estimated by the analysis include the impacts of heavy-haul truck or barge shipments of rail casks from the 24 sites to nearby railheads.

The analysis assumed that the truck shipments of spent nuclear fuel and high-level radioactive waste would make periodic stops for state inspections, changes of drivers, rest, and fuel. Rail shipments would

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VEHICLE EMISSION UNIT RISK FACTORS

DIRS 151198-Biwer and Butler (1999, all) presents unit risk factors for estimating vehicle emissions and the resulting health effects (fatalities) from truck and rail transportation. Changes to information used in the Biwer and Butler analysis resulted in revised factors used in the analyses in this EIS. DOE made four changes:

- *Fugitive dust emission factor*. Biwer and Butler used the paved road fugitive dust emission factor equation from DIRS 155786-EPA (1997, Volume 1, Supplement D, Section 13.2.1) to estimate fugitive dust emission factors for individual vehicle weight classes. The emission factor used in the Final EIS analysis is based on the fleet average weight, as recommended in the reference.

- *Diesel exhaust emission factor*. Biwer and Butler used diesel exhaust emission factors for trucks operating in 1995. The Final EIS analysis used information presented in the *Motor Vehicle-Related Air Toxics Study* (DIRS 155780-EPA 1993, all) to estimate diesel exhaust emission factors projected for the fleet of trucks operating in 2010.

- *Mortality rate used to estimate health effects*. The PM_{10} risk factor used in Biwer and Butler was calculated using a baseline mortality rate of 0.008. This is the crude rate, which is influenced by age differences in population composition. The analysis for the Final EIS used an age-adjusted mortality rate of 0.005.

- *PM_{10} risk factor*. The PM_{10} health risk factor used by Biwer and Butler was based on an upper bound reported by DIRS 152600-Ostro and Chestnut (1998, all), who also presented lower-bound and central estimates. To avoid compounding conservative assumptions, the Final EIS analysis uses the central estimate.

These changes resulted in values for vehicle emission health effect (fatality) unit risk factors that are about a factor of 30 smaller that those estimated by DIRS 151198-Biwer and Butler (1999, all).

also make periodic stops. However, the assumed frequency of the stops and the numbers of people nearby would be different from those for truck shipments and would result in a lower dose.

Incident-Free Radiological Impacts to Populations. Table 6-11 lists incident-free radiological impacts that would occur during the routine transportation of spent nuclear fuel and high-level radioactive waste under the mostly rail national transportation scenario. Because national impacts would result from transportation from the commercial and DOE sites to the repository, they include impacts from a Nevada rail or heavy-haul truck implementing alternative. For the case in which rail shipments would continue in Nevada, total impacts to members of the general public would differ depending on the implementing alternative (see Section 6.3.2 for additional details). The range of values listed in Table 6-11 includes the range of impacts from the Nevada implementing alternatives.

About 1 latent cancer fatality could result from shipments of spent nuclear fuel and high-level radioactive waste under the mostly rail scenario over 24 years. The latent cancer fatality would occur over the lifetime of an individual in the exposed population. The population within 800 meters (0.5 mile) of routes in which this fatality would occur would be approximately 16.4 million. Approximately 3.8 million members of this population would incur fatal cancers from all other causes not associated with the Proposed Action (DIRS 153066-Murphy 2000, p. 5).

Incident-Free Radiological Impacts to Maximally Exposed Individuals. Table 6-12 lists the results of risk calculations for maximally exposed individuals for the mostly rail transportation scenario over 24 years. Truck and rail crew members would receive the highest doses. The mostly rail scenario would require transport crews for legal-weight trucks (1,079 total shipments over 24 years) and for rail

Table 6-11. Population doses and radiological impacts from incident-free transportation for national mostly rail scenario.[a]

Category	Legal-weight truck shipments	Rail shipments[b,c]	Totals[d]
Involved workers			
Collective dose (person-rem)	360	3,300 - 4,300	3,700 - 4,600
Estimated LCFs[e]	0.14	1.3 - 1.7	1.5 - 1.9
Public			
Collective dose (person-rem)	130	1,100 - 1,500	1,200 - 1,600
Estimated LCFs	0.07	0.55 - 0.76	0.61 - 0.81

a. Impacts are totals for 24 years.
b. Barge transportation to a railhead on navigable waterways could be used for transportation from 17 commercial sites that do not have rail service but can load a rail cask. See Appendix J.
c. Includes impacts from intermodal transfer station operations.
d. Totals might differ from sums of values due to rounding.
e. LCF = latent cancer fatality.

Table 6-12. Estimated doses and radiological impacts to maximally exposed individuals for national mostly rail scenario.[a,b]

Receptor	Dose (rem)	Probability of latent fatal cancer
Involved workers		
Crew member (rail, heavy-haul truck, or legal-weight truck)	48[c]	0.02
Escort	48[c]	0.02
Inspector (rail)	34	0.014
Railyard crew member	4.2	0.0017
Public		
Resident along route (rail)	0.0016	0.0000008
Person in traffic jam (legal-weight truck)	0.016	0.000008
Person at service station (legal-weight truck)	0.075	0.000038
Resident near rail stop	0.29	0.00014

a. The assumed external dose rate is 10 millirem per hour at 2 meters (6.6 feet) from the vehicle for all shipments.
b. Totals for 24 years.
c. Based on 2-rem-per-year administrative dose limit. If a lower dose limit, for example 500 millirem per year, was imposed for transportation workers or state inspectors, maximally exposed individual doses would be lower. See DIRS 156764-DOE (1999, Article 211) for DOE guidance on occupational dose limits.

shipments. Individual crew members who operated legal-weight trucks and escorts for rail shipments could be exposed to as much as 48 rem over 24 years of operations (maximum exposure of 2 rem each year). State inspectors who would conduct frequent inspections of rail shipments could receive annual radiation doses as high as 1.4 rem (see Appendix J, Section J.1.3.2.2.2). Escorts traveling with rail shipments could be exposed to up to 48 rem over 24 years of operations (maximum exposure of 2 rem per year; see Appendix J, Section J.1.3.2.2.3).

Impacts from Vehicle Emissions. Less than 1 (a range from 0.55 to 0.77) fatality could result from exposure to vehicle emissions over 24 years under the mostly rail scenario. This potential would arise principally from exposure of people in urban areas to very small increases in levels of pollutants caused by vehicles transporting spent nuclear fuel and high-level radioactive waste.

6.2.4 ACCIDENT SCENARIOS

6.2.4.1 Loading Accident Scenarios

The analysis used existing information from several different sources (DIRS 104794-CRWMS M&O 1994, all; DIRS 103177-CP&L 1989, all; DIRS 103449-PGE 1996, all; DIRS 101816-DOE 1997, all) to estimate potential radiological impacts from accidents involving the loading of spent nuclear fuel or high-level radioactive waste for shipment and handling of shipping casks. As summarized below, the results in these sources indicate that, because no cask would be likely to be breached and thus no radionuclides released, there would be no or very small potential radiological consequences for the public and for workers from accidents in all cases. Appendix J, Section J.1.3.1, presents a description of typical operations for loading spent nuclear fuel in a shipping cask at a commercial facility.

Lift-handling incidents involving spent nuclear fuel in a transfer facility would have an estimated probability of 0.0001 (1 in 10,000) per handling operation (DIRS 104794-CRWMS M&O 1994, pp. 3 to 8). The estimated collective dose to workers from the incidents would be no more than 0.1 person-rem, and it would be much less to the public.

The total number of high-level radioactive waste canisters potentially handled would be approximately the same as the number of spent nuclear fuel canisters, and handling operations would be similar. DOE expects the consequences of handling incidents that involved high-level radioactive waste would be less than those involving spent nuclear fuel (DIRS 103237-CRWMS M&O 1998, p. 3). Thus, impacts from high-level waste handling would be less than the estimated 0.1 person-rem from a spent nuclear fuel handling accident.

Reports on independent spent fuel storage installations and previous DOE analyses provide further evidence of the low probable impacts associated with a loading accident. Safety analysis reports prepared for independent spent fuel storage installations at the Trojan Nuclear Station and the Brunswick Steam Electric Plant concluded that there would be no or low radiological consequences from accidents that could occur at such facilities (DIRS 103449-PGE 1996, Section 8.2; DIRS 103177-CP&L 1989, Section 8.2). This analysis examined the potential magnitude of impacts from spent nuclear fuel storage facility operations. Similarly, previous DOE analyses (DIRS 101816-DOE 1997, all; DIRS 104794-CRWMS M&O 1994, all) indicate that radiological consequences from accidents involving spent nuclear fuel and high-level radioactive waste management activities would be very small (Table 6-12). The low consequences listed in Table 6-13 are consistent with the results from an earlier DOE analysis (DIRS 104731-DOE 1986, Volume 2, p. xvii).

Table 6-13. Radiological consequences of accidents associated with handling and loading operations.

Affected group	Impact (per year)[a]	24-year impact	Source
Involved workers			
Maximally exposed involved worker			
Dose (rem)	0.0005	0.01	--[b]
Probability of LCF[c]	0.0000002	0.000005	--
Worker population			
Collective dose (person-rem)	0.1	2.4	DIRS 104794-CRWMS M&O (1994, p. 3-8)
Number of LCFs	0.00004	0.001	--
Noninvolved workers			
Maximally exposed noninvolved worker			
Dose (rem)	0.0002	0.005	--
Probability of LCF	0.00000005	0.000001	--
Public			
Maximally exposed individual			
Dose (rem)	0.0013	0.03	--
Probability of LCF	0.0000007	0.00002	--
Population			
Collective dose (person-rem)	0.000074	0.002	DIRS 104794-CRWMS M&O (1994, p. 3-8)
Number of LCFs	0.00000004	0.000001	--

a. Average annual impact for 24 years.
b. -- = determined by analysis.
c. LCF = latent cancer fatality.

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6.2.4.2 Transportation Accident Scenarios

Accidents could occur during the transportation of spent nuclear fuel and high-level radioactive waste. This section describes the risks and impacts to the public and workers for a range of accident scenarios including those that are highly unlikely but that could have high consequences (called *maximum reasonably foreseeable accident scenarios*) and those that are more likely but that would have less severe consequences. The impacts would include those to the population and to hypothetical maximally exposed individuals. The following paragraphs describe the analysis approach. Appendix J, Section J.1.4, contains more details.

The analysis did not address accident impacts to workers apart from impacts to the public. For example, fatalities from train and truck accident scenarios would include fatalities for vehicle operators. The collective radiological risk from accidents to highway vehicle and train crews would be much less than for the public because of the large difference in the numbers of individuals that could be affected. In addition, based on national accident statistics, motor carrier and train operators are much less likely to be fatalities in nonradiological accidents than operators of other vehicles (DIRS 103410-DOT 1998, p. 30).

MAXIMUM REASONABLY FORESEEABLE ACCIDENT SCENARIOS

Maximum reasonably foreseeable impacts from accident scenarios for the transportation of spent nuclear fuel and high-level radioactive waste would be characterized by extremes of mechanical (impact) forces, heat (fire), and other conditions that would lead to the highest reasonably foreseeable consequences. For postulated accident scenarios such as these, the forces and heat would exceed the regulatory design limits of transportation cask structures and materials. (The performance of transportation casks was demonstrated through a combination of tests and analyses.) In addition, these forces and heat would be applied to the structures and surfaces of a cask in a way that would cause the greatest damage and bring about releases of radioactive materials to the environment. The most severe accident scenarios analyzed in this chapter would release radioactive material. These accident scenarios correspond to those in the highest accident severity category, which represent events that would be very unlikely but, if they occurred, would result in human health effect consequences.

In general, this EIS considers accidents with conditions that have a chance of occurring more often than 1 in 10 million times in a year to be reasonably foreseeable. Accidents and conditions less likely than this are not considered to be reasonably foreseeable.

The specific number, location, and severity of an accident can be predicted only in general terms of the likelihood of occurrence (the probability). Similarly, the weather conditions at the time an accident occurs cannot be precisely predicted. Therefore, the EIS analysis evaluated a variety of accident scenarios and conditions to understand the influence of various conditions on environmental impacts. The analysis of impacts to populations along routes assumed that an accident could occur at any location along a route.

The EIS analysis considered accident scenarios based on the 19 truck and 21 rail accident cases presented by DIRS 152476-Sprung et al. (2000, all). Appendix J, Section J.1.4.2.1, describes those cases and their derivations. In addition, the analysis estimated impacts of postulated releases from accident scenarios in three population zones—urban, suburban, and rural—under a set of meteorological (weather) conditions that represent the national average meteorology. The analysis used state-specific accident data, the lengths of routes in the population zones in states through which the shipments would pass, and the number of shipments that would use the routes to determine accident scenario probabilities.

The EIS analysis used the properties of a representative commercial spent nuclear fuel along with the properties for the 15 categories of DOE spent nuclear fuel and high-level radioactive waste described in Appendix A. Since the publication of the Draft EIS, DOE has reevaluated the properties of commercial spent nuclear fuel that it used in analyses of transportation accidents and determined that the representative spent nuclear fuel described in Appendix A is more appropriate for analysis of such accidents. Representative commercial spent nuclear fuel would be (1) fuel discharged after 14 years from a boiling-water reactor with a burnup of 40,000 megawatt-days per MTHM and (2) fuel discharged from a pressurized-water reactor after 15 years with a burnup of 50,000 megawatt-days per MTHM. Because representative spent nuclear fuel would be younger and have higher burnup than typical spent nuclear fuel, its relative health and safety hazard would be greater. In fact, the hazard is about 2 times greater. As a consequence, estimates of impacts of transportation accidents involving casks containing representative spent nuclear fuel would be about 2 times greater than if the casks contained typical spent nuclear fuel.

TRANSPORTATION EMERGENCIES

Under Section 180(c) of the Nuclear Waste Policy Act, as amended, the Department would provide technical assistance and funding for training of local and American Indian public safety officials of eligible states and tribes in relation to transportation under the Proposed Action. The training would cover safe routine transportation and emergency response procedures. DOE would also require its transportation contractors to comply with *Carrier and Shipper Responsibilities and Emergency Response Procedures for Highway Transportation Accidents Involving Truckload Quantities of Radioactive Materials* (DIRS 156289-ANSI 1987, Section 5.2). This standard requires the preparation of an emergency response plan and describes appropriate provisions of information and assistance to emergency responders. The standard also requires the carrier to provide appropriate resources for dealing with the consequences of the accident including isolating and cleaning up spills, and to maintain working contact with the responsible governmental authority until the latter has declared the incident to be satisfactorily resolved and closed. DOE would, as requested, assist state, tribal, and local governments in several ways to reduce the consequences of accidents related to the transportation of spent nuclear fuel and high-level radioactive waste. In addition, DOE maintains an emergency response program through eight Regional Coordinating Offices across the United States. These offices are capable of responding to transportation radiological emergencies and are on call 24 hours a day. They respond to requests for radiological assistance from state or tribal authorities. Other DOE, Federal Emergency Management Agency, and U.S. Department of Transportation programs have provided training for transportation emergencies for many areas (for example, Colorado and South Carolina to support preparation for transportation for the Foreign Research Reactor and Waste Isolation Pilot Plant programs). Appendix M contains additional detail.

In addition to the risk due to accidents involving a release of radioactive material, the analysis examined the impacts of loss-of-shielding accidents. The loss-of-shielding scenarios range from an accident with no loss of shielding to a low-probability severe accident involving both a loss of shielding (and any increased direct exposure) and a release of some of the contents of the cask.

The EIS analysis also estimated impacts from an unlikely but severe accident scenario called a *maximum reasonably foreseeable accident* to provide perspective about the consequences for a population that might live nearby. For maximum reasonably foreseeable accident scenarios, the consequences were estimated for each of the accident scenarios and for both truck and rail casks from the spectrum of accidents presented in DIRS 152476-Sprung et al. (2000, all). For each accident scenario, possible combinations of weather conditions, population zones, and transportation modes were considered. The scenarios were then ranked according to those that would have a likelihood greater than 1 in 10 million per year and would have the greatest consequences (see Appendix J).

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REEXAMINATION OF SPENT FUEL SHIPMENT RISK ESTIMATES

Factors other than the environment can cause uncertainties in the prediction of accident impacts. Uncertainty can result from both limited data and the limitations of computer models used to predict accident impacts. The first comprehensive study that developed estimates of the impacts of severe accidents was the *Shipping Container Response to Severe Highway and Railway Accident Conditions* (DIRS 101828-Fischer et al. 1987, all; also called the *Modal Study*) for fractions of shipping cask contents (spent nuclear fuel or high-level radioactive waste) that such accident scenarios could release to the environment. The estimates of severe accident impacts developed in the Modal Study were reexamined by Sandia National Laboratories in *Re-Examination of Spent Fuel Shipment Risk Estimates* (DIRS 152476-Sprung et al. 2000, all) published in April 2000. The Nuclear Regulatory Commission staff, in a memorandum to the Commissioners, concluded "the best estimate spent-fuel shipment risks from the reexamination appear to be less than the 'Modal Study'-based estimates by as much as 2 orders of magnitude" (DIRS 155562-NRC 2000, all). Although the Commission staff offered this positive finding, it also observed that several questions on the Sandia methodology require resolution before the best-estimate results can be completed. Even though it expressed caution regarding its findings, on the basis of the results presented the Commission staff concluded "the transportation risk studies provide a technical basis for determining that current regulations are sufficient to prevent releases of radioactive material during transport" (DIRS 155562-NRC 2000, all).

6.2.4.2.1 *Impacts from Accidents – National Mostly Legal-Weight Truck Scenario*

This section summarizes the potential impacts and risks associated with accidents under the legal-weight truck scenario. The impacts and risks include those associated with the legal-weight truck and rail shipments to Nevada plus the transfer of the spent nuclear fuel and high-level waste to heavy-haul trucks and its transportation in Nevada. The section summarizes radiological impacts for six accident scenario categories, under two types of weather conditions, and in three population densities (urban, suburban, and rural), in terms of a collective dose risk and consequence (latent cancer fatalities). It describes the potential impacts from the maximum reasonably foreseeable accident scenario separately. It also describes nonradiological impacts in terms of accident fatalities.

Radiological Impacts to Populations from Accidents. Based on state-specific accident rates, the total estimated number of traffic accidents under the Proposed Action for the mostly legal-weight truck scenario would be 66, or 2.8 per year. The collective radiological accident dose risk, as described in Appendix J, Section J.1.4.2.1, would be less than 1 (0.5) person-rem for the population within 80 kilometers (50 miles) along routes for the national mostly legal-weight truck scenario. This calculated risk would be the total for 24 years of shipment operations. The radiological dose risk of accidents is the sum of the products of the probabilities (dimensionless) and consequences (in person-rem) of all potential transportation accidents. A radiological dose risk of 0.5 person-rem would be likely to cause much less than 1 (0.0002) latent cancer fatality, or approximately 2 chances in 10,000 of 1 latent cancer fatality among the more than 10 million persons within 80 kilometers of the routes that the shipments would use. The 0.5 person-rem risk includes the dose risk associated with loss-of-shielding events. The accident risk for legal-weight truck shipments dominates the total risk, contributing more than 99.9 percent of the population dose and risk in comparison to the risk associated with the 300 proposed shipments of naval spent nuclear fuel.

Consequences of Maximum Reasonably Foreseeable Accident Scenario. The analysis evaluated the impacts of a maximum reasonably foreseeable accident scenario in urbanized and rural population zones for both legal-weight truck and rail shipments under the mostly legal-weight truck scenario. The maximum reasonably foreseeable transportation accident scenario that would have the greatest consequences for the mostly legal-weight truck scenario (a probability of approximately 3 in 10 million per year) would be a long-duration severe fire accident in which the transportation cask was fully engulfed by the fire. This accident is further described by DIRS 152476-Sprung et al. (2000, p. 7-25) as case 18 in accidents evaluated for legal-weight truck casks (see Appendix J, Section J.1.4.2.1). The analysis assumed that the accident would occur under stable (slowly dispersing atmospheric conditions that would not be exceeded 95 percent of the time) meteorological conditions in an urban area. Severe accidents in other population zones under stable or neutral weather conditions (atmospheric conditions that would not be exceeded 50 percent of the time) would have smaller consequences. The accident scenario assumes a breach of the shipping cask and the release of a portion of its contents to the air. This accident in combination with stable atmospheric conditions would be very unlikely (2.3 in 10 million per year). Table 6-14 summarizes the impacts of the accident scenario. This accident scenario could cause 0.55 latent cancer fatality; in comparison, a population of 5 million within 80 kilometers (50 miles) of the center of a large U.S. metropolitan area such as that assumed in the analysis would be likely to experience more than 1.1 million lifetime cancer fatalities from other causes not related to the Proposed Action (DIRS 153066-Murphy 2000, p. 5). For this accident scenario, the analysis projected that most of the dose to a population would come from inhalation, cloudshine, and groundshine sources. The maximally exposed individual, assumed to be about 150 meters (490 feet) from the accident where particles heated by the accident would fall after cooling, would receive a dose of about 0.8 rem (Table 6-14). A first responder to this accident would receive a small dose (2.6 millirem).

Table 6-14. Estimated radiological impacts of maximum reasonably foreseeable accident scenario for national mostly legal-weight truck scenario.

Impact	Urbanized area (stable atmospheric conditions)
Accident scenario probability (annual)	0.00000023 per year (about 2.3 in 10 million)
Impacts to populations	
Population dose (person-rem)	1,100
Latent cancer fatalities	0.55
Impacts to maximally exposed individuals	
Maximally exposed individual dose (rem)	3
Probability of a latent cancer fatality	0.0015
Impacts to first responder	
Maximally exposed responder dose (rem)	0.26
Probability of latent cancer fatality	0.0000013

In addition to a maximum reasonably foreseeable accident, DOE evaluated other severe accidents. Appendix J, Section J.1.4.2.1, describes these accidents and their potential impacts. The accident conditions for one truck accident (Case 11) could be similar to those from a crash of a commercial jet airliner into a legal-weight truck cask (DIRS 157210-BSC 2001, all). The consequences of this accident (1,100 person-rem or 0.55 latent cancer fatality) would be about the same as those for the maximum reasonably foreseeable truck accident described above.

Section J.1.4.2.5 in Appendix J summarizes studies of potential economic and environmental impacts of hypothetical severe transportation accidents that would release radioactive materials from transportation casks.

Impacts from Traffic Accidents. Approximately 5 (4.9) traffic fatalities could occur in the course of transporting spent nuclear fuel and high-level radioactive waste under the mostly legal-weight truck national transportation scenario during the 24 years of operations for the Proposed Action. Essentially all of these fatalities would be from truck operations; none would occur from the 300 railcar shipments of naval spent nuclear fuel. The fatalities would be principally from traffic accidents; half would involve trucks transporting loaded casks to the repository and half would involve returning shipments of empty casks. The fatalities would occur over 24 years and approximately 380 million kilometers (240 million miles) of highway travel. Based on information extrapolated from the U.S. Department of Transportation

Bureau of Transportation Statistics (DIRS 150989-BTS 1998, p. 20), during the same 24-year period about 1 million deaths would be likely to occur in traffic accidents on U.S. highways.

6.2.4.2.2 *Impacts from Accidents – National Mostly Rail Transportation Scenario*

This section discusses the results of the analysis of radiological impacts to populations and maximally exposed individuals and of traffic fatalities that would arise from accidents during the transportation of spent nuclear fuel and high-level radioactive waste for the national mostly rail transportation scenario.

DOE used the models and calculations described in Appendix J, Section J.1.4.2.1, to estimate the impacts from rail accidents, and included impacts postulated to occur during the transportation of commercial spent nuclear fuel by legal-weight trucks from six commercial sites that do not have the capability to handle or load large rail casks. The analysis also included the impacts from accidents for heavy-haul truck or barge shipments to nearby railheads from 24 commercial sites that have the capability to load a rail cask but are not served by a railroad. DOE used the models and calculations described in Appendix J to estimate the impacts. Appendix J, Section J.2.4, presents additional information on heavy-haul truck and barge transportation from the 24 commercial sites.

Accident Radiological Impacts for Populations. Based on state-specific accident rates, the total estimated number of rail and truck traffic accidents under the Proposed Action for the mostly rail scenario would be about 10, or about 0.4 per year. The collective radiological dose risk of accidents would be approximately 1 (0.89) person-rem for the population within 80 kilometers (50 miles) along routes for the national mostly rail transportation scenario. This calculated dose risk would be the total for 24 years of shipment operations. The radiological dose risk of accidents is the sum of the products of the probabilities (dimensionless) and consequences (in person-rem) of all potential transportation accidents. A radiological dose risk of 1 person-rem would be likely to cause much less than 1 (0.00045) latent cancer fatality.

Radiological risks from accidents for the mostly rail scenario would include impacts associated with about 9,646 railcar shipments (one cask to a railcar) and 1,079 legal-weight truck shipments. National rail transportation of spent nuclear fuel and high-level radioactive waste would account for most of the population dose and risk to the public.

Impacts of Maximum Reasonably Foreseeable Accident Scenario. The analysis evaluated the impacts of a maximum reasonably foreseeable accident scenario in urbanized areas or rural population zones and under stable and neutral atmospheric conditions. The maximum reasonably foreseeable accident scenario under the mostly rail scenario would involve a release of a fraction of the contents of a rail cask in an urban area under stable meteorological conditions (slowly dispersing atmospheric conditions that would not be exceeded 95 percent of the time), where *atmospheric dispersion* of contaminants would occur more slowly only 5 percent of the time. This accident scenario would have a likelihood of about 2.8 in 10 million per year, and would result in about 5 latent cancer fatalities in the population (Table 6-15). The maximally exposed individual, assumed to be about 330 meters (1,080 feet) from the accident, would receive a dose of about 29 rem. An accident that involved high impact forces or a long-duration fire could reduce the effectiveness of the radiation shielding in a shipping cask. A first responder to this accident could receive a dose of as much as 0.83 rem.

Actual transportation accidents involve collisions of many kinds, such as with other vehicles and roadside objects, involvement in fires and explosions, inundation, and burial. These accidents are caused by a variety of initiating events including human error, mechanical failure, and natural causes such as earthquakes. Accidents occur in many different kinds of places including mountain passes and urban areas, rural freeways in open landscapes, and rail switching yards. Thus, there are as many different kinds of unique initiating events and accident conditions as there are accidents. DOE could not

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Table 6-15. Estimated impacts from maximum reasonably foreseeable accident scenario for national mostly rail transportation scenario.

Impact	Urbanized area (stable atmospheric conditions)
Accident probability	0.00000028 per year (about 2.8 in 10 million)
Impacts to populations	
Population dose (person-rem)	9,900
Latent cancer fatalities	5
Impacts to maximally exposed individuals	
Maximally exposed individual dose (rem)	29
Probability of a latent cancer fatality	0.01
Impacts to first responder	
Maximally exposed responder dose (rem)	0.83
Probability of latent cancer fatality	0.0004

practicably attempt to analyze every possible accident that could occur. Instead, DOE analyzed a broad range of accidents, each of which represents a grouping of initiating events and conditions having similar characteristics. For example, the EIS analyzes the impacts of a collection of collision accidents in which a cask would be exposed to impact velocities in the range of 60 to 90 miles per hour (see Appendix J, Section J.1.4.2.1).

In addition, the EIS analyzes a maximum reasonably foreseeable accident in which a collision would not occur but the temperature of a rail cask containing spent nuclear fuel would rise to between 750ºC and 1,000ºC (between 1,400ºF and 1,800ºF) (Section 6.2.4.2). The conditions of the maximum reasonably foreseeable accident analyzed in the EIS envelop conditions reported in newspapers for the Baltimore Tunnel fire (a train derailment and fire that occurred in July 2001 in a tunnel in Baltimore, Maryland). Temperatures in that fire were reported to be as high as 820ºC (1,500ºF) and the fire was reported to have burned for up to 5 days (DIRS 156753-Ettlin 2001, all; DIRS 156754-Rascovar 2001, all).

DOE evaluated other severe accidents. Appendix J, Section J.1.4.2.1, describes these accidents and their potential impacts. The accident conditions for one rail accident (Case 4) could be similar to those from a crash of a commercial jet airliner into a rail cask (DIRS 157210-BSC 2001, all). The consequences of this accident (1,300 person-rem or 0.65 latent cancer fatality) would be less than those for the maximum reasonably foreseeable rail accident described above.

Impacts From Traffic Accidents. The analysis estimated that across the United States approximately 3 (3.1) traffic and train accident fatalities could occur during transportation of spent nuclear fuel and high-level radioactive waste under the national mostly rail transportation scenario. Half of the fatalities would occur during the return of empty casks to commercial and DOE sites. Essentially all of the fatalities would involve train operations; about half would involve highway vehicles hit by trains. There would be about a 12-percent chance of 1 fatality from the 1,079 legal-weight truck shipments of commercial spent nuclear fuel. This fatality could happen during the 24 years of transportation operations involving approximately 77 million kilometers (48 million miles) of railcar travel and 10 million kilometers (6 million miles) of highway travel. On the basis of data presented by the Bureau of Transportation Statistics (DIRS 150989-BTS 1998, p. 20), during the same 24-year period about 1 million people will die in traffic accidents on U.S. highways.

6.2.4.2.3 *Impacts of Acts of Sabotage*

The Nuclear Regulatory Commission has developed a set of rules specifically aimed at protecting the public from harm that could result from sabotage of spent nuclear fuel casks. Known as physical protection and safeguards regulations (10 CFR 73.37), these security rules are distinguished from other regulations that deal with issues of safety affecting the environment and public health. The objectives of the physical protection and safeguard regulations are to:

- Minimize the possibility of sabotage
- Facilitate recovery of spent nuclear fuel shipments that could come under control of unauthorized persons

To achieve these objectives, the Nuclear Regulatory Commission physical protection and safeguard rules require:

- Advance notification of each shipment to the Nuclear Regulatory Commission, the states, and Native American governments [proposed rulemaking 10 CFR Parts 71 and 73 (64 *FR* 71331, December 21, 1999)]
- The licensee to have current procedures to cope with safeguards emergencies
- Instructions for escorts on how to determine if a threat exists and how to deal with it
- Maintenance of a communications center to monitor continually the progress of each shipment
- A written log describing the shipment and significant events during the shipment
- Advance arrangements with law enforcement agencies along the route
- Advance route approval by the Nuclear Regulatory Commission
- Avoidance of intermediate stops to the extent practicable
- At least one escort to maintain visual surveillance of the shipment during stops
- Shipment escorts to report status periodically
- Armed escorts in heavily populated areas
- Onboard communications equipment
- Protection of specific shipment information

The cask safety features that provide containment, shielding and thermal protection also provide protection against sabotage. The casks would be massive. The spent nuclear fuel in a cask would typically be only about 10 percent of the gross weight; the remaining 90 percent would be shielding and structure.

It is not possible to predict whether sabotage events would occur and, if they did, the nature of such events. Nevertheless, DOE examined various accidents, including an aircraft crash into a transportation cask. The consequences of both the maximum reasonably foreseeable accident and the aircraft crash are presented above for the mostly truck and mostly rail transportation scenarios and can provide an approximation of the types of consequences that could occur from a sabotage event. DOE also considered the consequences of a potential successful sabotage attempt on a cask. A study conducted by Sandia National Laboratories (DIRS 104918-Luna, Neuhauser, and Vigil 1999, all) estimated the amounts and characteristics of releases of radioactive materials from rail and truck casks subjected to the effects of two different devices.

Devices considered in the Sandia study (DIRS 104918-Luna, Neuhauser, and Vigil 1999, all) included possible devices that might be used in acts of sabotage against shipping casks. (Note: The shield walls of shipping casks for spent nuclear fuel and high-level radioactive waste are similar to the massive layered construction used in armored vehicles such as tanks.) These kinds of devices were demonstrated by the study to be capable of penetrating a cask's shield wall, leading to the dispersal of contaminants to the environment.

The truck cask design selected for analysis was the General Atomics GA-4 Legal-Weight Truck Cask. This cask, which uses uranium for shielding, is a state-of-the-art design recently certified by the Nuclear Regulatory Commission to ship four pressurized-water reactor nuclear fuel assemblies (DIRS 148184-NRC 1998, all). The rail cask design used was based on the conceptual design developed by DOE for the dual-purpose canister system. This design is representative of large rail casks that could be certified for shipping spent nuclear fuel and high-level radioactive waste.

DOE used the RISKIND code (DIRS 101483-Yuan et al. 1995, all) to evaluate the radiological health and safety impacts of the estimated releases of radioactive materials. The analysis used assumptions about the concentrations of radioisotopes in spent nuclear fuel, population densities, and atmospheric conditions (weather) used to evaluate the maximum reasonably foreseeable accidents.

Because it is not possible to forecast the location or the environmental conditions that might exist for acts of sabotage, the analysis determined consequences for urbanized areas (see Appendix J, Section J.1.4.2.1) under neutral (average) weather conditions.

For legal-weight truck shipments, the analysis estimated that a sabotage event occurring in an urbanized area could result in a population dose of 96,000 person-rem. This dose would cause an estimated 48 fatal cancers among the population of exposed individuals. A maximally exposed individual could receive a lifetime committed dose of 110 rem, which would increase the risk of a fatal cancer from about 23 percent from all other causes to about 29 percent.

These estimates exceed those presented in the Draft EIS for two reasons. The analysis for this section assumed that the cask would contain representative (or average hazard) spent nuclear fuel. The analysis in the Draft EIS assumed that the cask would contain typical (or average age) spent nuclear fuel. The amount of radioactivity in representative spent nuclear fuel is about twice that in typical spent nuclear fuel. In addition, the analysis in the Draft EIS used urban area populations reported in the 1990 Census, whereas the analysis for this section used populations projected to 2035. The population estimates used for 2035 are about 40 percent greater than those reported by the 1990 Census. The combined result of these changes is that the estimated consequences of an act of sabotage against a transportation cask in this section are about 3 times those estimated in the Draft EIS.

The consequences estimated for an act of sabotage involving a rail shipment would be less than those estimated for a legal-weight truck shipment. The smaller consequence for the rail shipment would be because less of the radionuclides would be released from a rail transportation cask than from a legal-weight truck transportation cask (DIRS 104918-Luna, Neuhauser, and Vigil 1999, all). For rail shipments, the analysis estimated that a sabotage event in an urbanized area could result in a population dose of 17,000 person-rem. This dose would be likely to cause an estimated 9 fatal cancers among the population of exposed individuals. A maximally exposed individual could receive a lifetime committed dose of 40 rem, which would increase the risk of a fatal cancer from about 23 percent from all other causes to about 25 percent.

Because of the attacks on September 11, 2001, the Department and other agencies are reexamining the protections built into our physical security and safeguards systems for transportation shipments. As dictated by results of this reexamination, DOE would modify its methods and systems as appropriate.

6.2.5 ENVIRONMENTAL JUSTICE

Shipments of spent nuclear fuel and high-level radioactive waste would use the Nation's existing railroads and highways. DOE expects that transportation-related impacts to land use; air quality; hydrology; biological resources and soils; cultural resources; socioeconomics; noise and vibration; aesthetics; utilities, energy, and materials; and waste management would be small. In addition, as described in the preceding sections, incident-free transportation and the risks from transportation accidents (the maximum reasonably foreseeable accident scenario would have about 3 chances in 10 million of occurring per year) would not present a large health or safety risk to the population as a whole, or to workers or individuals along national transportation routes. The low effect on the population as a whole also would be likely for any segment of the population, including minorities, low-income groups, and members of Native American tribes.

A previous DOE analysis of the potential for environmental justice concerns from the transportation of DOE spent nuclear fuel to the Idaho National Engineering and Environmental Laboratory (DIRS 101802-DOE 1995, Volume 1, pp. L-2 and L-36) also concluded that impacts to minority and low-income populations and to populations of American Indians in Idaho would not be disproportionately high and adverse. As part of that analysis, DOE consulted with the Shoshone Bannock Tribe to analyze impacts to tribe members because the shipments in question would cross the Fort Hall Reservation. The analysis (DIRS 101802-DOE 1995, Volume 3, Part A, p. 3-32) concluded that risks to the health and safety of the potentially affected tribal population in Idaho from incident-free transportation and from accidents would be very low.

The EIS analyzes potential public health effects of both routine (incident-free) transportation of radioactive materials and transportation accidents involving radioactive materials. First, regarding routine transportation, the EIS considers air emissions and doses from exposure to radioactive materials during transport. The EIS estimates the impact from air emissions to be 1 emissions-related fatality. The EIS also estimates that the 24-year national transportation campaign would cause fewer than about 3 latent cancer fatalities among the public under the mostly legal-weight truck scenario and fewer under the preferred mostly rail scenario. Although many people would be exposed nationwide over a long campaign, the radiation dose to any exposed individual would be very low. In this context, DOE does not consider such impacts to be high. Because DOE does not know of a plausible mechanism under these circumstances whereby low-income or minority populations could incur high and adverse impacts when the general public would not, the Department believes there could be no disproportionately high and adverse impacts on low-income or minority populations.

The EIS estimates the number of people in the general public who could be killed by accidents involving transportation of spent fuel and high-level radioactive waste. The two mechanisms for such impacts are bodily trauma from collisions or exposure to radioactivity that would be released if a sufficiently severe accident occurred. The analysis estimated that the 24-year national campaign would cause fewer than 5 fatalities among the general public from trauma sustained in collisions with vehicles carrying spent nuclear fuel or high-level radioactive waste. In this context, DOE does not consider such impacts to be high. Again, DOE does not know of a plausible mechanism under these circumstances whereby low-income or minority populations could incur high and adverse impacts when the general public would not.

Only a severe accident that resulted in a considerable release of radioactive material could cause high and adverse health effects to the affected population. Because the risk of these high and adverse consequences applies to the entire population along all transportation routes, it would not apply disproportionately to any minority or low-income population.

Based on the analysis of incident-free transportation and transportation accidents in this EIS and the results of a transportation analysis conducted by DOE in a previous programmatic EIS, and the fact that

DOE has identified no subsection of the population that would be disproportionately affected by transportation related to the Proposed Action, DOE has concluded that no disproportionately high and adverse impacts would be likely on minority or low-income populations from the national transportation of spent nuclear fuel and high-level radioactive waste to Yucca Mountain.

Section 6.3.4 discusses environmental justice in relation to transportation in Nevada. Chapter 4, Section 4.1.13.4, contains a discussion of a Native American perspective on the Proposed Action.

6.3 Nevada Transportation

The analysis of impacts from national transportation includes those from transportation activities in the State of Nevada. This section discusses Nevada transportation impacts separately to ensure that the impacts of alternative transportation modes in Nevada are apparent. Spent nuclear fuel and high-level radioactive waste shipped to the repository by legal-weight truck would continue in the same vehicles to the Yucca Mountain site. Material that traveled by rail would either continue to the repository on a newly constructed branch rail line or transfer to heavy-haul trucks at an intermodal transfer station that DOE would build in Nevada for shipment on existing highways that could require upgrades. Selection of a specific rail alignment within a corridor, or the specific location of an intermodal transfer station or the need to upgrade the associated heavy-haul truck routes, would require additional field surveys, environmental and engineering analysis, state, local, and Native American Tribal government consultation, and National Environmental Policy Act reviews.

The transportation analysis in the EIS treats the candidate legal-weight truck routes, rail corridors, and heavy-haul truck routes as current analysis tools and refers to them in the present tense. The EIS refers to impacts associated with these alternatives in the conditional voice *(would)* because they would not occur unless DOE proceeded with the Proposed Action. This convention is applied whenever the EIS discusses the transportation implementing alternatives.

This section describes potential impacts of three transportation scenarios and their respective implementing alternatives. The three transportation scenarios are (1) mostly legal-weight truck (corresponding to that portion of the national impacts that would occur in Nevada), (2) mostly rail, and (3) mostly heavy-haul truck.

The mostly legal-weight truck scenario does not include implementing alternatives. Under this scenario, highway shipments would be restricted to specific routes that satisfy the regulations of the U.S. Department of Transportation (49 CFR Part 397). Because the State of Nevada has not designated alternative preferred routes, only one combination of routes for legal-weight truck shipments would satisfy U.S. Department of Transportation routing regulations (I-15 to U.S. Highway 95 to Yucca Mountain). This scenario assumes that over 24 years approximately 300 shipments of naval spent nuclear fuel would arrive in Nevada by rail from the Idaho National Engineering and Environmental Laboratory and that heavy-haul trucks would transport them to the repository from a railhead.

The mostly rail scenario has five implementing alternatives, each of which includes a corridor with variations for a branch rail line in Nevada. Each implementing alternative includes the construction and operation of a rail line. These alternatives would include about 1,079 legal-weight truck shipments (about 45 per year) from 6 commercial sites that, while operational, would not have the capability to load rail casks.

The mostly heavy-haul truck scenario has implementing alternatives for five different routes on existing Nevada highways. The highways would have to be upgraded to enable heavy-haul trucks routinely to transport rail casks containing spent nuclear fuel and high-level radioactive waste from an intermodal transfer station to the repository. Each heavy-haul truck implementing alternative includes the construction and operation of an intermodal transfer station that DOE would use to transfer loaded rail casks from railcars to heavy-haul trucks and empty rail casks from the trucks to railcars. The analysis considered three potential intermodal transfer station locations. Each heavy-haul implementing alternative would also include 1,079 legal-weight truck shipments over 24 years from the 6 commercial sites that, while operational, would not have the capability to load rail casks.

Chapter 2, Section 2.1.3.3, contains detailed descriptions of the transportation scenarios and implementing alternatives in Nevada. Sections 6.3.1 through 6.3.3 discuss potential impacts for the three Nevada transportation scenarios. Section 6.3.1 discusses potential environmental impacts that could occur in Nevada for the national mostly legal-weight truck scenario. Section 6.3.2 discusses potential environmental impacts for each of the five Nevada rail transportation implementing alternatives, including those from the construction and operation of a branch rail line, and the impacts of 1,079 legal-weight truck shipments over 24 years. Section 6.3.3 discusses potential impacts of each of the five Nevada heavy-haul truck transportation implementing alternatives, including upgrading Nevada highways, the associated activities of constructing and operating an intermodal transfer station, and the impacts of 1,079 legal-weight truck shipments over the 24 years of operations. Appendix J, Section J.3.6, presents an analysis of impacts of transporting people and materials that would be necessary to implement the Proposed Action. Appendix J also discusses the methods used to analyze impacts for the 12 resource areas.

The EIS analysis evaluated potential impacts that would occur in Nevada from the construction and operation of a branch rail line or from upgrades to highways and construction and operation of an intermodal transfer station for the following environmental resource areas: land use and ownership; air quality; hydrology (surface water and groundwater); biological resources and soils; cultural resources; occupational and public health and safety; socioeconomics; noise and vibration; aesthetics; utilities, energy, and materials; waste management; and environmental justice. The following paragraphs describe the methods used to evaluate potential impacts to these resource areas for each of the three Nevada transportation scenarios—legal-weight truck, rail, and heavy-haul truck—and their applicable implementing alternatives.

Tables 6-16 and 6-17 compare the impacts of the Nevada rail and heavy-haul implementing alternatives, respectively, along with the impacts in Nevada under the mostly legal-weight truck scenario. The comparisons in the tables show that potential health and safety impacts to the public and workers in Nevada would be small for both the mostly legal-weight truck and mostly rail transportation scenarios. In addition, the tables illustrate that impacts would be similar among the 10 rail and heavy-haul truck implementing alternatives. The radiological impacts of incident-free transportation in the State for any of the 10 implementing alternatives or for the mostly legal-weight truck scenario would be small for both the public and workers. The radiological impact from 24 years of transportation would range from 0.0009 to 0.17 latent cancer fatality in the population along routes. The radiological impact to transportation workers from 24 years of operations would range from 0.28 to 0.75 latent cancer fatality for the mostly rail scenario with a Valley Modified Corridor branch rail line and the mostly legal-weight truck scenario, respectively.

As many as 5 latent cancer fatalities could occur from a maximum reasonably foreseeable accident involving a rail shipment. Less than 1 (0.5) latent cancer fatality would occur as the result of a severe truck accident with a similar probability. These accidents would have a chance of occurring nationally of less than 3 in 10 million per year. Because only a small part of each national route is in Nevada, the rate of occurrence in the State would be much less than that nationally. Accidents that would be more likely would have lesser consequences.

Traffic fatalities in Nevada and fatalities caused by the effects of vehicle emissions would be greater for the mostly rail transportation scenario than for the mostly legal-weight truck scenario. The estimate of

Table 6-16. Comparison of impacts for Nevada rail implementing alternatives and for legal-weight truck shipments (page 1 of 2).

Impact	Mostly rail with branch rail: Caliente	Carlin	Caliente-Chalk Mountain	Jean	Valley Modified	Mostly legal-weight truck
Corridor length (kilometers)	512 - 553	514 - 544	344 - 382	181 - 204	159 - 163	230 - 270
Land use and ownership						
Disturbed land (square kilometers)[a]	18 - 20	19 - 20	13 - 14	9.2 - 10	5 - 5.2	0
Private land (square kilometers)	0.9 - 2.5	7.3 - 15	0.8 - 1.1	0.1 - 3.5	0 - 0.18	0
Nellis Air Force Range land (square kilometers)	0 - 11	0 - 11	22	0	3.6 - 7.5	0
Tribal	0 - 1.6	0 - 1.6	0	0	0	0
Air quality						
PM_{10} and carbon monoxide (construction and operations)	Areas in attainment of air quality standards - branch rail line not a significant source of pollution	Areas in attainment of air quality standards - branch rail line not a significant source of pollution	Areas in attainment of air quality standards - branch rail line not a significant source of pollution	Except in Clark County, areas in attainment of air quality standards - branch rail line not a significant source of pollution	Clark County is in nonattainment of air quality standards for PM_{10} - branch rail line construction could be a significant source of pollution[b]	Not a significant source of pollution
Hydrology						
Surface water	Low	Low	Low	Low	Low	None
Surface water resources along route	5	6	3	0	0	NA[d]
Flood zones	9	11	At least 3	7	2	NA
Groundwater						
Water use (acre-feet)[c]	710	660	480	410	320	0
Water use (number of wells)	64	67	43	23	20	0
Biological resources and soils	Low	Low	Low	Low	Low	Very low
Cultural resources	None identified to archaeological, historical, or cultural resources	None identified to archaeological, historical, or cultural resources	None identified to archaeological, historical, or cultural resources	None identified to archaeological, historical, or cultural resources	None identified to archaeological or historical resources. Route passes close to the Las Vegas Paiute Indian Reservation	Since shipments would use existing highways, none to archaeological or historical resources. Shipments from the northeast would pass through the Moapa Indian Reservation. All shipments would pass through the Las Vegas Paiute Indian Reservation
Noise	Moderate	Low	Moderate	Moderate	Moderate	Low
Utilities and resources						
Diesel (million liters)[e]	45	41	36	30	14	Very low
Gasoline (thousand liters)	940	840	680	570	280	
Steel (thousand metric tons)[f]	78	75	52	29	23	0
Concrete (thousand metric tons)[g]	460	420	310	170	130	0

Table 6-16. Comparison of impacts for Nevada rail implementing alternatives and for legal-weight truck shipments (page 2 of 2).

Impact	Mostly rail with branch rail					Mostly legal-weight truck
	Caliente	Carlin	Caliente-Chalk Mountain	Jean	Valley Modified	
Aesthetics	Very low	Very low	Very low	Potential small area of conflict	Very low	None
Socioeconomics						
New jobs (percent of workforce in affected counties	840 (< 1% - 3.2%)	780 (< 1%)	650 (<1% - 2.3%)	530 (< 1%)	250 (< 1%)	Very low
Peak real disposable income (million dollars)	24	21	19	15	7	Very low
Peak incremental Gross Regional Product (million dollars)	40	36	31	26	13	Very low
Waste management	Limited quantity	Limited quantity	Limited quantity	Limited quantity	Limited quantity	Very low
Environmental justice (disproportionately high and adverse impacts)	None	None	None	None	None	None
Incident-free health and safety						
Industrial hazards						
Total recordable incidents	220	200	180	150	110	NA
Lost workday cases	110	100	90	80	60	NA
Fatalities	0.43	0.41	0.38	0.3	0.25	NA
Collective dose (person-rem [LCFs])						
Workers	850 [0.34]	980 [0.39]	740 [0.3]	760 [0.3]	710 [0.28]	1,900 [0.75]
Public	19 [0.009]	38 [0.019]	50 [0.025]	130 [0.06]	23 [0.012]	340 [0.17]
Fatalities from vehicle emissions	0.25	0.25	0.2	0.23	0.13	0.086
Accident impacts, nonradiological traffic						
Construction and operations workforce	1.9	1.8	1.5	1.2	0.9	NA
SNF[h] and HLW[i] shipping	0.07	0.09	0.05	0.06	0.05	0.49
Accident impacts, radiological						
Radiological accident risk						
Person-rem	0.002	0.003	0.002	0.007	0.002	0.053
Latent cancer fatalities	0.0000009	0.0000013	0.0000009	0.0000036	0.000001	0.000026
Maximum reasonably foreseeable accident						
Maximally exposed individual (rem)	29	29	29	29	29	3
Individual latent cancer fatality probability	0.014	0.014	0.014	0.014	0.014	0.0015
Collective dose (person-rem)	9,900	9,900	9,900	9,900	9,900	1,100
Latent cancer fatalities	4.9	4.9	4.9	4.9	4.9	0.55

a. Convert square kilometers to acres, multiply by 247.1.
b. Conformity determination could be required (see Chapter 6, Sections 6.3.2.1 and 6.3.2.2.5).
c. To convert acre-feet to gallons, multiply by 325,850.1.
d. NA = not applicable.
e. To convert liters to gallons, multiply by 0.26418.
f. To convert metric tons to tons, multiply by 1.1023.
g. To convert cubic feet to cubic meters, multiply by 0.028317.
h. SNF = spent nuclear fuel.
i. HLW = high-level radioactive waste.

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Table 6-17. Comparison of impacts for Nevada heavy-haul truck implementing alternatives and for legal-weight truck shipments (page 1 of 3).

	Mostly rail with heavy-haul truck					
Impact	Caliente	Caliente/Chalk Mountain	Caliente/Las Vegas	Sloan/Jean	Apex/Dry Lake	Mostly legal-weight truck
Corridor length (kilometers)	530	280	380	190	180	230 - 270
Land use and ownership						
Disturbed land (square kilometers)[a]	3.4	1.3	2.1	0.63	0.63	0
Private land (square kilometers)	0	0	0	0	0	0
Nellis Air Force Range land (square kilometers)	0	0	0	0	0	0
Air quality						
PM_{10} and carbon monoxide (construction and operations)	Areas in attainment of air quality standards - not a significant source of pollution	Areas in attainment of air quality standards - not a significant source of pollution	Clark County is in nonattainment of air quality standards - heavy-haul route construction could be a significant source of pollution[b]	Except in Clark County, areas in attainment of air quality standards - not a significant source of pollution	Except in Clark County, areas in attainment of air quality standards - not a significant source of pollution	Not a significant source of pollution
Hydrology						
Surface water	Low	Low	Low	Low	Low	None
Groundwater						
Water use (acre-feet)c	100	60	44	8	8	0
Water use (number of wells)	16	5	7	Truck water	Truck water	0
Biological resources and soils	Low	Low	Low	Low	Low	Very low
Cultural resources	None identified to archaeological, historical, or cultural resources	None identified to archaeological, historical, or cultural resources	None identified to archaeological, historical, or cultural resources; route near Moapa Indian Reservation and passes across 1.6-kilometer (1-mile) corner of the Las Vegas Paiute Indian Reservation	None identified to archaeological, historical, or cultural resources; route passes across 1.6-kilometer (1-mile) corner of the Las Vegas Paiute Indian Reservation	None identified to archaeological, historical, or cultural resources; IMT[d] and route near the Moapa Indian Reservation and passes across 1.6-kilometer (1-mile) corner of the Las Vegas Paiute Indian Reservation	Since shipments would use existing highways, none to archaeological or historical resources. Shipments from the northeast would pass through the Moapa Indian Reservation. All shipments would pass through the Las Vegas Paiute Indian Reservation
Noise	Low	Low	Low	Low	Low	Low
Utilities and resources						
Diesel (million liters)[e]	13	4.7	5.5	1.7	1.6	Very low
Steel (metric tons)[f]	49	14	21	2.3	2.3	0
Concrete (thousand metric tons)[g]	1.8	0.5	0.8	0.1	0.1	0
Aesthetics	Some potential near Caliente	Some potential near Caliente	Some potential near Caliente	Very low	Very low	None

Table 6-17. Comparison of impacts for Nevada heavy-haul truck implementing alternatives and for legal-weight truck shipments (page 2 of 3).

	Mostly rail with heavy-haul truck					
Impact	Caliente	Caliente/Chalk Mountain	Caliente/Las Vegas	Sloan/Jean	Apex/Dry Lake	Mostly legal-weight truck
Socioeconomics						
New jobs (percent of workforce in affected counties)	860 (< 1% - 3.3%)	750 (< 1% - 4.9%)	590 - 1,980 (< 1% - 3.3%)	630 - 3,050 (< 1%)	490 - 1,880 (< 1%)	Very low
Peak real disposable personal income (million dollars)	27	22	19 - 65	21 - 97	16 - 62	Very low
Peak incremental Gross Regional Product (million dollars)	45	40	33 - 104	36 - 153	29 - 100	Very low
Waste management	Limited quantity	Limited quantity	Limited quantity	Limited quantity	Limited quantity	Very low
Environmental justice (disproportionately high and adverse impacts)	None	None	None	None	None	None
Incident-free health and safety						
Industrial hazards						
Total recordable incidents	310	270	260	150	150	NA[h]
Lost workday cases	160	140	140	80	80	NA
Fatalities	0.72	0.68	0.63	0.37	0.37	NA
Collective dose (person-rem [LCFs])						
Workers	1,600 [0.65]	1,200 [0.50]	1,400 [0.56]	1,200 [0.48]	1,100 [0.46]	1,900 [0.75]
Public	76 [0.038]	61 [0.030]	220 [0.11]	300 [0.15]	160 [0.08]	340 [0.17]
Fatalities from vehicle emissions	0.47	0.32	0.46	0.42	0.29	0.086
Accident impacts, nonradiological traffic						
Construction and operations workforce	3.5	2.4	3.0	1.7	1.7	NA
SNF[i] and HLW[j] shipping	0.6	0.33	0.43	0.25	0.23	0.49
Accident impacts, radiological						
Radiological accident risk						
Person-rem	0.01	0.002	0.056	0.12	0.056	0.053
Latent cancer fatalities	0.0000051	0.000001	0.000028	0.00006	0.000028	0.000026

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Table 6-17. Comparison of impacts for Nevada heavy-haul truck implementing alternatives and for legal-weight truck shipments (page 3 of 3).

Impact	Mostly rail with heavy-haul truck: Caliente	Caliente/Chalk Mountain	Caliente/Las Vegas	Sloan/Jean	Apex/Dry Lake	Mostly legal-weight truck
Maximum reasonably foreseeable accident						
Maximally exposed individual (rem)	29	29	29	29	29	3
Individual latent cancer fatality probability	0.014	0.014	0.014	0.014	0.014	0.0015
Collective dose (person-rem)	9,900	9,900	9,900	9,900	9,900	1,100
Latent cancer fatalities	4.9	4.9	4.9	4.9	4.9	0.55

a. To convert square kilometers to acres, multiply by 247.1.
b. Conformity determination could be required (see Chapter 6, Sections 6.3.3.1 and 6.3.3.2.3).
c. To convert acre-feet to gallons, multiply by 325,850.1.
d. IMT = intermodal transfer.
e. To convert liters to gallons, multiply by 0.26418.
f. To convert metric tons to tons, multiply by 1.1023.
g. To convert cubic feet to cubic meters, multiply by 0.028317.
h. NA = not applicable.
i. SNF = spent nuclear fuel.
j. HLW = high-level radioactive waste.

traffic facilities includes those that could occur when workers associated with highway or railroad construction commute to and from their work site. The estimates also include traffic fatalities that could result from highway accidents in delivering construction materials used to construct a branch rail line or upgrade highways and construct an intermodal transfer station. Construction and operations activities to transport spent nuclear fuel and high-level radioactive waste in Nevada could result in less than 1 to 5 traffic fatalities (0.5 or a 50 percent chance of 1 fatality to about 4.6). The fewest number of traffic fatalities would occur under the mostly legal-weight truck scenario, principally because the scenario would not require workers associated with construction and operations for Nevada rail implementing alternatives.

Because the trucks would use existing highways and be less than 1 percent of other commercial truck traffic on these highways, measurable impacts would not occur in environmental resource areas other than health and safety in Nevada for mostly legal-weight truck transportation. In contrast, the mostly rail scenario, or any other mix of rail and truck transportation that included a large amount of rail transportation, would require DOE to construct and operate a branch rail line in one of the five candidate rail corridors or construct and operate an intermodal transfer station and work with the State to upgrade highways to use one of the candidate routes for heavy-haul trucks. As a consequence, for the DOE-preferred mostly rail scenario, there would be impacts in Nevada to land use, air quality, hydrological resources, biological resources and soils, cultural resources, socioeconomics, aesthetics, noise and vibration, and waste management. Because it would require acquisition of a large area of land in the State, disturbance of land areas not previously disturbed, and the greatest amount of construction activity, construction of a branch rail line would have the potential to cause greater impacts in all resource areas except health and safety than would construction of an intermodal transfer station and highway upgrades. However, all five of the candidate rail corridors pass through sparsely populated or uninhabited areas of Nevada. Therefore, trains on a branch rail line after construction would have less day-to-day impact on daily life in communities than would heavy-haul trucks, which would share highways with other vehicles. Operational impacts (encompassing those impacts that would occur after construction of a branch rail line or highway upgrade for heavy-haul trucks) would be small in all resource areas for all ten of the rail and heavy-haul truck implementing alternatives.

In general, the longest rail corridor (Caliente) would have the largest potential for impacts, but there are exceptions. For example, construction of a branch rail line in the Valley Modified Corridor, which is the shortest of the five, could affect the Clean Air Act attainment objectives of Clark County for PM_{10} and carbon monoxide, for which the Las Vegas Valley air basin is currently in nonattainment. In addition, both the Jean and Valley Modified Corridors pass through desert tortoise habitat over their entire length and over a distance greater than the three longer corridors. The Wilson Pass Option of the Jean Corridor would require construction of a branch rail line in areas classified by the Bureau of Land Management as Class II for visual resource management. Construction and use of a branch rail line in these areas could be in conflict with Bureau Visual Resource Management guidelines. All five corridors and the Caliente/ Chalk Mountain heavy-haul route have potential land-use conflicts at some points along their lengths. The ability of DOE to avoid or mitigate these conflicts varies among the implementing alternatives.

Construction or upgrading of the longest heavy-haul route (Caliente) would lead to the greatest potential for impacts, with some exceptions. For example, although most impacts of using an Apex/Dry Lake heavy-haul truck implementing alternative would be less than those of using a Caliente heavy-haul truck implementing alternative, the potential for impacts to air quality in the Las Vegas Valley air basin and impacts on traffic flow in the Las Vegas metropolitan area are greater for the Apex/Dry Lake route than for the Caliente route. In addition, socioeconomic impacts in Lincoln County, although small, would be greatest for construction and use of a Caliente/Chalk Mountain heavy-haul route. Furthermore, while health and safety impacts in small communities in Nevada, while small, would be greatest for a Caliente heavy-haul route, the shortest route would use the Las Vegas Beltway, which would pass through a highly populated commercial and residential area of North Las Vegas.

Each rail corridor and heavy-haul route could pass near or through areas having high percentages of minority or low-income populations. However, DOE has determined that there would be no environmental justice concerns for any of the proposed routes for heavy-haul trucks or corridors for a potential branch rail line because no potential impact to these populations would be both high and adverse.

LAND USE AND OWNERSHIP

DOE determined that information useful for an evaluation of land-use and ownership impacts should identify the current ownership of the land that its activities could disturb, and the present and anticipated future uses of the land. The region of influence for land-use and ownership impacts was defined as land areas that would be disturbed or whose ownership or use would change as a result of the construction and use of a branch rail line, intermodal transfer station, midroute stopover for heavy-haul trucks, and an alternative truck route near Beatty, Nevada.

AIR QUALITY

The evaluation of impacts to air quality considered potential emissions of criteria pollutants [nitrogen dioxide, sulfur dioxide, carbon monoxide, particulates with aerodynamic diameters of less than 10 micrometers (PM_{10})], lead, and ozone, the percentage of applicable standards and limits, and the potential for releases of these pollutants in the Las Vegas Valley. The region of influence for the air quality analysis included (1) the Las Vegas Valley for implementing alternatives that could contribute to the levels of carbon monoxide and PM_{10}, which are already in nonattainment of Clean Air Act standards (DIRS 101826-FHWA 1996, pp. 3-53 and 3-54), during the construction and operation of a branch rail line or highway for heavy-haul trucks, and (2) the atmosphere in the vicinity of the sources of criteria pollutants that transportation-related construction and operation activities would emit. The evaluation included a conformity review for emissions to the Las Vegas Valley air basin that would result from the Proposed Action.

HYDROLOGY

The analysis evaluated surface-water and groundwater impacts separately. The attributes used to assess surface-water impacts were the potential for introduction and movement of contaminants, potential for changes to runoff and infiltration rates, alterations in natural drainage, and potential for flooding or dredging and filling actions to aggravate or worsen any of these conditions. The region of influence for surface-water impacts included areas near construction activities, areas that would be affected by permanent changes in flow, and areas downstream of construction.

The analysis addressed the potential for a change in infiltration rates that could affect groundwater, the potential for introduction of contaminants, the availability for use for construction, the potential for changing flow patterns and, if available, the potential that such use would affect other users. The region of influence for this analysis included groundwater reservoirs.

BIOLOGICAL RESOURCES AND SOILS

The evaluation of impacts to biological resources considered the potential for conflicts with areas of critical environmental concern; special status species (plants and animals), including their habitats; and jurisdictional waters of the United States, including wetlands and riparian areas. The evaluation also considered the potential for impacts to migratory patterns and populations of big game animals. The region of influence for this analysis included the following:

- Habitat, including jurisdictional waters of the United States, including wetlands and riparian areas

- Migratory ranges of big game animals that could be affected by the presence of a branch rail line

DOE identified known biological resources within 5 kilometers (3 miles) of each rail corridor or variation. Resources were categorized based on proximity to the railroad—that is, inside the 400-meter-(0.25-mile)-wide corridor or outside the corridor but within 5 kilometers of the railroad. A railroad would be unlikely to influence some resources outside the corridor, such as populations of sensitive plant species or springs. It could influence other resources, especially those involving large game animals, horses, or burros, because they could traverse the distance to the railroad easily.

DOE identified soils classified as Easily Erodible, Prime Farmland, Shrink-Swell, Unstable Fill, or Blowing Soil along each route. No Prime Farmland was identified for any route. Although these soil characteristics would principally influence construction, they could influence the amount of land disturbed inside and outside the corridor and the local environment during construction, such as temporary increases in sediment loads in nearby waterways or springs, or entrainment of blowing soil.

The analysis assessed soil impacts to determine the potential to increase erosion rates by water or wind. The region of influence for the analysis of soil impacts included areas where construction would take place and downwind or downgradient areas that would be affected by eroded soil.

CULTURAL RESOURCES

The evaluation of impacts on cultural resources considered the potential for disrupting, or modifying the character of, archaeological or historic sites, artifacts, and other cultural resources, such as traditional cultural properties and cultural landscapes.

The specific region of influence for the *direct impact* analysis included the lands in the 400-meter (0.25-mile)-wide rail corridors, lands within existing highway rights-of-way that would be upgraded for heavy-haul truck use, and sites where an intermodal transfer station could be constructed and operated. The analysis assessed the potential for impacts to areas adjacent to a proposed rail corridor, such as landscapes traditional to American Indians or other historic cultural landscapes.

OCCUPATIONAL AND PUBLIC HEALTH AND SAFETY

The analysis of impacts to occupational and public health and safety from transportation-related activities in Nevada used the same methods, assumptions, attributes, and regions of influence used for the analysis of impacts of national transportation of spent nuclear fuel and high-level radioactive waste. However, it used the rail and highway accident rates reported for the State of Nevada (DIRS 103455-Saricks and Tompkins 1999, Table 4). The analysis also considered the daily average nonresident population in the Las Vegas metropolitan area for routes that pass through the Las Vegas metropolitan area.

In addition, the analysis included potential impacts from industrial hazards to Nevada workers from constructing and operating a branch rail line, upgrading highways for use by heavy-haul trucks, and constructing and operating an intermodal transfer station. The region of influence for the analysis included branch rail line and highway construction work sites and highways that workers and other construction-related vehicle traffic would use. The analysis considered potential radiological impacts from intermodal transfer station operations.

In addition, the analysis estimated doses to potential maximally exposed individuals in Nevada communities through which truck or rail shipments could travel. Appendix J, Section J.1.3.2.2 discusses the basis for these estimates. The health and safety portions of Sections 6.3.2.1 and 6.3.3.1 describe the potential impacts to maximally exposed individuals in Nevada.

SOCIOECONOMICS

The analysis of transportation-related socioeconomic impacts considered changes in annual levels of employment, population, housing, and schools, in addition to the economic measures of real disposable income, Gross Regional Product, and state and local government expenditures based on analyses DOE conducted using the Regional Economic Models, Inc. model (DIRS 148193-REMI 1999, all). The region of influence for the analysis included Clark, Lincoln, and Nye Counties. The other Nevada counties were included collectively in the Rest of Nevada analysis. The analysis considered impacts that would occur during construction and operation of the various transportation implementing alternatives.

The analysis expressed socioeconomic impacts as a percentage change, which it calculated by comparing the derived increase or decrease in a given socioeconomic parameter to the estimated baseline value for:

- Each county in the region of influence (Clark, Nye, and Lincoln), the Rest of Nevada, and the State of Nevada.
- The year.
- Economic measures (employment, population, real disposable income, Gross Regional Product, and State and local government spending).

Chapter 3, Section 3.1.7 lists the baseline values of each economic measure.

DOE has described the socioeconomic measures on a peak year basis for constructing a branch rail line, upgrading of highways, or constructing an intermodal transfer station and on an average basis for transportation operations. The Department used peak values and their impacts for construction because impacts would tend to be concentrated in 1 or 2 years. DOE used average values for the period of transportation operations as a more meaningful presentation of the data. Impacts, as a percentage of the baselines, would tend to be relatively stable over the 24 years of transportation operations for the Proposed Action.

In light of public comments received on the Draft EIS concerning perception-based and stigma-related impacts, DOE examined relevant studies and literature on perceived risk and stigmatization of communities to determine whether the state of the science in predicting future behavior based on perceptions had advanced sufficiently since scoping to allow DOE to quantify the impact of public risk perception on economic development or property values in potentially affected communities. Of particular interest were those scientific and social studies carried out in the past few years that directly relate to either Yucca Mountain or to DOE actions such as the transportation of foreign research reactor spent nuclear fuel. DOE also reevaluated the conclusions of previous literature reviews such as those conducted by the Nuclear Waste Technical Review Board and the State of Nevada, among others. DOE has concluded that:

- While in some instances risk perceptions could result in adverse impacts on portions of a local economy, there are no reliable methods whereby such impacts could be predicted with any degree of certainty
- Much of the uncertainty is irreducible, and
- Based on a qualitative analysis, adverse impacts from perceptions of risk would be unlikely or relatively small.

While stigmatization of southern Nevada can be envisioned under some scenarios, it is not inevitable or numerically predictable. Any such stigmatization would likely be an aftereffect of unpredictable future events, such as serious accidents, which may not occur. As a consequence, DOE did not attempt to quantify any potential for impacts from risk perceptions or stigma in this Final EIS. Chapter 2, Section 2.5.4 contains further detail.

NOISE AND VIBRATION

Nevada does not have a noise code, so the analysis used daytime and nighttime noise standards adopted by Washington State (Washington Administrative Code 173-58-040 to 173-60-040) for residential and commercial areas as benchmarks and for establishing the region of influence for potential impacts. DOE used these benchmarks [60 dBA for residential use (nighttime reduction to 50 dBA), 65 dBA for light commercial, and 70 dBA for industrial zones] to evaluate the impacts of noise from construction and operational activities for receptors in the region of influence near transportation facilities and corridors. Noise levels in areas and communities outside the region of influence were not addressed. To analyze the potential for community noise impacts, DOE established the region of influence as 1,000 meters (about 0.63 mile) based on the residential nighttime benchmark. This is the approximate distance from a railroad or highway at which the sound levels from passing trains or traffic would fall below 50 dBA. The distances for noise levels from a railroad to fall below 50 dBA (nighttime residential noise standard) and 60 dBA (daytime residential guideline) are 1,000 meters and 450 meters (about 0.25 mile), respectively.

DOE also defined a region of influence for locations where there would be a potential for impacts to solitude. These locations would include sites of special interest to Native Americans, where DOE assumes a sound level of 20 dBA would be necessary for solitude. This distance from passing trains or traffic would be about 6,000 meters (3.7 miles). To provide some perspective on the potential severity of noise impacts, the analysis estimated the population within 2 kilometers (about 1.3 miles) of each proposed rail corridor and heavy-haul truck route.

In addition to noise standards, the analysis assessed the frequency at which transportation noise from construction or operation of a transportation route could lead to complaints. It considered the proximity of transportation routes to centers of population and the frequency of shipments.

The analysis also considered potential effects of ground vibration from trains and heavy-haul trucks. In general, the operation of trains and trucks does not create vibration levels of an intensity that can damage most buildings unless they are very close to the rail line or highway (DIRS 155547-HMMH 1995, p. 8-3). Because trucks run on inflated tires, ground vibration is greatly reduced and the only situation that can produce potentially damaging ground vibration occurs when the vehicle strikes a bump or hole in the road. The intensity of the vibration depends on the size of the bump, speed and weight of the vehicle, and geology. Ground vibration can be disturbing to people, particularly at night, and it can adversely affect vibration-sensitive activities such as semiconductor manufacturing, operation of electron microscopes, and other activities. The U.S. Department of Transportation has proposed critical distances for the evaluation of ground vibration (DIRS 155547-HMMH 1995, pp. 9-4 and 8-3). These are expressed in feet and are based on the *decibel* scale for vibration (VdB) of root-mean-square (in relation to a microinch per second base). (A microinch is one-millionth of an inch or 0.0000025 centimeter; this measurement is used in applications that require extremely tight tolerances.) The endpoint for sensitive buildings is 65 VdB and the corresponding critical distance is 600 feet (about 180 meters). For human annoyance, the critical distance is based on 72 VdB and corresponds to 200 feet (about 61 meters). The estimated critical distance for structural damage due to the operation of unit coal trains is 100 meters (about 330 feet) based on a peak particle velocity measurement of 0.1 inch per second. Trains traveling to Yucca Mountain would include two locomotives and probably no more than 10 cars. The U.S. Department of Transportation (DIRS 155547-HMMH 1995, all) has proposed a structure protection criterion of

0.12-inch-per-second peak particle velocity. A corresponding region of influence is 100 meters (about 330 feet). High levels of ground vibration can be managed in sensitive areas by reducing the speed of the trains, a factor that usually occurs for safety purposes. Most of the candidate rail corridors to Yucca Mountain are in open or isolated areas with few structures; as a consequence, the chance of building damage from the operation of trains would be very small.

The analysis of impacts on biological resources considered the effects of environmental noise from trains and trucks on animals. There are no standards or regulatory measures for such impacts.

AESTHETICS

The analysis of potential impacts on aesthetic resources considered Bureau of Land Management ratings for land areas (DIRS 101505-BLM 1986, all). The regions of influence used in the analysis included the landscapes along the potential rail corridors and highway routes and near possible locations of intermodal transfer stations with aesthetic quality that construction and operations could affect.

The analysis of impacts was based on visual sensitivity ratings of viewsheds in Nevada and the Bureau of Land Management Visual Resource Management System objectives. It established ratings for scenery based on the number and types of users, public interest in the area, and adjacent land uses. The ratings are based on the scenic quality classes in the Bureau of Land Management Visual Resource Management System (DIRS 101505-BLM 1986, all).

UTILITIES, ENERGY, AND MATERIALS

The attributes used to assess impacts to utilities, energy, and materials included the requirements for electric power, fossil fuel for construction, and key consumable construction materials. The analysis compared needs to available capacity. The region of influence included the local, regional, and national supply infrastructure that would have to satisfy the needs.

WASTE MANAGEMENT

Evaluations of impacts of waste management considered the nonhazardous industrial, sanitary, hazardous, and low-level radioactive wastes that the Proposed Action would generate. The region of influence included construction areas and camps and facilities that would support transportation operations such as locomotive and railcar maintenance facilities.

ENVIRONMENTAL JUSTICE

DOE performs environmental justice analyses to identify whether any high and adverse impacts would fall disproportionately on minority and low-income populations. There would be a potential for environmental justice concerns if the following occurred:

- *Disproportionately high and adverse human health effects to minority or low-income populations:* Adverse health effects would be risks and rates of exposure that could result in latent cancer fatalities and other fatal or nonfatal adverse impacts to human health. Disproportionately high and adverse human health effects occur when the risk or rate for a minority or low-income population from exposure to a potentially large environmental hazard appreciably exceeds or is likely to appreciably exceed the risk to the general population and, where available, to another appropriate comparison group (DIRS 103162-CEQ 1997, all).

- *Disproportionately high and adverse environmental impacts to minority or low-income populations:* An adverse environmental impact is one that is unacceptable or above generally accepted norms. A disproportionately high impact is an impact (or the risk of an impact) to a low-income or minority community that significantly exceeds the corresponding impact to the larger community (DIRS 103162-CEQ 1997, all).

The approach to environmental justice analysis first brings together the results of analyses from different technical disciplines that focus on consequences to certain resources, such as air, land use, socioeconomics, air quality, noise, and cultural resources, that could affect human health or the environment. The environmental justice approach considers assessments from these disciplines that identify potential impacts on the general population. Second, based on available information, the approach assesses if there are unique exposure pathways, sensitivities, or cultural practices that would result in high and adverse impacts on minority and low-income populations. If potential impacts identified under either assessment would be high and adverse, the approach then compares the impacts on minority and low-income populations to those on the general population to determine if any high and adverse impacts would fall disproportionately on minority and low-income populations. In other words, if high and adverse impacts on a minority or low-income population would not appreciably exceed the same type of impacts on the general population, disproportionately high and adverse impacts would be unlikely. In making these determinations, DOE considers geographic areas that contain high percentages of minority or low-income populations as reported by the Bureau of the Census.

The EIS definition of a minority population is in accordance with the basic racial and ethnic categories reported by the Bureau of the Census. A minority population is one in which the percent of the total population comprising a racial or ethnic minority is meaningfully greater than the percent of such groups in the total population; for this EIS, a minority population is one in which the percent of the total population comprising of a racial or ethnic minority is 10 percentage points or more higher than the percent of such groups in the total population (DIRS 103162-CEQ 1997, all). Nevada had a minority population of 34.8 percent in 2000 (see Chapter 3, Section 3.1.13 for a discussion of population information). For this EIS, therefore, one focus of the environmental justice analysis is the potential for transportation-related activities of the Proposed Action to have disproportionately high and adverse impacts on the populations in census tracts in the region of influence (principally in Clark, Nye, and Lincoln Counties) with a minority population of 44.8 percent or higher.

Nevada had a low-income population of 10 percent in 1990. Using the approach described in the preceding paragraph for minority populations, a low-income population is one in which 20 percent or more of the persons in a census block group live in poverty, as reported by the Bureau of the Census in accordance with Office of Management and Budget requirements (DIRS 152051-OMB 1999, all; DIRS 103127-Bureau of the Census 1999, pp. 114 and 116). Therefore, the second focus of the environmental justice analysis for this EIS is the potential for the Proposed Action to have disproportionately high and adverse impacts on the populations in census block groups with a low-income population of 20 percent or higher.

In response to comments, DOE has updated and refined available information to determine whether the Draft EIS overlooked any unique exposure pathways or unique resource uses that could create opportunities for disproportionately high and adverse impacts to minority and low-income populations, even though the impacts to the general population would not be high and adverse. The Department identified and analyzed several unique pathways and resources (for example, cultural and aesthetic resources, land use, air quality, and noise), but none revealed a potential for disproportionately high and adverse impacts (see Section 6.3 and Appendix J, Section J.3). DOE has updated and refined information germane to environmental justice analysis, including additional and more detailed mapping of minority populations (see Appendix J, Section J.3.1.2).

Section 6.3.4 describes the results of the analysis for the Nevada transportation scenarios.

6.3.1 IMPACTS OF THE NEVADA MOSTLY LEGAL-WEIGHT TRUCK TRANSPORTATION SCENARIO

Legal-weight truck shipments in Nevada of spent nuclear fuel and high-level radioactive waste to the Yucca Mountain site would use existing highways (see Figure 6-13) and would be a very small fraction of the total traffic [less than 600,000 kilometers (370,000 miles) per year for legal-weight truck shipments in Nevada in comparison to an estimated 1.2 billion kilometers (750 million miles) per year of commercial vehicle traffic on I-15 and U.S. Highway 95 in southern Nevada]. As a consequence, impacts to land use; hydrology; biological resources; cultural resources; socioeconomics; noise and vibration; aesthetics; utilities, energy, and materials; and waste management would not be large.

Because of a U.S. Fish and Wildlife Service concern about populations of desert tortoises and Clark County concern about air quality in the Las Vegas air basin, this section addresses the potential for impacts to this threatened species and to the quality of air in the basin. This section focuses on impacts to occupational and public health and safety in Nevada. Section 6.3.4 contains a consolidated discussion of the potential for transportation activities to cause environmental justice concerns.

6.3.1.1 Impacts to Air Quality

DOE conducted a conformity review using the guidance in DIRS 155566-DOE (2000, all) for the transportation activities of the mostly legal-weight truck scenario. The Las Vegas air basin is in nonattainment status for carbon monoxide, which is largely a result of vehicle emissions (DIRS 156706-Clark County 2000, Appendix A, Table 1-3). The review determined that during repository-related operations, when maximum emissions would occur, the transportation of employees, materials, and supplies, and the transportation of spent nuclear fuel and high-level radioactive waste would not exceed the General Conformity threshold levels for carbon monoxide. Total emissions would be 63 metric tons (69 tons) per year (69 percent of the threshold) and 0.25 metric ton (0.28 ton) per day (0.07 percent of the 2000 daily carbon-monoxide levels in the Las Vegas air basin) (DIRS 156706-Clark County 2000, Appendix A, Table 1-3).

The DIRS 155112-Berger (2000, p. 55) estimate for transportation of radioactive materials only for the legal-weight truck transport for 2010 is 0.27 metric ton (0.03 ton) per day. This estimate includes traffic congestion emissions. Although DOE believes the estimate is high, a value of 0.03 ton per day, 5 days per week, 50 weeks per year, would result in about 6.8 metric tons (7.5 tons) of carbon monoxide per year, which is less than 10 percent of the threshold.

6.3.1.2 Impacts to Biological Resources

Legal-weight truck shipments in Nevada to a Yucca Mountain Repository would involve travel over highways that cross desert tortoise habitat, but none of the routes would cross habitat that the U.S. Fish and Wildlife Service has designated as critical for the recovery of this threatened species (50 CFR 17.95). Over the course of 24 years of operations under the Proposed Action and 53,000 shipments, vehicles probably would kill individual desert tortoises. However, under this scenario legal-weight trucks would contribute only about 1 percent to the daily traffic of vehicles to and from the repository site and only about 0.15 percent of all commercial truck traffic along I-15 and U.S. 95 in southern Nevada. Thus, any desert tortoises killed by trucks transporting spent nuclear fuel or high-level radioactive waste probably would be only a small fraction of all desert tortoises killed on highways. Loss of individual desert tortoises due to legal-weight truck shipments would not be a large threat to the conservation of this species. DOE is engaged in consultation with the U.S. Fish and Wildlife Service to ensure protection of desert tortoises and other biological resources.

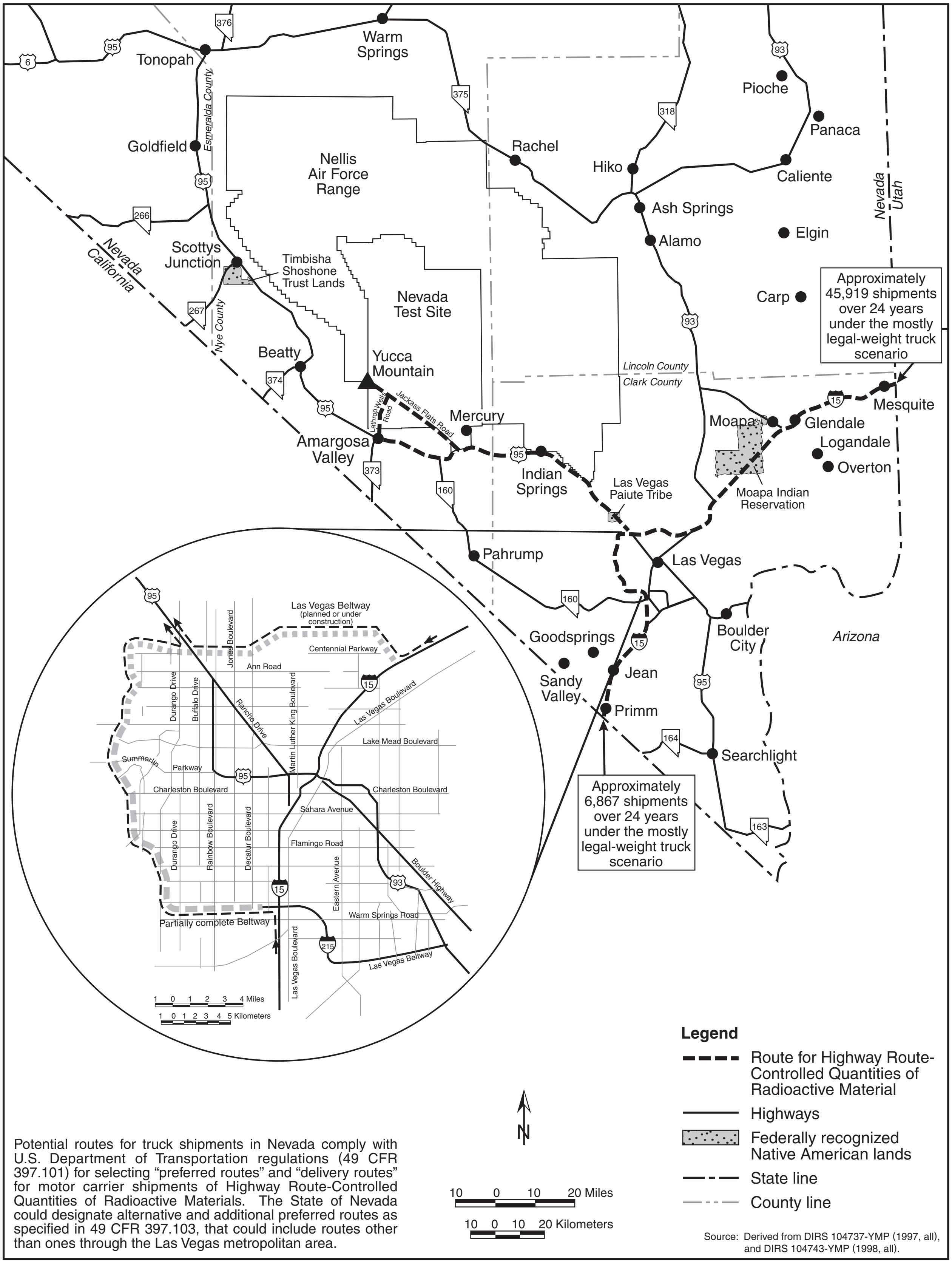

Figure 6-13. Potential Nevada routes for legal-weight trucks and estimated number of shipments.

6.3.1.3 Impacts to Occupational and Public Health and Safety

6.3.1.3.1 *Impacts from Incident-Free Transportation*

This section addresses radiological impacts to populations and maximally exposed individuals in Nevada from the incident-free transportation of spent nuclear fuel and high-level radioactive waste for the mostly legal-weight truck scenario. It includes potential impacts from exposure to vehicle emissions in Nevada.

Incident-Free Radiological Impacts to Populations. Table 6-18 lists the incident-free population dose and radiological impacts for the Nevada mostly legal-weight truck scenario. The impacts include those from the shipment of naval spent nuclear fuel by rail in Nevada to an intermodal transfer station, heavy-haul transfer activities, and subsequent heavy-haul truck transportation to the proposed repository. The analysis included the radiological impacts of intermodal transfer operations for naval spent nuclear fuel shipments. Occupational impacts would include estimated radiological exposures to security escorts for legal-weight truck, rail, and heavy-haul truck shipments. The estimated radiological impacts would be 0.75 latent cancer fatality for workers and 0.18 latent cancer fatality for members of the public over the 24 years of operation.

Table 6-18. Population doses and radiological health impacts from incident-free transportation for Nevada mostly legal-weight truck scenario.[a]

Category	Legal-weight truck shipments	Rail shipments of naval spent nuclear fuel[b]	Totals[c]
Involved workers			
Collective dose (person-rem)	1,900	18	1,900
Estimated LCFs[d]	0.75	0.01	0.75
Public			
Collective dose (person-rem)	340	10	350
Estimated LCFs	0.17	0.005	0.18

a. Impacts are totals for shipments over 24 years.
b. Includes impacts at intermodal transfer stations.
c. Totals might differ from sums of values due to rounding.
d. LCF = latent cancer fatality.

DOE based estimated impacts of legal-weight truck shipments in Nevada on routes identified for analysis in accordance with requirements in U.S. Department of Transportation regulations (49 CFR 397.101). As required by those regulations, and because the Las Vegas Beltway will be part of the Interstate Highway System, DOE assumed its use to avoid travel through the heavily traveled center of Las Vegas. In addition, DOE analyzed the potential impacts of using other routes that the State of Nevada has studied and of routing shipments through the Interstate 15-U.S. 95 interchange (the "*Spaghetti Bowl*"). Appendix J, Section J.3.1.3 discusses the results of these analyses, which range from 83 to 490 person-rem (0.04 to 0.25 latent cancer fatality in the affected population) for Nevada populations.

Incident-Free Radiological Impacts to Maximally Exposed Individuals. Table 6-19 lists estimates of dose and radiological impacts for maximally exposed individuals for the Nevada legal-weight truck scenario from 24 years of shipment activity. The analysis used the assumptions presented in Section 6.2.1 and Appendix J.

The analysis assumed the annual dose to state inspectors who conducted frequent inspections of shipments of spent nuclear fuel and high-level radioactive waste would be limited to 2 rem.

The analysis estimated that a maximally exposed individual at a service station would receive 2.4 person-rem over 24 years under the legal-weight truck scenario. This estimate conservatively assumed the person would be exposed to 450 truck shipments each year for 24 years. For perspective, under the mostly legal-weight truck scenario, which assumes an average of 2,200 legal-weight truck shipments per

Table 6-19. Estimated doses and radiological health impacts to maximally exposed individuals during incident-free transportation for Nevada mostly legal-weight truck scenario.[a,b]

Individual	Dose (rem)	Probability of latent fatal cancer
Involved workers		
Crew member	48[c]	0.02
Inspector	48[c]	0.02
Railyard crew member	0.13	0.00005
Public		
Resident along route[d]	0.02	0.00001
Person in traffic jam[e]	0.016	0.000008
Person at service station[f]	2.4	0.0012
Resident near rail stop	0.009	0.000005

a. The assumed external dose rate is 10 millirem per hour at 2 meters (6.6 feet) from the vehicle for all shipments.
b. Impacts are totals over 24 years.
c. Based on 2-rem-per-year dose limit (DIRS 156764-DOE 1999, Article 211).
d. This represents a Nevada resident approximately 11 meters (36 feet) from the highway. See Appendix J, Section J.1.3.2.2.
e. Person in a traffic is assumed to be exposed one time only.
f. Assumes the person works at the service station for all 24 years of repository operations. Mitigation would be required to reduce doses to members of the public to less than 100 millirem per year.

year, about 450 truck shipments would pass through the Mercury, Nevada, gate to the Nevada Test Site in 1,800 hours. A worker at a truck stop along the route to Mercury would work about 1,800 hours per year. Thus, if every shipment stopped at that truck stop, the maximum number of shipments the worker would be exposed to in a year would be 450. Appendix J, Section J.1.3.2.2, describes assumptions for estimating doses to maximally exposed individuals along routes in Nevada.

Impacts from Vehicle Emissions. There is potential for human health impacts to people in Nevada who would be exposed to pollutants emitted from vehicles transporting spent nuclear fuel and high-level radioactive waste, including escort vehicles. Table 6-20 lists the estimated number of vehicle emission-related fatalities from legal-weight trucks, a small number of heavy-haul trucks carrying naval spent nuclear fuel, escort vehicles, and rail locomotives under the mostly legal-weight truck scenario. Trucks would be the major contributors. Less than 1 (0.093) vehicle emission-related fatality would be likely.

Table 6-20. Population health impacts from vehicle emissions during incident-free transportation for Nevada mostly legal-weight truck scenario.[a]

Category	Legal-weight truck shipments	Rail shipments of naval spent nuclear fuel[b]	Total
Vehicle emission-related fatalities	0.086	0.0069	0.093

a. Impacts are totals for shipments over 24 years.
b. Includes heavy-haul truck shipments in Nevada.

6.3.1.3.2 *Impacts from Accidents – Nevada Legal-Weight Truck Scenario*

This section discusses radiological impacts to populations and maximally exposed individuals in Nevada and the potential number of traffic accident fatalities from accidents during the transportation of spent nuclear fuel and high-level radioactive waste for the mostly legal-weight truck scenario. The analysis of accident impacts under this scenario includes impacts from accidents that would occur during the transportation of naval spent nuclear fuel by rail in Nevada to an intermodal transfer station and by heavy-haul truck to the repository. Section 6.3.3 discusses impacts to workers from industrial hazards during the operation of an intermodal transfer station for shipments of naval spent nuclear fuel.

Radiological Impacts from Accidents. The calculated collective radiological dose risk of accidents would be approximately 0.053 person-rem for the population in Nevada within 80 kilometers (50 miles) along the routes under the mostly legal-weight truck transportation scenario. This calculated dose risk

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would be the total for 24 years of shipment operations. The radiological dose risk of accidents is the sum of the products of the probabilities (dimensionless) and consequences (in person-rem) of all potential transportation accidents. A radiological dose risk of 0.05 person-rem would result in much less than 1 (0.000026) latent cancer fatality in the exposed population. The radiological risk from accidents would include impacts from approximately 53,000 legal-weight truck shipments and 300 naval spent nuclear fuel rail shipments. The accident risk for legal-weight truck shipments would account for essentially all of the population dose and radiological impacts. Because DOE would not build a branch rail line to the repository under this scenario, the accident risk for rail shipments of naval spent nuclear fuel includes risks from accidents that could occur during intermodal transfers from railcars to heavy-haul trucks and during heavy-haul transportation in Nevada. Section 6.3.3 provides additional information on heavy-haul truck implementing alternatives for transporting rail casks in Nevada.

Consequences of Maximum Reasonably Foreseeable Accident Scenarios. The analysis evaluated the impacts of a maximum reasonably foreseeable accident scenario presented in Section 6.2.4.2.

MAXIMUM REASONABLY FORESEEABLE ACCIDENT SCENARIOS IN NEVADA

Maximum reasonably foreseeable accident scenarios analyzed for transportation in Nevada were the same as maximum reasonably foreseeable accident scenarios analyzed in Section 6.2.4.2 for national transportation. That is, the EIS analysis assumed that an accident determined to be reasonably foreseeable for national transportation could occur in Nevada. Because the distances traveled in Nevada would be much less than the total national travel to deliver spent nuclear fuel and high-level radioactive waste to the Yucca Mountain site, the likelihoods of these accident scenarios occurring in the State would be less than those for the rest of the Nation. The likelihoods of two of these accident scenarios occurring in national travel are reported in Section 6.2.4.2.

Impacts from Traffic Accidents. In Nevada, less than 1 (0.49) fatality from traffic accidents would be likely during the course of transporting spent nuclear fuel and high-level radioactive waste under the mostly legal-weight truck transportation scenario. This estimate includes traffic fatalities involving escort vehicles.

6.3.2 IMPACTS OF NEVADA RAIL TRANSPORTATION IMPLEMENTING ALTERNATIVES

This section describes the analysis of human health and safety and environmental impacts for five rail transportation implementing alternatives, each of which would use a newly constructed branch rail line in Nevada to transport spent nuclear fuel and high-level radioactive waste to the repository. The branch line would transport railcars carrying large shipping casks from a mainline railroad to the repository (loaded) and back (empty). DOE has identified five 400-meter (0.25-mile)-wide corridors of land—Caliente, Carlin, Caliente-Chalk Mountain, Jean, and Valley Modified—for the possible construction and operation of the branch line (Figure 6-14). Chapter 2, Section 2.1.3.3.2 describes the corridors. Chapter 3, Section 3.2.2.1, discusses their affected environments.

Appendix J, Section J.3.1.2, contains additional information on the characteristics of possible variations of each corridor. Figure 6-14 shows these variations. Section 6.3.2.1 discusses impacts that would be common among the five possible corridors, and Section 6.3.2.2 discusses impacts that would be unique for each corridor.

DOE identified the five rail corridors through a process of screening the potential rail corridors it had studied in past years.

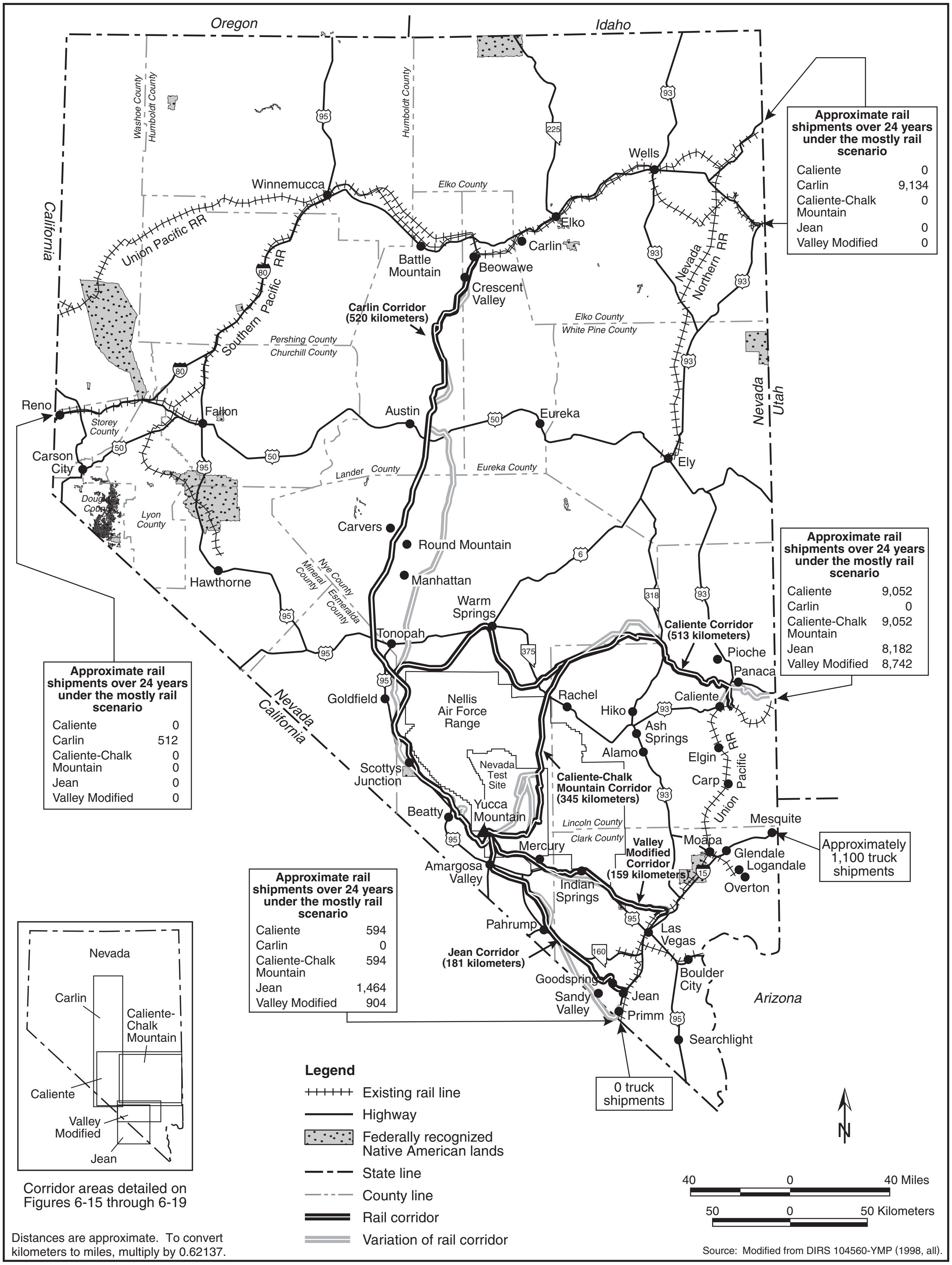

Figure 6-14. Potential Nevada rail routes to Yucca Mountain and estimated number of shipments for each route.

- The *Feasibility Study for Transportation Facilities to Nevada Test Site* study (DIRS 104777-Holmes & Narver 1962, all) determined the technical and economic feasibility of constructing and operating a railroad from Las Vegas to Mercury.

- The *Preliminary Rail Access Study* (DIRS 104792-YMP 1990, all) identified 13 and evaluated 10 rail corridor options. This study recommended the Carlin, Caliente, and Jean Corridors for detailed evaluation.

- *The Nevada Railroad System: Physical, Operational, and Accident Characteristics* (DIRS 104735-YMP 1991, all) described the operational and physical characteristics of the current Nevada railroad system.

- The *High Speed Surface Transportation Between Las Vegas and the Nevada Test Site (NTS)* report (DIRS 104786-Cook 1994, all) explored the rationale for a potential high-speed rail corridor between Las Vegas and the Nevada Test Site to accommodate personnel.

- The *Nevada Potential Repository Preliminary Transportation Strategy, Study 1* (DIRS 104795-CRWMS M&O 1995, all), reevaluated 13 previously identified rail routes and evaluated a new route called the Valley Modified route. This study recommended four rail corridors for detailed evaluation—Caliente, Carlin, Jean, and Valley Modified corridors.

- The *Nevada Potential Repository Preliminary Transportation Strategy, Study 2* (DIRS 101214-CRWMS M&O 1996, all), further refined the analyses of potential rail corridors in Study 1.

Public comments submitted to DOE during hearings on the scope of this EIS resulted in the addition of a fifth potential rail corridor—Caliente/Chalk Mountain.

The analysis of impacts for the five Nevada rail transportation implementing alternatives assumed the mostly rail transportation scenario. Therefore, the analysis included the impacts of legal-weight truck transportation from six commercial sites that would not have the capability while operational to handle or load a large rail cask. About 1,079 legal-weight truck shipments over 24 years would enter Nevada and travel to the repository. These shipments would use the same transport routes and carry about the same amounts of spent nuclear fuel per shipment as those described for the mostly legal-weight truck scenario (Section 6.3.1).

The analysis evaluated impacts to land use and ownership; air quality; hydrology; biological resources and soils; cultural resources; occupational and public health and safety; socioeconomics; noise and vibration; aesthetics; utilities, energy, and materials; and waste management. Section 6.3.4 discusses the potential for transportation activities to cause environmental justice impacts in Nevada.

6.3.2.1 Impacts Common to Nevada Branch Rail Line Implementing Alternatives

The estimated life-cycle cost of constructing and operating a branch rail line in Nevada would range from $283 million to $880 million (2001 dollars), depending on the corridor and variation. This section discusses impacts for the analysis areas listed above that would be common to all five branch rail line implementing alternatives. DOE evaluated these impacts as described in Section 6.3. The construction of the branch rail line would last between 40 and 46 months, depending on the rail corridor. Shipping operations in the rail corridor would begin at a mainline siding where railcars carrying casks of spent nuclear fuel and high-level radioactive waste would switch from the mainline to the branch line for transport to the repository, and railcars carrying empty casks from the repository would switch to the mainline for transport back to the commercial and DOE sites. These shipments would continue for 24 years. Section 6.3.2.2 discusses impacts specific to each rail implementing alternative.

6.3.2.1.1 *Common Rail Land-Use and Ownership Impacts*

In identifying the land potentially affected by a rail corridor, the analysis assumed a corridor width of 400 meters (1,300 feet, or about 0.25 mile). The purpose of the 400-meter width was to provide sufficient space for final alignment to route the rail line around sensitive land features or engineering obstacles. Actual construction and operation in the corridor would mostly require less than about 60 meters (200 feet) of the 400-meter width. Thus, at most, about 15 percent of the land in the corridor would be disturbed by construction. The analysis also assumed that as much as 3.6 square kilometers (890 acres) of land outside of the main disturbed area within the corridor would be disturbed during the construction of a branch rail line for construction roads and camps and other construction-related activities.

Each rail corridor has possible variations providing different land ownerships and projected disturbances, as described in Appendix J, Section J.3.1.2. These possible variations would make little difference in land-use impacts, which could be more or less than those described below.

The analysis indicates no conflicts with commercial use and no identified conflicts with scientific studies for any of the proposed corridors. At present, the public land in each corridor, with the exception of portions of the Caliente-Chalk Mountain Corridor, is open to mining and recreational use, as discussed in Chapter 3, Section 3.2.2.1.1.

The construction and operation of a branch rail line in any of the rail corridors would directly and indirectly affect private property. The Valley Modified Corridor would have the smallest range of private land affected, from 7.3 to 0.2 square kilometer (45 acres). The Carlin Corridor would have the largest, from 7.3 to 15 square kilometers (1,800 to 3,700 acres). Most of the private property in the Carlin Corridor is in the vicinity of Beowawe and Crescent Valley. The ownership of each parcel of affected private land would require that DOE negotiate use arrangements with owners. The division of private property parcels could affect the current and future use of the property. Each corridor contains lands associated with the Nevada Test Site and managed by DOE. The amount of land in each corridor varies from 5 square kilometers (1,200 acres) for the Carlin and Caliente Corridors to 38 square kilometers (9,400 acres) for the Caliente-Chalk Mountain Corridor. With the exception of the Caliente-Chalk Mountain Corridor, the corridors cross Nevada Test Site lands only at entry points to the repository site close to the perimeter of the property and would be unlikely to result in a change of current land use. The Caliente-Chalk Mountain Corridor would enter the northeast portion of the Test Site and pass generally through the center of the site. Although this corridor would not result in a change of ownership, it would alter the current use of the land in the vicinity of the rail corridor.

Each rail corridor, with the exception of the Jean Corridor, would cross a portion of the Nellis Air Force Range (also known as the Nevada Test and Training Range) under the management of the U.S. Air Force. Lands along the corridors managed by the Air Force range from none for the Jean Corridor to 22 square kilometers (5,400 acres) for the Caliente-Chalk Mountain Corridor. The Caliente-Chalk Mountain Corridor would enter Nellis Air Force Range lands along the northern boundary and cross approximately 52 kilometers (32 miles) of land used for Department of Defense training operations.

The U.S. Air Force has identified national security issues in relation to a Caliente-Chalk Mountain Corridor, citing interference with Nellis Air Force Range testing and training activities (DIRS 104887-Henderson 1997, all). In response to Air Force concerns, DOE regards this route as a “nonpreferred alternative.”

As of July 2001, the Nevada Public Utility Commission’s website listed 20 electric power generating facilities scheduled for construction in Nevada by 2004. Five of the 20 plants have received permits to proceed. Two of these are located in Storey County and Pershing County. Three are in Clark County—one in North Las Vegas and two for the same company in an industrial park at Apex. None is anticipated to impact land use for the repository or the transportation routes. The remaining 15 sites are anticipated to begin construction through 2002. The rights-of-way associated with the new plants are likely to cross Bureau of Land Management land. Of the 20 plants proposed, 13 are scheduled for construction in Clark County. These are on private, public, and reservation lands. None of the 20 proposed power plants would be within 50 miles (80 kilometers) of the proposed repository at Yucca Mountain. In addition, none of the proposed plant locations would conflict with any of the proposed transportation route options. The transmission lines and natural gas utility rights-of-way for the proposed locations could cross potential transportation routes. Current documentation is not sufficient to determine the locations for the proposed transmission line and natural gas rights-of-way. Conflicts due to proposed power plant rights-of-way would predominantly be associated with the proposed rail corridors and would be similar to existing rights-of-way discussed later in this section.

Each corridor has areas the public uses and areas available for sale and transfer. Each corridor crosses some roads used to access recreation areas on State of Nevada and Federal lands that are outside the corridors. As a consequence, the proposed branch rail line could result in limited access to areas currently in use by the public. Similarly, because of the corridor interface with grazing lands and wildlife areas, a rail line could create a barrier to livestock movement. Impacts to wildlife are discussed later in this section. Each corridor crosses road, highway, or utility rights-of-way. The passage of a branch rail line through these areas could result in land-use conflicts that, in turn, could result in the transfer of lands in the rights-of-way to DOE or a renegotiation of rights-of-way.

Construction. DOE expects the potential impacts of construction to be greater than those during the operation of a rail corridor. If the repository was approved and a rail corridor was selected, the following impacts from the construction of a branch rail line could occur:

- Difficulty for cattle to access water if the corridor divided Bureau of Land Management grazing allotments. Disruption of ranch operations and livestock rotations. Livestock deaths along roads used during construction. Disruptions to use of access roads to grazing allotments which typically consist of two-track roads and crisscross many of the corridors.

- Effects to private property divided by a branch rail line if alternative access was not available or provided. Although DOE would mitigate construction activities through stringent construction practices, those practices could affect property use, especially if the property was inhabited.

- Effects to mining activities such as mine operations or exploration if access roads were temporarily blocked or altered. Divided mining claims, making development of a claim less profitable if access became a problem.

- Effects on access to recreational areas. Division of some Bureau of Land Management lands currently used for recreation, which could temporarily isolate sections of land from the general public. Less ease of access in areas where Federal and State recreation areas can be accessed by roads (including two-track roads) from Bureau lands. Alteration of the recreational experience for some users; for example, construction of a rail corridor close to Bureau lands set aside for primitive and semiprimitive recreational use would alter those experiences.

- Effects on rights-of-way. Construction through these areas would require an evaluation of the impact to the road or utility or use of the right-of-way. Alteration of the construction of current roads or utility lines. Alteration of above-ground utility lines to pass beneath the branch rail line through an underpass to enable continued access to the utilities for maintenance. Movement of overhead transmission towers and poles to accommodate the branch rail line. Use of bridges or underpasses across high-volume roads to preclude at-grade crossings. Use of fencing where increased public contact could occur.

DOE would consult with the Bureau of Land Management, U.S. Air Force, other affected agencies, and other DOE program operations on the Nevada Test Site to help ensure that the final alignment of a branch rail line avoided or mitigated potential land-use conflicts.

Operations. DOE expects the operation of a rail line to cause smaller impacts than would construction. If the repository was approved and a rail corridor was selected, the following impacts of the operation of a branch rail line could occur:

- Division of some grazing lands. The Bureau of Land Management has stated that dividing grazing lands would result in a small loss of animal-unit months in large allotments, but would probably not affect ranch operations as long as there was available access across the corridor. (An *animal-unit month* represents enough dry forage for one mature cow for one month.) The loss of animal-unit months could affect the permittee's operation. In addition, the Bureau indicated that, if a branch rail line divided an allotment into separate pastures, an opportunity to rotate pasture use and thereby enable new grazing management options could be beneficial to livestock and vegetation. The Bureau acknowledges that fencing could be required along corridors where there are grazing allotments and that livestock could be isolated from water. Under these circumstances, water would have to be hauled to livestock or supplied in some other manner. In relation to branch rail line operations, train and track inspection and maintenance activities would be confined to areas disturbed by construction activities, so no additional disturbances would occur.

- No additional impacts to land use as long as there was property accessibility.

- No effects on mining activities over the long term. Effects on mining exploration if access to leases was blocked or restricted, but current mining operations probably would remain accessible.

- Effects to access to recreational areas. Division of Bureau of Land Management lands currently used for recreation and for access to Federal and State lands, which could limit access to portions of those lands. Alteration of the recreational experience for some users; for example, operation of a rail corridor close to Bureau lands set aside for primitive and semiprimitive recreational use could alter those recreational experiences.

6.3.2.1.2 *Common Rail Air Quality Impacts*

Construction. The construction of a branch rail line would comply with all applicable air quality regulations and associated requirements in the construction permits. Construction activities would increase pollutant concentrations in the areas near the rail corridor or any of the variations described in subsequent sections. Fuel use by construction equipment would emit carbon monoxide, nitrogen dioxide, sulfur dioxide, and particulate matter with diameters of 10 micrometers or less (PM_{10}) and 2.5 micrometers or less ($PM_{2.5}$). Construction activities would also emit PM_{10} in the form of fugitive dust from excavation and truck traffic. The emissions would be temporary and would cover a very large area as construction moved along the length of the corridor.

No air quality impacts would be unique to the branch rail line implementing alternatives with the exception of the Valley Modified Corridor, as described in Section 6.3.2.2.5.

Operations. Fuel use by diesel train engines would emit carbon monoxide, nitrogen dioxide, PM_{10}, and $PM_{2.5}$. Based on the Federal standards for locomotives (40 CFR 92.005), there are no emission standards for sulfur dioxide.

DOE conducted a conformity review using the guidance in DIRS 155566-DOE (2000, all) for the transportation activities of the Nevada rail implementing alternatives. The Las Vegas air basin is in nonattainment status for carbon monoxide, which is largely a result of vehicle emissions (DIRS 156706-Clark County 2000, Appendix A, Table 1-3). The review determined that during the construction phase carbon monoxide emissions from the transportation of employees, materials, and supplies and from engine exhaust of construction vehicles working on the Valley Modified route could exceed the Clean Air Act General Conformity threshold level (about 110 to 160 percent of the threshold). These emission estimates represent about 0.1 to 0.2 percent of the 2000 daily carbon monoxide levels in the Las Vegas air basin. More detailed planning probably would result in emissions below the threshold. Emissions during the construction of all other routes and during repository operations would not exceed the carbon monoxide General Conformity threshold level in the nonattainment area.

The Las Vegas air basin is also in nonattainment status for PM_{10}, which is largely a result of dust from construction activities (DIRS 155557-Clark County 2001, Tables 3-8 and 5-3). The conformity review determined that PM_{10} emissions from the fugitive dust generated by Valley Modified route construction could exceed the General Conformity threshold level for PM_{10} (see Section 6.3.2.2.5.2). Additional dust control measures and construction planning in the nonattainment area could reduce the emissions to levels below the threshold. Emissions during the construction of all other routes and during the operation of any of those routes would not exceed the PM_{10} General Conformity threshold levels in the nonattainment area.

No air quality impacts would be unique to the branch rail line implementing alternatives with the exception of the Valley Modified Corridor, as described in Section 6.3.2.2.5.

6.3.2.1.3 *Common Rail Hydrology Impacts*

This section describes impacts to surface water and groundwater.

Surface Water

Construction. Construction-related impacts could involve the possible release and spread of contaminants by precipitation or intermittent runoff events or, for corridors near surface water, possible release to the surface water, the alteration of natural drainage patterns or runoff rates that could affect downgradient resources, and the need for dredging or filling of perennial or ephemeral streams.

Construction-related materials that could cause contamination would consist of petroleum products (fuels and lubricants) and coolants (antifreeze) necessary to support equipment operations. In addition, remote work camps would include some bulk storage of these materials, and supply trucks would routinely bring new materials and remove used materials (lubricants and coolants) from the construction sites. These activities would present some potential for spills and releases. Compliance with regulatory requirements on reporting and remediating spills and properly disposing of or recycling used materials would result in a low probability of spills. If a spill occurred, the potential for contamination to enter flowing surface water would present the greatest risk of a large migration of a contaminant before remediation took place. If there was no routinely flowing surface water (most areas along the corridors), released material would not travel far or affect critical resources before remediation occurred. During construction activities, water spraying would control dust and achieve soil compaction criteria, but water would not be used in quantities large enough to support surface-water flow and possible contaminant transport for any distance.

During construction, a contractor would move large amounts of soil and rock to develop the track platform (subgrade) and the access road. These construction activities could block storm drainage channels temporarily. However, the contractor would use standard engineering design and best management practices to place culverts, as appropriate, to move runoff water from one side of the track or road to the other. These culverts or other means of runoff control would be put in place early in the construction effort, because standing water in the work area would generally hinder progress.

Depending on site-specific conditions, construction could include regrading such that a number of minor drainage channels would collect in a single culvert, resulting in water flowing from a single location on the downstream side rather than across a broader area. This would cause some localized changes in drainage patterns but probably would occur only in areas where natural drainage channels are small.

All of the rail corridors would cross 100-year flood zones as identified on Flood Insurance Rate Maps published by the Federal Emergency Management Agency. None of the corridors has complete coverage (the percentage of the rail corridor included on the flood zone maps) on these maps due to large unstudied areas such as the Nellis Air Force Range and the Nevada Test Site, and areas with very limited coverage such as Lincoln County. For example, coverage by these flood maps ranges from about 10 percent for the Caliente-Chalk Mountain Corridor to about 90 percent for the Jean Corridor. However, the available information does provide an idea of corridor-specific flood zones, as summarized in the individual corridor discussions in Sections 6.3.2.2.1 to 6.3.2.2.5. In general, construction-related impacts associated with these flood zones would be very similar to those that could occur in any other identified drainage areas (that is, the alteration of natural drainage patterns and possible changes in erosion and sedimentation rates or locations). Construction in washes or other flood-prone areas probably would reduce the area through which floodwaters naturally flow. This could result in water building up, or ponding, on the upstream side of crossings during flood events, and then slowly draining through the culverts or bridges. Sedimentation would be likely on the upstream side of structures in such events and, accordingly, water going through the structure could be more prone to cause erosion once on the downstream side. Maintenance of a branch rail line would require periodic inspections of flood-prone areas (particularly after flood events) to verify the condition of the track and drainage structures. When necessary, sediment accumulating in these areas would be removed and disposed of appropriately. Similarly, eroded areas encroaching on the track bed would be repaired.

These alterations to natural drainage, sedimentation, and erosion would be unlikely to increase future flood damage, increase the impact of floods on human health and safety, or cause significant harm to the natural and beneficial values of the floodplains. Flood zone impacts would be minor primarily because of the relatively limited size of the disturbance that would be necessary to construct a branch rail line, and because the rail line design would accommodate a 100-year flood. In addition, the candidate rail corridors are in a region where flash flooding events are the primary concern. Though such flooding can be very violent and hazardous, it is generally focused in its extent and duration, limiting the potential for extensive impacts associated with the rail line. If DOE selected a rail corridor, it would initiate additional engineering and environmental studies and would perform additional National Environmental Policy Act reviews as a basis for final alignment selection and construction. DOE would then prepare a more detailed floodplain/wetlands assessment of the selected alternative.

Operations. The use of a completed branch rail line would have little impact on surface waters beyond the permanent drainage alterations from construction. The road and rail beds probably would have runoff rates different from those of the natural terrain but, given the relatively small size of the potentially affected areas in a single drainage system, there would be little impact on overall runoff quantities.

There would be no surface-water impacts unique to any of the branch rail line implementing alternatives with the exception of their relative proximity to surface-water resources.

Appendix L contains a floodplain/wetlands assessment that examines the effects of branch rail line construction, operation, and maintenance on the following floodplains in the vicinity of Yucca Mountain: Fortymile Wash, Busted Butte Wash, Drill Hole Wash, and Midway Valley Wash (see Section L.4.1). There are no delineated wetlands at Yucca Mountain. This section on common impacts and the following section on corridor-specific impacts address, in general terms, the flood zones along the rail corridors outside the immediate vicinity of Yucca Mountain. Appendix L, Section L.3.2, contains additional information on these portions of the corridors.

Groundwater

Construction. Potential groundwater impacts from rail line construction could include changes to infiltration rates, new sources of contamination that could migrate to groundwater, and depletion of groundwater resources resulting from increased demand. However, the potential for impacts would be spread over a large geographic area, so the probability would be low for a resource in a single area to receive adverse impacts. The above discussion of impacts to surface water identifies potential contaminants that branch rail line construction could release. These contaminants would be the same for groundwater.

Construction activities would disturb and loosen the ground, which could produce greater infiltration rates. However, this situation would be short-lived as the access road and railbed materials became compacted and less porous. In either case, localized changes in infiltration probably would cause no noticeable change in the amount of recharge in the area.

The analysis assumed that a number of wells would be required to support construction and that they would be installed along the rail corridor. It also assumed a 1-year period for construction activities in the vicinity of each well. Water withdrawal from these wells would not contribute to the depletion of a particular groundwater basin for two reasons: (1) the demand would be relatively short-term because it would stop when construction was complete, and (2) annual demands would be limited to a fraction of the perennial yields of the aquifers that would supply the water (see Chapter 3, Section 3.1.4). In addition, the Nevada State Engineer would approve water production from any well installed to support rail corridor construction. To grant approval, the State Engineer would have to determine that the short-term demand would not cause adverse impacts for other uses and users of the groundwater resource.

For the case in which water was obtained from a source other than a newly installed well and brought to the construction site by truck, water would be obtained from appropriated sources. That is, the water would be from allocations that the Nevada State Engineer had previously determined did not adversely affect groundwater resources.

Impacts on groundwater would differ among the implementing alternatives. These impacts, which Section 6.3.2.2 describes for the implementing alternatives, would include the projected water needs to support the construction of each candidate rail corridor and the estimated number of wells DOE would install along each corridor to meet that need.

Operations. The use of a completed railway corridor would have little impact on groundwater resources. There would be no continued need for water along the corridor, and possible changes to recharge, if any, would be the same as those at the completion of construction.

6.3.2.1.4 *Common Rail Biological Resources and Soils Impacts*

Construction. Construction activities would generally disturb no more than about 15 percent of the land inside a 400-meter (0.25-mile)-wide corridor. Vegetation would be cleared in an area generally less than 60 meters (200 feet) wide in the corridor to enable the construction of a branch rail line and a parallel access road. Vegetation would also be cleared from borrow areas and covered in disposal areas for excavated materials. Land for construction camps and in small areas where wells would be drilled would also be cleared of vegetation. Clearing vegetation and disturbing the soil would create habitat for colonization by exotic plant species present along a corridor. This could result in an increase in abundance of exotic species along the corridor, which could result in suppression of native species and increased fuel loads for fire. Reclamation of disturbed areas would enhance the recovery of native vegetation and reduce colonization by exotic species.

Impacts to biological resources from the construction of a branch rail line would occur due to a loss of habitat for some terrestrial species. Individuals of some species would be displaced or killed by construction activities. After the selection of a rail corridor, DOE would perform preconstruction surveys of potentially disturbed areas to identify and locate special status species that would need to be protected during construction.

Construction could affect the following biological resources:

- *Game and Game Habitat and Wild Horses and Burros.* Each candidate rail corridor or its variations would cross or be near [within 5 kilometers (3 miles)] several areas the Bureau of Land Management and the Nevada Division of Wildlife have designated as game habitat or wild horse and burro management areas (DIRS 104593-CRWMS M&O 1999, pp. 3-23 to 3-32). Construction activities in these areas would result in a loss of some habitat. Each rail corridor has the potential to disrupt movement patterns of game animals and wild horses and burros. The design of fences, if built along a rail corridor, would accommodate the movement of these animals. Large animals including game species (elk, bighorn sheep, mule deer, etc.), wild horses, and burros probably would avoid contact with humans at construction locations and would temporarily move to other areas during construction. Larger game animals occupy large home ranges and could easily traverse the distance between their designated habitat and a proposed corridor. Construction activities probably would disturb individuals or groups of animals and they would avoid the areas where construction was occurring. Fencing of the rail line could disrupt movements of horses, burros, and game animals, but the branch rail line would be designed to accommodate animal movement, to the extent possible, with such features as underpasses to enable large animals to cross from one side to the other. In the absence of fencing, movements of large animals would not be disrupted by the long-term presence of a rail line, but the possibility of trains colliding with game animals would be greater.

- *Special Status Species.* The construction of a branch rail line in any of the five rail corridors or their variations would involve the loss of varying amounts [3 to 11 square kilometers (740 to 2,700 acres)] of desert tortoise habitat. None of the corridors cross areas designated by the Fish and Wildlife Service as critical desert tortoise habitat (50 CFR 17.95). The abundance of tortoises varies from very low to medium along the proposed corridors (DIRS 101840-Karl 1980, pp. 75 to 87; DIRS 103281-Karl 1981, pp. 76 to 92; DIRS 101914-Rautenstrauch and O'Farrell 1998, pp. 407 to 411), but some desert tortoise deaths could occur during land-clearing operations. Numerous special status species occur along each of the proposed branch rail lines. Construction of a branch rail line could lead to habitat loss and fragmentation for the special status species, as well as to mortality of individuals.

- *Wetlands and Riparian Areas.* Each corridor could affect wetlands, springs, and riparian areas (DIRS 104593-CRWMS M&O 1999, pp. 3-23 to 3-32). These areas are generally important for biological resources and typically have high biodiversity. Potential impacts to these areas include destruction, alteration, or fragmentation of habitat; increased siltation in streams during construction; changes in stream flow; and loss of biodiversity.

- *Prime Farmland.* DOE identified no prime farmland for any corridor or route.

Section 6.3.2.2 describes the impacts to biological resources that would be unique for each corridor.

All of the candidate rail corridors and their variations would cross perennial or ephemeral streams that could be classified as jurisdictional waters of the United States. Section 404 of the Clean Water Act regulates discharges of dredged or fill material into such waters. After the selection of a rail corridor, DOE would identify any jurisdictional waters of the United States that the construction of a rail line would affect; develop a plan to avoid when possible, and otherwise minimize, impacts to those waters;

and, as applicable, obtain an individual or regional permit from the U.S. Army Corps of Engineers for the discharge of dredged or fill material. By implementing the plan and complying with other permit requirements, DOE would ensure that impacts to waters of the United States would be small.

The general design criteria for a branch rail line would include a requirement that a 100-year flood would not inundate the rails at channels fed by sizable drainage areas. During the operation and monitoring phase of the repository, conditions more intense than those that would generate a 100-year storm could occur in the area. Such conditions, depending on their intensity, could wash out access roads and possibly even the rail line. Although DOE would have to repair these structures, there is no reason to believe that such an occurrence would unduly affect area resources. If necessary, a permit would be obtained from the U.S. Army Corps of Engineers for discharge of dredge and fill material to repair the rail line. There would be no contamination that floodwaters could spread and, with the exception of areas of steep terrain, debris would not travel far. The operation of a branch rail line would stop during conditions that could lead to the flooding of track areas and would not resume until DOE had made necessary repairs.

Soil impacts from branch rail line construction would be primarily the direct impacts of land disturbance in the selected corridor. The amount of land disturbance, both inside and outside the corridor, would vary by corridor. The disturbed areas probably would be subject to an increase in erosion potential during construction. DOE would use dust suppression measures to reduce this potential. As construction proceeded, the railbed would be covered with ballast rock, which would virtually halt erosion from that area, and the access roads would be compacted, and gravelled, which would reduce erosion. As construction ended, disturbed areas (other than the railbed and access roads) would slowly recover. Other permanent erosion control systems would be installed as appropriate. Introduction of contaminants into the soil is also a potential concern. Proper control of hazardous materials during construction and prompt response to spills or releases would, however, reduce this concern. Impacts to soils would be limited to these areas disturbed and would be transitory and small.

Operations. Impacts to biological resources from shipments of spent nuclear fuel and high-level radioactive waste to the proposed repository along any of the five rail corridors, including their variations, would include periodic disturbances of wildlife from trains going by and from personnel servicing the corridor. Trains probably would kill individuals of some species.

Rail operations would not lead to additional habitat losses, although maintenance activities would prevent habitat recovery in the narrow band occupied by the branch rail line and access road. In addition, there could be loss of habitat due to inadvertent fires along the right-of-way from rolling equipment operations and maintenance activities. Although trains probably would kill individuals of some species, losses would be unlikely to affect regional populations of any species because all species are widespread geographically and trains would only use the corridor once or twice per day. Fewer individuals of large species would be likely to be killed during operations if the corridor was fenced, but fencing could restrict animal movement and disrupt migration patterns. Furthermore, fences would require continual surveillance to prevent individual animals or herds from becoming trapped. Nevertheless, the demographics of small herds could be adversely affected if individuals important to the viability of the herd were struck by a train. Fencing of the branch rail line and other features, such as tunnels (Jean Corridor), could lead to losses of individual animals or groups of animals. Individual animals could become caught inside fenced sections of the railroad and fail to find escape from oncoming trains. Game animals, horses, or burros could seek shelter in a tunnel and fail to escape if a train passed through.

Passing trains could disrupt wildlife, including game animals, horses, and burros, but such effects would be transitory. Noise from a train probably would disturb animals close to the track throughout operations, but this disturbance would diminish with distance from the track and over time as animals acclimated to daily disturbances from passing trains. The frequency of trains using the corridor (estimated to be 10 per

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week, 5 in each direction) indicates that disturbance of animals near the rail line would probably be minimal. Noise from the trains could cause animals to move away from the tracks and, possibly, cause changes in migratory patterns.

Trains, and the presence of the branch rail line, could lead to the death of individual desert tortoises. DOE would consult with the Fish and Wildlife Service under Section 7 of the Endangered Species Act on means of mitigating the potential for losses, and would implement all terms and conditions required by the Fish and Wildlife Service.

No additional habitat loss would occur during operations, although the loss of habitat could become permanent if a long-term use for the rail line became viable after completion of the repository project and operations continued.

Impacts to soils from operation of the branch rail line would be small because train movement would not disturb soils and maintenance of the railbed and rails would involve minimal disturbance beyond that which had occurred during the construction of the rail line.

6.3.2.1.5 *Common Rail Cultural Resources Impacts*

Construction. Chapter 3, Section 3.2.2.1.5 lists the archaeological information currently available in each corridor that branch rail line construction could affect, including tables that list linear historic properties (for example, the Pony Express Trail) and sites listed on State of Nevada and national historic registers, respectively. DIRS 155826-Nickens and Hartwell (2001, all) contains more information about known and potential cultural resources along the candidate corridors and their variations. Direct impacts to these cultural resources (such as disturbing the sites or crushing artifacts) could occur from a variety of construction-related activities, including building the rail line and the right-of-way. In addition, rail line construction activities would include borrow areas, areas for the disposal of excavated material, construction camps, and access roads that would be outside the defined right-of-way. Because archaeological sites sometimes include buried components, ground-disturbing actions could uncover previously unidentified cultural materials. If cultural resources were encountered, a qualified archaeologist would participate in directing activities to ensure that the resources would be properly protected or the impact mitigated. DOE would use procedures to avoid or reduce direct impacts to cultural resources in construction areas where surface-disturbing activities would occur (see Chapter 9).

Indirect impacts, such as non-project-related disturbances of archaeological sites by purposeful or accidental actions of project employees, could occur from construction activities as a result of increased access and increased numbers of workers near cultural resource sites. These factors would increase the probability for either intentional or inadvertent indirect impacts to cultural resources. Section 6.3.2.2 discusses potential impacts specific to each corridor.

Systematic studies would be completed for a selected corridor to identify sites, resources, or areas that might hold traditional value for Native American peoples or communities. Two of the corridors (Caliente and Carlin) could affect as-yet unidentified resources because they could pass through the Timbisha Shoshone Trust Lands parcel near Scottys Junction. If sites or resources important to Native Americans were discovered in the future, either in or near an identified right-of-way, adverse effects could occur through direct means, such as construction activities, or indirectly through visual or auditory (sound and vibration) impacts.

In the viewpoint of Native Americans, the construction and operation of a branch rail line would constitute an intrusion on the holy lands of the Southern Paiute and Western Shoshone. In addition, some corridors pass through or near several significant places (see Chapter 3, Section 3.2.2.1.5). The American Indian Writers Subgroup has commented that the overall significance of these places and potential impacts from operation of a rail line on them cannot be fully understood until DOE has identified the rail alignment and completed ethnographic field studies and consultations (DIRS 102043-AIWS 1998, p. 4-6). If DOE selected a rail corridor, it would initiate additional engineering and environmental studies (including cultural resource surveys), conduct consultations with Federal agencies, the State of Nevada, and tribal governments, and perform additional National Environmental Policy Act reviews as a basis for final alignment selection and construction. DOE would address the mitigation of potential impacts to archaeological and historic sites during the identification, evaluation, and treatment planning phases of the cultural resource surveys.

Operations. No additional direct or indirect impacts would be likely at archaeological and historic sites from the operation of a branch rail line. However, if Native Americans identified specific concerns during the preconstruction consultations described above, DOE would address them at that time.

6.3.2.1.6 *Common Rail Occupational and Public Health and Safety Impacts*

Incident-Free Transportation. Incident-free impacts of rail transportation in Nevada would be unique for each of the five Nevada rail transportation implementing alternatives; these are discussed for each implementing alternative in Section 6.3.2.2. Incident-free impacts to hypothetical maximally exposed individuals would be similar among the Nevada rail transportation implementing alternatives. Table 6-21 lists the impacts to hypothetical maximally exposed individuals in Nevada who would be exposed to all rail shipments along a branch rail line. Appendix J, Section J.1.3.2.2 describes assumptions for estimating doses to maximally exposed individuals along routes in Nevada.

Table 6-21. Estimated doses and radiological impacts to maximally exposed individuals for Nevada rail implementing alternatives.[a,b]

Individual	Dose (rem)	Probability of latent cancer fatality
Involved workers		
Inspector	34	0.012
Railyard crew member	4.2	0.002
Public		
Nevada resident along route (rail)[c]	0.002	0.0000008
Person in traffic jam (legal-weight truck)[d]	0.02	0.000008
Person at service station (legal-weight truck)[e]	0.08	0.00004
Resident near rail stop	0.29	0.0001

a. The assumed external dose rate is 10 millirem per hour at 2 meters (6.6 feet) from the vehicle for all shipments.
b. Totals for 24 years of operation.
c. This represents a Nevada resident approximately 30 meters (98 feet) from the branch rail line. See Appendix J, Section J.1.3.2.2.
d. Person in a traffic jam is assumed to be exposed one time only.
e. Assumes the person works at the service station for all 24 years of operations. Mitigation would be required to reduce doses to members of the public to below 100 millirem per year.

Accidents. Accident risks and maximum reasonably foreseeable accidents for rail shipments of spent nuclear fuel and high-level radioactive waste would be common to the Nevada rail transportation implementing alternatives. This section, therefore, discusses these risks.

Table 6-22 lists accident risks for transporting spent nuclear fuel and high-level radioactive waste in Nevada for the five Nevada rail transportation implementing alternatives. The data show that the risks, which are listed for 24 years of operations, would be low for each alternative. These risks include risks associated with transporting 1,079 legal-weight truck shipments made from the commercial sites that could not load rail casks while operational. Small variations in the risk values, principally evident for the Jean branch rail line, are a result of risks that would be associated with transporting rail casks arriving from the east on the Union Pacific Railroad's mainline through the Las Vegas metropolitan area. The values that would apply for a Valley Modified or Caliente-Chalk Mountain branch line would be lower

Table 6-22. Estimated health impacts[a] to the public from potential accident scenarios for Nevada rail implementing alternatives.

Risk	Caliente	Carlin	Caliente-Chalk Mountain	Jean	Valley Modified
Radiological accident risk[b]					
Dose risk (person-rem)	0.0017	0.0026	0.0017	0.0071	0.0021
LCFs[c]	0.0000009	0.0000013	0.0000009	0.000004	0.000001
Traffic fatalities	0.07	0.09	0.05	0.06	0.05

a. Data are reported for 24 years of operations.
b. In this table, radiological accident dose risk is the sum of the products of the probabilities (dimensionless) and consequences (in person-rem) of all potential transportation accidents. This sum is converted to latent cancer fatalities using the conversion factor of 0.0005 latent cancer fatality per person-rem.
c. LCF = latent cancer fatality.

because of a shorter corridor (Valley Modified), or a more remote and mid-length corridor (Caliente-Chalk Mountain).

Consequences of Maximum Reasonably Foreseeable Accidents. The national transportation analysis evaluated impacts of maximum reasonably foreseeable accidents (see Section 6.2.4.2).

6.3.2.1.7 *Common Rail Socioeconomics Impacts*

The common social and economic activities and changes associated with the construction of a branch rail line include:

- A period of brief, intense elevation in project-related employment followed by an abrupt decrease in associated employment opportunities as construction workers move to other projects.
- Transition of workers associated with construction of the branch rail line to other construction work in Nevada (if these workers did not move into positions associated with rail line operations).
- Population increases and then subsequent net declines as related employment requirements decline.
- A very slightly slower rate of growth in the level of employment as the economy moved from construction of a rail line to operations.
- A rise in the economic measures of real disposable income, Gross Regional Product, and State and local government expenditures during construction. Gross Regional Product, which is extremely sensitive to employment fluctuations, would be affected. Real disposable income, which consists of all forms of income including transfer payments (primarily unemployment compensation), is less responsive to changes in employment.

DOE performed detailed analyses for the corridors of the five branch rail line implementing alternatives. The results of these analyses, driven by the length of the corridor, are representative of the potential variations (options and alternates) of each corridor as listed in Appendix J, Section J.3.1.2. The lengths of the variations for each corridor are similar to the original corridor, as listed in Section 6.3.2.2.

Section 6.3.2.2 describes socioeconomic impacts for each particular implementing alternative.

6.3.2.1.8 *Common Rail Noise and Vibration Impacts*

Construction. For the most part, the rail corridors would pass through areas that are remote from human habitation. Thus, the potential for noise impacts from the construction of a branch rail line would be limited. Nonetheless, some people could be affected, including persons living near the corridor, using nearby recreational areas, seeking quiet and solitude at nearby locations, or living in nearby small rural communities. Noise from railroad construction could affect wild animals that inhabit the areas through which the corridors pass. However, construction noise would be transient and its sources would be gone when construction was complete.

Estimated noise levels for railroad construction would range from 62 to 74 A-weighted decibels (dBA) within 150 meters (500 feet) of the noise source and from 54 to 67 dBA at 600 meters (2,000 feet) (DIRS 104892-ICC 1992, p. 4-97). At distances up to 6 kilometers (3.7 miles), sound could exceed levels required for solitude (20 dBA). Trips to borrow and spoil areas would be another source of noise. Rail line construction would occur primarily during daylight hours, so nighttime noise would not be an issue unless there was a need to use accelerated construction to meet schedule constraints. There is a possibility that the construction of some structures associated with the rail line would occur during hours not in the normal workday, but the frequency and associated noise levels would be unlikely to be great. Because construction would progress along a corridor, construction noise would be transient in nearby communities. Noise levels could approach generally accepted limits for some residential and commercial areas, but this would be for a brief time. Because there are no permanent residences, construction noise would not be an issue for activities inside the boundaries of the Nellis Air Force Range, the Nevada Test Site, or the land withdrawal area that DOE analyzed for the proposed repository. Occupational Health and Safety Administration regulations (29 CFR) establish hearing protection standards for workers. DOE would meet those standards for workers involved in building a branch rail line.

Ground vibration from the construction of engineered structures, such as bridge foundations, could be discernible in some areas. The areas that would be affected would be determined by engineering surveys and detailed alignment analyses conducted after the selection of a corridor.

Operations. About five rail round trips (10 one-way trips) of spent nuclear fuel, high-level radioactive waste, or other material would occur weekly for 24 years on the branch rail line during normal operations. Noise from these trains could affect the same group of individuals and animals as construction of the rail line. To estimate noise impacts, the analysis assumed that trains would travel as fast as 80 kilometers (50 miles) an hour. The equivalent-continuous (average) sound level at 2,000 meters (6,600 feet) from a train consisting of two locomotives and 10 cars traveling at 80 kilometers an hour would be 51 dBA (DIRS 148155-Hanson, Saurenman, and Towers 1998, pp. 1 to 8), which is near the nighttime standard for residential areas (50 dBA). The estimated noise level at 200 meters (660 feet) would be 62 dBA (DIRS 148155-Hanson, Saurenman, and Towers 1998, pp. 1 to 8). This is slightly higher than the daytime standard for residential communities. In isolated regions, few people would be affected. In addition, trains traveling through or near communities would normally operate at reduced speed, so their noise levels would be lower. The combination of sparse population in the vicinity of the rail corridors, remoteness of a branch rail line from populated areas, substantial diminishing of the level of train noise with distance, and infrequent passage of trains indicates that the potential for noise impacts would be low for any of the corridors. In addition, in areas where a branch rail line or a variation could pass near a community, DOE would limit operating speeds to the extent necessary to ensure safety and noise levels below those listed in accepted noise standards.

DOE is not aware of traditional cultural properties or other areas along the rail corridors or variations where noise from trains or construction of a branch rail line could interfere with conditions necessary for meditation by, or religious ceremonies of, Native Americans. Similarly, there are no known ruins or other culturally sensitive structures that ground vibration could affect.

Ground vibration from trains using a branch rail line to Yucca Mountain would have the potential to cause impacts (see Section 6.3). Sections 6.3.2.2.1 to 6.3.2.2.5 discuss specific issues related to vibration for each corridor.

DIRS 155939-Nelson (2000, Appendix F, Table 1, p. 4) discussed vibration criteria for protection of historic buildings and presented data on vibration (peak particle velocity) for unit coal trains. Unit coal trains can consist of many loaded coal cars (usually more than 100) and multiple locomotives. The data (DIRS 155939-Nelson 2000, Appendix F) show that at distances of 100 meters (330 feet) from the track and for track not specially selected to reduce vibration, vibration from trains traveling at 56 kilometers (35 miles) per hour would be below the criterion for preservation of historic structures. Vibration from trains traveling on track that does not have rolling-mill undulation falls below the criterion at distances as close as 10 meters (33 feet) and speeds as high as 80 kilometers (50 miles) per hour. For shorter trains, such as those that would transport railcars with spent nuclear fuel and high-level radioactive waste to Yucca Mountain, attenuation of vibration with distance would be greater than that reported (DIRS 155939-Nelson 2000, p. 23).

6.3.2.1.9 *Common Rail Aesthetics Impacts*

Construction. The greatest impact on visual resources from the construction of a branch rail line would be the presence of workers, camps, vehicles, large earth-moving equipment, laydown yards, borrow areas, and dust generation. These activities, however, would have a limited duration (about 40 to 46 months depending on the corridor). The potential rail corridors and variations have all been affected to some extent by human activity, as described in Chapter 3, Section 3.2.2.1.1. Construction would progress along the selected corridor from its starting point to the proposed repository. Only a small portion of the overall construction time would be spent in one place; the exception to this would be places where major structures, such as bridges, would be built. In general, an individual construction camp would be active only for part of the construction period; after the completion of construction in an area, the camp would close.

Dust generation would be controlled by implementing best management practices such as misting or spraying disturbed areas. Construction activities would not exceed the criteria in the Bureau of Land Management Visual Resource Management guidelines (DIRS 101505-BLM 1986, all) with the exception of the Wilson Pass Option of the Jean Corridor. If the rail line crossed Class II lands, more stringent management and reclamation requirements would be necessary to retain as much as possible of the existing character of the landscape. The short duration of branch rail line construction activities, combined with the use of best management practices, would help mitigate the impacts of activities that could exceed the management requirements for Class II lands. Visual impacts to scenic quality Class C lands on the Nevada Test Site would not occur because of the remoteness and inaccessibility of the location. Impacts to the viewshed during construction of a branch rail line would include loss of vegetation in the areas surrounding the rail line. This loss could result in a long-term loss of viewshed along the corridor.

Operations. During proposed repository operations, visual impacts would be due to the existence of the branch rail line, access road, and borrow pits in the landscape and the passage of trains to and from the repository. The passage of 10 trains a week (5 coming and 5 returning) would have a small impact, temporarily attracting the attention of the casual observer. In limited access recreational areas classified as primitive or semiprimitive, the passage of these trains would have a greater impact. In addition, the noise generated by the trains would attract attention to them, temporarily increasing their impact on the scenic quality of the landscape. There would be no aesthetic impacts unique to any of the rail implementing alternatives.

6.3.2.1.10 *Common Rail Utilities, Energy, and Materials Impacts*

Construction. Because all five corridors would pass through sparsely populated areas with little access to support services, portable generators would provide electricity to support construction activities. The total fossil-fuel consumption in Nevada was about 3.8 billion liters (1 billion gallons) in 1996 (DIRS 148094-BTS 1997, Table MF-21). Fuel consumption estimates for construction of a branch rail line indicate low impacts compared to the statewide consumption of petroleum fuel.

Steel for rails and concrete, principally for rail ties, bridges, and drainage structures, and rock for ballast would be the primary materials consumed in the construction of a branch rail line. DOE would buy precast concrete railbed ties, culverts, bridge beams, and overpass components from a number of suppliers. Actual onsite pouring of concrete [less than 120,000 metric tons (132,000 tons)] would account for less than 30 percent of the total mass of concrete, which would be less than 0.5 percent of the concrete use in Nevada in 1998 (DIRS 104926-Bauhaus 1998, all). Because DOE would buy precast concrete components from suppliers and because onsite concrete construction would involve a small amount of material for some abutments, the localized impact of concrete use in rail corridor construction would not be great for any of the corridors.

Because sources for rails and railroad ties are well established in the southwest and nationally, none of the quantities of materials required for constructing a rail line in Nevada would create demand or supply impacts in southern Nevada (DIRS 105033-Zocher 1998, all).

Impacts on utilities, energy, and materials differ among the implementing alternatives, as described in Section 6.3.2.2.

Operations. Impacts to utilities, energy, and materials from the operation of a branch rail line in Nevada would be small. Use of fossil fuel for train operations would be small. Chapter 10 discusses fossil fuel used for rail operations. No impacts would be unique to any of the branch rail line implementing alternatives.

6.3.2.1.11 *Common Rail Waste Management Impacts*

Construction. The construction of a branch rail line would require materials such as rail ties and steel; rock ballast; concrete; oils, lubricants, and coolants for heavy machinery; and compressed gasses (hazardous materials) for welding. DOE could order construction materials in correct sizes and number, resulting in very small amounts of waste (DIRS 152540-Hoganson 2000, all). In addition, much of the residual material from rail line construction would be saved for reuse or recycled. Construction of the branch rail line, service road, and access roads would require land clearing. Excavated soil would be used for fill as much as possible. Vegetation would be disposed of in accordance with State of Nevada requirements. Construction in any of the five corridors would result in small amounts of waste that would require disposal. Wastes would consist of construction debris such as banding material that bound ties and rails (DIRS 152540-Hoganson 2000, all) that DOE would dispose of in permitted landfills. Hazardous waste such as lubricants and solvents, if any, would be shipped to a permitted hazardous waste treatment and disposal facility.

Sanitary solid waste and sanitary sewage from flush toilets and showers would be generated in construction camps. The estimated peak annual generation would be 940 metric tons (1,000 tons) of sanitary solid waste and 37 million liters (10 million gallons) of sanitary sewage. The solid waste would be disposed of in a permitted landfill. Nevada has 24 operating municipal solid waste landfills (DIRS 155564-NDEP 2001, p. 1) with a combined capacity to accept 11,000 metric tons (12,000 tons) of waste per day (DIRS 155563-NDEP 2001, landfill inventory). In 2000, approximately 3.5 million metric tons (3.9 million tons) of sanitary solid waste were disposed of in Nevada (DIRS 155565-NDEP 2001, Section 2.1), so the construction camp waste would add approximately 0.03 percent. The sanitary sewage could be treated in an onsite treatment facility for which the contractor had obtained the necessary permits. In addition, a commercial vendor would provide portable restroom facilities where needed and manage the sanitary sewage.

All waste would be handled in accordance with applicable environmental, occupational safety, and public health and safety requirements to minimize the possibility of adverse impacts from construction to plants, animals, soils, water resources, and air quality inside or outside the region of influence.

Operations. The use of a branch rail line in any of the five corridors would result in wastes from the maintenance of rolling and stationary railroad equipment and track. These wastes would include lubricants from equipment and machinery; solvents, paint, and other hazardous material; sanitary waste; and industrial wastes typical for operations of a small branch rail line. Operational wastes would include those generated during equipment maintenance. Maintenance of each locomotive would generate about 420 liters (110 gallons) of waste oil (DIRS 155559-Best 2001, all) that would be reclaimed rather than disposed. Worn or damaged parts and components would be repaired or remanufactured and returned to use. Routine maintenance of newer model rail cars would consist primarily of inspection and replacement of worn or damaged components. However, these cars are designed to last many years. In addition, sealed components would minimize the need for lubrication (DIRS 155558-Hoganson 2001, all). Routine maintenance and repair of rolling equipment would be performed at maintenance and repair yards operated by an independent contractor. Wastes from the maintenance of fixed rail line equipment such as signals and rail crossings would be minimal (DIRS 155560-Hoganson 2001, all). Crossties, ballast, rails, and bridges would be unlikely to require replacement before 2033 (DIRS 152540-Hoganson 2000, all). The management and disposition of operational wastes would comply with applicable environmental, occupational safety, and public health and safety regulations. Wastes would be handled such that adverse impacts from rail corridor operation waste to plants, animals, soils, air quality, and water resources along the right-of-way would be minimized.

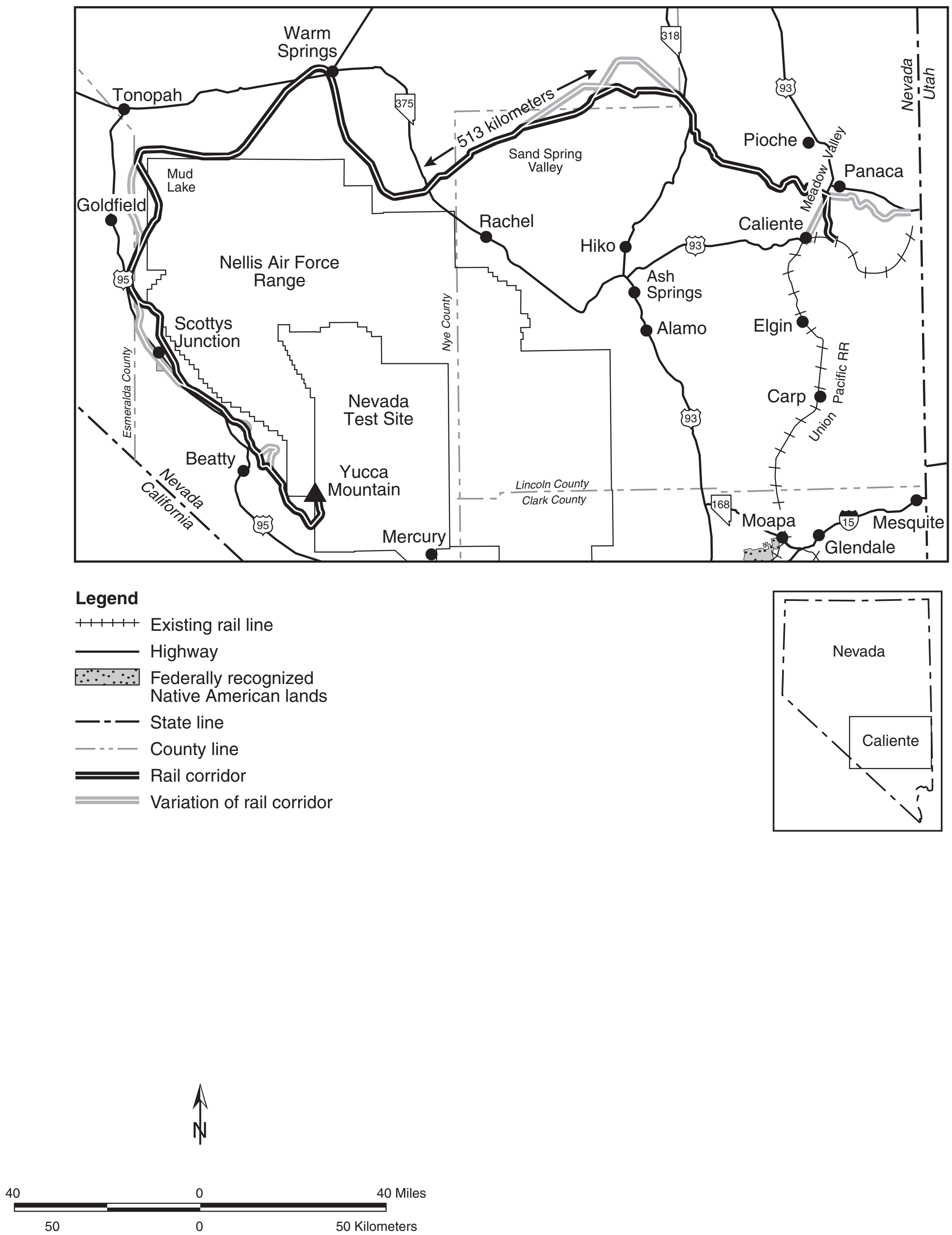
There would be no waste management impacts unique to any of the branch rail line implementing alternatives.

6.3.2.2 Impacts Specific to Individual Rail Corridor Implementing Alternatives

6.3.2.2.1 *Caliente Corridor Implementing Alternative*

The Caliente Corridor would originate at an existing siding to the Union Pacific mainline railroad at Eccles siding near Caliente, Nevada (Figure 6-15). The corridor travels west, traversing the Chief, North Pahroc, Golden Gate, and Kawich Mountain Ranges. The Caliente and Carlin corridors converge near the northwest boundary of the Nellis Air Force Range. Past this point, the corridors are identical. The Caliente Corridor is 513 kilometers (319 miles) long from the Union Pacific line connection to the Yucca Mountain site. Variations of the route range from 512 to 553 kilometers (318 to 344 miles). Figure 6-15 shows this corridor, along with possible variations identified by engineering studies (DIRS 131242-CRWMS M&O 1997, all). The corridor variations provide flexibility in addressing engineering, land-use, or environmental resource issues that could arise in a future, more detailed survey along the corridor. This section addresses impacts that would occur along the corridor shown in Figure 6-15. With the exception of the differences identified in Appendix J, Section J.3.1.2, the impacts would be generally the same among the possible variations.

Construction of a branch rail line in the Caliente corridor would require approximately 46 months. Construction would take place simultaneously at multiple locations along the corridor. An estimated six construction camps at roughly equal distances along the corridor would provide temporary living accommodations for construction workers and construction support facilities. A train would take about



To convert kilometers to miles, multiply by 0.62137.

Source: Modified from DIRS 104560-YMP (1998, all).

Figure 6-15. Caliente Corridor.

10 hours to travel from the junction with the Union Pacific mainline to a Yucca Mountain Repository on a Caliente branch rail line (DIRS 101214-CRWMS M&O 1996, Volume 1, Section 4, Branch Line Operations Plan). The estimated life-cycle cost of constructing and operating a branch rail line in the Caliente Corridor would be $880 million in 2001 dollars.

The following sections address impacts that would occur to land use; biological resources and soils; cultural resources; hydrology including surface water and groundwater; occupational and public health and safety; socioeconomics; noise and vibration; and utilities, energy, and materials. Impacts that would occur to air quality, aesthetics, and waste management would be the same as those described in Section 6.3.2.1 and are not repeated here. Section 6.3.4 discusses the potential for transportation activities to cause environmental justice impacts in Nevada.

6.3.2.2.1.1 Caliente Rail Land Use and Ownership

Table 6-23 summarizes the amount of land required for the Caliente corridor, its ownership, and the estimated amount of land that would be disturbed, as well as ranges for the variations. Table 6-24 summarizes the amount of land required for the Caliente Corridor variations and its ownership.

Table 6-23. Land use in the Caliente Corridor.[a]

Factor	Corridor (percent)	Range due to variations
Corridor length (kilometers)[b]	513	512 - 553
Land area in 400-meter[c]*-wide corridor (square kilometers)*[d]	205 (100)	205 - 221
Land ownership in 400-meter-wide corridor (square kilometers)		
Bureau of Land Management	188 (92)[e]	188 - 216
Air Force	10.9 (5.3)	0 - 10.9
DOE	4.6 (2.3)	4.6 - 4.6
Private	0.9 (0.46)	0.9 - 2.5
Tribal	None	0 - 1.6
Land area in 60-meter[f] right-of-way *(square kilometers)*	30.7	30.7 - 33.2
Disturbed land (square kilometers)		
Inside 60-meter right-of-way	14.7	14.7 - 15.9
Outside 60-meter right-of-way	3.6	3.6 - 3.9

a. Source: DIRS 155549-Skorska (2001, all).
b. To convert kilometers to miles, multiply by 0.62137.
c. 400 meters = about 0.25 mile.
d. To convert square kilometers to acres, multiply by 247.1.
e. Percentages do not total 100 due to rounding.
f. 60 meters = 200 feet.

Construction. This corridor crosses several telephone, pipeline, highway, and power line rights-of-way, areas designated as available for sale or transfer, and oil and gas leases (DIRS 104993-CRWMS M&O 1999, Table 2, p. 10 and Table 3, p. 11). The corridor crosses Bureau of Land Management lands used for recreation, nine grazing allotments (Bennett Springs, Highland Peak, Black Canyon, Reveille, Ralston, Stone Cabin, Montezuma, Magruder Mountain, and Razorback), and seven wild horse and burro herd management areas. Section 6.3.2.1 discusses impacts common to all rail implementing alternatives. This section discusses impacts unique to a branch rail line in the Caliente Corridor.

The corridor passes just east of the Weepah Spring Wilderness Study Area and just north of the Worthington Mountains Wilderness Study Area. It also passes near the Kawich Wilderness Study Area and crosses a portion of the South Reveille Wilderness Study Area. The Kawich Area in the Kawich Range and the South Reveille Area in the Reveille Range and along Reveille Valley form a narrow corridor through which the Caliente Corridor passes. A portion of the Kawich and South Reveille Ranges have Bureau of Land Management Class II aesthetic classifications. Construction activities in the vicinity of a Wilderness Study Area could affect the experience in the wilderness environment. As indicated in Appendix J, Section J.3.1.2, the White River Alternate would be more distant from the Area. This route

Table 6-24. Possible variations in the Caliente Corridor.[a]

Variation	Length (kilometers)[b]	Land area in variation (square kilometers)[c]	Ownership in variation [square kilometers (percent)]		
			Bureau of Land Management	Private	Tribal
Eccles Option	16.7	6.7	6.3 (95)	0.4 (5)	--[e]
Caliente Option	17.2	6.9	6.2 (90)	0.69 (10)	--
Crestline Option	37.8	15.1	14.5 (95.9)	0.6 (4.1)	--
White River Alternate	47.5	19	18.98 (99.9)	0.02 (< 0.1)	--
Garden Valley Alternate	37.7	15.1	15.1 (100)	0	--
Mud Lake Alternate	(f)	(f)	(f)	--	--
Goldfield Alternate	45.8	18.3	17.6 (96)	0.7 (4)	--
Bonnie Claire Alternate	42.2[g]	16.9	14.8 (87.4)	0.5 (3)	1.6 (10)
Oasis Valley Alternate	5.57	2.2	2.0 (89)	0.2 (11)	--
Beatty Wash Alternate	23.0	9.2	9.2 (100)	0	--

a. Source: DIRS 155549-Skorska (2001, all).
b. To convert kilometers to miles, multiply by 0.62137.
c. To convert square kilometers to acres, multiply by 247.1.
d. NA = not applicable; length included in total corridor distance.
e. -- = none.
f. Mud Lake Alternate on Bureau of Land Management land included in other variations.
g. Includes 4.5 kilometers (2.8 miles) through Timbisha Shoshone Trust Lands.

variation would cross a small additional amount of private property. Impacts of constructing a branch rail line between the Kawich and South Reveille Areas would be less if DOE implemented Bureau of Land Management Class II requirements for building in these areas.

The Bonnie Claire Alternate of this corridor, in the vicinity of Scottys Junction, would pass through and bisect an 11.3-square-kilometer (2,800-acre) portion of the Timbisha Shoshone Trust Lands (DIRS 155930-Reynolds, Pool, and Abbey 2001, all). Bisecting this parcel could limit its proposed use, which includes tourism and housing for the Timbisha Shoshone.

If the Bonnie Claire Alternate was not used, the corridor would encroach on the Nellis Air Force Range (also known as the Nevada Test and Training Range). In addition, the Mud Lake Alternative would encroach on the Range. The U.S. Air Force has noted the potential for safety risks of crossing lands that are hazard areas and encompass weapons safety footprints for live weapons deployment. For each of the sections that could enter the Nellis Range, DOE has identified a corridor variation that would avoid the potential land-use conflict (see Appendix J, Section J.3.1.2).

If DOE decided to build and operate a branch rail line in the Caliente Corridor, it would consult with the Bureau of Land Management, the U.S. Air Force, and other affected agencies and Native American governments to help ensure that it avoided or mitigated potential land-use conflicts associated with the alignment of a right-of-way. Because the Military Lands Withdrawal Act of 1999 (Public Law 106-65, 113 Stat. 885) withdraws and reserves the Nellis Air Force Range for use by the Secretary of the Air Force, the Secretary would need to concur with a decision to build and operate a branch rail line through any part of the Range.

The presence of a rail line could influence future development and land use along the railroad in the communities of Beatty, Caliente, Goldfield, Scottys Junction, and Warm Springs (that is, zoning and land use might differ depending on the presence or absence of a railroad), as well as a potential Timbisha Shoshone community at their Trust Lands parcel near Scottys Junction.

Operations. DOE expects operations along the Caliente Corridor to cause fewer impacts than the construction phase of the project.

The operation of a rail line in the vicinity of the Weepah Spring Wilderness Study Area could affect the experience of visitors to the Area. The White River Alternate would not pass near the Area, as indicated in Appendix J, Section J.3.1.2. The proximity of an operational rail line to the Kawich and South Reveille Wilderness Study Areas probably would affect these areas by drawing attention to the rail line during operational or maintenance activities.

The operation of a rail line along the Bonnie Claire Alternate could limit or potentially enhance economic development in the Timbisha Shoshone Trust Lands parcel and could limit the use for housing by restricting access. The alternate currently passes almost directly through the center of the parcel.

6.3.2.2.1.2 Caliente Rail Hydrology

Surface Water

Surface-water resources along the Caliente Corridor are discussed in Chapter 3, Section 3.2.2.1.3, and summarized in Table 6-25. The table indicates that the number of surface-water resources in the vicinity of the corridor could vary if DOE used corridor variations, but only by small numbers. In fact, the Caliente Corridor has the smallest number of nearby water resources with the possible exception of the Oasis Valley Alternate. This alternate would be farther away from one identified spring such that the spring's location would no longer be within the 400-meter (0.25-mile)-wide corridor. The spring would, however, still be within 1 kilometer (0.6 mile) of the corridor. As discussed in Section 6.3.2.1, impacts during construction or operations from the possible spread of construction-related materials by precipitation or intermittent runoff events, releases to surface water, or the alteration of natural drainage patterns or runoff rates that could affect downgradient resources would be unlikely.

Table 6-25. Surface-water resources along Caliente Corridor and its variations.[a,b,c]

	Resources in 400-meter[d] corridor			Resources outside corridor within 1 kilometer[e]		
Description	Spring	Stream/ riparian area	Reservoir	Spring	Stream/ riparian area	Reservoir
Caliente Corridor	1	3	--[f]	5	--	--
with Crestline Option	1	3	--	7	--	--
with Caliente Option	2	3	--	7	--	--
with Goldfield Alternate	1	3	--	7	--	--
with Oasis Valley Alternate	--	3	--	6	--	--

a. Source: reduced from tables in Chapter 3, Section 3.2.2.1.3.
b. Resources are the number of locations; that is, a general location with more than one spring was counted as one water resource.
c. Resources shown for variations are for the entire corridor with only the identified changes. Variations not listed (White River Alternate, Garden Valley Alternate, Mud Lake Alternate, Bonnie Claire Alternate, and Beatty Wash Alternate) are not associated with any identified water resources, nor would they avoid any resources along the corridor.
d. 400 meters = about 1,300 feet.
e. 1 kilometer = 0.6 mile.
f. -- = none.

Flood zones identified along the Caliente Corridor and its variations are listed in Table 6-26. As indicated in the table's footnotes, the 100-year flood zone information is summarized from Federal Emergency Management Agency maps, which provide coverage for about half the corridor's length. Based on the available data, this corridor would cross nine different 100-year flood zones or flood zone groups between its beginning near Caliente and when it enters the Nevada Test Site. None of the variations would change this number notably. Use of the Crestline Option would decrease the number of flood zones by one, and the other applicable variations would leave the number unchanged or increased by one. As indicated in Section 6.3.2.1, impacts associated with altering drainage patterns or changing erosion and sedimentation rates or locations would be minor and localized.

Table 6-26. 100-year flood zones crossed by the Caliente Corridor and its variations.[a,b]

Rail corridor portion	Crossing distance (kilometers)	Flood zone feature(s)	Avoided by variation (Yes or No)
Eccles Siding to Meadow Valley	0.2[c]	Clover Creek (intermittent)	Y-1
	0.8[c]	Meadow Valley Wash (wet)	Y-1, 2
Meadow Valley Wash to Sand Spring Valley	0.5[c]	White River (intermittent)	N
Sand Spring Valley to Mud Lake	1.1	Unnamed drainage gully on FEMA map in East/Central Nye County; crosses twice (dry)	N
	17.5	Mud Lake basin and drainage tributaries (normally dry)	N
Mud Lake to Yucca Mountain	0.8	Unnamed washes to the north and south of Ralston (dry)	N
	0.3	Tolicha Wash (intermittent)	Y-7
	1.1	Amargosa River (wet in sections, intermittent in others)	Y-8
	0.1	Beatty Wash (intermittent)	Y-9
Variations			
1. Crestline Option	0.8	Crosses Meadow Valley Wash (wet)	
2. Caliente Option	0.8	Crosses Meadow Valley Wash (wet)	
	0.2	Crosses Clover Creek (intermittent)	
	0.9	Crosses Meadow Valley Wash (wet) three times, rail corridor runs adjacent to Meadow Valley Wash. Passes in and out of flood zone	
3. White River Alternative	None	Located to the north of the corridor	
4. Garden Valley Alternative	None	Located to the north of the corridor	
5. Mud Lake Alternative	3.1	Crosses a larger amount of the Mud Lake flood zone (3.1 kilometers vs. 1.8 kilometers for the corridor)	
6. Goldfield Alternative	None	Located to west of corridor.	
7. Bonnie Claire Alternative	1.3	Crosses an unnamed wash south of Ralston	
	0.7	Crosses Tolicha Wash (intermittent)	
8. Oasis Valley Alternative	1.0	Crosses Amargosa River (wet in segments, intermittent in others)	
9. Beatty Wash Alternative	0.1	Crosses Beatty Wash (intermittent)	

a. Areas where natural floodwater movement might be altered and where erosion and sedimentation rates and locations could change. Sources:
   1. Federal Emergency Management Agency Flood Insurance Rate Maps for Lincoln and Nye Counties, Nevada.
   2. DIRS 154961-CRWMS M&O (1998, all).

b. About 47 percent of the Caliente Corridor is not available on maps, due primarily to limited coverage in Lincoln County, the Nellis Air Force Range, and the Nevada Test Site.

c. Projected from limited data. The specific area is not covered by Federal Emergency Management Agency maps; values were extrapolated from the closest maps.

d. Certain 100-year flood zones can be avoided by alternate corridor segments. These are identified with a "Y" (yes) and a number representing the specific variations from the second half of the table that avoids the specific flood zone. The same flood zone could be crossed by the corridor and its variations at different locations. In such cases, the feature will be marked "Avoided" for the corridor, but will appear again for the variation.

Groundwater

Construction. The water used during construction would come largely from groundwater resources. The annual demands would be a fraction of the perennial yields of most producing aquifers (see Chapter 3, Section 3.2.2.1.3, for estimated perennial yields for the hydrographic areas over which a branch rail line in the Caliente Corridor would pass).

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HYDROGRAPHIC AREA

The Nevada Division of Water Planning has divided the State into groundwater basins, or *hydrographic areas*. These areas are used in the management of groundwater resources. Hydrographic areas are generally based on topographic divides (that is, they typically comprise a valley, a portion of a valley, or a terminal basin), but can also be based on administrative divisions. The State classifies a hydrographic area as a Designated Groundwater Basin when the permitted water rights (or appropriations) approach or exceed the area's estimated perennial yield and the water resources are depleted or require additional administration. The Division of Water Planning's home page *http://www.state.nv.us/cnr/ndwp* identifies the hydrographic areas that are Designated Groundwater Basins.

The amount of water needed for the construction of a branch rail line in the Caliente Corridor for soil compaction, dust control, and workforce use would be about 880,000 cubic meters (710 acre-feet) (DIRS 104914-DOE 1998, all). For planning purposes, DOE assumed that this water would come from 64 wells installed along the rail corridor. The average amount of water withdrawn from each well would be approximately 14,000 cubic meters (11 acre-feet). Most (91 percent) of the water need would be for use in the compaction of fill material. The estimate of fill quantities needed for construction would change if variations were used. However, no single variation applicable to the Caliente Corridor would increase the estimate of water demand by more than 5 percent.

Chapter 3, Section 3.2.2.1.3, discusses the hydrographic areas over which the Caliente rail corridor would pass, their perennial yields, and whether the State of Nevada considers each a Designated Groundwater Basin. If the hydrographic area is a Designated Groundwater Basin, permitted groundwater rights approach or exceed the estimated perennial yield, depleting water resources or requiring additional administration. Table 6-27 summarizes the status of the hydrographic areas associated with the Caliente Corridor and the approximate portion of the corridor that would pass over Designated Groundwater Basins. Use of corridor variations would make no notable difference in the portion of the corridor that crosses Designated Groundwater Basins.

Table 6-27. Hydrographic areas along Caliente Corridor and its variations.

		Designated Groundwater Basins	
Corridor description	Hydrographic areas	Number	Percent of corridor length
Caliente Corridor	17	6	40
Variations[a]	16 to 18	6	40

a. Several of the variations would involve small changes in the hydrographic areas crossed or the crossing distances. However, all (Caliente Option, Crestline Option, White River Alternate, Garden Valley Alternate, Mud Lake Alternate, Goldfield Alternate, Bonnie Claire Alternate, and Oasis Valley Alternate) would cross the same six Designated Groundwater Basins which, rounded to the nearest 10 percent, would represent the same portion of the total corridor.

The withdrawal of about 14,000 cubic meters (11 acre-feet) a year from a well would have little impact on the hydrographic areas associated with the Caliente Corridor based on their perennial yields (Chapter 3, Section 3.2.2.1.3). However, the installation of 64 wells along the corridor would mean that many hydrographic areas would have multiple wells. As Table 6-27 indicates, about 40 percent of the corridor length would be over Designated Groundwater Basins, which the Nevada State Engineer's office watches carefully for groundwater depletion. This does not mean that DOE could not obtain water appropriations in these areas; the State Engineer would have the authority to approve such appropriations. Because the DOE requests would be for a short-term construction action, the State Engineer would have even more discretion. Rather than spacing the wells evenly along the corridor, DOE could use locations that would make maximum use of groundwater areas that are not Designated Groundwater Basins. Another option would be to lease temporary water rights from individuals along the corridor. Obtaining a water appropriation from the State Engineer for short-term construction use or using an approved allocation should ensure that groundwater resources would not be adversely affected.

As an alternative, DOE could transport water by truck to meet construction needs. The construction of a branch rail line in the Caliente Corridor would require about 47,000 tanker-truck loads of water or about eight truckloads each day for each work camp along the corridor. Again, water obtained from permitted sources, which would be within allocations determined by the Nevada State Engineer, would not affect groundwater resources.

Operations. Operations along a completed rail line would have little impact on groundwater resources. There would be no changes in recharge beyond those at the completion of construction.

6.3.2.2.1.3 Caliente Rail Biological Resources and Soils

Construction. The construction of a rail line in the Caliente Corridor including possible variations (see Appendix J, Section J.3.1.2) would disturb approximately 18 square kilometers (4,500 acres) of land (Table 6-23). The analysis assumed that the types of land cover in disturbed areas outside the corridor would be the same as that within the corridor. Areas within 12 of the land-cover types identified in the State of Nevada (DIRS 104593-CRWMS 1999, pp. C1 to C5) would be affected by construction of a branch rail line in the Caliente Corridor (see Table 6-28). The greatest amounts of disturbance would occur in the salt desert scrub and sagebrush land-cover types, but would involve less than 0.001 percent of the existing area of Nevada in those land-cover types. The 0.001 fraction that would be disturbed for each cover type would be very small. The disturbance would have no discernible impact on the availability of habitat in any cover type. Although some alignment variations could lead to a small increase in the total amount of land disturbed, the portion of the corridor, including its variations, in each land-cover type would be similar to the unvaried corridor.

Table 6-28. Maximum area disturbed (square kilometers)[a] in each land-cover type for the Caliente Corridor.[b,c]

Land-cover type	ercent of corridor length	Area disturbed	Area in Nevada	Percent disturbed
Agriculture	0.3	0.05	5,200	0.001
Blackbrush	0.1	0.02	9,900	<0.001
Creosote-bursage	6.0	1.1	15,000	0.007
Grassland	0.2	0.04	2,800	0.001
Greasewood	0.4	0.07	9,500	<0.001
Hopsage	2.0	0.36	630	0.06
Juniper	0.3	0.05	1,400	0.003
Mojave mixed scrub	4.5	0.82	5,600	0.01
Pinyon-juniper	0.0	0	15,000	0.00
Playa	0.1	0.02	7,000	<0.001
Sagebrush	30	5.4	67,000	0.01
Sagebrush/grassland	0.3	0.05	52,000	<0.001
Salt desert scrub	56	10	58,000	0.02
Urban		ND[d]	2,400	ND

a. To convert square kilometers to acres, multiply by 247.1.
b. Based on the proportion of the route in each land-cover type; percent disturbed was based on the variation with the greatest disturbance within a particular land-cover type. Percentages add to more than 100 because maximum values were used.
c. Source: DIRS 104593-CRWMS M&O (1999, Appendix D).
d. ND = not determined.

About 50 kilometers (31 miles) along the southern end of the corridor, including variations in this area, is in desert tortoise habitat. Assuming that a maximum of about 0.06 square kilometer (15 acres) of land would be disturbed for each kilometer of rail line in this area, construction activities would disturb as much as 3 square kilometers (740 acres) of desert tortoise habitat, none of which is classified as critical habitat. In addition, these activities could kill individual desert tortoises; however, their abundance is low in this area (DIRS 103281-Karl 1981, pp. 76 to 92; DIRS 101914-Rautenstrauch and O'Farrell 1998, pp. 407 to 411) so losses would be few. Relocation of tortoises along the route prior to construction would minimize losses of individuals. The presence of the branch rail line could interfere with the normal movements of individual tortoises. DOE would consult with the Fish and Wildlife Service (under Section 7 of the Endangered Species Act) regarding this species if it selected this corridor and would implement all terms and conditions required by the Fish and Wildlife Service.

Although the southwestern willow flycatcher occurs near some portions of the corridor, including the variations, there is no suitable habitat of dense riparian vegetation for this Federally endangered species in the Caliente Corridor (DIRS 152511-Brocoum 2000, pp. A-9 to A-13).

The only other Federally listed species near the corridor and its variations is the Railroad Valley springfish (Federally threatened), which has been found about 3 kilometers (1.9 miles) north of the corridor, and it should not be affected. The Eccles, Crestline, or Caliente variations of this corridor cross a portion of the Meadow Valley Wash, which is habitat for an unnamed subspecies of the Meadow Valley Wash speckled dace and the Meadow Valley Wash desert sucker, both of which are sensitive species. Construction of a branch rail line in this corridor could temporarily affect populations of these fish by increasing the sediment load in the wash during construction. Four other special status species occur along this corridor and its variations but could be avoided during land-clearing activities (DIRS 104593-CRWMS M&O 1999, p. 3-23) and, therefore, would not be affected.

One population of the Nevada sanddune beardtongue, a sensitive plant species, occurs within the 400-meter (0.25-mile) corridor and could be directly or indirectly affected by land-clearing activities and construction of the branch rail line. The location of this population would be identified through surveys before these activities, and disturbance of the plants would be avoided if possible.

In addition, there are six known populations of four sensitive plant species outside the 400-meter (0.25-mile) corridor, but within 5 kilometers (3 miles). Several additional populations of these four species and one other sensitive plant species occur within 5 kilometers of one or more of the variations listed in Appendix J, Section J.3.1.2. One population of one species (Needle Mountain milkvetch) outside the 400-meter corridor would be avoided by the Caliente Option and three populations of this species would be avoided by the Crestline Option. DOE anticipates that corridor activities would not affect these populations because land disturbance would not extend to these areas and changes would be unlikely in the aquatic or soil environment as a result of construction or the long-term presence of a railroad.

The rail corridor crosses 15 areas designated as game habitat and 8 areas designated as wild horse and burro management areas (see Chapter 3, Section 3.2.2.1.4). Construction activities would reduce habitat in these areas. Depending on the variation, several other designated game habitat areas could be within 5 kilometers (3 miles) of a rail line in the Caliente Corridor. Wild horses, burros, and game animals near these areas during construction would be disturbed and their migration routes could be disrupted.

At least one group of springs and three stream or riparian areas are within the 400-meter (0.25-mile) corridor including its variations (Table 6-26). Although formal delineations have not been made, these springs and riparian areas may be jurisdictional wetlands or other waters of the United States. Construction could increase sedimentation in these areas. In addition, the corridor, including its variations, crosses a number of ephemeral streams that could be classified as waters of the United States. DOE would work with the U.S. Army Corps of Engineers to minimize impacts to these areas and would obtain individual or regional permits if necessary. DOE anticipates some changes to local drainage along a branch rail line, and would design the rail line to accommodate existing drainage patterns.

In addition, as many as 25 known springs and riparian areas occur outside of the 400-meter (0.25-mile) corridor, but within 5 kilometers (3 miles) of the corridor, including its variations. Eight known populations of three sensitive animal species are associated with these aquatic resources. DOE anticipates that corridor activities would not affect these populations because land disturbance would not extend to these areas and these areas would not be disturbed during the construction or long-term presence of a railroad.

Construction activities would temporarily disturb about 18 square kilometers (4,500 acres) of soils in and adjacent to the corridor. The impacts to soils of disturbing 18 square kilometers along the 513-kilometer-(319-mile)-long corridor would be transitory and small. However, several soil characteristics could influence construction activities and the amount of disturbed area. Soils susceptible to water or wind erosion occur along much of the corridor and its variations as do soils exhibiting relatively high shrink-swell characteristics (see Chapter 3, Section 3.2.2.1.4). Disturbance of erodible soils could lead to increased silt loads in water courses or increased soil transport by winds. Erosion control during construction and revegetation, or other means of soil stabilization after construction, would minimize these concerns. The presence of soils with poor (that is, high) shrink-swell characteristics could influence the amount of disturbed area if soils from outside areas were brought in for replacement or mixing with the native soil.

As stated in Chapter 3, Section 3.2.2.1.4, the variations identified for the Caliente Corridor could avoid some biological resources, as listed in Table 6-29.

Table 6-29. Biological resources avoided by Caliente Corridor variations.[a]

	Occurrence of resource			
	For unvaried segment of corridor		Occurrence avoided by variation	
Alignment variation resource	In corridor[b]	Within 5 km[c]	In corridor	Within 5 km
Caliente variation[d]				
Sensitive species–Needle Mountain milkvetch	0	3	0	1
Springs or groups of springs	4	24	0	1
Crestline variation				
Sensitive species–Needle Mountain milkvetch	0	3	0	3
Springs or groups of springs	4	24	0	4

a. The only corridor variations listed are those that would result in the avoidance of biological resources along the corridor.
b. In the corridor [or springs within 400 meters (0.25-mile)], but avoided by the corridor variation.
c. Within 5 kilometers (3 miles) of the corridor, but more than 5 kilometers from the corridor variation.
d. Appendix J, Section J.3.1.2, lists variations for the Caliente Corridor implementing alternative.

6.3.2.2.1.4 Caliente Rail Cultural Resources

Construction. Site file searches for the Caliente Corridor and its variations (see Appendix J, Section J.3.1.2) yielded 97 recorded archaeological sites, 36 of which are either potentially eligible or have not been fully evaluated for the *National Register of Historic Places* (Chapter 3, Section 3.2.2.1.5). If DOE selected this corridor, it would conduct on-the-ground surveys of the 400-meter (0.25-mile)-wide corridor before and during construction activities to determine if construction of a branch rail line in this corridor could disturb sites or crush artifacts at archaeologic and historic sites.

At various points along the route, the Caliente Corridor and its variations intersect physical vestiges of historic railroads, including the Caliente and Pioche, Tonopah and Goldfield, and Las Vegas and Tonopah Railroads. The corridor also intersects the 1849 Jayhawker Emigrant Trail in Lincoln and Nye Counties. It passes close to three *National Register of Historic Places* properties—the Union Pacific Depot in Caliente (Caliente variation), the Tonopah Multiple Resource Area, and the Goldfield Historic District (Goldfield variation). However, the corridor and its variations passes these resources at a distance where adverse impacts would be unlikely. Southeast of Tonopah, the route passes through the former bombing range of the World War II Tonopah Army Air Station. Features related to that activity would be likely to occur on the landscape, but precise identification would not be possible until the completion of a cultural resource field inventory.

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No areas or properties of interest to Native Americans have been identified and field-verified in the Caliente Corridor or its variations. However, the proposed right-of-way is near several potentially significant areas, including the Wild Horse and Willow Springs vicinity east of Goldfield (Caliente Corridor and Goldfield variation), the Oasis Valley north of Beatty (Oasis Valley Alternate), Crater Flat, and the Busted Butte-Fortymile Canyon area near the repository (DIRS 155826-Nickens and Hartwell 2001, all). In addition, the Bonnie Claire Alternate of the Carlin and Caliente Corridors passes through the land at Scottys Junction recently transferred to the Timbisha Shoshone Tribe.

Operations. As stated in Section 6.3.2.1, additional impacts to these resources during the operation of the branch rail line would be unlikely.

6.3.2.2.1.5 Caliente Rail Occupational and Public Health and Safety

Construction. Industrial safety impacts on workers from the construction and use of the Caliente branch rail line would be small. The analysis evaluated the potential for impacts in terms of total reportable cases of injury and illness, lost workday cases, and fatality risks to workers and the public from construction and operation activities. Table 6-30 lists these results.

Table 6-30. Impacts to workers from industrial hazards during rail construction and operations in the Caliente Corridor.

Group and industrial hazard category	Construction[a]	Operations[b]
Involved workers		
Total recordable cases[c]	110	95
Lost workday cases	55	52
Fatalities	0.2	0.3
Noninvolved workers		
Total recordable cases	6.7	5.4
Lost workday cases	2.5	2.0
Fatalities	0.01	0.01
Totals[d]		
Total recordable cases	120	100
Lost workday cases	57	54
Fatalities	0.2	0.3

a. Totals for 46 months of construction.
b. Totals for 24 years of operations.
c. Total recordable cases includes injury and illness.
d. Totals might differ from sums due to rounding.

The analysis also evaluated traffic fatality impacts that would occur during the moving of equipment and materials for construction, worker commutes to and from construction sites, and transport of water to construction sites if wells were not available. Table 6-31 lists these results.

Operations. Incident-free radiological impacts would occur during the routine transportation of spent nuclear fuel and high-level radioactive waste in the Caliente Corridor. Table 6-32 lists the incident-free impacts, which include transportation along the Caliente Corridor and along railways in Nevada leading to a Caliente branch line. The table includes the impacts of 1,079 legal-weight truck shipments from commercial sites that do not have the capability to load rail casks while operational.

6.3.2.2.1.6 Caliente Rail Socioeconomics

The following paragraphs discuss potential socioeconomic impacts associated with the construction and operation of a branch rail line in the Caliente Corridor.

Construction. The length of the Caliente Corridor—513 kilometers (319 miles)—is the most important factor for determining the number of workers that would be required. To construct a branch rail line in this corridor would require workers laboring approximately 2.8 million hours or 1,410 worker years during the 46-month construction period (DIRS 154822-CRWMS M&O 1998, all). The route would require six construction camps to house workers temporarily.

Employment

DOE anticipates that total (direct and indirect) employment in the region of influence attributable to the Caliente branch rail line would peak in the first year of construction, 2006, at about 842 workers. Clark County would gain about 664 workers and Nye County would gain 101. The increase in employment

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Table 6-31. Estimated number of fatalities from construction material delivery vehicles and construction and operations worker commuting traffic for the Caliente Corridor.

Activity	Kilometers[a]	Traffic fatalities	Emissions fatalities
Construction			
Material delivery vehicles	20,000,000	0.3	0.04
Commuting workers	85,000,000	0.8	0.11
Subtotals	*100,000,000*	*1.2*	*0.15*
Operations			
Commuting workers	68,000,000	0.7	0.09
Totals	***170,000,000***	***1.9***	***0.24***

a. To convert kilometers to miles, multiply by 0.62137.

Table 6-32. Health impacts from incident-free Nevada transportation for the Caliente Corridor implementing alternative.[a]

Category	Legal-weight truck shipments	Rail shipments	Totals[b]
Involved workers			
Collective dose (person-rem)	38	810	850
Estimated LCFs[c]	0.02	0.32	0.34
Public			
Collective dose (person-rem)	7	12	19
Estimated LCFs	0.003	0.01	0.01
Estimated vehicle emission-related fatalities	0.0016	0.0056	0.0071

a. Impacts are totals for 24 years.
b. Totals might differ from sums of values due to rounding.
c. LCF = latent cancer fatality.

represents less than 1 percent of the baseline employment in Clark and Nye Counties. The additional 77 workers would represent a 3.2-percent increase of the employment baseline for Lincoln County. Changes in the Lincoln County level of employment would be the result primarily of indirect employment created by the presence of the transient construction workers.

Employment of Caliente Corridor construction workers and some indirect support workers would end in 2009. As a result, the projected total growth (2009 to 2010) of 15,240 jobs in the region of influence would be reduced by 827. The expected addition of 14,886 jobs in Clark County would be reduced by 788, and the expected growth of 330 jobs in Nye County would be reduced by 53. The expected growth of 24 jobs in Lincoln County would be supplemented by a net gain of 14. DOE anticipates that project-related workers not moving to Caliente Corridor operational jobs would be absorbed in other work in the State. These changes in employment would represent less than 1 percent of the applicable baselines.

Population

Population increases in the region of influence associated with the construction of a Caliente branch rail line would peak in 2009 at about 822 persons. About 728 individuals would live in Clark County, 64 in Nye County, and 29 in Lincoln County. The estimated population increase attributable to the rail construction in the three counties is less than 1 percent of each county’s population baseline. Because the change in population in relation to the population baseline would be small and transient, impacts to housing or schools would be unlikely.

Economic Measures

The expected peak annual changes in economic measures in the region of influence attributable to the Caliente Corridor would be increases of $24.3 million in real disposable income in 2009; $40.3 million in Gross Regional Product in 2007; and $2.8 million in State and local expenditures in the final year of construction, 2009. Clark County would generate more than 94 percent of the Gross Regional Product, experience more than 94 percent of the increase in real disposable income, and absorb more than 83 percent of the increase in expenditures by State and local governments. Nye and Lincoln Counties would share the remainder. (All dollar values in this section are in 2001 dollars unless otherwise stated).

Construction-related impacts to real disposable income, Gross Regional Product, and State and local government expenditures would be a less-than-1 percent increase for Clark and Nye Counties. Although the estimated increase in Lincoln County's Gross Regional Product would be about 1.6 percent of the baseline in 2006, increases in Gross Regional Product during the other years of construction. The increases in real disposable income would be about 1.2 percent in 2006 and less than 1 percent in other years. Increases in State and local government expenditures during all years of construction would be less than 1 percent from the County's baselines.

Transition and Operations Period. Employment opportunities associated with the construction of the branch rail line would probably dissipate at the project's completion and reduce the region's employment by 46 positions annually for 4 years. However, Nye County would have a net gain of 6 jobs and Lincoln County would have a net gain of 56 employment positions above the baseline. The additional job gain in Lincoln County represents a 2.2-percent average increase over the employment baseline in the referenced 4-year period. The employment gain in Nye County would be less than 1 percent. Constructing and operating a Caliente branch rail line would contribute to the growth in residential population throughout the transition period and to the employment base after 2013.

Employment and Population

Estimated annual direct employment for Caliente branch rail line operations would be 47 workers. Increased employment in the three counties comprising the region of influence would average about 79 jobs annually over the 24-year operations period (2010 to 2033). DOE anticipates that, on average, approximately 56 of these individuals would work in Lincoln County, representing a 2.1-percent increase of the employment baseline for Lincoln County. Increases in Clark and Nye Counties would be less than 1 percent of the baselines. In the region of influence, the average change to population because of a Caliente branch rail line would be about 351 additional people. DOE anticipates that approximately 95 individuals probably would choose to live in Lincoln County, an addition of 2 percent of the population baseline. The impact due to increases in population in Clark and Nye Counties would be much less than 1 percent of the applicable baseline. Because the impacts to population and employment would be so small in Clark and Nye Counties, impacts to housing or schools would be unlikely in either county. As discussed in Chapter 3, Section 3.1.7.4, Lincoln County has a low occupancy rate for housing; therefore, the impact to Lincoln County's housing market would be very small despite a 2-percent increase in population. The annual impact to schools in Lincoln County resulting from the increase in population would average about 22 additional pupils.

Economic Measures

Within the three-county region of influence, the estimated greatest annual increase above the baseline in real disposable income attributable to operations would occur in 2033, the last year of operation, and would be $6.2 million; annual increases during the 24 years of operation would average $5.2 million. Increases in Gross Regional Product would average about $4.5 million. As discussed above, the region would experience a slower growth in employment for several years. In the case of the Caliente branch rail line, on average during operation, changes in real disposable income would exceed changes in Gross Regional Product. Annual State and local government expenditures during operations, averaging $1.8 million, would be much lower than those reported above for construction. Impacts to real disposable income, Gross Regional Product, and State and local government expenditures from the operation of a Caliente branch rail line would be less than 1 percent of the baseline for Clark and Nye Counties.

In Lincoln County, the impact of the change to the baseline in real disposable personal income and in government spending would be to increase levels by averages of 1.6 percent and 2.4 percent, respectively, for the duration of operations. Changes to the Gross Regional Product would average 2.6 percent above the baseline. Workers associated with operation of a Caliente rail line would purchase many goods and services in Lincoln County. These dollars would continue to circulate largely in the area, creating a positive economic impact.

DOE performed detailed analyses for the Caliente Corridor branch rail line implementing alternative. The results of the analyses are representative of the potential variations listed in Appendix J, Section J.3.1.2.

In addition, DOE analyzed a sensitivity case that assumed all Lincoln County socioeconomic impacts would occur only in the City of Caliente. Under this assumption, City population would rise by 3 percent (29 persons) during construction and by 6.9 (67 persons) percent during operations. Employment would rise by about 5 percent during construction and about 7.2 percent during operations.

6.3.2.2.1.7 Caliente Rail Noise and Vibration

Over most of its length, the Caliente Corridor passes through undeveloped land managed by the Bureau of Land Management, where human inhabitants are mostly isolated ranchers and persons involved with outdoor recreation. The Towns of Caliente and Panaca are near or along the eastern end of the corridor. The Caliente variation for connecting to the Union Pacific Railroad mainline would follow an old railroad bed through the center of the Town of Caliente. Corridor variations (see Appendix J, Section J.3.1.2) with the exception of Caliente are close enough to the rail line for noise impacts to be significant (Table 6-33). Noise levels in Caliente would not differ much from existing background noise levels associated with normal rail traffic through the community. Noise levels associated with waste shipments would occur at most three times a day and probably not within any given hour. Where the branch rail line passed through Caliente, train speed would be reduced for safety and noise levels would be minimized. There is one traffic crossing in the Town of Caliente where traffic could be delayed. Adverse community response to the added rail noise would be unlikely because of the long-term presence of railroad traffic in Caliente, the short trains associated with transport of waste shipments, and the low frequency of rail trips to and from the Yucca Mountain site.

Table 6-33. Estimated propagation of noise from the operation of waste transport train using two locomotives in communities near the Caliente Corridor.

Community	Distance (kilometers)[a]	Estimated noise (dBA)[b]
Caliente Option		
Caliente	0	>90 at 15 meters[c]
Panaca	6[d]	26.0
Crestline Option		
Panaca	4.5[d]	26.3
Eccles Option		
Caliente	6.5[d]	<26[e]
Tonopah	12[d]	<26
Goldfield	6.2[d]	<26
Beatty	9.6[d]	<26
Beatty Wash Alternate		
Beatty	11.2[d]	<26
Amargosa Valley	9.6[d]	<26

a. To convert kilometers to miles, multiply by 0.62137.
b. Estimated values do not include noise loss due to interactions with the ground that could account for decreases in estimated noise levels from 10 to 20 dBA at 100 meters (330 feet) from the tracks.
c. 15 meters = 49 feet.
d. Noise estimates at distances greater than 2 kilometers (1.2 miles) have large uncertainty.
e. At these distances, the A-weighted sound pressure level is dominated by lower frequencies (lower than 63 Hertz) and would not be distinguishable from normal background levels of noise.

In addition to passing near communities, the Caliente Corridor, including its variations, would pass through areas with farms and ranches. Some rural residences could fall within the region of influence for noise. The corridor, except the Caliente Option that would pass through Caliente, would be at least 4 kilometers (2.5 miles) from every town or community along its length. The noise from trains in these remote communities would not exceed daytime or nighttime noise standards for residential areas (60 or 50 dBA, respectively). Similarly, there would be little potential for noise impacts from construction and operation activities.

The estimated population residing within 2 kilometers (1.2 miles) of the Caliente Corridor in 2035 would be about 350 persons.

The Caliente Corridor would pass within 1.9 kilometers (1.2 miles) of the border of the Timbisha Shoshone Homeland. The Bonnie Claire Alternate would pass through 4.1 kilometers (2.5 miles) of the Timbisha Shoshone Trust Lands parcel near the intersection of State Route 267 and U.S. Highway 95. Noise levels from trains passing through the homeland would be 90 dBA at 15 meters (49 feet) for the Bonnie Claire Alternate. At the closest point of the Caliente Corridor, the estimated noise levels would be 44 dBA. Ethnographic responses to noise have not been determined (see Section 6.1.2.5). However, the noise levels associated with the Caliente Corridor would be lower than those associated with the Bonnie Claire Alternate.

Vibration. With the exception of the historic railroad station in Caliente, which is near the existing Union Pacific Railroad mainline, a branch rail line in the Caliente Corridor would be distant from historic structures, ruins, and buildings. Therefore, vibration impacts would be unlikely except at the Caliente Rail Station. However, the vibrations added by the relatively few trains carrying spent nuclear fuel and high-level radioactive waste at slow speeds through Caliente would not add appreciably to the vibrations to which the station is exposed from commercial train traffic. The small number of trips (two per day) and the small train size would result in low levels of rail-induced ground vibration.

6.3.2.2.1.8 Caliente Rail Utilities, Energy, and Materials

Table 6-34 lists the use of fossil fuel and other materials for the construction of a Caliente branch rail line.

Table 6-34. Construction utilities, energy, and materials for a Caliente branch rail line.

Length (kilometers)[a]	Diesel fuel use (million liters)[b]	Gasoline use (thousand liters)	Steel (thousand metric tons)[c]	Concrete (thousand metric tons)[c]
510 - 550	42 - 45	870 - 940	72 - 78	420 - 460

a. To convert kilometers to miles, multiply by 0.62137.
b. To convert liters to gallons, multiply by 0.26418.
c. To convert metric tons to tons, multiply by 1.1023.

6.3.2.2.2 *Carlin Corridor Implementing Alternative*

The Carlin corridor originates at the Union Pacific main line railroad near Beowawe in north-central Nevada. Figure 6-16 shows this corridor along with possible variations identified by engineering studies (DIRS 131242-CRWMS M&O 1997, all). The variations provide flexibility in addressing engineering, land-use, or environmental resource issues that could arise in a future, more detailed survey along the corridor. This section addresses impacts that would occur along the corridor shown in Figure 6-16. With the exception of the differences identified in Appendix J, Section J.3.1.2, the impacts would be generally the same among the possible variations.

The corridor travels south through Crescent, Grass, and Big Smoky Valleys, passing west of the City of Tonopah and east of the City of Goldfield. The corridor then travels south following and periodically

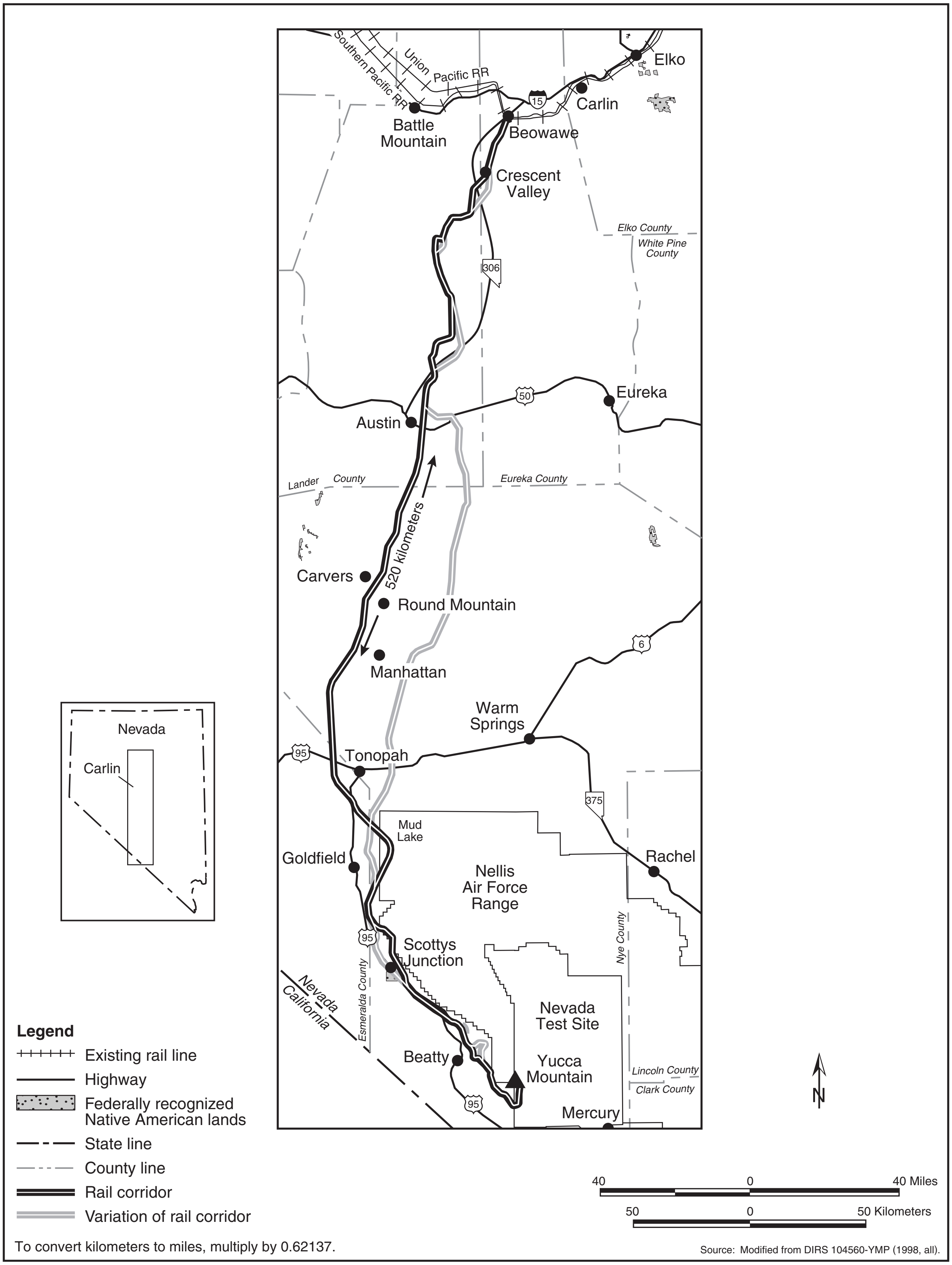

Figure 6-16. Carlin Corridor.

crossing the western boundary of the Nellis Air Force Range, passing through Oasis Valley and Beatty Wash. It travels along Fortymile Wash to the proposed repository location. The Carlin Corridor is about 520 kilometers (323 miles) long from its link with the Union Pacific line to the Yucca Mountain site. Variations of the route range from 513 to 544 kilometers (319 to 338 miles).

The construction of a branch rail line in the Carlin Corridor would require approximately 46 months. Construction would take place simultaneously at multiple locations along the corridor. DOE would establish an estimated five construction camps at roughly equal distances along the corridor. These camps would provide temporary living accommodations for construction workers and construction support facilities. A train would take about 9 hours to travel from the junction with the Union Pacific mainline to the Yucca Mountain site on a Carlin branch rail line (DIRS 101214-CRWMS M&O 1996, Volume 1, Section 4, Branch Line Operations Plan). The estimated life-cycle cost to construct and operate a branch rail line in the Carlin Corridor would be about $821 million in 2001 dollars.

The following sections address impacts that would occur to land use; biological resources and soils; cultural resources; hydrology including surface water and groundwater; occupational and public health and safety; socioeconomics; noise and vibration; and utilities, energy, and materials. Impacts that would occur to air quality, aesthetics, and waste management would be the same as those common impacts discussed in Section 6.3.2.1 and are, therefore, not repeated here. Section 6.3.4 discusses the potential for transportation activities to cause environmental justice impacts in Nevada.

6.3.2.2.2.1 Carlin Rail Land Use and Ownership

Table 6-35 summarizes the amount of land required for the Carlin Corridor, its ownership, and the estimated amount of land that would be disturbed, as well as ranges for the variations. Table 6-36 summarizes the amount of land required for the Carlin Corridor variations and its ownership.

Table 6-35. Land use in the Carlin Corridor.[a]

Factor	Corridor (percent)	Range due to variations
Corridor length (kilometers)[b]	520	513 - 544
Land area in 400-meter[c]*-wide corridor (square kilometers)*[d]	208 (100)	205 - 218
Land ownership in 400-meter-wide corridor (square kilometers)		
Bureau of Land Management	179 (86)	177 - 201
Air Force	11 (5.2)	0 - 10.9
DOE	4.6 (2.2)	4.6 - 4.6
Private	14 (6.7)	7.3 - 15.2
Tribal	None	0 - 1.6
Land area in 60-meter[e] *right-of-way (square kilometers)*	31.2	30.8 - 32.6
Disturbed land (square kilometers)		
Inside 60-meter right-of-way	17	16.7 - 17.7
Outside 60-meter right-of-way	2.3	2.2 - 2.4

a. Source: DIRS 155549-Skorska (2001, all).
b. To convert kilometers to miles, multiply by 0.62137.
c. 400 meters = about 0.25 mile.
d. To convert square kilometers to acres, multiply by 247.1.
e. 60 meters = 200 feet.

Construction. The Carlin Corridor crosses various telephone, highway, and utility rights-of-way. The corridor also crosses a Desert Land Entry withdrawal, 12 Bureau of Land Management grazing allotments (Carico Lake, Dry Creek, Grass Valley, Kingston, Simpson Park, Wildcat Canyon, Big Smoky, Francisco, San Antone, Montezuma, Magruder Mountain, and Razorback) and six wild horse and burro herd management areas. Other areas crossed by the corridor include the Bates Mountain antelope release area,

Table 6-36. Possible variations in the Carlin Corridor.[a]

Variation	Length (kilometers)[b]	Land area in variation (square kilometers)[c]	Ownership in variation [square kilometers (percent)] Bureau of Land Management	Private	Tribal
Crescent Valley Alternate	24.4	9.8	7.2 (77)	2.3 (23)	--[d]
Wood Spring Canyon Alternate	11.7	4.7	4.7 (100)	0	--
Rye Patch Alternate	35.3	14.1	14.1 (100)	0	--
Steiner Creek Alternate	41.5	16.6	16.6 (100)	0	--
Big Smoky Valley Option	197	78.9	78.9 (100)	0	--
Monitor Valley Option	225.4	90.2	90.2 (100)	0	--
Mud Lake Alternate	(e)	(e)	(e)	--	--
Goldfield Alternate	43.1	18.3	17.6 (96)	0.7 (4)	--
Bonnie Claire Alternate	42.2[f]	16.9	14.3 (87)[g]	0.4 (3)	1.6 (10)
Oasis Valley Alternate	5.57	2.2	2.0 (89)	0.2 (11)	--
Beatty Wash Alternate	23.0	9.2	9.2 (100)	0	--

a. Source: DIRS 155549-Skorska (2001, all).
b. To convert kilometers to miles, multiply by 0.62137.
c. To convert square kilometers to acres, multiply by 247.1.
d. -- = none.
e. Mud Lake Alternate included in other variations.
f. Includes 4.5 kilometers (2.8 miles) of Timbisha Shoshone Tribal land.
g. Includes 18 square kilometers (450 acres) of Timbisha Shoshone Tribal land.

three designated riparian habitats, and the Simpson Park habitat management area. It does not cross any oil or gas exploration and extraction areas. However, Bureau of Land Management lands are open to mineral and oil and gas exploration. The corridor passes through Bureau lands that are used for recreation, but does not pass through state or national forests. It does pass through areas adjacent to such facilities.

The construction of a branch rail line through Desert Land Entry withdrawal areas could affect the economic development of such properties by removing a portion of the lands and transferring it to DOE. If such property was divided, continued access to the property would be required. Construction impacts would be similar to those discussed in Section 6.3.2.1. As with the Caliente Corridor, the Bonnie Claire Alternate in the vicinity of Scottys Junction would pass through and divide an 11.3-square-kilometer (2,800-acre) portion of the Timbisha Shoshone Trust Lands (DIRS 155930-Reynolds, Pool, and Abbey 2001, all). The construction of a branch rail line in the Bonnie Claire Alternate could limit or potentially enhance economic development in the Timbisha Shoshone Trust Lands parcel and could limit the use for housing by restricting access.

The withdrawal of property from the private sector and the transfer of public lands would occur under existing government protocols. The withdrawal of lands from private ownership could impact area city and county economic expansion through the loss of tax revenues.

There are current mining operations in the Cortez Mine area of Crescent Valley. These operations, along with the historic mines in the area, make continued mining of this area a probability. Although the Carlin Corridor crosses no current leases, access through the valley could be affected for a short period during the construction of a branch rail line. The corridor also passes through areas of potential future exploration. The Crescent Valley Alternate (see Appendix J, Section J.3.1.2) passes just west of the Cortez Gold Mines. This corridor variation crosses an existing road right-of-way leading from the Gold Acres Mine to the ore mills at the Cortez mining facility. It also crosses a proposed pipeline right-of-way from the Cortez Gold Mine to the Dean Ranch. This pipeline would deliver water to the ranch (DIRS 155095-BLM 2000, all). Construction activities could deny or interfere with access to the milling facility at Cortez. The pipeline right-of-way would have to be modified to include DOE or the property rights would have to be transferred to DOE. Impacts to the road right-of-way would be slight if access to the area's mining facilities was maintained. The pipeline could require modifications to allow the building of a rail line through the right-of-way.

The Steiner Creek Alternate passes close to and might encroach on the Simpson Park Wilderness Study Area. Construction activities in the vicinity of a wilderness study area could affect the experience in the wilderness environment.

One segment of the Carlin Corridor and the Mud Lake Alternate would encroach on the Nellis Air Force Range (also known as the Nevada Test and Training Range). The U.S. Air Force has noted the potential for safety risks of crossing lands that are hazard areas and encompass weapons safety footprints for live weapons deployment. For each of the sections that could enter the Nellis Range, DOE has identified a corridor variation that would avoid the potential land-use conflict (see Appendix J, Section J.3.1.2). If DOE decided to build and operate a branch rail line in the Carlin Corridor, it would consult with the Bureau of Land Management, the U.S. Air Force, and other affected agencies and Native American governments to help ensure that it avoided or mitigated potential land-use conflicts associated with alignment of a right-of-way. Because the Military Lands Withdrawal Act of 1999 (Public Law 106-65, 113 Stat. 885) withdraws and reserves the Nellis Air Force Range for use by the Secretary of the Air Force, the Secretary would need to concur with a decision to build and operate a branch rail line through any part of the Range.

The presence of a rail line could influence future development and land use along the railroad in the communities of Austin, Beatty, Carver's Station, Cortez, Crescent Valley, Manhattan, Round Mountain, Scottys Junction, and Tonopah (that is, zoning and land use might differ depending on the presence or absence of a railroad), as well as a potential Timbisha Shoshone community at their Trust Lands parcel near Scottys Junction.

Operations. DOE expects operations along the Carlin Corridor, including its variations, to cause fewer impacts than the construction phase of the project, even though the branch rail line would pass through areas of private ownership and a number of other unique areas (see Table 6-2 in Section 6.1.2.1). The presence of an operational rail line near the Simpson Park Wilderness Study area could detract from the wilderness experience. The operation of a branch rail line along the Bonnie Claire Alternate could limit economic development in the Timbisha Shoshone parcel and could limit the parcel's use for reservation housing by restricting access. The Bonnie Claire Alternate passes almost directly through the center of the parcel.

6.3.2.2.2.2 Carlin Rail Hydrology

Surface Water

Surface-water resources along the Carlin Corridor and its variations are discussed in Chapter 3, Section 3.2.2, and summarized in Table 6-37. As listed in the table, the number of surface-water resources in the vicinity of the corridor would change by small numbers if DOE used any of the variations. Both the Rye Patch and Oasis Valley Alternates would involve one less surface-water resource in the 400-meter (0.25-mile)-wide corridor, and a corresponding increase in the number of resources outside the corridor but within 1 kilometer (0.6 mile). As discussed in Section 6.3.2.1, impacts during construction or operations from the possible spread of construction-related materials by precipitation or intermittent runoff events, releases to surface waters, and the alteration of natural drainage patterns or runoff rates that could affect downgradient resources would be unlikely.

Flood zones identified along the Carlin Corridor and its variations are listed in Table 6-38. The Federal Emergency Management Agency maps from which DOE derived the flood zone information provided coverage for about 83 percent of the corridor's length. This corridor would cross 11 different 100-year

Table 6-37. Surface water resources along Carlin Corridor and its variations.[a,b,c]

Corridor description	Resources in 400-meter[d] corridor			Resources outside corridor within 1 kilometer[e]		
	Spring	Stream/ riparian area	Reservoir	Spring	Stream/ riparian area	Reservoir
Carlin Corridor	1	5	--[f]	10	2	1
with Wood Spring Canyon Alternate	1	5	--	8	2	1
with Steiner Creek Alternate	1	5	--	10	1	1
with Rye Patch Alternate	1	4	--	11	3	1
with Monitor Valley Option	1	5	--	9	2	--
with Gold Field Alternate	1	5	--	12	2	1
with Oasis Valley Alternate	--	5	--	11	2	1

a. Source: Reduced from tables in Chapter 3, Section 3.2.2.1.3.
b. Resources are the number of locations; that is, a general location with more than one spring was counted as one water resource.
c. Resources shown for variations are for the entire corridor with only the identified variation changed. Variations not shown (that is, Crescent Valley Alternate, Mud Lake Alternate, Bonnie Claire Alternate, and Beatty Wash Alternate) are neither associated with any identified water resources, nor would they avoid any resources along the Corridor.
d. 400 meters = about 1,300 feet.
e. 1 kilometer = 0.6 mile.
f. -- = none.

flood zones or flood-zone groups before entering the Nevada Test Site. Eight of the 10 variations would change the number of flood zones crossed but, with one exception, changes would be up or down by one. The exception would be the Monitor Valley Option, which would increase the number of 100-year flood zones crossed by four. As indicated in Section 6.3.2.1, impacts associated with altering drainage patterns or changing erosion and sedimentation rates or locations would be minor and localized.

Groundwater

Construction. The water used during construction would come largely from groundwater resources. The annual demands would be a fraction of the perennial yields of most producing aquifers (see Chapter 3, Section 3.2.2.1.3, for estimated perennial yields for the hydrographic areas over which the potential branch rail line in the Carlin Corridor passes).

The estimated amount of water needed for the construction of a branch rail line in the Carlin Corridor for soil compaction, dust control, and workforce use would be about 810,000 cubic meters (660 acre-feet) (DIRS 104914-DOE 1998, all). For planning purposes, DOE assumed that this water would come from 67 groundwater wells installed along the rail corridor. The average amount of water withdrawn from each well would be approximately 12,000 cubic meters (10 acre-feet). Most (91 percent) of the water would be used for compaction of fill material. The estimate of fill quantities for construction varies according to the variation. However, no single variation applicable to the Carlin Corridor would increase the estimate of water demand by more than 5 percent.

Chapter 3, Section 3.2.2.1.3, discusses the hydrographic areas over which the corridor would pass, their perennial yields, and whether the State of Nevada considers each a Designated Groundwater Basin. If the hydrographic area is a Designated Groundwater Basin, permitted groundwater rights approach or exceed the estimated perennial yield, depleting water resources or requiring additional administration.
Table 6-39 summarizes the status of the hydrographic areas associated with the Carlin Corridor, and the approximate portion of the corridor that passes over Designated Groundwater Basins. As listed in Table 6-39, use of the Monitor Valley Option would result in an approximate 20-percent decrease in the portion of the corridor crossing Designated Groundwater Basins.

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Table 6-38. 100-year flood zones crossed by the Carlin Corridor and its variations.[a,b]

Corridor portion	Crossing distance (kilometers)[c]	Flood zone feature(s)	Avoided by variation[d] (Yes or No)
Beowawe to Austin	4.0	Flood zone associated with Coyote Creek drainage (dry)	N
	1.6	Indian Creek (dry) and unnamed wash to the south	Y-1
	0.9	Unnamed Callaghan tributary, Skull and Callaghan Creeks (intermittent)	Y-3
	0.1	Rye Patch Canyon Creek (intermittent)	Y-4, 5
	1.4	Simpson Park Canyon Creek (intermittent) and Canyon Creek drainage (intermittent)	Y-4, 5
	1.4	Canyon Creek and Canyon Creek drainage (intermittent)	Y-5
Austin to Mud Lake	0.3	Peavine Creek tributary (intermittent)	Y-5
Mud Lake to Yucca Mountain	0.8	Unnamed washes to the north and south of Ralston (dry)	N
	0.3	Tolicha Wash	Y-8
	1.1	Amargosa River (wet in sections, intermittent in others)	Y-9
	0.1	Beatty Wash	Y-10
Variations			
1. Crescent Valley Alternate	2.0	Crosses Indian Creek (intermittent)	
	3.2	Crosses an unnamed wash to the south	
2. Wood Spring Alternate	None	Located to the west of the primary rail corridor	
3. Steiner Creek Alternate	4.9	Crosses Callaghan and Canyon Creeks (intermittent)	
4. Rye Patch Alternate	1.4	Crosses Canyon Creek and Canyon Creek drainage (intermittent)	
5. Monitor Valley Option[d]	0.6	Crosses Mosquito Creek (intermittent)	
	0.5	Crosses Corcoran Creek and Meadow Creek (intermittent)	
	1.5	Crosses Meadow Creek drainage; (dry)	
	0.6	Crosses Hunts Canyon Creek (intermittent)	
	0.2	Crosses Willow Creek (intermittent)	
	2.0	Crosses drainage areas approaching Mud Lake (dry)	
	5.7	Crosses drainage areas approaching Mud Lake (dry)	
	4.8	Crosses Mud Lake drainage (dry)	
6. Mud Lake Alternate	3.1	Crosses the Mud Lake flood zone	
7. Goldfield Alternate	None	Located to west of rail Corridor	
8. Bonnie Claire Alternate	1.3	Crosses an unnamed wash south of Ralston	
	0.7	Crosses Tolicha Wash (intermittent)	
9. Oasis Valley Alternate	1.0	Crosses Amargosa River (wet in segments, intermittent in others)	
10. Beatty Wash Alternate	0.1	Crosses Beatty Wash (intermittent)	

a. Areas where natural floodwater movement might be altered and where erosion and sedimentation rates and locations could change. Sources:
   1. Federal Emergency Management Agency Flood Insurance Rate Maps for Eureka, Lander, and Nye Counties, Nevada.
   2. DIRS 154961-CRWMS M&O (1998, all).

b. About 17 percent of the primary Carlin Corridor is not available on Federal Emergency Management Agency maps, due primarily to limited coverage in Esmeralda County, the Nellis Air Force Range, and the Nevada Test Site.

c. To convert kilometers to miles, multiply by 0.62137.

d. Certain 100-year flood zones can be avoided by alternate corridor segments. These are identified with a "Y" (yes) and a number representing the specific alternate(s) from the second half of the table that avoids the specific flood zone. The same flood zone might be crossed by the corridor and its variations at different locations. In such cases, the feature will be marked "Avoided" for the corridor, but will appear again for the variations.

Table 6-39. Hydrographic areas along Carlin Corridor and its variations.[a]

Corridor description	Hydrographic areas	Designated Groundwater Basins	
		Number	Percent of corridor length
Carlin Corridor	12	6	70
with Monitor Valley Option	12	5	50
with Goldfield Alternate	11	5	70
other alternates[a]	12	6	70

a. Crescent Valley, Wood Spring, Rye Patch, Steiner Creek, Mud Lake, Bonnie Claire, Oasis Valley, and Beatty Wash.

The withdrawal of about 12,000 cubic meters (10 acre-feet) a year from a well would have little impact on the hydrographic areas associated with the corridor based on their perennial yields (Chapter 3, Section 3.2.2.1.3). However, the installation of 67 wells along the corridor would mean that many hydrographic areas would have multiple wells. As indicated in Table 6-39, about 70 percent of the length of the Carlin Corridor is in Designated Groundwater Basins, which the Nevada State Engineer's office watches carefully for groundwater depletion. This does not mean that DOE could not obtain water appropriations in these areas; the State Engineer would have the authority to approve such appropriations. Because the DOE requests would be for a short-term construction action, the State Engineer would have even more discretion. Rather than spacing the wells evenly along the corridor, DOE could use locations that would make maximum use of groundwater areas that are not Designated Groundwater Basins. With such a large portion of the corridor over these basins, however, this would mean that DOE would truck water for long distances. Another option would be to lease temporary water rights from individuals along the corridor. Obtaining a water appropriation from the State Engineer for short-term construction use or using an approved allocation would ensure no adverse effects to groundwater resources. Use of the Monitor Valley Option would decrease the portion of the corridor crossing Designated Groundwater Basins and possibly increase DOE's flexibility in obtaining water along the corridor.

As an alternative, DOE could transport water by truck to meet construction needs. The construction of a branch rail line in the Carlin Corridor would require about 43,000 tanker-truck loads of water or about 9 truckloads each day for each work camp along the corridor. Again, water obtained from permitted sources, which would be within allocations determined by the Nevada State Engineer, would not affect groundwater resources.

Operations. Operations along a completed rail line would have little impact on groundwater resources. Possible changes in recharge, if any, would be the same as those at the completion of construction.

6.3.2.2.2.3 Carlin Rail Biological Resources and Soils

Construction. The construction of a rail line in the Carlin Corridor, including its variations, would disturb approximately 19 square kilometers (4,700 acres) (Table 6-35). Areas in nine of the land-cover types identified in Nevada (DIRS 104593-CRWMS M&O 1999, pp. C1 to C5) would be affected by the construction of a branch rail line in the Carlin Corridor (Table 6-40). The analysis assumed that the types of land cover in disturbed areas outside the corridor would be the same as that within the corridor. The EIS analysis assumed that the composition of land-cover types in these areas would be similar to the cover types in the corridor. The greatest amounts of disturbance would occur in the sagebrush, salt-desert scrub, and creosote bursage land-cover types for both the Big Smoky Valley Option and Monitor Valley Option, but would involve far less than 0.01 percent of the existing area in those land-cover types. The fraction disturbed for each cover type would be very small. The disturbance would have no discernible impact on the availability of habitat for plants or animals associated with any cover type. Although some alignment variations could lead to a small increase in the total amount of land disturbed, the portion of the corridor, including its variations, in each land-cover type would be similar to that in the unvaried corridor.

About 50 kilometers (31 miles) of its length along the southern end of the corridor occurs in desert tortoise habitat. Assuming 0.06 square kilometer (15 acres) disturbed per linear kilometer of railroad, construction activities would disturb about 3 square kilometers (740 acres) of this habitat. Such activities could kill individual desert tortoises; however, the abundance of this species is low in this area (DIRS 103281-Karl 1981, pp. 76 to 92; DIRS 101914-Rautenstrauch and O'Farrell 1998, pp. 407 to 411) so losses would be few. Relocation of tortoises along the corridor prior to construction would minimize losses of individuals. The presence of a branch rail line could interfere with movement of individual tortoises. If DOE selected this corridor, it would consult with the Fish and Wildlife Service (under Section 7 of the Endangered Species Act) regarding this species, and would implement all terms and conditions required by the Fish and Wildlife Service.

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Table 6-40. Maximum area disturbed (square kilometers)[a] in each land-cover type for the Carlin Corridor.[b,c]

	Big Smoky Valley Option		Monitor Valley Option			
Land-cover type	Percent of corridor length	Land area	Percent of corridor length	Land area	Area in Nevada	Percent disturbed
Agriculture	0	0	0	0	5,200	0
Blackbrush	0.1	0.02	0.1	0.02	9,900	<0.001
Creosote-bursage	5.9	1.1	5.9	1.2	15,000	0.007
Grassland	0	0	0	0	2,800	0
Greasewood	6.4	1.2	4.3	0.86	9,500	0.013
Hopsage	1.9	0.37	1.9	0.38	630	0.057
Juniper	0	0	0	0	1,400	0
Mojave mixed scrub	4.5	0.87	4.5	0.9	5,600	0.015
Pinyon-juniper	0.6	0.12	0.6	0.12	15,000	<0.001
Playa	0	0	0	0	7,000	0
Sagebrush	24.9	4.8	43.1	8.7	67,000	0.012
Sagebrush/grassland	2.3	0.44	5.9	1.2	52,000	0.002
Salt desert scrub	53.4	10	33.7	6.8	58,000	0.018
Urban	ND[d]	ND	ND	ND	2,400	ND
Total[e]	100	19.3	100	20.1	250,000	N/A[f]

a. To convert square kilometers to acres, multiply by 247.1.
b. Based on the proportion of the route in each land-cover type; percent disturbed was based on the variation with the greatest disturbance within a particular land-cover type. Percentages add to more than 100 because maximum values were used.
c. Source: DIRS 104593-CRWMS M&O (1999, Appendix D).
d. ND = not determined.
e. Totals might differ from sums of values due to rounding.
f. N/A = not applicable.

Three other sensitive species occur in the 400-meter- (0.25-mile)-wide corridor: one population of a sensitive plant species, the Nevada sanddune beardtongue; and one population each of two sensitive animal species (a ferruginous hawk nesting area and the San Antonio pocket gopher). Use of the Monitor Valley Option rather than the Big Smoky Valley Option would avoid the pocket gopher population, and the Steiner Creek Alternate would avoid the hawk nesting area (Appendix J, Section J.3.1.2 lists corridor variations). These populations could be disturbed during construction activities. Adverse impacts to the hawk nesting area could be long term because periodic disturbances associated with the presence of a railroad could cause the hawks to abandon the area.

At least three populations of three sensitive plant species occur outside the corridor, but within 5 kilometers (3 miles). Use of the Monitor Valley Option would avoid one of these populations. DOE anticipates no impacts to these populations because land disturbance would not extend to these areas and changes in the aquatic or soil environment in these areas as a result of construction or long-term presence of a railroad would be unlikely.

Fourteen populations of eight sensitive animal species occur outside the corridor, but within 5 kilometers (3 miles). Ten populations of five of these species are associated with springs or aquatic habitat. These populations would not be affected by construction activities due to their distance from the corridor. The Monitor Valley Option would avoid one population each of two of these species.

This rail corridor, including its variations, crosses seven areas designated as game habitat and six areas designated as wild horse and burro management areas (see Chapter 3, Section 3.2.2.1.4). Construction activities would reduce habitat in these areas. Wild horses, burros, and game animals near these areas during construction would be disturbed, and their migration routes could be disrupted. In addition, there are 17 areas designated as game habitat outside the 400-meter (0.25-mile)-wide corridor but within 5 kilometers (3 miles). Larger game animals occupy large home ranges and could easily traverse the distance between the designated habitat and the proposed corridor. Four of these areas are associated with sage grouse (1 nesting and 3 strutting) and probably would not be affected by construction of the rail line.

One group of springs and three to four stream or riparian areas are within the 400-meter (0.25-mile)-wide corridor, and its variations (Table 6-37). Although no formal delineations have been made, these areas may be jurisdictional wetlands or other waters of the United States. Construction could increase sedimentation in these areas. In addition, the corridor crosses a number of ephemeral streams that may be classified as waters of the United States. DOE would work with the U.S. Army Corps of Engineers to minimize impacts to these areas and would obtain individual or regional permits if necessary. DOE anticipates some changes to local drainage along a branch rail line and would design the rail line to accommodate existing drainage patterns.

In addition, as many as 60 known springs and 6 riparian areas occur outside the corridor, but within 5 kilometers (3 miles), including the corridor variations. Nine known populations of four sensitive animal species are associated with these aquatic resources. DOE anticipates no impacts to these populations because these areas would not be disturbed during construction or by the long-term presence of a railroad. Although there are differences in the number of springs or riparian areas that some corridor variations would avoid, the Monitor Valley Option would avoid 13 of the springs and four of the riparian areas that are outside of the corridor but within 5 kilometers.

Construction activities would temporarily disturb about 19 square kilometers (4,700 acres) of soils in and adjacent to the corridor. The impacts to soils of disturbing 19 square kilometers (4,700 acres) along the 520-kilometer (323-mile)-long corridor would be transitory and small. However, several soil characteristics could influence construction activities and the amount of disturbed area. Soils susceptible to water or wind erosion occur along much of the corridor and its variations as do soils exhibiting relatively high shrink-swell characteristics (see Chapter 3, Section 3.2.2.1.4). Disturbance of erodible soils could lead to increased silt loads in water courses or increased soil transport by wind. Erosion control during construction, and revegetation or other means of soil stabilization after construction, would minimize these concerns. The presence of soils with poor (that is, high) shrink-swell characteristics could influence the amount of area disturbed by construction if soils from outside areas had to be brought in for replacement or mixing with native soil.

As stated in Chapter 3, Section 3.2.2.1.4, potential variations identified for the Carlin Corridor could avoid some biological resources, as listed in Table 6-41.

6.3.2.2.2.4 Carlin Rail Cultural Resources

Construction. This section discusses the segment of the Carlin Corridor from the existing Union Pacific main line railroad near Beowawe in north-central Nevada to its junction with the Caliente Corridor, northwest of Mud Lake. The remainder of the corridor is the same as the final segment of the Caliente Corridor from that point to the proposed repository; impact potential along that segment is discussed in Section 6.3.2.2.1.4.

Archaeological site file searches for the overall Carlin Corridor, including its variations (see Appendix J, Section J.3.1.2), resulted in the identification of 110 known sites (see Chapter 3, Section 3.2.2.1.5), 47 of which are eligible or potentially eligible for inclusion in the *National Register of Historic Places*. The segment of the Carlin Corridor north of the junction point with the Caliente Corridor crosses or passes through several potentially important areas for archaeological and historical sites. Based on currently available information (DIRS 155826-Nickens and Hartwell 2001, p. 27), each of the valleys through which the corridor and its variations pass—Crescent, Grass, Big Smoky, Monitor, and Ralston—have medium to high potential for prehistoric and historic Native American sites. Late 19th- and early 20th-century Western Shoshone village sites are collocated with the historic Grass Valley Ranch; similar situations might occur at other historic ranches the Corridor passes.

Table 6-41. Biological resources avoided by Carlin Corridor variations.[a]

Alignment variation resource	Occurrence of resource: For unvaried segment of corridor – In corridor[b]	Within 5 km[c]	Occurrence avoided by variation – In corridor	Within 5 km
Steiner Creek Variation				
Sensitive species–ferruginous hawk nesting	1	2	1	0
Game habitat–sage grouse strutting	2	3	1	1
Springs or groups of springs	4	59	0	2
Riparian areas	3	7	2	1
Rye Patch Variation				
Springs or groups of springs	4	59	1	0
Riparian areas	3	7	1	0
Monitor Valley Variation				
Sensitive species				
Big Smoky Valley speckled dace	0	1	0	1
Crescent Dune aegialian scarab	0	1	0	1
Nevada sanddune beardtongue	1	1	0	1
San Antonio pocket gopher	1	0	1	0
Game habitat				
Pronghorn–year round	1	0	1	0
Waterfowl	0	1	0	1
Springs or groups of springs	4	59	0	13
Riparian areas	3	7	0	4

a. Variations listed are those that would result in the avoidance of biological resources along the corridor.
b. In the corridor [or springs within 400 meters (0.25 mile)], but avoided by the corridor variation.
c. Within 5 kilometers (3 miles) of the corridor, but more than 5 kilometers from the corridor variation.

Between Beowawe and U.S. Highway 50, the Carlin Corridor intersects with the California Emigrant Trail and the Pony Express Trail, both designated by Congress as *National Historic Trails* under the National Trails System Act, and the historic Pacific Telegraph Line, Butterfield Overland Mail and Stage route, and Lincoln Highway routes (DIRS 155826-Nickens and Hartwell 2001, p. 15). None of these resources has been evaluated for eligibility for the *National Register of Historic Places*, although the segment of the Pony Express Trail intersected by the Carlin Corridor, Rye Patch Alternate, and Monitor Valley Option has been designated a High Potential segment by the National Park Service. The Monitor Valley Option passes within view of the Belmont Historic District at the southern end of the valley, and to the south in Ralston Valley passes close to known but unrecorded and unevaluated archaeological sites, as well as the former bombing range for the Tonopah Army Air Station.

Construction of a branch rail line in this corridor could affect two historic Native American cemeteries, one in Crescent Valley and the other in Grass Valley (DIRS 155826-Nickens and Hartwell 2001, p. 27). The corridor passes within 3 kilometers (2 miles) of another cemetery southeast of Beowawe that local Western Shoshone families still use. Crescent Valley itself is part of the disputed Western Shoshone homelands, and grazing rights throughout the valley have been the subject of litigation between local Western Shoshone ranchers and the Bureau of Land Management.

Operations. As stated in Section 6.3.2.1, additional impacts to these resources during the operation of the branch rail line would be unlikely.

6.3.2.2.2.5 Carlin Rail Occupational and Public Health and Safety

Construction. Industrial safety impacts on workers from the construction and use of the Carlin branch rail line would be small (see Table 6-42). The analysis evaluated the potential for impacts in terms of

Table 6-42. Impacts to workers from industrial hazards during rail construction and operations for the Carlin Corridor.

Group and industrial hazard category	Construction[a]	Operations[b]
Involved workers		
Total recordable cases[c]	99	95
Lost workday cases	49	52
Fatalities	0.14	0.26
Noninvolved workers		
Total recordable cases	5.9	5.4
Lost workday cases	2.2	2.0
Fatalities	0.006	0.006
Totals[d]		
Total recordable cases	110	100
Lost workday cases	51	54
Fatalities	0.14	0.27

a. Totals for 46 months for construction.
b. Totals for 24 years for operations.
c. Total recordable cases includes injury and illness.
d. Totals might differ from sums due to rounding.

total reportable cases of injury, lost workday cases, and fatalities to workers from construction and operation activities.

The analysis also evaluated traffic fatality impacts that would occur during the moving of equipment and materials for construction, worker commutes to and from construction sites, and transport of water to construction sites if wells were not available. Table 6-43 lists these results.

Operations. Incident-free radiological impacts would occur during the routine transportation of spent nuclear fuel and high-level radioactive waste in the Carlin Corridor. Table 6-44 lists the incident-free impacts, which would include transportation along the Carlin Corridor and transportation along railways in Nevada that led to a Carlin branch line. The table includes the impacts of 1,079 legal-weight truck shipments from commercial sites that would not have the capability to load rail casks while operational.

Table 6-43. Estimated number of fatalities from construction material delivery vehicles and construction and operations worker commuting traffic for the Carlin Corridor.

Activity	Kilometers[a]	Traffic fatalities	Emissions fatalities
Construction[b]			
Material delivery vehicles	19,000,000	0.3	0.04
Commuting workers	76,000,000	0.8	0.10
Subtotals	*95,000,000*	*1.1*	*0.14*
Operations[c]			
Commuting workers	68,000,000	0.7	0.09
Totals	*160,000,000*	*1.8*	*0.23*

a. To convert kilometers to miles, multiply by 0.62137.
b. Totals for 46 months for construction.
c. Totals for 24 years for operations.

Table 6-44. Health impacts from incident-free Nevada transportation for the Carlin Corridor.[a]

Category	Legal-weight truck shipments	Rail shipments	Totals[b]
Involved workers			
Collective dose (person-rem)	38	940	980
Estimated latent cancer fatalities	0.02	0.38	0.39
Public			
Collective dose (person-rem)	7	32	38
Estimated latent cancer fatalities	0.003	0.02	0.02
Estimated vehicle emission-related fatalities	0.002	0.017	0.018

a. Impacts are totals for 24 years.
b. Totals might differ from sums of values due to rounding.

6.3.2.2.2.6 Carlin Rail Socioeconomics

The following paragraphs discuss potential socioeconomic impacts associated with the construction of a branch rail line in the Carlin Corridor and with the operation of the line.

The Carlin Corridor passes through Lander County, very small portions of Eureka and Esmeralda Counties, and Nye County. DOE considered potential socioeconomic impacts in Lander, Eureka, and Esmeralda Counties collectively as part of the Rest of Nevada, the portion of the State outside the region of influence.

Construction. The length of the Carlin Corridor, 520 kilometers (323 miles), would determine the number of workers required. The construction of a branch rail line in this corridor would require workers laboring for 2.5 million hours or 1,230 worker-years during the 46-month construction period (DIRS 154822-CRWMS M&O 1998, all). During the work week, the workers would commute to and temporarily live in five construction camps.

Employment

DOE anticipates that total (direct and indirect) employment in Nevada attributable to the construction of a Carlin branch rail line would peak in the first year of construction, 2006, at about 783 jobs, 85 percent of which would be in the region of influence. The increase in employment represents less than 1 percent of the baseline for employment in each of the three counties in the region of influence (Clark, Nye, and Lincoln Counties) and in the Rest of Nevada. Clark County would supply about 574 workers, Nye County 95, and Lincoln County 1. The balance of the workers, 113, would come from the Rest of Nevada. Employment of Carlin Corridor construction workers and some indirect support workers would end in 2009. As a result, the projected total growth of 19,915 jobs (2009 to 2010) in the State of Nevada would be reduced by approximately 700. The expected 14,886 additional jobs in Clark County would be reduced by 690, and the expected growth of 330 jobs in Nye County would be reduced by 46. The expected growth of 24 jobs in Lincoln County would be unaffected. The expected 4,675 additional jobs in the Nevada counties outside the region of influence would be supplemented by 37. DOE anticipates that project-related workers not moving to Carlin Corridor operational jobs would be absorbed in other work in the State. These changes in employment would represent less than 1 percent of the applicable baselines.

Population

Population increases in Nevada attributable to the construction of a Carlin rail line, which would lag increases in employment, would peak 2 years later in 2009 at about 728 persons. About 683 persons, or 94 percent of the expected additional residents, would live in the region of influence. Clark County would gain about 625 residents, Nye County would gain about 57 residents, and Lincoln County would gain 1. The Rest of Nevada, would gain approximately 44 residents. Because Clark County has a larger population, the expected impact from the change in population would be less than 1 percent. The impacts of projected increases in population in Nye and Lincoln Counties, and in the Rest of Nevada would also be less than 1 percent. Because the increases in population resulting from the construction of a rail line in the Carlin Corridor would be small and transient in Clark, Nye, and Lincoln Counties, and in the Rest of Nevada, impacts to schools or housing would be unlikely.

Economic Measures

The expected peak annual changes in economic measures in the State due to the construction of a branch rail line in the Carlin Corridor would be increases of $21.4 million in real disposable income in 2009; $36.0 million in Gross Regional Product during 2007; and $2.5 million in State and local expenditures in 2009 with 90 percent concentrated in the region of influence. More than 90 percent of the increase in Gross Regional Product and real disposable income would be generated in Clark County. Clark County would absorb approximately 83 percent of the increases in State and local government expenditures. About 3 percent of the increase in Gross Regional Product and real disposable income would be generated in Nye County as would 7 percent of the expenditures by State and local governments. Because there would be virtually no change to employment or population in Lincoln County attributable to a rail line in the Carlin Corridor, there would be virtually no impact or change to Gross Regional

Product, real disposable income, or expenditures by State and local government. (Dollar values reported in this section are in 2001 dollars unless otherwise stated.)

Construction-related impacts to employment, population, real disposable income, Gross Regional Product, and State and local government expenditures for a branch rail line in the Carlin Corridor would be less than 1 percent of the applicable baselines for Clark, Nye, and Lincoln Counties and the Rest of Nevada.

Transition and Operations Period. In the period from 2010 to 2012, the State of Nevada would have an average of 27 fewer jobs. For perspective, the State of Nevada would have an average employment of about 1.5 million during this same period. Slightly slower growth would be confined to Clark County from 2010 to 2016. Growth in employment in Clark County during this transitional period would be approximately 66 fewer jobs than if DOE did not build a branch rail line in the Carlin Corridor. The Lincoln County employment baseline during this period would average about 75,000 jobs. During this period, Nye County would gain 5 jobs. There would be no change in employment in Lincoln County. A Carlin branch rail line would accelerate the rate of growth in the region's employment starting in 2016. The area outside the region of influence, the Rest of Nevada, would gain approximately 78 project-related jobs during this transition period. A Carlin rail line would contribute to growth in residential populations in and outside the region of influence throughout the transition period and to the employment base in the State after 2012.

Employment and Population

Estimated direct employment for operations in the Carlin Corridor would be 47 workers during the 24 years of operations. The change in total employment would average about 86 jobs in Nevada. DOE assumed that 6 of the additional workers would be employed in Clark County, about 6 in Nye County, and none in Lincoln County. The rest of the individuals would work in the Rest of Nevada, primarily in Elko County. The average annual addition to population in the State attributable to a branch rail line in the Carlin Corridor would be about 294 persons. About 160 of these persons would live in Clark County, 31 in Nye County, and none in Lincoln County. The rest of the individuals would live elsewhere within the State. DOE assumed that half of the Carlin rail operational personnel (approximately 24 directly employed individuals) would live at each end of the branch rail line. Rail operations employees and indirectly employed individuals who would live near the Beowawe end of the rail line would live in or near the Town of Elko in Elko County. Impacts due to changes in population and employment attributable to a Carlin rail line in Elko County, which had an estimated 2000 population of about 45,500 and about 21,100 jobs, would be less than 0.5 percent. Because impacts from increases in population and employment in each county would be small, impacts to schools or housing would be unlikely. The average annual impact, in relation to the baselines for population and employment in Clark, Nye, and Lincoln Counties and the Rest of Nevada, would be less than 1 percent.

Economic Measures

From 2010 until 2033 the estimated average annual increase in Nevada from operating a branch rail line in the Carlin Corridor in real disposable income would be $5.7 million. Approximately 33 percent would be generated in the region of influence, and the balance would be generated primarily in Elko County. The average increase in annual Gross Regional Product in the State attributable to a Carlin rail line would be about $5.3 million, of which $4.9 million would come from goods and services outside the region of influence. On average, during operation of a Carlin rail line, changes in real disposable income would exceed changes in Gross Regional Product. The increase in annual State and local government expenditures would be about $1.2 million, much lower than those reported above for construction. Approximately 46 percent of these additional expenditures would come from outside the region of influence. The impact of changes in Gross Regional Product, real disposable income, and expenditures by State and local governments would be less then 1 percent for Clark, Nye, and Lincoln Counties and for the Rest of Nevada.

DOE performed a detailed analysis for the Carlin rail line because of its length. The results of this analysis are representative of the potential variations (options and alternates) listed in Appendix J, Section J.3.1.2. The lengths of the variations are similar to those listed in Table 6-36.

6.3.2.2.2.7 Carlin Rail Noise and Vibration

Over most of its length, the Carlin Corridor, including the Monitor Valley and Big Smoky Valley Options, passes through undeveloped land managed by the Bureau of Land Management. Human inhabitants of this land consist primarily of isolated ranchers and persons involved with outdoor recreation. DOE identified 12 communities along or near the Carlin Corridor (including its Monitor Valley and Big Smoky Valley Options) and estimated the distances from a branch rail line to the community's nearest boundary (Table 6-45). The estimated maximum railroad noise from a two-locomotive train would occur at the boundary of the community. Estimated noise levels would not exceed the 60-dBA benchmark for residential communities during daytime hours. Communities within 1 kilometer (0.6 mile) of the rail line would experience single episodes of noise higher than the nighttime 50-dBA benchmark. A limitation of 10 dBA above the benchmark is allowable if its duration is less than 5 minutes in an hour (Washington Administrative Code-170-60). The estimated duration of noise that peaked at 57 dBA would be less than 2 minutes in communities 1 kilometer from the rail line at a speed of 50 kilometers (30 miles) per hour. For distances of 5 kilometers (3 miles) or greater, the estimate of 26 dBA would be subject to large uncertainty.

Table 6-45. Estimated propagation of noise (dBA) from the operation of a waste transport train with two locomotives in communities near the Carlin Corridor.

Corridor/community	Distance (kilometers)[a]	Estimated noise (dBA)[b]
Carlin Corridor		
Beowawe	3.2[c]	32
Crescent Valley	1.9	44
Austin	16	< 26
Big Smoky Valley Option		
Carver	1.0	57
Round Mountain	1.0	57
Manhattan	1.0	57
Monitor Valley Option		
Belmont	2.0	43
Tonopah (east alignment)	8[c]	< 26[d]
Tonopah (west alignment)	13[c]	< 26
Goldfield	6.0	< 26
Beatty	9.6[c]	< 26
Amargosa Valley	9.6[c]	< 26

a. To convert kilometers to miles, multiply by 0.62137.
b. Estimated values do not include noise loss due to interactions with the ground that could account for decreases in estimated noise levels of from 10 to 20 dBA at 100 meters (330 feet) from the tracks.
c. Noise estimates at distances greater than 2.0 kilometers (1.2 miles) have large uncertainty.
d. At these distances, the A-weighted sound pressure level is dominated by lower frequencies (lower than 63 Hertz) and would not be distinguishable from normal background levels of noise.

In addition to passing near communities, the variations of the Carlin Corridor pass through areas with farms and ranches. Therefore, some rural residences could fall in the region of influence for noise. The corridor and its 10 variations (see Appendix J, Section J.3.1.2) are at least 1 kilometer (0.6 mile) or more from every town along its length. The noise from trains would not exceed daytime noise standards for residential areas (60 dBA) more than 1 kilometer from a branch rail line. Because a Carlin rail line would pass near some communities, there would be a potential for noise impacts from both construction and operations. As discussed in Section 6.3.2.1, in areas where a branch rail line or variation passed near a community, train speeds could be limited to the extent necessary to ensure that noise was below levels listed in accepted noise standards.

The Carlin Corridor passes within 1.9 kilometers (1.2 miles) of the border of the Timbisha Shoshone Trust Lands parcel. The Bonnie Claire Alternate of the corridor passes through 4.1 kilometers (2.5 miles) of the Timbisha Shoshone Trust Lands parcel near the intersection of State Route 267 and U.S. Highway 95. Noise levels from trains passing through the parcel would be at 90 dBA at 15 meters (49 feet) for the Bonnie Claire Alternate. At the closest point of the Carlin Corridor, the estimated noise levels would be 44 dBA.

The estimated population residing within 2 kilometers (1.25 miles) of the Carlin Corridor in 2035 would be about 3,200 persons. The potential for human annoyance would be small.

Vibration. There are no known ruins of cultural significance along the Carlin Corridor. A branch rail line in the corridor or its variations would be distant from historic structures and buildings, so vibration impacts to such structures would be unlikely. The small number of trips (three per day) and the small train size would result in low levels of rail-induced ground vibration.

6.3.2.2.2.8 Carlin Rail Utilities, Energy, and Materials

Table 6-46 lists the projected use of fossil fuels and other materials in the construction of a Carlin branch rail line.

Table 6-46. Construction utilities, energy, and materials for a Carlin branch rail line.

Length (kilometers)[a]	Diesel fuel use (million liters)[b]	Gasoline use (thousand liters)	Steel (thousand metric tons)[c]	Concrete (thousand metric tons)
510 - 540	39 - 41	790 - 840	71 - 75	400 - 420

a. To convert kilometers to miles, multiply by 0.62137.
b. To convert liters to gallons, multiply by 0.26418.
c. To convert metric tons to tons, multiply by 1.1023.

6.3.2.2.3 *Caliente-Chalk Mountain Rail Corridor Implementing Alternative*

The Caliente-Chalk Mountain Corridor is identical to the Caliente Corridor until it reaches the northern boundary of the Nellis Air Force Range. At this point the Caliente-Chalk Mountain Corridor turns south through the Nellis Air Force Range and the Nevada Test Site to the Yucca Mountain site. Figure 6-17 shows this corridor along with possible variations identified by engineering studies (DIRS 154822-CRWMS M&O 1998, all). The corridor variations provide flexibility in addressing engineering, land-use, or environmental resource issues that could arise in a future survey along the corridor. This section addresses impacts that would occur along the corridor shown in Figure 6-17. With the exception of differences identified in Appendix J, Section J.3.1.2, the impacts would be generally the same among the possible corridor variations. The corridor is 345 kilometers (214 miles) long from its link at the Union Pacific railroad near Caliente to Yucca Mountain. Variations of the route range from 340 to 380 kilometers (210 to 240 miles).

The construction of a branch rail line in the corridor would require approximately 43 months. Construction would take place simultaneously at a number of locations. An estimated four construction camps would be established at roughly equal distances along the corridor. These camps would provide temporary living accommodations for construction workers and construction support facilities. A train would take about 8 hours to travel from the junction with the Union Pacific mainline to a Yucca Mountain Repository on a Caliente-Chalk Mountain branch rail line (DIRS 101214-CRWMS M&O 1996, Volume 1, Section 4, Branch Line Operations Plan). The estimated life-cycle cost to construct and operate a branch rail line in the Caliente-Chalk Mountain Corridor would be $622 million in 2001 dollars.

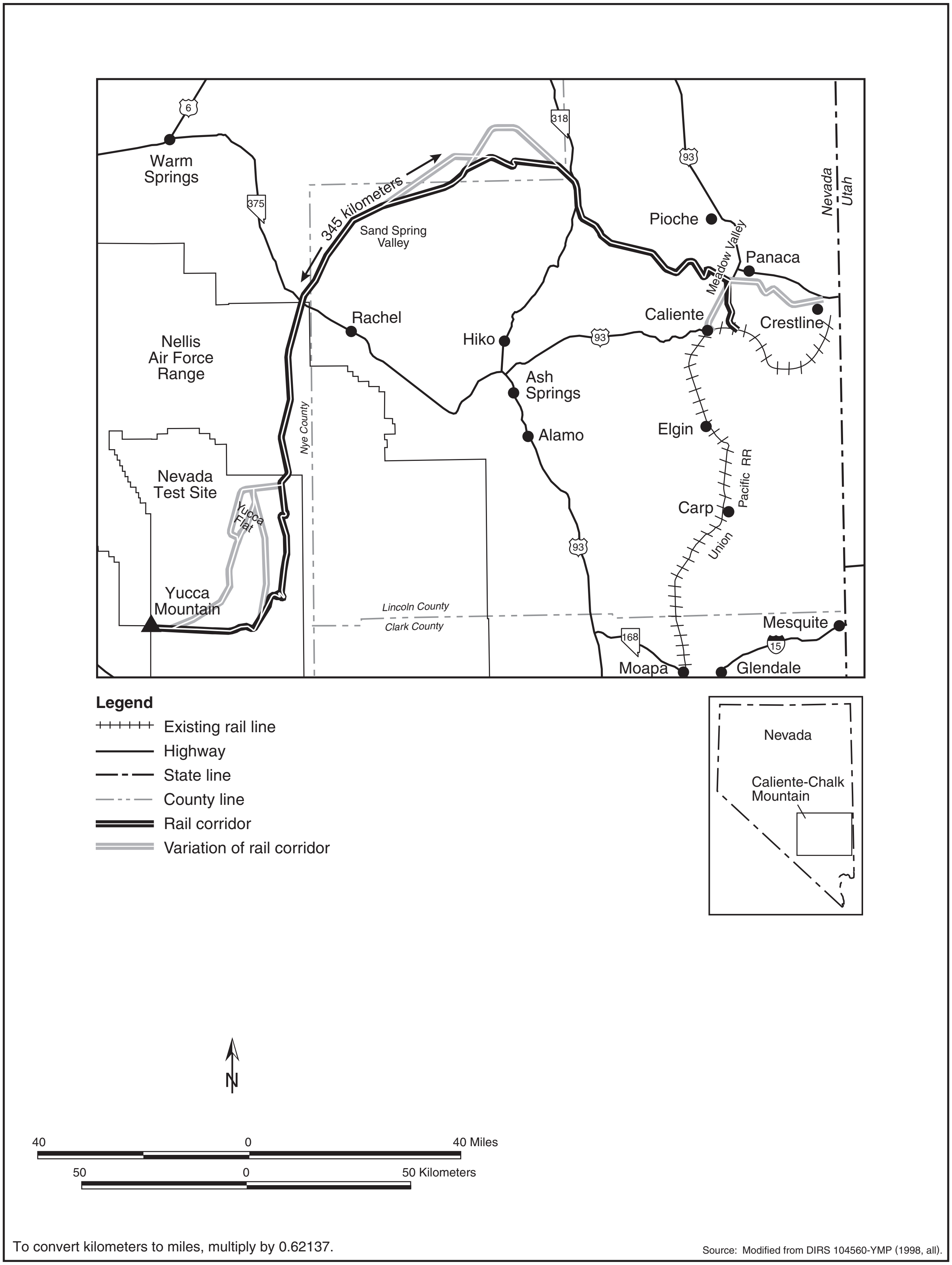

Figure 6-17. Caliente-Chalk Mountain Corridor.

The following sections address impacts that would occur to land use; biological resources and soils; cultural resources; hydrology including surface water and groundwater; occupational and public health and safety; socioeconomics; noise and vibration; and utilities, energy, and materials. Impacts that would occur to air quality, aesthetics, and waste management would be the same as those discussed in Section 6.3.2.1 and are, therefore, not repeated here. Section 6.3.4 discusses the potential for transportation activities to cause environmental justice impacts in Nevada.

6.3.2.2.3.1 Caliente-Chalk Mountain Rail Land Use and Ownership

Construction. Table 6-47 summarizes the amount of land required for the Caliente-Chalk Mountain corridor, its ownership, and the estimated amount of land that would be disturbed. Table 6-48 summarizes the amount of land required for the Caliente-Chalk Mountain corridor variations and its ownership.

Table 6-47. Land use in the Caliente-Chalk Mountain Corridor.[a]

Factor	Corridor (percent)	Range due to variations
Corridor length (kilometers)[b]	345	344 - 382
Land area in 400-meter[c]*-wide corridor (square kilometers)*[d]	138 (100)	138 - 153
Land ownership in 400-meter-wide corridor (square kilometers)		
Bureau of Land Management	78 (56)[e]	77.4 - 88.5
Air Force	21.5 (16)	21.5 - 21.5
DOE	37.8 (27)	31.5 - 37.8
Private	0.8 (0.6)	0.8 - 1.1
Other	None	None
Land area in 60-meter[f] *right-of-way (square kilometers)*	20.7	20.6 - 22.9
Disturbed land (square kilometers)		
Inside 60-meter right-of-way	9.6	9.6 - 10.6
Outside 60-meter right-of-way	3	3 - 3.4

a. Source: DIRS 155549-Skorska (2001, all).
b. To convert kilometers to miles, multiply by 0.62137.
c. 400 meters = about 0.25 mile.
d. To convert square kilometers to acres, multiply by 247.1.
e. Percentages do not total 100 due to rounding.
f. 60 meters = 200 feet.

The Caliente-Chalk Mountain Corridor would involve several road, power line, and utility rights-of-way before it entered the Nellis Air Force Range west of Groom Mountain and then the Nevada Test Site. The rights-of-way are similar to those discussed in relation to the Caliente Corridor and therefore the land-use impacts for this section of the corridor would be similar (see Sections 6.3.2.1 and 6.3.2.2.1). South of Rachel, Nevada the corridor crosses an additional road right-of-way (DIRS 104993-CRWMS M&O 1999, Table 5, p. 18). Variations of the corridor, as indicated in Appendix J, Section J.3.1.2, provide flexibility to address engineering, land use, or environmental constraints. Included are variations identified to provide flexibility to circumvent Test Site surface areas and associated facilities and radiologically contaminated areas. The corridor would also cross five oil and gas leases and three grazing allotments (Highland Peak, Bennett Springs, and Black Canyon). Many of the impacts along the Caliente-Chalk Mountain Corridor would be similar to those described for the Caliente Corridor (see Section 6.3.2.2.1) or are common to all five rail corridors as discussed in Section 6.3.2.1. The following paragraphs discuss impacts unique to the Caliente-Chalk Mountain Corridor.

Table 6-48. Possible variations in the Caliente-Chalk Mountain Corridor.[a]

Variation	Length (kilometers)[b]	Land area in variation (square kilometers)[c]	Land ownership [square kilometers (percent)] Bureau of Land Management	Private	DOE
Eccles Option	16.7	6.7	6.3 (95)	0.4 (5)	--[e]
Caliente Option	17.2	6.9	6.21 (90)	0.69 (10)	--
Crestline Option	37.8	15.1	14.5 (95.9)	0.6 (4.1)	--
White River Alternate	47.5	19	18.98 (99.9)	0.02 (<0.1)	--
Garden Valley Alternate	37.7	15.1	15.1 (100)	--	--
Orange Blossom Road Option	85.9	34.4	--	--	34.4 (100)
Topopah Option	78.4	31.4	--	--	31.4 (100)
Topopah Option with Mine Mountain Alternate	77.8	31.1	--	--	31.1 (100)
Topopah Option with Area 4	72.1	28.8	--	--	28.8 (100)
Mercury Highway Option	52.3	20.9	--	--	20.9 (100)

a. Source: DIRS 155549-Skorska (2001, all).
b. To convert kilometers to miles, multiply by 0.62137.
c. To convert square kilometers to acres, multiply by 247.1.
d. NA = not applicable; the Eccles Option and Orange Blossom Road Option lengths are included in the overall corridor length.
e. -- = none.

The Caliente-Chalk Mountain Corridor passes just east of the Weepah Springs Wilderness Study Area and just north of the Worthington Mountains Wilderness Study Area. The corridor involves land controlled by the Nellis Air Force Range (also known as the Nevada Test and Training Range) and, according to the Air Force, would affect Range operations. Because the Military Lands Withdrawal Act of 1999 (Public Law 106-65, 113 Stat. 885) withdraws and reserves the Nellis Air Force Range for use by the Secretary of the Air Force, the Secretary would need to concur with a decision to build and operate a branch rail line through any part of the Range before DOE could build and operate this line.

Operations. DOE expects operations along the Caliente-Chalk Mountain Corridor to cause smaller impacts than the construction phase of the project.

The Air Force has identified national security issues related to a Chalk Mountain route (DIRS 104887-Henderson 1997, all), citing interference with Nellis Air Force Range testing and training activities. In response to Air Force concerns, DOE regards the route as a “non-preferred alternative.”

6.3.2.2.3.2 Caliente-Chalk Mountain Rail Hydrology

Surface Water

Chapter 3, Section 3.2.2.1.3, discusses surface-water resources along the Caliente-Chalk Mountain Corridor; Table 6-49 summarizes these resources. The use of corridor variations could result in changes to the number of surface-water resources in the vicinity of the corridor. However, the changes would be primarily to the number of resources outside, but within 1 kilometer (0.6 mile), of the corridor. As discussed in Section 6.3.2.1, impacts during construction or operations from the possible spread of construction-related materials by precipitation or intermittent runoff events, releases to surface waters, and the alteration of natural drainage patterns or runoff rates that could affect downgradient resources would be unlikely.

Table 6-50 lists flood zones identified along the Caliente-Chalk Mountain Corridor and its variations. This corridor would cross at least three 100-year flood zones or flood-zone groups before entering the Nellis Air Force Range. Two of the four variations would change the number of flood zones crossed by one (up or down). The low number of flood zones identified for the Caliente-Chalk Mountain Corridor must be qualified by the fact that the Federal Emergency Management Agency maps, from which DOE

Table 6-49. Surface-water resources along Caliente-Chalk Mountain Corridor and its variations.[a,b,c]

Corridor description	Resources in 400-meter[d] corridor			Resources outside corridor within 1 kilometer[e]		
	Spring	Stream/ riparian area	Reservoir	Spring	Stream/ riparian area	Reservoir
Caliente-Chalk Mountain Corridor	--[f]	2	--	5	--	--
with Crestline Option	--	2	--	7	--	--
with Caliente Option	1	2	--	7	--	--
with Topopah Option	--	2	--	4	--	--
with Topopah-Area 4 Alternate	--	2	--	3	--	--
with Topopah-Mine Mountain Alternate	--	2	--	4	--	--

a. Source: Reduced from table in Chapter 3, Section 3.2.2.1.3.
b. Resources are the number of locations; that is, DOE counted a general location with more than one spring as one water resource.
c. Resources listed for variations are for the entire corridor with only the identified variations changed. Variations not listed (White River Alternate, Garden Valley Alternate, Mercury Highway Connection, Orange Blossom Road Option) are not associated with identified water resources, nor would they avoid resources along the corridor.
d. 400 meters = about 0.25 mile.
e. 1 kilometer = about 0.6 mile.
f. -- = none.

derived the flood zone information, provided coverage for only about 10 percent of the corridor length. As indicated in Section 6.3.2.1, impacts associated with altering drainage patterns or changing erosion and sedimentation rates or locations would be minor and localized.

Groundwater

Construction. The water used during construction would come largely from groundwater resources. The annual demands would be a fraction of the perennial yields of most producing aquifers (Chapter 3, Section 3.2.2.1.3, discusses estimated perennial yields for the hydrographic areas over which the Caliente-Chalk Mountain Corridor passes).

The estimated amount of water needed for construction of a branch rail line in the corridor for soil compaction, dust control, and workforce use would be about 594,000 cubic meters (480 acre-feet) (DIRS 104914-DOE 1998, all). For planning purposes, DOE assumed that this water would come from 43 wells installed along the corridor. The average amount of water withdrawn from each well would be approximately 14,000 cubic meters (11 acre-feet). DOE would use most (90 percent) of the water for compaction of fill material, and the estimate of fill quantities needed for construction would vary if the Department used variations. Use of either the Topopah or Mercury Highway Options on the Nevada Test Site would involve the largest increase in fill material and could increase the total water needed for this corridor by as much as 16 percent.

Chapter 3, Section 3.2.2.1.3, discusses the hydrographic areas over which the corridor would pass, their perennial yields, and if the State of Nevada considers each a Designated Groundwater Basin. If the hydrographic area is a Designated Groundwater Basin, permitted groundwater rights approach or exceed the estimated perennial yield, depleting the basin and water resources or requiring additional administration. Table 6-51 summarizes the status of the hydrographic areas associated with the Caliente-Chalk Mountain Corridor and the approximate portion of the corridor that passes over Designated Groundwater Basins. Use of the variations (Caliente Option, Crestline Option, White River Alternate, Garden Valley Alternate, Mercury Highway Option, Topopah Option, Mine Mountain Alternate, Orange Blossom Road Option, and Area 4 Alternate) would change the number of hydrographic areas crossed, but would have no effect on the portion of the corridor crossing Designated Groundwater Basins.

Table 6-50. 100-year flood zones crossed by the Caliente-Chalk Mountain Corridor and its variations.[a,b]

Corridor portion	Crossing distance (kilometers)[c]	Flood zone feature(s)	Avoided by variation[d] (yes or no)
Eccles Siding to Meadow Valley	0.2[e]	Clover Creek (intermittent)	Y-1
	0.8[e]	Meadow Valley Wash (wet)	Y-1,2
Meadow Valley Wash to Sand Spring Valley	0.5[e]	White River (intermittent)	N
Sand Spring Valley to Yucca Mountain	--[f,g]	Not available	
Variations			
1. Crestline Option	0.8	Crosses Meadow Valley Wash (wet)	
2. Caliente Option	0.8	Crosses Meadow Valley Wash (wet)	
	0.2	Crosses Clover Creek (intermittent)	
	0.9	Crosses Meadow Valley Wash (wet) three times, rail corridor runs adjacent to Meadow Valley Wash. Passes in and out of flood zone	
3. White River Alternate	None	Located to the north of the corridor	
4. Garden Valley Alternate	None	Located to the north of the corridor	
5. Topopah Option	--[g]	Located adjacent to corridor	
5a. Area 4 Alternate	--[g]	Variation along the Topopah Option	
5b. Mine Mountain Alternate	--[g]	Variation along the Topopah Option	
6. Mercury Highway Option	--[g]	Located adjacent to corridor	

a. Areas where natural floodwater movement might be altered and where erosion and sedimentation rates and locations could change. Sources:
   1. Federal Emergency Management Agency Flood Insurance Rate Maps for Lincoln and Nye Counties, Nevada.
   2. DIRS 154961-CRWMS M&O (1998, all).

b. About 91 percent of the Caliente-Chalk Mountain Corridor is not available on Federal Emergency Management Agency maps, due primarily to limited coverage in Lincoln County, the Nellis Air Force Range, and the Nevada Test Site.

c. To convert kilometers to miles, multiply by 0.62137.

d. Certain 100-year flood zones can be avoided by corridor variations. These are identified with a "Y" (yes) and a number representing the specific variation(s) that avoid the specific flood zone. The same flood zone might be crossed by both the corridor and variations at different locations. In such cases, the feature will be marked "Avoided" for the corridor route, but will appear again for the variations.

e. Projected from limited data. Specific area not covered by Federal Emergency Management Agency maps; values were extrapolated from the closest maps.

f. No information available on Federal Emergency Management Agency maps.

g. Limited information due to the Nellis Air Force Range or the Nevada Test Site.

Table 6-51. Hydrographic areas along Caliente-Chalk Mountain Corridor and its variations.

		Designated Groundwater Basins	
Description	Hydrographic areas	Number	Percent of corridor length
Caliente-Chalk Mountain Corridor	11	2	30
Variations[a]	10 to 12	2	30

a. Several of the variations would involve small changes in the hydrographic areas crossed or the crossing distances. However, all (Caliente Option, Crestline Option, White River Alternate, Garden Valley Alternate, Mercury Highway Option, Topopah Option, Mine Mountain Alternate, Orange Blossom Road Option, and Area 4 Alternate) would cross the same two Designated Groundwater Basins. Rounded to the nearest 10 percent, this would represent the same portion of the total corridor.

The withdrawal of about 14,000 cubic meters (11 acre-feet) a year from a well would have little impact on the hydrographic areas associated with the corridor based on their perennial yields (Chapter 3, Section 3.2.2.1.3). However, the installation of 43 wells along the corridor would mean that many hydrographic areas would have multiple wells. As listed in Table 6-51, about 30 percent of the corridor length is over

Designated Groundwater Basins, which the Nevada State Engineer's office watches carefully for groundwater depletion. This does not mean that DOE could not obtain water appropriations in these areas; the State Engineer would have the authority to approve such appropriations. Because the DOE requests would be for a short-term construction action, the State Engineer would have even more discretion. Rather than spacing the wells evenly along the corridor, DOE could use well locations that would make maximum use of groundwater areas that are not Designated Groundwater Basins. Another option would be to lease temporary water rights from individuals along the corridor. Obtaining a water appropriation from the State Engineer for short-term construction use or using an approved allocation should ensure that groundwater resources did not receive adverse impacts.

As an alternative, DOE could transport water by truck to meet construction needs. The construction of a branch rail line in the Caliente-Chalk Mountain Corridor would require about 32,000 tanker-truck loads of water or about eight truckloads each day for each work camp area along the corridor. Again, water obtained from permitted sources, which would provide water in allocations determined by the Nevada State Engineer, would not affect groundwater resources.

Operations. Operations along a completed rail line would have little impact on groundwater resources. Possible changes in recharge, if any, would be the same as those at the completion of construction.

6.3.2.2.3.3 Caliente-Chalk Mountain Rail Biological Resources and Soils

Construction. The construction of a branch rail line in the Caliente-Chalk Mountain Corridor, including potential variations, would disturb about 12 square kilometers (3,000 acres) of land (Table 6-47). The analysis assumed that the types of land cover in disturbed areas outside the corridor would be the same as that within the corridor. Areas in eight of the land-cover types identified in Nevada (DIRS 104593-CRWMS M&O 1999, pp. C1 to C5) would be affected (Table 6-52). The greatest amounts of disturbance would occur in the salt desert scrub, sagebrush, and blackbrush land cover types, but would involve far less than 0.01 percent of the existing area in those types. The fraction disturbed for each cover type would be very small. The disturbance would have no discernable impact on the availability of habitat for plants or animals associated with any cover type. Although some alignment variations could lead to a small increase in the total amount of land disturbed, the portion of the corridor, including its variations, in each land-cover type would be similar to the unvaried corridor.

About 40 kilometers (25 miles) of the corridor length at its southern end, including potential variations, crosses desert tortoise habitat. Assuming that 0.06 square kilometer (15 acres) would be disturbed for each linear kilometer of railroad, construction activities would disturb as much as 2.4 square kilometers (590 acres) of desert tortoise habitat, some of which is classified as critical habitat. Such activities could kill individual desert tortoises; however, their abundance is low in this area (DIRS 101914-Rautenstrauch and O'Farrell 1998, pp. 407 to 411) so losses would be few. The presence of a branch rail line could interfere with movements of individual tortoises. Relocation of tortoises along the corridor prior to construction would minimize losses of individuals. If DOE selected this corridor, it would consult with the Fish and Wildlife Service (under Section 7 of the Endangered Species Act) in relation to this species and would implement all terms and conditions required by the Fish and Wildlife Service.

Although the southwestern willow flycatcher occurs near some portions of the Caliente-Chalk Mountain Corridor, there is no suitable habitat of dense riparian vegetation for this listed endangered species in the corridor (DIRS 152511-Brocoum 2000, pp. A-9 to A-13).

The Eccles, Crestline, and Caliente variations for this corridor cross a portion of the Meadow Valley Wash, which is habitat for an unnamed subspecies of the Meadow Valley Wash speckled dace and the Meadow Valley Wash desert sucker, both of which are sensitive species (see Chapter 3, Section 3.2.2.1.4). The construction of a branch rail line near Caliente could temporarily affect populations of these fish by increasing the sediment load in the wash during construction. Three special status plant

Table 6-52. Maximum area disturbed (square kilometers)[a] in each land-cover type for the Caliente-Chalk Mountain Corridor.[b,c]

Land cover type	Percent of corridor length	Area disturbed	Area in Nevada	Percent disturbed
Agriculture	0.5	0.05	5,200	0.01
Blackbrush	24.8	2.45	9,900	0.02
Creosote-bursage	0.0	0	15,000	0
Grassland	0.4	0.04	2,800	0.001
Greasewood	0.0	0	9,500	0
Hopsage	1.9	0.19	630	0.03
Juniper	0.0	0	1,400	0
Mojave mixed scrub	2.4	0.24	5,600	0.004
Pinyon-juniper	0.0	0	14,700	0
Playa	0.0	0	7,000	0
Sagebrush	30.1	3	67,000	0.004
Sagebrush/grassland	0.4	0.04	52,000	<0.001
Salt desert scrub	39.3	3.89	58,000	0.007
Urban		ND[d]	2,400	ND

a. To convert square kilometers to acres, multiply by 247.1.
b. Based on the proportion of the route in each land-cover type; percent disturbed was based on the variation with the greatest disturbance within a particular land-cover type. Percentages add to more than 100 because maximum values were used.
c. Source: DIRS 104593-CRWMS M&O (1999, Appendix D).
d. ND = not determined.

species are found along this corridor and its variations but could be avoided during land-clearing activities and would not be affected.

At least 40 populations of five sensitive plant species occur outside the 400-meter (0.25-mile)-wide corridor, but within 5 kilometers (3 miles) of the corridor. Several other populations of three other sensitive plant species occur within 5 kilometers of one or more of the corridor variations listed in Appendix J, Section J.3.1.2. DOE anticipates that these populations would be unaffected because land disturbance would not extend to these areas and changes in the aquatic or soil environment in these areas as a result of construction or the long-term presence of a railroad would be unlikely.

This rail corridor, including variations, would cross seven areas designated as game habitat and two areas designated as wild horse or wild horse and burro management areas. Construction activities would reduce habitat in these areas. Depending on the variation, several other designated game habitat areas could be within 5 kilometers (3 miles) of a rail line in the corridor. Game animals, burros, and horses near areas of active construction would be disturbed and their migration routes could be disrupted.

Two stream or riparian areas and possibly one spring (with the Caliente Option) are within the 0.4-kilometer (0.25-mile)-wide corridor, including its variations (Table 6-50). Although no formal delineations have been made, these areas may be jurisdictional wetlands or other waters of the United States. Construction could increase sedimentation in these areas. The corridor, including its potential variations, also crosses a number of ephemeral streams that may be classified as waters of the United States. DOE would work with the U.S. Army Corps of Engineers to minimize impacts to these areas and would obtain individual or regional permits if necessary. DOE anticipates some changes to local drainage along the branch rail line and would design the rail line to accommodate existing drainage patterns.

As many as 14 springs and riparian areas occur outside the 400-meter (0.25-mile)-wide corridor and its variations, but within 5 kilometers (3 miles) of the corridor under the variations. Eight known populations of three sensitive animal species are associated with these aquatic resources. DOE anticipates that these populations would be unaffected and these areas would not be disturbed during construction or by the long-term presence of a railroad.

Soils in and adjacent to the corridor would be disturbed on approximately 12 square kilometers (3,000 acres) of land. The impacts of disturbing 12 square kilometers of soil along the 345-kilometer (214-mile)-long corridor would be transitory and small. However, several soil characteristics could influence construction activities and the amount of area disturbed. Soils susceptible to water or wind erosion occur along much of the corridor and its variations as do soils exhibiting relatively high shrink-swell characteristics (see Chapter 3, Section 3.2.2.1.4). Disturbance of erodible soils could lead to increased silt loads in water courses or increased soil transport by wind. Erosion control during construction and revegetation, or other means of soil stabilization after construction, would minimize these concerns. The presence of soils with poor (that is high) shrink-swell characteristics could influence the amount of area disturbed by construction if soils from outside areas had to be brought in for replacement or mixing with native soil.

As stated in Chapter 3, Section 3.2.2.1.4, variations identified for the Caliente-Chalk Mountain Corridor could avoid some biological resources, as listed in Table 6-53.

Table 6-53. Biological resources avoided by Caliente-Chalk Mountain Corridor variations.[a,b,c]

	Occurrence of resource			
	For unvaried segment of corridor		Occurrence avoided by variation	
Alignment variation resource	In corridor[b]	Within 5 km[c]	In corridor	Within 5 km
Caliente Variation				
Sensitive species–Needle Mountain Milkvetch	0	3	0	1
Springs or groups of springs	1	14	0	1
Crestline Variation				
Sensitive species–Needle Mountain Milkvetch	0	3	0	3
Springs or groups of springs	1	14	0	4
Mercury Highway, Topopah, Mine Mountain, and Area 4 Variations				
Sensitive species				
Beatley's scorpionweed	0	17	0	17
Funeral Mountain milkvetch	0	1	0	1
Largeflower suncup	1	18	1	17
Ripley's springparsley	1	1	1	0
Mine Mountain Variation only				
Sensitive species				
Largeflower suncup	0	1	0	1
Oasis Valley springsnail	0	1	0	1
Springs or groups of springs	1	14	0	1

a. Variations listed are those that would result in the avoidance of biological resources along the corridor.
b. In the corridor [or springs within 400 meters (0.25 mile)], but avoided by the corridor variation.
c. Within 5 kilometers (3 miles) of the corridor, but more than 5 kilometers from the corridor variation.

6.3.2.2.3.4 Caliente-Chalk Mountain Rail Cultural Resources

Construction. The potential for cultural resource impacts in the Caliente-Chalk Mountain Corridor would be identical to that for the Caliente Corridor, as discussed in Section 6.3.2.2.1.4, until the Caliente-Chalk Mountain Corridor diverges at the northern boundary of the Nellis Air Force Range. From that point south the corridor passes through the Range and the Nevada Test Site to the repository site.

Archaeological site file searches have identified the presence of 100 recorded sites in the Caliente-Chalk Mountain Corridor (see Chapter 3, Section 3.2.2.1.5), including the variations (Appendix J, Section J.3.1.2). Of these, 34 are potentially eligible for inclusion in the *National Register of Historic Places.* Precise impacts to any of these resources cannot be specified until the rail alignment has been identified and its relationship to the known archaeological sites evaluated. At some point on the Nevada

Test Site, the Caliente-Chalk Mountain Corridor would intersect the 1849 Jayhawker's Emigrant Trail, but because physical expressions of the trail are unlikely, no direct impacts would occur. Although there are no known Native American resources in the corridor, there have been no field ethnographic studies. If DOE selected this corridor, this assessment of the potential for such impacts would have to wait until the completion of field studies involving Native Americans.

Operations. As stated in Section 6.3.2.1, additional impacts to these resources during the operation of the branch rail line would be unlikely.

6.3.2.2.3.5 Caliente-Chalk Mountain Rail Occupational and Public Health and Safety

Construction. Industrial safety impacts on workers from the construction and use of the Caliente-Chalk Mountain branch rail line would be small (Table 6-54). The analysis evaluated the potential for impacts in terms of total reportable cases of injury, lost workday cases, and fatalities to workers and the public from construction and operation activities. The analysis also evaluated traffic fatality impacts that would occur in moving equipment and materials for construction, worker commutes to and from construction sites, and transport of water to construction sites if wells were not available. Table 6-55 lists these results.

Table 6-54. Impacts to workers from industrial hazards during rail construction and operations for the Caliente-Chalk Mountain Corridor.

Group and industrial hazard category	Construction[a]	Operations[b]
Involved workers		
Total recordable cases[c]	79	95
Lost workday cases	39	52
Fatalities	0.11	0.26
Noninvolved workers		
Total recordable cases	4.8	5.4
Lost workday cases	1.8	2.0
Fatalities	0.005	0.006
Totals[d]		
Total recordable cases	84	100
Lost workday cases	41	54
Fatalities	0.12	0.27

a. Totals for 43 months for construction.
b. Totals for 24 years for operations.
c. Total recordable cases includes injury and illness.
d. Totals might differ from sums due to rounding.

Operations. Incident-free radiological impacts would occur during the routine transportation of spent nuclear fuel and high-level radioactive waste in the Caliente-Chalk Mountain rail corridor.

Table 6-56 lists the incident-free impacts, which include transportation along the corridor and along railways in Nevada leading to a Caliente-Chalk Mountain branch line. The table includes the impacts of 1,079 legal-weight truck shipments from commercial sites that do not have the capability to load rail casks while operational.

6.3.2.2.3.6 Caliente-Chalk Mountain Rail Socioeconomics

The following paragraphs discuss potential socioeconomic impacts associated with the construction and operation of a branch rail line in the Caliente-Chalk Mountain Corridor.

Table 6-55. Estimated number of fatalities from construction material delivery vehicles and construction and operations worker commuting traffic for the Caliente-Chalk Mountain Corridor.

Activity	Kilometers[a]	Traffic fatalities	Emissions fatalities
Construction[b]			
Material delivery vehicles	14,000,000	0.2	0.03
Commuting workers	61,000,000	0.6	0.08
Subtotals	*75,000,000*	*0.8*	*0.11*
Operations[c]			
Commuting workers	68,000,000	0.7	0.09
Totals	***140,000,000***	***1.5***	***0.2***

a. To convert kilometers to miles, multiply by 0.62137.
b. Totals for 43 months for construction.
c. Totals for 24 years for operations.

Table 6-56. Health impacts from incident-free Nevada transportation for the Caliente-Chalk Mountain implementing alternative.[a]

Category	Legal-weight truck shipments	Rail shipments	Totals[b]
Involved workers			
Collective dose (person-rem)	38	700	740
Estimated latent cancer fatalities	0.02	0.28	0.3
Public			
Collective dose (person-rem)	7	12	18
Estimated latent cancer fatalities	0.003	0.01	0.01
Estimated vehicle emission-related fatalities	0.002	0.0055	0.0071

a. Impacts are totals for 24 years.
b. Totals might differ from sums of values due to rounding.

Construction. The length of the Caliente-Chalk Mountain Corridor, 345 kilometers (214 miles), would determine the number of workers required. The construction of a branch rail line in this corridor would require workers laboring for approximately 2 million hours or about 1,000 worker-years over a 43-month construction period. The route would require four construction camps to house workers temporarily (DIRS 154822-CRWMS M&O 1998, all).

Employment

Estimated employment in the region of influence attributable to the construction of a Caliente-Chalk Mountain branch rail line, would peak in 2007 at about 647 jobs. Clark County would supply approximately 569 of the workers and Nye County would supply about 22. These additional workers would represent an increase of less than 1 percent of the Clark and Nye County employment baselines. About 56 individuals would work in Lincoln County, adding about 2.3 percent to employment in the county. DOE anticipates changes in Lincoln County's employment would be primarily the result of indirect employment caused by the presence of transient construction workers. Employment of Caliente-Chalk Mountain Corridor construction workers and some indirect support workers would end in 2009. As a result, the projected total growth (2009 to 2010) of 15,240 jobs in the region of influence would be reduced by 612. The expected addition of 14,886 jobs in Clark County would be reduced by 594, and the expected growth of 330 jobs in Nye County would be reduced by 17. The expected growth of 24 jobs in Lincoln County would be reduced by 1. DOE anticipates that project-related workers not moving to Caliente-Chalk Mountain Corridor operational jobs would be absorbed in other work in the State. These changes in employment would represent less than 1 percent of the applicable baselines.

Population

Population increases in the region of influence attributable to the construction of a Caliente-Chalk Mountain rail line would peak in 2009 at 589 persons. Clark County would gain about 527 residents, Nye County about 24, and Lincoln County about 38. The increase in population would be less than 1 percent of the baselines for Clark, Nye, and Lincoln Counties. Because the change in the population, relative to the population baselines, would be small and transient in Clark, Nye, and Lincoln Counties, impacts to housing or schools would be unlikely.

Economic Measures

The expected peak year changes in economic measures in the region of influence attributable to a branch rail line in the Caliente-Chalk Mountain Corridor would be increases of $18.6 million in real disposable income in 2009; $30.9 million in Gross Regional Product in 2007; and $2.1 million in State and local expenditures in the last year of construction, 2009. More than 93 percent of the real disposable income and Gross Regional Product would accrue to Clark County, which would experience about 78 percent of the additional spending by State and local governments. Lincoln County would gain slightly less than 4.6 percent of the change in real disposable income, 3.7 percent of the change in Gross Regional Product, and 16 percent of the expenditures by State and local governments. The increases in each economic measure would be less than 1 percent of the baseline in each affected county, except the increase of expenditures by State and local governments in Lincoln County would be 1.1 percent. (Dollar values reported in this section are in 2001 dollars unless otherwise stated.)

Transition and Operations Period. A period of slightly slower growth in employment in the region of influence would occur from 2010 to 2012. Following this period, employment to operate a Caliente-Chalk Mountain branch rail line would stimulate growth in the region. Growth in employment in the region of influence during the transitional period would average 19 fewer jobs than would occur without a Caliente rail line. Clark County would absorb the entire slower rate of growth, with an average of 82 fewer jobs. The Clark County employment baseline would average about 1 million during this period. Nye County would gain an average of 5 jobs and Lincoln County would gain 57 jobs during this period. The job gain in Lincoln County would represent a 2.2-percent average increase over the employment baseline in the 3-year period. The employment gain in Nye County would be less than 1 percent. A Caliente-Chalk Mountain rail line would contribute to the growth in residential population throughout the transition period and into the employment base after 2012.

Employment and Population

Estimated direct employment to operate a Caliente-Chalk Mountain rail line would be 47 jobs. Increased total employment in the region of influence would average about 78 jobs over the 24-year operations period (2010 to 2033). The majority, 57, would work in Lincoln County. The increases in Lincoln County employment attributable to a Caliente-Chalk Mountain branch rail line would be 2.1 percent of the baseline. On average, 14 jobs would be created in Clark County and 6 in Nye County. The change in the population in the region from the operation of a Caliente-Chalk Mountain branch line would average about 290 persons. DOE anticipates that 99 of these individuals would settle in Lincoln County, representing a 2.1-percent increase of the population baseline for the County. An additional 171 would live in metropolitan Clark County and represent less than 1 percent of the County's population baseline. The remaining individuals would live in Nye County and would affect the community by less than 1 percent. There would be no impacts to the school system or the housing market in Clark or Nye Counties. The increase in population in Lincoln County would add an average of about 22 students a year to the rolls of the school system. There would be no impact to housing in Lincoln County given the high housing vacancy rate in the County (see Chapter 3, Section 3.1.7.4).

Economic Measures

The estimated average, real disposable income increase attributable to the operation of a Caliente-Chalk Mountain branch rail line in the three-county region of influence would be $4.7 million per year. Contributions to real disposable personal income would range from $3.2 million in the early years of operation to $5.6 million in the last year. The annual increase in Gross Regional Product would average $4.6 million. On average, changes in real disposable income would exceed changes in Gross Regional Product. The increases in annual State and local government expenditures would average $1.6 million. The average impacts to real disposable income, Gross Regional Product, and State and local government expenditures from operating a Caliente-Chalk Mountain branch rail line would be less than 1 percent of the baselines for Clark and Nye Counties.

In Lincoln County, the changes in real disposable income and Gross Regional Product of operating a Caliente-Chalk Mountain branch rail line would range from about 1.7 percent for real disposable income to 2.6 percent for Gross Regional Product. State and local government spending would be higher by about 2.5 percent of the baseline. Workers associated with a Caliente-Chalk Mountain branch rail line would purchase many goods and services in the Lincoln County community. These dollars would continue to circulate largely within the area creating a positive economic impact. These impacts would not exceed historic short-term changes in the various socioeconomic measures.

DOE performed a detailed analysis was for the Caliente-Chalk Mountain Corridor. The results of this analysis, driven by the length of the Corridor, is representative of the potential variations (options and alternates) listed in Appendix J, Section J.3.1.2. The lengths of the variations are similar to those listed in Table 6-48.

In addition, DOE analyzed a sensitivity case that assumed all Lincoln County socioeconomic impacts would occur only in the City of Caliente. Under this assumption, City population would rise by 3 percent during construction and by 6.9 percent during operations. Employment would rise by about 5 percent during construction and about 7.2 percent during operations. If DOE selected this rail corridor, it would initiate additional engineering and environmental studies (including socioeconomic analyses); consult with Federal, State of Nevada, Native American, and local governments; and perform additional National Environmental Policy Act reviews as a basis for constructing and operating a Caliente-Chalk Mountain Corridor.

6.3.2.2.3.7 Caliente-Chalk Mountain Rail Noise and Vibration

Over most of its length, the Caliente-Chalk Mountain Corridor passes through undeveloped land managed by the Bureau of Land Management where human inhabitants are mostly isolated ranchers and persons involved with outdoor recreation. Almost half of the corridor's length is on the Nellis Air Force Range and Nevada Test Site, where there is little potential for noise impacts. The Caliente and Caliente-Chalk Mountain Corridors are the same in most of Lincoln County and in the northeastern part of Nye County. The Towns of Caliente and Panaca are along the eastern end of the corridor. This corridor includes the Caliente Option, Eccles Option, and Crestline Option as starting points; these are fairly remote from any rural communities.

The five variations on restricted government land (see Appendix J, Section J.3.1.2), the White River Alternate, and the Garden Valley Alternate would not affect rural communities. The variations outside restricted government land pass through areas that are farmed. Hence, some rural residences in this area could fall within the region of influence for noise.

None of the communities along the Caliente-Chalk Mountain Corridor and its nine variations (see Appendix J, Section J.3.1.2), with the exception of Caliente, would be close enough to the rail line for noise impacts to approach the noise guidelines of 50 dBA for evenings and 60 dBA during the day (Table 6-57). The Caliente Option for connecting to the Union Pacific Railroad mainline would follow an old railroad bed through the center of the Town of Caliente. Noise levels in Caliente would not differ much from existing background noise levels associated with normal rail traffic through the community. Noise levels associated with waste shipments would occur at most three times a day and probably not in a given hour. Where a branch rail line passed through Caliente, train speed would be reduced for safety and noise levels would be minimized. Traffic could be delayed at one traffic crossing in the Town of Caliente. Adverse community response to the added rail noise would be unlikely because of the long-term presence of railroad traffic in Caliente, the short trains associated with the transport of waste shipments, and the low frequency of rail shipments to and from the site.

The estimated population residing within 2 kilometers (1.3 miles) of the Caliente-Chalk Mountain Corridor in 2035 would be about 28 persons.

Vibration. Except for the historic railroad station in Caliente, which is near the existing Union Pacific Railroad mainline, the branch rail line in the Caliente-Chalk Mountain Corridor and associated variations would be sufficiently distant from historic structures, cultural ruins, and buildings to preclude building damage as a result of ground vibration. Vibration levels at reduced train speeds would be unlikely to damage the Caliente Railroad station. Moreover, the vibrations added by the relatively few trains carrying waste to Yucca Mountain at slow speeds would not add appreciably to the total vibration to

Table 6-57. Estimated propagation of noise from the operation of a waste transport train with two locomotives in communities near the Caliente-Chalk Mountain Corridor.

Corridor[a]/community	Distance (kilometers)[b]	Noise (dBA)[c]
Caliente Option		
Caliente	0	>90 at 15 meters[d]
Panaca	6[e]	26.0
Crestline Option		
Panaca	4.5[e]	26.3
Eccles Option		
Caliente	6.5[e]	<26[f]
Rachel	>20[e]	<26

a. The White River, Garden Valley, Mercury Highway, Topopah, Mine Mountain, Area 4, and Orange Blossom Road variations occur on Nellis Air Force Range or Nevada Test Site lands, too far from any community to cause noise impacts.
b. To convert kilometers to miles, multiply by 0.62137.
c. Estimated values do no include noise loss due to interactions with the ground that could account for decreases in estimated noise levels of from 10 to 20 dBA at 100 meters (330 feet) from the tracks.
d. 15 meters = 49 feet.
e. Noise estimates at distances greater than 2 kilometers (1.2 miles) have large uncertainty.
f. At these distances, the A-weighted sound pressure level is dominated by lower frequencies (less than 63 hertz) and would not be distinguishable from normal background levels of noise.

which the station is exposed from commercial trains that pass through Caliente. The small number of trips (three per day) and the small train size would result in low levels of rail-induced ground vibration.

6.3.2.2.3.8 Caliente-Chalk Mountain Rail Utilities, Energy, and Materials

Table 6-58 lists the use of fossil fuels and other materials in the construction of a Caliente-Chalk Mountain branch rail line.

Table 6-58. Construction utilities, energy, and materials for a Caliente-Chalk Mountain branch rail line.

Length (kilometers)[a]	Diesel fuel use (million liters)[b]	Gasoline use (thousand liters)	Steel (thousand metric tons)[c]	Concrete (thousand metric tons)[c]
340 - 370	32 - 36	610 - 680	47 - 52	280 - 310

a. To convert kilometers to miles, multiply by 0.62137.
b. To convert liters to gallons, multiply by 0.26418.
c. To convert metric tons to tons, multiply by 1.1023.

6.3.2.2.4 *Jean Corridor Implementing Alternative*

The Jean Corridor originates at the existing Union Pacific mainline railroad near Jean, Nevada. It travels northwest, passing near the Towns of Pahrump and Amargosa Valley before reaching the Yucca Mountain site. The Jean Corridor is about 181 kilometers (114 miles) long from its link at the Union Pacific line to the site. Variations of the route range from 181 to 204 kilometers (112 to 127 miles). Figure 6-18 shows this corridor along with possible variations identified by engineering studies (DIRS 154822-CRWMS M&O 1998 p. 1, Item 6; see Appendix J, Section J.3.1.2). The corridor variations provide flexibility in addressing engineering, land-use, or environmental resource issues that could arise in a future survey along the corridor. This section addresses impacts that would occur along the corridor shown in Figure 6-18. With the exception of differences identified in Appendix J, Section J.3.1.2, the impacts would be generally the same among the possible corridor variations.

The construction of a branch rail line in the corridor would require approximately 43 months. Construction would take place simultaneously at a number of locations. An estimated two construction camps would be established at roughly equal distances along the corridor. These camps would provide temporary living accommodations for construction workers and construction support facilities. A train would take about 4 hours to travel from the junction with the Union Pacific mainline to a Yucca Mountain

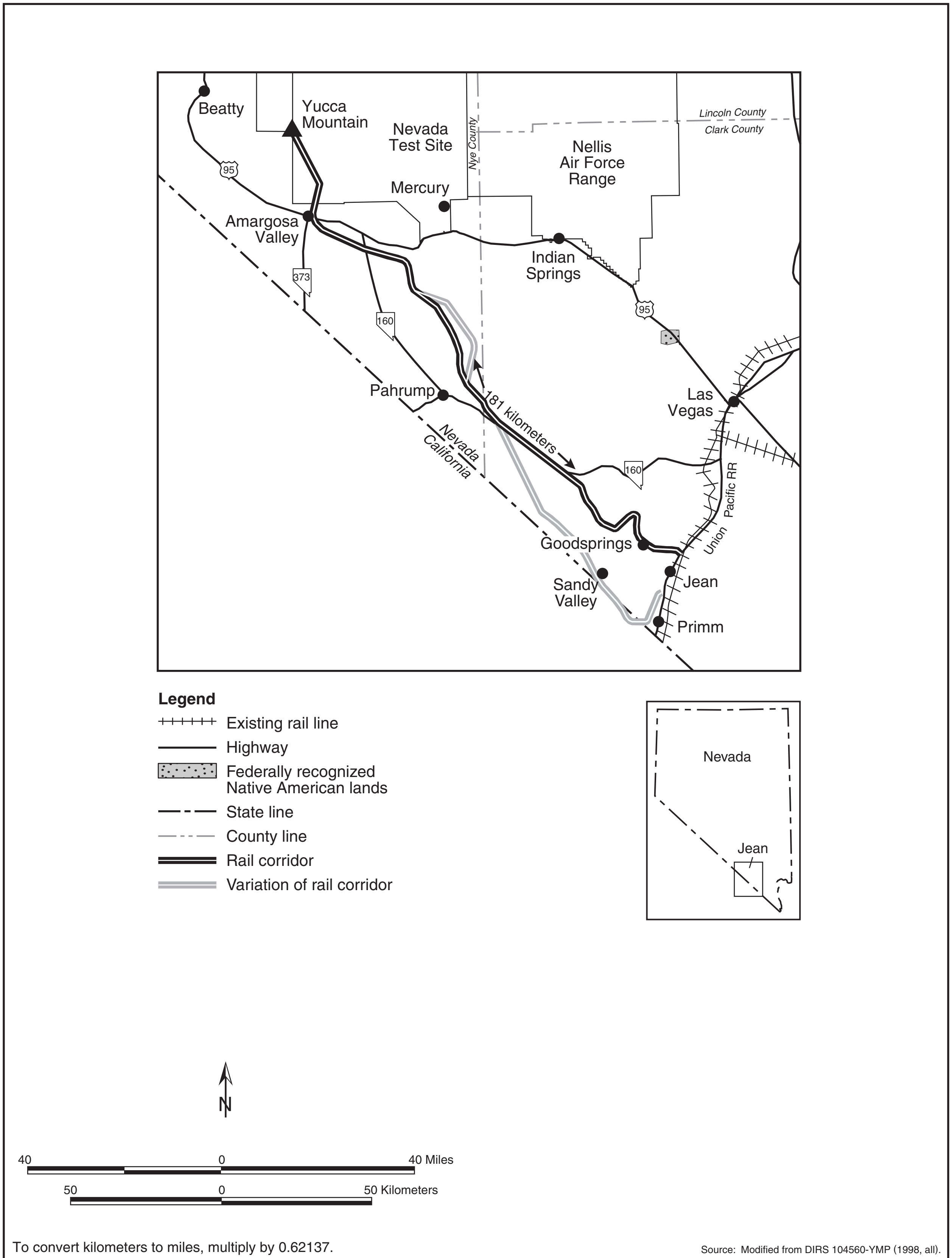

Figure 6-18. Jean Corridor.

Repository on a Jean branch rail line (DIRS 101214-CRWMS M&O 1996, Volume 1, Section 4, Branch Rail Operations Plan). The estimated life-cycle cost to construct and operate a branch rail line in the Jean Corridor would be $462 million in 2001 dollars.

The following sections address impacts that would occur to land use; biological resources and soils; cultural resources; hydrology, including surface water and groundwater; occupational and public health and safety; socioeconomics; noise and vibration; aesthetics; and utilities, energy, and materials. Impacts that would occur to air quality and waste management would be the same as those discussed in Section 6.3.2.1 and are, therefore, not repeated here. Section 6.3.4 discusses the potential for transportation activities to cause environmental justice impacts in Nevada.

6.3.2.2.4.1 Jean Rail Land Use and Ownership

Table 6-59 summarizes the amount of land required for the Jean Corridor, its ownership, and the estimated amount of land that would be disturbed, as well as ranges for the variations. Table 6-60 summarizes the amount of land required for the Jean Corridor variations and its ownership.

Table 6-59. Land use in the Jean Corridor.[a]

Factor	Corridor (percent)	Range due to variations
Corridor length (kilometers)[b]	181	181 - 204
Land area in 400-meter[c]-wide corridor (square kilometers)[d]	72 (100)	72 - 82
Land ownership in 400-meter-wide corridor (square kilometers)		
Bureau of Land Management	60 (83)	60 - 69
Air Force	None	None
DOE	8.5 (12)	8.5 - 8.5
Private	3.5 (5)	0.1 - 3.5
Other	None	None
Land area in 60-meter[e] right-of-way (square kilometers)	10.9	10.8 - 12.2
Disturbed land (square kilometers)		
Inside 60-meter right-of-way	6.6	6.6 - 7.4
Outside 60-meter right-of-way	2.6	2.6 - 2.9

a. Source: DIRS 155549-Skorska (2001, all).
b. To convert kilometers to miles, multiply by 0.62137.
c. 400 meters = about 0.25 mile.
d. To convert square kilometers to acres, multiply by 247.1.
e. 60 meters = 200 feet.

Table 6-60. Variations in the Jean Corridor.[a]

Variation	Length (kilometers)[b]	Area in variation (square kilometers)[c]	Land ownership [square kilometers (percent)]	
			Bureau of Land Management	Private
Wilson Pass Option	73.5	29.4	29.4 (99.98)	0.01 (0.02)
Pahrump Valley Alternate	32.1	12.8	12.7 (99.2)	0.1 (0.8)
Stateline Pass Option	91.9	36.8	36.79 (99.97)	0.01 (0.03)

a. Source: DIRS 155549-Skorska (2001, all).
b. To convert kilometers to miles, multiply by 0.62137.
c. To convert square kilometers to acres, multiply by 247.1.

Construction. The Jean Corridor (Wilson Pass Option) crosses eight Bureau of Land Management grazing allotments (Mount Stirling, Spring Mountain, Stump Springs, Table Mountain, Wheeler Wash, and three unnamed and unallotted areas); two wild horse and burro herd management areas (both in Pahrump Valley); the Old Spanish Trail/Mormon Road special recreation management area; and four areas designated as available for sale or transfer. It also crosses several telephone, pipeline, highway, and power line rights-of-way. The corridor is within 1.6 kilometers (1 mile) of the Toiyabe National Forest and three mines (Bluejay, Snowstorm, and Pilgram). The Wilson Pass Option also passes through Bureau of Land Management Class II lands in the vicinity of Wilson Pass in the Spring Mountains, potentially affecting the recreational use of this area.

The Stateline Pass Option origination location along an existing Union Pacific rail line conflicts directly with lands set aside for the proposed Ivanpah Valley Airport under the Ivanpah Valley Airport Public Lands Transfer Act (Public Law 106-362, 114 Stat. 1404). The Stateline Pass Option crosses the California-Nevada boundary line along Bureau of Land Management lands and passes near the Stateline Wilderness Area established by the California Desert Conservation Act. Construction activities could affect recreational use of the Stateline Wilderness Area. Impacts would be similar to the construction impacts discussed in Section 6.3.2.1. Corridor variations are listed in Appendix J, Section J.3.1.2. Impacts common to the rail implementing alternates are discussed in Section 6.3.2.1. The following paragraphs discuss impacts unique to this corridor.

The transfer of land from Bureau of Land Management for the Ivanpah Valley Airport would require DOE to realign the Stateline Pass Option for constructing a branch rail line.

Construction activities could affect the Old Spanish Trail/Mormon Road special recreation management area. Ease of access from one portion of the management area to the other would be reduced. These impacts could be mitigated by providing access to connect the parcels separated by the railroad right-of-way.

In the vicinity of Pahrump, Nevada, a branch rail line in the Jean Corridor would pass through approximately 9 kilometers (5.5 miles) of private property. As discussed in Section 6.3.2.1, DOE would have to make arrangements with owners to use this land. As indicated in Appendix J, Section J.3.1.2, the North Pahrump Alternate includes no private property. The North Pahrump Alternate would abut a Bureau of Land Management utility corridor and a section of the Toiyabe National Forest and could affect access to these recreational areas.

During the construction and operation and monitoring phases of the Proposed Action, there would be a potential for encroachment of the Jean Corridor by private interests. If encroachment occurred, conflicts could result as impediments to the full use of the land. Areas most likely for use by private interests are those already privately owned in the vicinity of Pahrump and those that are currently designated for sale or transfer by the Bureau of Land Management.

If DOE decided to build and operate a branch rail line in the Jean corridor, it would consult with the Bureau of Land Management and other affected agencies and with Native American tribal governments to help ensure that it avoided or mitigated potential land-use conflicts associated with alignment of a right-of-way.

Although there are no known community development plans that would conflict with the rail line, the presence of a rail line could influence future development and land use along the railroad in the communities of Amargosa Valley, Goodsprings, Jean, Johnnie, and Pahrump (that is, zoning and land use might differ depending on the presence or absence of a railroad). Construction of a branch rail line within the Jean corridor would require conversion of land within wild horse or wild horse and burro management areas; however, because the railroad would be unlikely to interfere with animal movements, the functionality of these areas would not be affected.

Operations. As with the other corridors, DOE expects the operation of a branch rail line in the corridor to cause fewer impacts than construction. Impacts due to rail operations would be similar to those described in Section 6.3.2.1.

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6.3.2.2.4.2 Jean Rail Hydrology

Surface Water

Chapter 3, Section 3.2.2.1.3, notes that there are no surface-water resources along the Jean Corridor, including its variations.

Table 6-61 lists flood zones identified along the Jean Corridor and its variations. The Federal Emergency Management Agency maps from which DOE derived the flood zone information provided coverage for 90 percent of the corridor length. This corridor would cross seven 100-year flood zones or flood-zone groups before entering the Nevada Test Site. One of the two variations would increase the number of flood zones crossed by 1; the other segment would have no change. As indicated in Section 6.3.2.1, impacts associated with altering drainage patterns or changing erosion and sedimentation rates or locations would be minor and localized.

Table 6-61. 100-year flood zones crossed by the Jean Corridor and its variations.[a,b]

Corridor portion	Crossing distance (kilometers)[c]	Flood zone feature(s)	Avoided by variation[d] (Yes or No)
Jean to Yucca Mountain	0.6	Three tributaries leading to Roach Lake (intermittent)	Y-2
	0.7	Lovell Wash with drainage (intermittent)	Y-2
	0.4	Two unnamed washes northwest of Lovell Wash	N
	4.1	Peak Springs Alluvial Fan (dry)	N
	1.9	Wheeler Wash (dry)	N
	0.3	Wash drainage leading to Alkali Flats (dry)	N
	0.1	Rock Valley Wash (intermittent)	N
Variations			
1. Pahrump Valley Alternate	None	Located northeast of corridor.	
2. Stateline Pass Option	0.4	Crosses two tributaries to Roach Lake (dry).	
	0.8	Crosses Potasi Wash, an unnamed wash, and Lovell Wash drainage.	
	1.1	Crosses four unnamed washes and Peak Springs Fan (intermittent).	

a. Areas where natural floodwater movement could be altered and where erosion and sedimentation rates and locations could change. Sources:
   1. Federal Emergency Management Agency Flood Insurance Rate Maps for Clark and Nye Counties, Nevada.
   2. DIRS 154961-CRWMS M&O (1998, all).

b. About 10 percent of the Jean Corridor is not available on Federal Emergency Management Agency maps because a portion of the route is on the Nevada Test Site.

c. To convert kilometers to miles, multiply by 0.62137.

d. Certain 100-year flood zones can be avoided by alternative corridor segments. These are identified with a "Y" (yes) and a number representing the variation(s) that avoid the specific flood zone. The same flood zone might be crossed by both the corridor and variations at different locations. In such cases, the feature will be marked "Avoided" for the corridor route, but will appear again for the variation.

Groundwater

Construction. The water used during construction would come largely from groundwater resources. The annual demands would be a fraction of the perennial yields of most producing aquifers (Chapter 3, Section 3.2.2.1.3, discusses estimated perennial yields for the hydrographic areas over which the Jean Corridor passes).

The estimated amount of water needed for construction of a rail line in the corridor for soil compaction, dust control, and workforce use would be about 500,000 cubic meters (410 acre-feet) (DIRS 104914-DOE 1998, all). For planning purposes, DOE assumed that this water would come from 23 wells installed along the corridor. The average amount of water withdrawn from each well would be approximately 22,000 cubic meters (18 acre-feet). Most (89 percent) of the water would be used for compaction of fill material. The estimate of fill quantities needed for construction would vary if DOE used a variation. Use of the Pahrump Valley Alternate or Stateline Pass Option would involve an increase in fill material (over that required for the corridor) and would increase the total water demand by 12 or 27 percent, respectively.

Chapter 3, Section 3.2.2.1.3, discusses the hydrographic areas over which the corridor would pass, their perennial yields, and whether the State of Nevada considers each a Designated Groundwater Basin. If the hydrographic area is a Designated Groundwater Basin, permitted groundwater rights approach or exceed the estimated perennial yield, depleting the basin and water resources or requiring additional administration. Table 6-62 summarizes the status of the hydrographic areas associated with the Jean Corridor and the approximate portion of the corridor that passes over Designated Groundwater Basins. The use of variations would change the number of hydrographic areas crossed, but would have no effect on the portion of the corridor crossing Designated Groundwater Basins.

Table 6-62. Hydrographic areas along the Jean Corridor and its variations.

		Designated Groundwater Basins	
Description	Hydrographic areas	Number	Percent of corridor length
Jean Corridor	7	5	90
With Stateline Pass Option	6	4	90
With Pahrump Valley Alternate	7	5	90

The withdrawal of 22,000 cubic meters (18 acre-feet) a year from a well would have little impact on the hydrographic areas associated with the corridor based on their perennial yields (Chapter 3, Section 3.2.2.1.3). However, the installation of 23 wells along the corridor would mean that several of the hydrographic areas would have multiple wells. As indicated in Table 6-62, about 90 percent of the corridor length is over Designated Groundwater Basins, which the Nevada State Engineer's office watches carefully for groundwater depletion. This does not mean that DOE could not obtain water appropriations in these areas; the State Engineer would have the authority to approve such appropriations. Because the DOE requests would be for a short-term construction action, the State Engineer would have even more discretion. Rather than spacing the wells evenly along the corridor, DOE could use locations that would make maximum use of groundwater areas that are not Designated Groundwater basins. With such a large portion of the corridor over these basins, however, this would mean trucking water for long distances. Another option would be to lease temporary water rights from individuals along the corridor. Obtaining a water appropriation from the State Engineer for short-term construction use or using an approved allocation should ensure that groundwater resources are not adversely affected.

As an alternative, DOE could transport water by truck to meet construction needs. The construction of a branch rail line in the Jean corridor would require about 27,000 tanker-truck loads of water or about 14 truckloads each day for each work camp area along the corridor. Again, water obtained from permitted sources, which would provide water within allocations determined by the Nevada State Engineer, would not affect groundwater resources.

Operations. Operations along a completed rail line would have little impact on groundwater resources. Possible changes in recharge, if any, would be the same as those at the completion of construction.

6.3.2.2.4.3 Jean Rail Biological Resources and Soils

Construction. The construction of a branch rail line in the Jean Corridor would disturb approximately 9.3 square kilometers (2,300 acres) of land (Table 6-59). The analysis assumed that the types of land cover in disturbed areas outside the corridor would be the same as that within the corridor. Table 6-63 compares the approximate area of disturbance in each land-cover type along all variations of the Jean Corridor to the area in each land-cover type in Nevada. In addition, the table lists the percentage of the area that would be disturbed. The fraction disturbed for each cover type would be very small. The disturbance would not have a discernible impact on any land-cover type. Although some alignment variations could lead to a small increase in the total amount of land disturbed, the portion of the corridor, including its variations, in each land-cover type would be similar to that in the unvaried corridor.

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Table 6-63. Maximum area disturbed (square kilometers)[a] in each land-cover type for the Jean Corridor.[b,c]

	Wilson Pass Option		Stateline Pass Option			
Land-cover type	Percent of corridor length	Land area	Percent of corridor length	Land area	Area in Nevada	Percent disturbed
Agriculture	0	0	0	0	5,200	0
Blackbrush	18.4	1.69	0.1	0.01	9,900	0.017
Creosote-bursage	58.6	5.39	80.8	8.32	15,000	0.055
Grassland	0	0	0	0	2,800	0
Greasewood	0	0	0	0	9,500	0
Hopsage	0	0	0	0	630	0
Juniper	0	0	0	0	1,400	0
Mojave mixed scrub	21.1	1.94	14.6	1.5	5,600	0.035
Pinyon-juniper	0	0	0	0	15,000	0
Playa	0	0	0	0	7,000	0
Sagebrush	0	0	0	0	67,000	0
Sagebrush/grassland	0	0	0	0	52,000	0
Salt desert scrub	2	0.18	1.8	0.19	58,000	<0.001
Urban	ND[d]	ND	ND	ND	2,400	ND
Total[e]	100	9.2	97.3[f]	10	250,000	N/A[g]

a. To convert square kilometers to acres, multiply by 247.1.
b. Based on the proportion of the route in each land-cover type; percent disturbed was based on the variation with the greatest disturbance within a particular land-cover type. Percentages add to more than 100 because maximum values were used.
c. Source: DIRS 104593-CRWMS M&O (1999, Appendix D).
d. ND = not determined.
e. Totals might differ from sums of values due to rounding.
f. About 2.7 percent of land would be in California for the proposed Jean corridor with the Stateline Pass Option.
g. N/A = not applicable.

The Jean Corridor, including its variations passes through desert tortoise habitat along its entire length, so construction activities would disturb approximately 9.3 square kilometers (2,300 acres) of desert tortoise habitat, some of which is designated as critical habitat. Construction activities could kill individual desert tortoises, and the presence of a rail line could disrupt movements of individuals. The abundance of tortoises is low along much of this corridor; however, some areas in the Ivanpah, Goodsprings, Mesquite, and Pahrump Valleys have higher abundance (DIRS 101521-BLM 1992, Map 3-13; DIRS 101914-Rautenstrauch and O'Farrell 1998, pp. 407 to 411). DOE anticipates that losses would be few and would be unlikely to affect the regional population of the desert tortoise. Relocation of tortoises along the corridor prior to construction would minimize losses of individuals. DOE would consult with the Fish and Wildlife Service (under Section 7 of the Endangered Species Act) in relation to this species if it selected this corridor and would implement all terms and conditions required by the Fish and Wildlife Service.

Two populations of Pinto beardtongue (a Bureau of Land Management sensitive species) occur in the corridor and could be affected directly or indirectly by land-clearing activities. The locations of these populations would be identified though surveys prior to disturbance and would be avoided to the extent possible. No populations of sensitive species occur in the Stateline Pass Option.

There are 33 populations of seven sensitive plant species outside the 400-meter (0.25-mile)-wide corridor, but within 5 kilometers (3 miles) of the corridor. Thirteen populations of five sensitive plant species are outside the corridor but within 5 kilometers of the Stateline Pass Option. These populations would not be affected because land disturbance would not extend to these areas. Changes in the aquatic or soil environment in these areas as a result of construction would be unlikely.

Ten designated game habitat areas for bighorn sheep, mule deer, or quail occur within the corridor and 16 areas occur within 5 kilometers (3 miles) of the corridor. The Stateline Pass Option avoids five of the designated game habitat areas in the corridor.

The Wilson Pass Option crosses three Herd Management Areas for wild horses and burros (DIRS 104593-CRWMS M&O 1999, p. 3-29). The Stateline Pass Option would avoid two of these areas. Construction activities in these areas would result in the loss of a small amount of habitat and probably would disturb animals or their movements for the duration of the activities.

No springs, perennial streams, or riparian areas occur in the Jean Corridor. Eleven springs or groups of springs are outside the corridor, but within 5 kilometers (3 miles) of the corridor. Impacts to biological resources associated with these areas are not anticipated. The corridor crosses a number of ephemeral streams that may be classified as waters of the United States, although formal delineations have not been made (DIRS 104593-CRWMS M&O 1999, p. 3-29). DOE would work with the U.S. Army Corps of Engineers to minimize impacts to these areas and would obtain individual or regional permits if necessary. The Department anticipates some changes to local drainage along the potential branch rail line and would design the rail line to accommodate existing drainage patterns.

Soils in and adjacent to the corridor would be disturbed on approximately 9.3 square kilometers (2,300 acres) of land during construction of a railroad. Impacts to soils in the corridor, including its variations [6.5 square kilometers (1,600 acres)], would be small, but could occur throughout construction. However, several soil characteristics could influence construction activities and the amount of area disturbed. Soils susceptible to wind erosion occur along much of the corridor and its variations (see Chapter 3, Section 3.2.2.1.4.). Soils considered to be highly susceptible to water erosion and having poor stability characteristics are also present, but along much smaller portions of the corridor. Disturbance of erodible soils could lead to increased silt loads in water courses or increased soil transport by wind. Erosion control during construction and revegetation, or other means of soil stabilization after construction, would minimize these concerns. The presence of soils with poor (that is, high) shrink-swell and stability characteristics could influence the amount of area disturbed by construction if soils from outside areas had to be brought in for replacement or mixing with native soil. The source of suitable fill material and the land area that would be disturbed in obtaining the material is presently unknown, so the potential for impacts to soils and biological resources associated with the borrow areas cannot be determined.

Soils classified as unstable fill also occur along portions of the Jean corridor, including its variations. The amount of land disturbance in the corridor for stabilization of a rail line and outside the corridor at the source of fill material could increase due to the presence of these soils. The source of suitable fill material and the land area that would be disturbed in obtaining the material is unknown at present, so DOE cannot determine the potential for impacts to soils and biological resources associated with the borrow areas.

As stated in Chapter 3, Section 3.2.2.1.4, variations identified for the Jean Corridor could avoid some biological resources, as listed in Table 6-64.

6.3.2.2.4.4 Jean Rail Cultural Resources

Construction. The Jean Corridor passes through the Goodsprings and Johnnie historic mining districts, and intersects the historic Yellow Pine Mining Company Railroad grade. In the southern part of the Pahrump Valley, the corridor, including the Wilson Pass and Stateline Options, crosses the Old Spanish Trail, which is under consideration for designation as a National Historic Trail. Based on Bureau of Land Management resource planning, both the Goodsprings and Pahrump Valleys are expected to contain fairly high numbers of potentially significant archaeological and historic sites. Precise impacts from rail line construction activities would be identified after completion of a cultural resource study of the corridor.

Table 6-64. Biological resources avoided by Jean Corridor variations.[a]

Alignment variation resource	Occurrence of resource: For unvaried segment of corridor – In corridor[b]	Within 5 km[c]	Occurrence avoided by variation – In corridor	Within 5 km
Stateline Pass Variation				
Sensitive species				
Allen's big-eared bat	0	1	0	1
Desert bearpoppy	0	3	0	1
Fringed myotis	0	1	0	1
Gila monster	0	1	0	1
Long-legged myotis	0	1	0	1
Pinto beardtongue	2	18	2	17
Sheep fleabane	0	1	0	1
Spring Mountain milkvetch	0	2	0	2
Townsend's big-eared bat	0	1	0	1
White-margined beardtongue	0	5	0	3
Yuma myotis	0	1	0	1
Game habitat				
Bighorn sheep–crucial	1	1	1	1
Bighorn sheep–migration corridor	2	0	1	0
Bighorn sheep-winter	1	7	0	3
Chukar–crucial	1	0	1	0
Mule deer–summer crucial	0	2	0	1
Mule deer–winter	2	2	1	1
Quail–crucial	3	4	1	3
Springs or groups of springs	0	11	0	5
Herd Management Units	3	0	2	0

a. Variations listed are those that would result in the avoidance of biological resources along the corridor.
b. In the corridor [or springs within 400 meters (0.25 mile)], but avoided by the corridor variation.
c. Within 5 kilometers (3 miles) of the corridor, but more than 5 kilometers from the corridor variation.

Archaeological site file searches for the Jean Corridor and its variations (Appendix J, Section J.3.1.2) revealed six recorded archaeological sites, four of which have been evaluated as being not eligible for the *National Register of Historic Places.*

There are no known Native American resources in this corridor, although the corridor passes through the traditional homelands of the Pahrump Paiute Band. In the early historic period, there were several village sites in the northern area at the base of the Spring Mountains; a branch rail line could affect some of these locations. Pending completion of field ethnographic studies, there could be other sites or resources of importance to Native Americans along this corridor that rail construction activities could affect.

Operations. As stated in Section 6.3.2.1, additional impacts to these resources during the operation of the branch rail line would be unlikely.

6.3.2.2.4.5 Jean Rail Occupational and Public Health and Safety

Construction. Industrial safety impacts on workers from the construction and use of the Jean branch rail line would be small (Table 6-65). The analysis evaluated the potential for impacts in terms of total reportable cases of injury, lost workday cases, and fatalities to workers from construction and operation activities. The analysis also evaluated traffic fatality impacts that would occur during the moving of equipment and materials for construction, worker commutes to and from construction sites, and transport of water to construction sites if wells were not available. Table 6-66 lists these results.

Operations. Incident-free radiological impacts would occur during the routine transportation of spent nuclear fuel and high-level radioactive waste in using the Jean Corridor. Table 6-67 lists the incident-free

Table 6-65. Impacts to workers from industrial hazards during rail construction and operations for the Jean Corridor.

Group and industrial hazard category	Construction[a]	Operations[b]
Involved workers		
Total recordable cases[c]	67	73
Lost workday cases	33	40
Fatalities	0.09	0.20
Noninvolved workers		
Total recordable cases	4.0	4.1
Lost workday cases	1.5	1.5
Fatalities	0.004	0.004
Totals		
Total recordable cases	71	77
Lost workday cases	35	41
Fatalities	0.10	0.20

a. Totals for 43 months for construction.
b. Totals for 24 years for operations.
c. Total recordable cases includes injury and illness.

impacts, which include transportation along the corridor and along railways in Nevada leading to a Jean branch line. The table includes the impacts of 1,079 legal-weight truck shipments from commercial sites that would not have the capability to load rail casks while operational.

6.3.2.2.4.6 Jean Rail Socioeconomics

The following paragraphs discuss potential socioeconomic impacts associated with the construction and operation of a branch rail line in the Jean Corridor.

Construction. The length of the Jean Corridor, 181 kilometers (112 miles), is the principal factor that would determine the number of workers required to construct a branch rail line. The construction of a branch rail line in this corridor would require workers laboring approximately 1.7 million hours or 855 worker years over a 43-month construction period. The workers would be temporarily housed in two construction camps (DIRS 154822-CRWMS M&O 1998, all).

Table 6-66. Estimated number of fatalities from construction material delivery vehicles and construction and operations worker commuting traffic for the Jean Corridor.

Jean	Kilometers[a]	Traffic fatalities	Emissions fatalities
Construction[b]			
Materials delivery vehicles	10,000,000	0.2	0.02
Commuting workers	52,000,000	0.5	0.07
Subtotals	*62,000,000*	*0.7*	*0.09*
Operations[c]			
Commuting workers	52,000,000	0.5	0.07
Totals	***110,000,000***	***1.2***	***0.16***

a. To convert kilometers to miles, multiply by 0.62137.
b. Totals for 43 months for construction.
c. Totals for 24 years for operations.

Table 6-67. Health impacts from incident-free Nevada transportation for the Jean Corridor implementing alternative.[a]

Category	Legal-weight truck shipments	Rail shipments	Totals[b]
Involved workers			
Collective dose (person-rem)	38	720	760
Estimated latent cancer fatalities	0.02	0.29	0.3
Public			
Collective dose (person-rem)	7	150	160
Estimated latent cancer fatalities	0.003	0.08	0.08
Estimated vehicle emission-related fatalities	0.002	0.08	0.08

a. Impacts are totals for 24 years.
b. Totals might differ from sums of values due to rounding.

Employment

DOE anticipates that the total (direct and indirect) employment in the region of influence attributable to rail line construction would peak in 2007 at about 526 jobs. DOE anticipates that 92 percent or 483 workers, would come from Clark County. Approximately 42 workers would come from Nye County and 1 from Lincoln County. The increase in employment represents less than 1 percent of the baseline for Clark, Nye, and Lincoln Counties. Employment of Jean Corridor construction workers and some indirect support workers would end in 2009. As a result, the projected total growth (2009 to 2010) of 15,240 jobs in the region of influence would be reduced by 490. The expected addition of 14,886 jobs in Clark County would be reduced by 449, and the expected growth of 330 jobs in Nye County would be reduced by 41. The expected growth of 24 jobs in Lincoln County would be unaffected. DOE anticipates that project-related workers not moving to Jean Corridor operational jobs would be absorbed in other work in the State. These changes in employment would represent less than 1 percent of the applicable baselines.

Population

Population increases in the region of influence attributable to the construction of a Jean branch rail line, which would lag behind increases in employment, would peak in 2009 at about 492 persons. DOE anticipates that approximately 449 would live in Clark County, 42 in Nye County, and 1 in Lincoln County. The increase in population would be less than 1 percent of each county's population baseline. Because the impacts to population in each county would be small and transient, impacts to schools or housing would be unlikely.

Economic Measures

The expected peak changes in the region of influence attributable to constructing a branch rail line in the Jean Corridor would be increases of about $15.2 million in real disposable income in 2009; about $25.7 million in Gross Regional Product in 2007; and about $1.6 million in State and local expenditures in 2009. More than 96 percent of the increases in real disposable income and Gross Regional Product and about 91 percent of the increase in State and local government expenditures would occur in Clark County. Most of the remainder of the increase would occur in Nye County. The impacts to Clark, Nye, and Lincoln Counties for each of these measures would be less than 1 percent for each county's applicable baseline. (Dollar values reported in this section are in 2001 dollars unless otherwise stated.)

Transition and Operations Period. A period of slightly slower employment growth would occur from 2010 to 2012, and then employment to operate a branch rail line would contribute to an increased rate of growth. Growth in employment in the region of influence during this transitional period would be approximately 15 fewer jobs annually than would occur without a rail line in the Jean Corridor. Clark County would experience all of the slower rate of growth. During this period, the Clark County employment baseline would be about 1 million jobs. Nye County would gain 1 job during this period. The Jean rail line would contribute to the growth in residential population throughout the transition period.

Employment and Population

Estimated direct employment for the operation of a branch rail line in the Jean Corridor would be 36 workers. The total increase in employment in the region of influence would average 54 jobs over the 24-year operation period (2010 to 2033). On average, 52 of these jobs would be in Clark County, 1 in Nye County, and none in Lincoln County. These increases represent less than 1 percent of the counties' employment baselines. An increase in the Clark and Nye County populations attributable to a Jean rail line would be about 208 individuals, 91 percent of whom would live in Clark County. The balance would live in Nye County. The impact to the baseline population in both counties would be less than 1 percent. Because the increase to the population baseline would be small, impacts to the school system or housing would be unlikely. There would be no change in employment or the number of residents in Lincoln County due to a Jean rail line.

Economic Measures

In the three-county region of influence the greatest increase in real disposable income above the baseline attributable to operations would occur in 2033, the last year of operation. This increase would be $4.3 million; the average increase in each of the 24 years of operation would be about $3.7 million. The increase in Gross Regional Product would average about $3.6 million. On average during rail line operations, changes in real disposable income would exceed changes in Gross Regional Product. Annual State and local government expenditures would average $722,000. Nearly all of the economic activity would occur in Clark County; virtually none would occur in Lincoln and Nye Counties. Annual impacts to real disposable income, Gross Regional Product, and State and local government expenditures from the operation of a branch rail line in the Jean Corridor would be less than 1 percent of the baseline for each county.

The results of the detailed analysis performed for the Jean Corridor driven by the corridor length are representative of the variations (options and alternates) listed in Appendix J, Section J.3.1.2. The lengths of the variations are similar to those listed in Table 6-60.

6.3.2.2.4.7 Jean Rail Noise and Vibration

The Wilson Pass and Stateline Pass Options in the southern portion of the Jean Corridor and the Pahrump Valley Alternate pass through mostly U.S. Government land set aside for use by DOE or managed by the Bureau of Land Management. They also cross a small amount of private land. The Wilson Pass Option passes the communities of Amargosa Valley, Goodsprings, Jean, and Pahrump. In addition, the Stateline Pass Option passes the small communities of Sandy Valley and Primm. The smaller rural communities associated with the Jean Corridor and its variations (Appendix J, Section J.3.1.2) would be likely to experience noise levels from the operation of trains in excess of the benchmark nighttime noise level of 50 dBA, but not the daytime residential noise level of 60 dBA (Table 6-68). Jean and Primm are principally commercial business communities consisting of gaming industry, retail, and Primm businesses. In addition, the potential for growth and development in the Jean and Pahrump areas could place residents and businesses close to a Jean branch rail line, leading to noise impacts from both construction and operations.

Table 6-68. Estimated propagation of noise (dBA) from the operation of a waste transport train with two locomotives in communities near the Jean Corridor.

Corridor/community	Distance (kilometers)[a]	Noise (dBA)[b]
Wilson Pass Option		
Jean	1.6	48
Goodsprings	1.2	54
Pahrump	2.0	43
Amargosa Valley	1.0	57
Stateline Pass Option		
Stateline	1.6	48
Sandy Valley	1.0	57
Goodsprings	1.2	54
Pahrump	2.0[c]	43
Amargosa Valley	1.0	57

a. To convert kilometers to miles, multiply by 0.62137.
b. Estimated values do not include noise loss due to interactions with the ground that could account for decreases in estimated noise levels of from 10 to 20 dBA at 100 meters (33 feet) from the tracks.
c. Noise estimates at distances greater than 2 kilometers (1.2 miles) have large uncertainty.

Noise impacts for the Jean Corridor would be limited because, at distances more than 0.8 kilometer (0.5 mile) daytime noise from trains would be below noise standards for residential areas (60 dBA) and because few residents and businesses are this close to the corridor. Nonetheless, because a Jean branch rail line could pass near some communities, there would be a potential for noise impacts from both construction and operations. As discussed in Section 6.3.2.1, in areas where a branch rail line or variation passed near a community, transports could be limited to the extent necessary to ensure that noise was below levels listed as accepted noise hazards.

The estimated population that would reside within 2 kilometers (1.3 miles) of the Jean Corridor in 2035 is about 1,300 persons.

Vibration. The Jean Corridor and its variations would be distant [more than 200 meters (660 feet)] from historic structures and buildings. There are no known ruins of cultural significance along the corridor. Therefore, vibration impacts to structures would be unlikely. The small number of trips (three per day) and the small train size would result in low levels of rail-induced ground vibration.

6.3.2.2.4.8 Jean Rail Aesthetics

The Wilson Pass Option of the Jean Corridor would pass through Class II lands in the Goodsprings Valley and Spring Mountains. The objective of Bureau of Land Management Visual Resource Class II lands is to preserve the existing character of the landscape. According to the Bureau, the level of changes to the landscape should be low. Management activities could be seen, but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture of the characteristic landscape. Because of this, the building of a rail line in the Wilson Pass Option probably would require more stringent construction practices to limit visual resource impacts. Although impacts due to construction activities would be short term, visual impacts to recreational land use in this area would be likely. If DOE selected this option, additional consultation with the Bureau would be necessary to address aesthetic impacts.

The operation of a branch rail line through the Class II visual resource lands in the vicinity of Wilson Pass in the Spring Mountains would draw attention to the rail line and degrade the aesthetics of the area, thereby reducing the quality of recreational use of the area.

6.3.2.2.4.9 Jean Rail Utilities, Energy, and Materials

Table 6-69 lists the use of fossil fuels and other materials in the construction of a Jean branch rail line.

Table 6-69. Construction utilities, energy, and materials for a Jean branch rail line.

Route	Length (kilometers)[a]	Diesel fuel use (million liters)[b]	Gasoline use (thousand liters)	Steel (thousand metric tons)[c]	Concrete (thousand metric tons)
Jean	180 - 200	26 - 30	500 - 570	26 - 29	150 - 170

a. To convert kilometers to miles, multiply by 0.62137.
b. To convert liters to gallons, multiply by 0.26418.
c. To convert metric tons to tons, multiply by 1.1023.

6.3.2.2.5 *Valley Modified Corridor Implementing Alternative*

The Valley Modified Corridor originates near the existing Apex rail siding off the Union Pacific mainline railroad. It travels northwest passing north of the City of Las Vegas, north of the Town of Indian Springs, parallel to U.S. 95 before entering the southwest corner of the Nevada Test Site and reaching the Yucca Mountain site. The Valley Modified Corridor is about 159 kilometers (98 miles) long from its link with the Union Pacific line to the site. Variations of the route range from 157 to 163 kilometers (98 to 101 miles). Figure 6-19 shows this corridor along with possible variations identified by engineering studies (DIRS 154960-CRWMS M&O 1998, all). The variations provide flexibility in addressing engineering, land-use, or environmental resource issues that could arise in a future, more detailed survey along the corridor. This section addresses impacts that would occur along the corridor shown in Figure 6-19. With the exception of differences identified in Appendix J, Section J.3.1.2, the impacts would be generally the

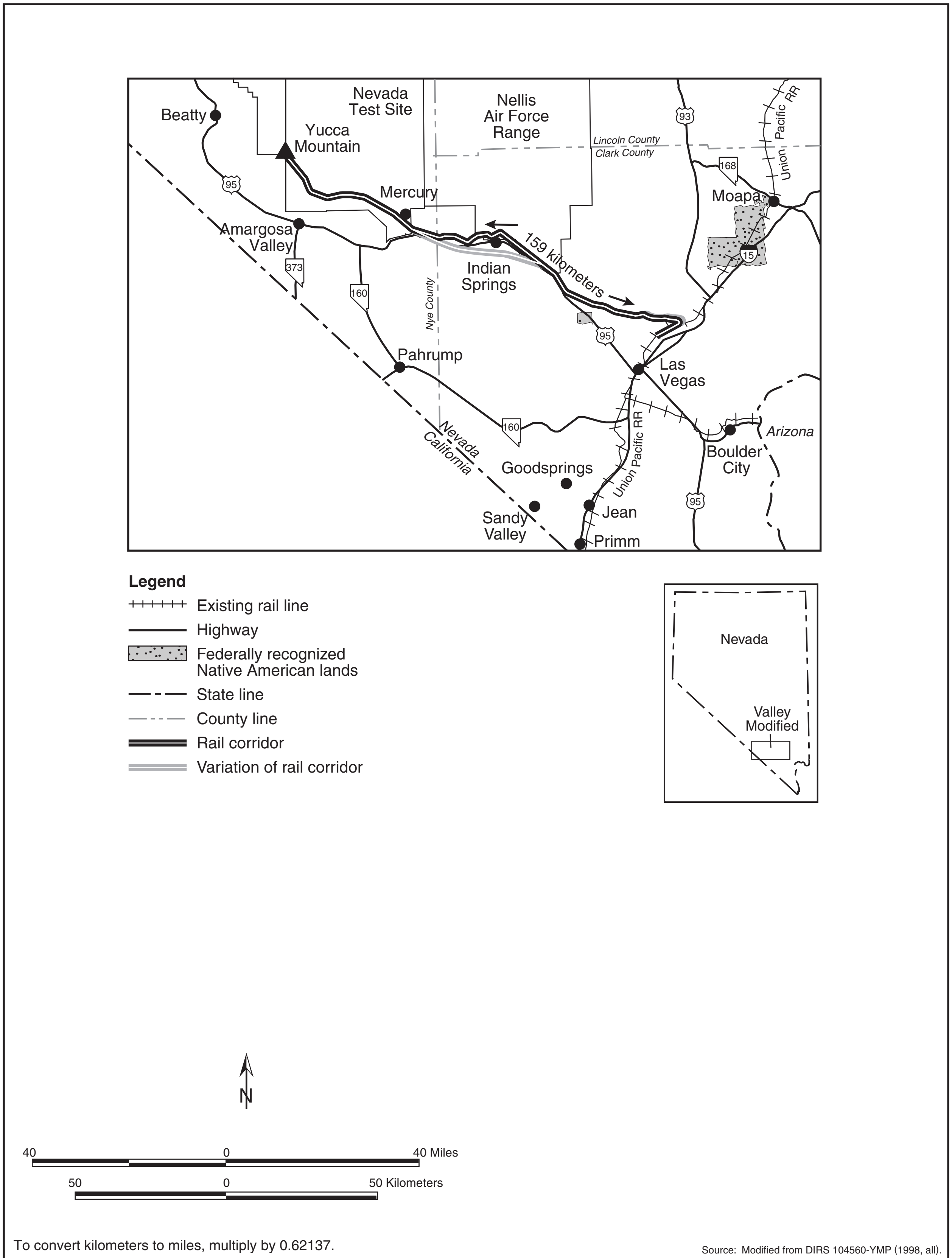

Figure 6-19. Valley Modified Corridor.

same among the possible variations. The Indian Hills Alternate of the Valley Modified Corridor also crosses the original route of the historic Las Vegas-to-Bullfrog Stage Road.

The construction of a branch rail line in the corridor would require approximately 40 months. Construction would take place simultaneously at a number of locations along the corridor. Two construction camps would be established to provide temporary living accommodations for construction workers and construction support facilities. A train would take about 3 hours to travel from the junction with the Union Pacific mainline to the Yucca Mountain Repository on a Valley Modified branch rail line (DIRS 101214-CRWMS M&O 1996, Volume 1, Section 4, Branch Rail Operations Plan). The estimated life-cycle cost to construct and operate a branch rail line in the Valley Modified Corridor would be $283 million in 2001 dollars.

The following sections address impacts that would occur to land use; air quality; biological resources and soils; hydrology including surface water and groundwater; cultural resources; occupational and public health and safety; socioeconomics; noise and vibration; and utilities, energy, and materials. Impacts that would occur to aesthetics, and waste management would be the same as those discussed in Section 6.3.2.1 and are, therefore, not repeated here. Section 6.3.4 discusses the potential for transportation activities to cause environmental justice impacts in Nevada.

6.3.2.2.5.1 Valley Modified Rail Land Use and Ownership

Table 6-70 summarizes the amount of land required for the Valley Modified corridor, its ownership, and the estimated amount of land that would be disturbed, as well as ranges for the variations. Table 6-71 summarizes the amount of land required for the variations of the Valley Modified Corridor and its ownership.

Table 6-70. Land use in the Valley Modified Corridor.[a]

Factor	Corridor (percent)	Range due to variations
Corridor length (kilometers)[b]	159	157 - 163
Land area in 400-meter[c]*-wide corridor (square kilometers)*[d]	63 (100)	63 - 65
Land ownership in 400-meter-wide corridor (square kilometers)		
Bureau of Land Management	34 (53)[e]	29.9 - 36.7
Air Force	7 (11)	3.6 - 7.5
DOE	21 (32)	20. 6 - 20.6
Private	0.2 (0.3)	0 - 0.18
Fish and Wildlife Service	1.8 (3)	1.7 - 4.1
Land area in 60-meter[f] *right-of-way (square kilometers)*	9.6	9.4 - 9.8
Disturbed land (square kilometers)		
Inside 60-meter right-of-way	4.4	4.3 - 4.5
Outside 60-meter right-of-way	0.6	0.68 - 0.7

a. Source: DIRS 155549-Skorska (2001, all).
b. To convert kilometers to miles, multiply by 0.62137.
c. 400 meters = about 0.25 mile.
d. To convert square kilometers to acres, multiply by 247.1.
e. Percentages do not total 100 due to rounding.
f. 60 meters = 200 feet.

Construction. The corridor crosses three Bureau of Land Management grazing allotments (Wheeler Slope, Indian Springs, and Las Vegas Valley), two wilderness study areas (Nellis ABC and Quail Spring, both recommended by the Bureau as unsuitable for inclusion in the National Wilderness System), and one area designated as available for sale or transfer (DIRS 104993-CRWMS M&O 1999, Table 7, p. 22). It also crosses several telephone, pipeline, highway, and power line rights-of-way, and the Nellis Air Force Base small arms range. Impacts common to rail implementing alternates are discussed in Section 6.3.2.1. The following paragraphs discuss impacts unique to this corridor.

Table 6-71. Variations in the Valley Modified Corridor.[a]

Variation	Length (kilometers)[b]	Land area in variation (square kilometers)[c]	Land ownership [square kilometers (percent)] Bureau of Land Management	Fish and Wildlife Service	Department of Defense	Private
Indian Hills Alternate	45.2	18.1	18.1 (100)	--[d]	--	--
Sheep Mountain Alternate	23.3	9.8	3.2 (33)	3.4 (35)	3.1 (32)	--
Valley Connection	21.1	2.7	2.5 (93)	--	0.01 (0.4)	0.2 (6.6)

a. Source: DIRS 155549-Skorska (2001, all).
b. To convert kilometers to miles, multiply by 0.62137.
c. To convert square kilometers to acres, multiply by 247.1.
d. -- = none.

Variations to this corridor are listed in Appendix J, Section J.3.1.2. The Indian Hills Alternate would avoid Nellis Air Force Range by traveling south of Indian Springs. This variation would cross Fish and Wildlife Service lands and pass almost entirely within a Bureau of Land Management utility corridor. It would also pass through a Bureau Land Withdrawal Area (N50945) for a power project. The Sheep Mountain Alternate would pass through the Nellis Small Arms Range and Nellis Wilderness Study Areas A, B, and C, as well as the Quail Mountain Wilderness Study Area and the Desert National Wildlife Range. Although the Bureau considers these Wilderness Study Areas unsuitable for inclusion in the National Wilderness System, DOE would have to consult with the Bureau before it could build a branch rail line.

The corridor passes along the Las Vegas metropolitan area's northern boundary, in an area that is currently undergoing growth and where future commercial and residential growth might occur. However, metropolitan area growth might not extend to the corridor area until after the operations phase of the repository, when DOE assumes that it would no longer have use for a branch rail line. The corridor also passes next to the Dry Lake siding and within about 1.6 kilometers (1 mile) of the Las Vegas Paiute Indian Reservation north of Las Vegas. There would be no significant land-use impact to this reservation because of its distance from the corridor.

During the construction and operation and monitoring phases of the Proposed Action, there would be a potential for encroachment of the Valley Modified Corridor by private interests. If encroachment occurred, conflicts could result as impediments to the full use of lands. Areas most likely for use by private interests are those currently designated for sale or transfer by the Bureau of Land Management.

Two segments of the corridor encroach slightly on the Nellis Air Force Range. The U.S. Air Force has noted the potential for safety risks of crossing lands that are hazard areas and encompass weapons safety footprints for live weapons deployment. DOE has identified the Indian Hills Alternate, which would avoid the larger encroachment (see Appendix J, Section J.3.1.2). If DOE decided to build and operate a branch rail line in the Valley Modified corridor, it would consult with the Bureau of Land Management, U.S. Air Force, other affected agencies and Native American Tribal governments, and other DOE program operations on the Nevada Test Site to help ensure that it avoided or mitigated potential land-use conflicts associated with alignment of a rail line right-of-way. Because the Military Lands Withdrawal Act of 1999 (Public Law 106-65; 113 Stat. 885) withdraws and reserves the Nellis Air Force Range for use by the Secretary of the Air Force, the Secretary would need to concur with a decision to build and operate a branch rail line through any part of the Range.

Although there are no known community development plans that would conflict with the rail line, the presence of a rail line could influence future development and land use along the railroad in the communities of Indian Springs and North Las Vegas (that is, zoning and land use might differ depending on the presence or absence of a railroad).

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Operations. DOE anticipates that operations along the Valley Modified Corridor would cause fewer impacts than construction. Operations impacts would be similar to those discussed in Section 6.3.2.1.

6.3.2.2.5.2 Valley Modified Rail Air Quality

Construction. The Valley Modified Corridor and some of its variations would involve construction in the Las Vegas Valley air basin, which is in nonattainment for particulate matter (PM_{10}) and carbon monoxide (DIRS 101826-FHWA 1996, pp. 3-53 and 3-54). To assess nonradiological air quality impacts from branch rail line construction in this air basin, DOE compared emissions from earthmoving activities and vehicles to General Conformity and Prevention of Significant Deterioration thresholds. Appendix G, Section G.1.4.1, describes the method used to determine PM_{10} emissions from earthmoving activities. This method takes no credit for dust suppression measures; however, the analysis for transportation construction activities included dust suppression measures. Appendix G, Section G.1.4.5 describes the method used to determine criteria pollutant emissions from construction vehicle activity which, for the Valley Modified Corridor, would consume an estimated 7.1 million liters (about 1.9 million gallons) of diesel fuel and 150,000 liters (38,000 gallons) of gasoline in the nonattainment area over the length of the construction period.

Eighty-four kilometers (52 miles) of the total 160 kilometers (98 miles) of a branch rail line in the Valley Modified Corridor would be in the nonattainment area. Table 6-72 lists emission rates of PM_{10} and carbon monoxide from earthmoving activities and vehicle emissions in the nonattainment area assuming a work crew completed this section over 21 months and used standard construction techniques. There would be five borrow areas, five spoils areas, and one construction camp along the 84-kilometer (52-mile) construction corridor. Estimated emission rates would exceed the PM_{10} General Conformity threshold for a nonattainment area (see Table 6-73). The PM_{10} exceedance would primarily be the result of earthmoving activities. Dust abatement measures, assumed to be 70 percent effective (DIRS 155557-Clark County 2001, p. 4-63), would reduce emissions by a significant amount.

Table 6-72. Emission rates from Valley Modified Corridor construction in the nonattainment area.

Activity and emission	Emission rate (kilograms per year)
Earthmoving, PM_{10}	110,000
Vehicle, PM_{10}	14,000
Vehicle, carbon monoxide	98,000

a. To convert kilograms to pounds, multiply by 2.2046.

Table 6-73. Particulate matter (PM_{10}) and carbon monoxide air quality impacts (kilograms per year)[a] from Valley Modified Corridor construction in the nonattainment area.

Criteria pollutant/threshold	Threshold level[b]	Percent of threshold[c]		
		Earthmoving	Vehicles	Total
PM_{10}				
General Conformity	63,500 (serious)	170	22	190
Prevention of Significant Deterioration	227,000	48	6	54
Carbon monoxide				
General Conformity	90,700	NA[d]	110	110
Prevention of Significant Deterioration	227,000	NA	43	43

a. Kilograms per year; to convert kilograms to pounds, multiply by 2.2046.
b. Sources: 40 CFR 52.21 and 93.153.
c. Numbers are rounded to two significant figures.
d. NA = not applicable.

If DOE selected the Valley Modified Corridor for the construction and operation of a branch rail line, the final plans, specifications, and estimates would require adherence to the Clark County Health District PM_{10} emissions control measures. These measures are being developed in the Particulate Matter State Implementation Plan (DIRS 155557-Clark County 2001, all). Implementation of the comprehensive measures should enable rail line construction to start. The purpose of the measures under development is not to prohibit construction activity, but to enable it within the Environmental Protection Agency air quality requirements. Because the estimated impacts to air quality in the Las Vegas Valley air basin would exceed the General Conformity thresholds for carbon monoxide and PM_{10} in a nonattainment area, DOE would have to implement mitigation measures if it selected the Valley Modified Corridor. Under the construction design analyzed above, one crew at a time would construct the branch rail line from beginning to end over about 40 months, and the emissions in the Las Vegas Valley air basin would occur over about 21 months. A potential mitigation measure would be to have two crews construct the line at half the pace from each end of the corridor. Under this plan, the emissions in the basin would occur over the full 40 months, which would result in a decrease of about half in the emission rates, which would reduce the impacts listed above to levels at or less than the General Conformity thresholds. In addition, as part of final construction planning DOE would plan to use dust control measures and ensure fuel efficiency to reduce emissions. These measures should result in emissions below the General Conformity threshold levels.

The Valley Modified Corridor includes the Indian Hills Alternate, Sheep Mountain Alternate, and Valley Connection. The Sheep Mountain Alternate and Valley Connection are entirely in the nonattainment area, whereas only half of the Indian Hills Alternate is in the nonattainment area. The rail extents of the Indian Hill Alternate and the Valley Modified Corridor in the nonattainment area are equivalent. Therefore, no greater or smaller air quality impacts would result from selection of the Indian Hill Alternate. The Sheep Mountain Alternate and Valley Connection, if used, would add 3 and 7 kilometers (1.9 and 4.3 miles) of rail, respectively, to the length of the Corridor. Therefore, air quality impacts would be slightly but not significantly (less than 10 percent) greater if these variations were used.

Operations. Fuel consumption by diesel train engines operating along the rail corridor would emit carbon monoxide, nitrogen dioxide, and particulate matter (PM_{10} and $PM_{2.5}$). Based on the Federal standards for locomotives (40 CFR 92.005), there are no emission standards for sulfur dioxide.

In attainment areas, the pollutant concentrations in the air would increase slightly during the passage of a train, but the emissions from one or two trains a day would not exceed the ambient air quality standards. However, the Valley Modified Corridor would include a route through the Las Vegas Valley air basin, which is in nonattainment for carbon monoxide and PM_{10}. The air quality impacts to this air basin from train operation along the Valley Modified Corridor would be a small contribution in comparison to the amount of pollutants emitted by automotive travel in the basin. Thus, emissions from train operations in the Las Vegas Valley air basin would not produce further violations of the ambient air quality standards.

6.3.2.2.5.3 Valley Modified Rail Hydrology

Surface Water

Chapter 3, Section 3.2.2.1.3, notes that there are no surface-water resources along the Valley Modified Corridor, including its variations.

Table 6-74 lists flood zones identified along the Valley Modified Corridor and its variations. The Federal Emergency Management Agency maps from which DOE derived the flood zone information provided coverage for about 75 percent of the corridor length. The corridor crosses only two different 100-year flood zones or flood zone groups before entering the Nevada Test Site. Of the three variations, the Indian Hills Alternate would lessen the number of flood zones to one; the other two segments would have no change. As indicated in Section 6.3.2.1, impacts associated with altering drainage patterns or changing erosion and sedimentation rates or locations would be minor and localized.

Groundwater

Construction. The water used during construction would come largely from groundwater resources. The annual demands would be a fraction of the perennial yields of most producing aquifers (Chapter 3,

Table 6-74. 100-year flood zones crossed by the Valley Modified Corridor and its variations.[a,b]

Corridor portion	Crossing distance (kilometers)[c]	Flood zone feature(s)	Avoided by variation[d] (Yes or No)
Dry Lake to Yucca Mountain	0.1[e]	Unnamed creek NW of the city of Las Vegas (intermittent)	N
	1.2[f]	Drainage (projected) west of Indian Springs Air Force Auxiliary Base (intermittent)	Y-3
Variation			
1. Valley Connection	None	Located at the origin of the corridor	
2. Sheep Mountain Alternate	None	Located to the north of the corridor	
3. Indian Hills Alternate	None	Located to the south of the corridor	

a. Areas where natural floodwater movement could be altered and where erosion and sedimentation rates and locations could change. Sources:
   1. Federal Emergency Management Agency Flood Insurance Rate Maps for Clark and Nye Counties, Nevada.
   2. DIRS 154961-CRWMS M&O (1998, all).

b. Approximately 25 percent of the Valley Modified Corridor is not available on Federal Emergency Management Agency maps because that portion of the route is on the Nevada Test Site and the Nellis Air Force Range.

c. To convert kilometers to miles, multiply by 0.62137.

d. Certain 100-year flood zones can be avoided by corridor variations. These are identified with a "Y" (yes) and a number representing the specific variation(s) from the second half of the table that avoids the specific flood zone.

e. Limited information due to the Nellis Air Force Range.

f. Projected from limited data. Specific area not covered by Federal Emergency Management Agency maps; values were extrapolated from the closest maps.

Section 3.2.2.1.3, discusses estimated perennial yields for the hydrographic areas over which the Valley Modified corridor passes).

The estimated amount of water needed for construction of a rail line in the Valley Modified Corridor for soil compaction, dust control, and workforce use would be about 395,000 cubic meters (320 acre-feet) (DIRS 104914-DOE 1998, all). For planning purposes, DOE assumed that this water would come from 20 groundwater wells installed along the corridor. The average amount of water withdrawn from each well would be approximately 20,000 cubic meters (16 acre-feet). Most (90 percent) of the water would be used for compaction of fill material. The estimate of fill quantities needed for construction would vary if DOE used either of the variations. The Indian Hills Alternate would increase the total water demand for the Valley Modified Corridor, but only by 6 percent.

Chapter 3, Section 3.2.2.1.3, discusses the hydrographic areas over which the Valley Modified Corridor would pass, their perennial yields, and whether the State of Nevada considers each a Designated Groundwater Basin. If the hydrographic area is a Designated Groundwater Basin, permitted groundwater rights approach or exceed the estimated perennial yield, depleting the basin and water resources or requiring additional administration. Table 6-75 summarizes the designation status of the hydrographic areas associated with the Valley Modified Corridor and the approximate portion of the corridor that passes over Designated Groundwater Basins. Use of either variation would make no notable change in the status of hydrographic areas crossed.

Table 6-75. Hydrographic areas along the Valley Modified Corridor and its variations.[a]

Corridor description	Hydrographic areas	Designated Groundwater Basins	
		Number	Percent of corridor length
Valley Modified Corridor	6	3	70
Variations	6	3	70

a. All three variations (Indian Hills Alternate, Sheep Mountain Alternate, and Valley Connection) would cross the same six hydrographic areas (two with slightly different crossing distances) and the same three designated groundwater basins which, rounded to the nearest 10 percent, would represent the same portion of the total corridor.

The withdrawal of 20,000 cubic meters (16 acre-feet) a year from a well would have little impact on the hydrographic areas associated with the corridor based on their perennial yields (Chapter 3, Section 3.2.2.1.3). However, the installation of 20 wells along the corridor would mean that hydrographic areas would have multiple wells. As indicated in Table 6-75, about 70 percent of the corridor length is over Designated Groundwater Basins, which the Nevada State Engineer's office watches carefully for groundwater depletion. This does not mean that DOE could not obtain water appropriations in these areas; the State Engineer would have the authority to approve such appropriations. Because the DOE requests would be for a short-term construction action, the State Engineer would have even more discretion. Rather than spacing the wells evenly along the corridor, DOE could use locations that would make maximum use of groundwater areas that are not Designated Groundwater Basins. With such a large portion of the corridor over these basins, however, this would mean trucking water for long distances. Another option would be to lease temporary water rights from individuals along the corridor. Obtaining a water appropriation from the State Engineer for short-term construction use or using an approved allocation should ensure that groundwater resources are not adversely affected.

As an alternative, DOE could transport water by truck to meet construction needs. The construction of a branch rail line in the Valley Modified corridor would require about 21,000 tanker-truck loads of water or about 20 truckloads each day. Again, water obtained from permitted sources, which would provide water in allocations determined by the Nevada State Engineer, would not affect groundwater resources.

Operations. Operations along a completed rail line would have little impact on groundwater resources. Possible changes in recharge, if any, would be the same as those at the completion of construction.

6.3.2.2.5.4 Valley Modified Rail Biological Resources and Soils

Construction. The construction of a rail line in the Valley Modified corridor, including its variations, would disturb approximately 5 square kilometers (1,200 acres) of land (Table 6-71). The analysis assumed that the types of land cover in disturbed areas outside the corridor would be the same as that within the corridor. Table 6-76 compares the approximate area of disturbance in each land-cover type along the Valley Modified Corridor, including its possible variations, to the amount of land area within each land-cover type in Nevada. In addition, the table lists the percentage of the area that would be disturbed. The fraction disturbed for each cover type would be very small. The disturbance would not have a discernible impact on any land-cover type. Although some alignment variations could lead to a small increase in the total amount of land disturbed, the portion of the corridor, including its variations, in each land-cover type would be similar to that in the corridor.

This corridor, including its variations, passes through desert tortoise habitat along its entire length, so construction activities would disturb approximately 5 square kilometers (1,200 acres) of desert tortoise habitat, some of which is designated as critical habitat. Construction activities could kill individual desert tortoises, and the presence of a rail line could disrupt movements of individuals. However, desert tortoise abundance is low along this corridor (DIRS 101521-BLM 1992, Map 3-13; DIRS 101914-Rautenstrauch and O'Farrell 1998, pp. 407 to 411) so losses would be few, and would be unlikely to affect the regional population. Relocation of tortoises along the route prior to construction would minimize losses of individuals. The long-term presence of a rail line could block movements of individual tortoises. DOE would consult with the Fish and Wildlife Service (under Section 7 of the Endangered Species Act) regarding this species if it selected this corridor, and would implement all terms and conditions required by the Service.

Two populations of Parish scorpionweed and one of Ripley's springparsley (a Bureau of Land Management sensitive species) occur in the corridor and could be affected directly or indirectly by land-clearing activities. The locations of these populations would be identified though surveys prior to disturbance and would be avoided to the extent possible.

Table 6-76. Maximum area disturbed (square kilometers)[a] in each land-cover type for the Valley Modified Corridor.[b,c]

Land cover type	Percent of corridor length	Area disturbed	Area in Nevada	Percent disturbed
Agriculture	0.0	0.00	5,200	0.00
Blackbrush	0.0	0.00	9,900	0.00
Creosote-bursage	79.0	4.03	15,000	0.026
Grassland	0.0	0.00	2,800	0.00
Greasewood	0.0	0.00	9,500	0.00
Hopsage	0.0	0.00	630	0.00
Juniper	0.0	0.00	1,400	0.00
Mojave mixed scrub	15.9	0.81	5,600	0.014
Pinyon-juniper	0.0	0.00	15,000	0.00
Playa	0.6	0.03	7,000	<0.001
Sagebrush	0.0	0.00	67,000	0.0
Sagebrush/grassland	0.0	0.00	52,000	0.0
Salt desert scrub	4.5	0.23	58,000	<0.001
Urban		ND[d]	2,400	ND

a. To convert square kilometers to acres, multiply by 247.1.
b. Based on the proportion of the route in each land-cover type; percent disturbed was based on the variation with the greatest disturbance within a particular land-cover type. Percentages add to more than 100 because maximum values were used.
c. Source: DIRS 104593-CRWMS M&O (1999, Appendix D).
d. ND = not determined.

There are 46 populations of 11 sensitive plant species outside of the 400-meter (0.25-mile)-wide corridor, but within 5 kilometers (3 miles) of Sheep Mountain Alternate (see Appendix J, Section J.3.1.2 for a list of corridor variations). An additional five populations of two sensitive plant species are outside the corridor but within 5 kilometers of the Indian Hills Alternate. The use of either alternate would avoid one population of desert bearpoppy. These populations would not be affected because land disturbance would not extend to these areas and changes would be unlikely in the aquatic or soil environment as a result of construction or the long-term presence of a railroad.

Several designated game habitat areas for bighorn sheep, mule deer, or quail occur within 5 kilometers (3 miles) of the corridor. Larger game animals occupy large home ranges and could easily traverse the distance between the designated habitat and the corridor. Construction activities probably would disturb individuals or groups of animals and they would avoid construction areas.

The Indian Hills Alternate would cross one herd management area for wild horses and burros (DIRS 104593-CRWMS M&O 1999, p. 3-29). Construction in this area would result in the loss of a small amount of habitat and probably would disturb animals or their movements for the duration of the activity.

No springs, perennial streams, or riparian areas occur in this corridor or its variations and, therefore, impacts to biological resources associated with these areas and located within 5 kilometers (3 miles) of the corridor would be unlikely. The corridor and variations cross a number of ephemeral streams that may be classified as waters of the United States, although no formal delineations have been made (DIRS 104593-CRWMS M&O 1999, p. 3-29). DOE would work with the U.S. Army Corps of Engineers to minimize impacts to these areas and would obtain individual or regional permits, if necessary. Some changes to local drainage along a branch rail line would be likely; DOE would design the rail line to accommodate existing drainage patterns.

This corridor would cross two Wilderness Study Areas. Construction of a railroad in these areas would be incompatible with a Wilderness designation. Although the Bureau considers these Wilderness Study

Areas unsuitable for inclusion in the National Wilderness System, DOE would have to consult with the Bureau before it could build a branch rail line.

Soils in and adjacent to the corridor would be disturbed on approximately 5 square kilometers (1,200 acres) of land during construction of the railroad. Impacts to soils in the corridor [4.4 square kilometers (1,100 acres)] would be small, but could occur throughout construction. Impacts to disturbed areas outside the corridor would be transitory. DOE could reclaim these areas as practicable.

Shrink-swell soils occur along much of the corridor, including its variations, as does the potential for blowing soils. The presence of such soils could influence the amount of area disturbed by construction because soils in the vicinity of the railroad would have to be stabilized. Disturbance during construction would increase the amount of soil that could be transported by wind because the existing vegetation would be disturbed, at least temporarily. Revegetation after construction or other means of soil stabilization could minimize the amount of wind-borne soil.

As stated in Chapter 3, Section 3.2.2.1.4, variations identified for the Valley Modified Corridor could avoid some biological resources, as listed in Table 6-77.

Table 6-77. Biological resources avoided by Valley Modified Corridor variations.[a]

	Occurrence of resource			
	For unvaried segment of corridor		Occurrence avoided by variation	
Alignment variation resource	In corridor[b]	Within 5 km[c]	In corridor	Within 5 km
Sheep Mountain Alternate				
Sensitive species–desert bearpoppy	0	1	0	11
Indian Hills Alternate				
Sensitive species–desert bearpoppy	0	1	0	11

a. Variations listed are those that would result in the avoidance of biological resources along the corridor.
b. In the corridor [or springs within 400 meters (0.25 mile)], but avoided by the variation.
c. Within 5 kilometers (3 miles) of the corridor, but more than 5 kilometers from the variation.

6.3.2.2.5.5 Valley Modified Rail Cultural Resources

Construction. Cultural field studies in the area of the Valley Modified Corridor indicated that the area crossed by the corridor has the potential for relatively high densities of archaeological and historic sites. The corridor, including the Sheep Mountain Alternate, passes within 3 kilometers (1.9 miles) of three properties listed on the *National Register of Historic Places*: Tule Springs Archaeological Site, Tule Springs Ranch District, and the Corn Creek Campsite (DIRS 155826-Nickens and Hartwell 2001, Table 6). Direct impacts on these properties from rail line construction activities would be unlikely. The Bureau of Land Management Las Vegas District predicts that the Indian Springs Valley has the highest possible density of unrecorded significant cultural resources in Clark County. An archaeological records search yielded 19 previously recorded sites along the corridor and its variations (see Appendix J, Section J.3.1.2), 11 of which are considered potentially eligible for the *National Register of Historic Places* (Chapter 3, Section 3.2.2.1.5). Known historic sites that could be affected by rail construction activities include early railroad construction camps along the Union Pacific line near Apex and the historic Las Vegas and Tonopah Railroad (unvaried corridor segment, Sheep Mountain Alternate, and Indian Springs Alternate), as well as the original grade of that railroad. This corridor passes through Camp Desert Rock, a significant historic military site southwest of Mercury.

The Southern Paiute used Indian Springs Valley. There were several early historic period villages at springs such as Indian Springs, Tule Springs, and Corn Creek, and at other locations north of Las Vegas. Some of these locations could be affected by rail line construction activities along the corridor or the Sheep Mountain or Indian Hills Alternates.

The Valley Modified Corridor passes within about 1 kilometer (0.6 mile) of the Las Vegas Paiute Indian Reservation in the northeastern part of the Las Vegas Valley. The corridor would not affect identified cultural resources on the reservation.

Operations. As stated in Section 6.3.2.1, additional impacts to these resources during the operation of the branch rail line would be unlikely.

6.3.2.2.5.6 Valley Modified Rail Occupational and Public Health and Safety

Construction. Industrial safety impacts on workers from the construction and use of the Valley Modified branch rail line would be small (Table 6-78). The analysis evaluated the potential for impacts in terms of total reportable cases of injury, lost workday cases, and fatalities to workers from construction and operation activities. The analysis also evaluated traffic fatality impacts that would occur during the moving of equipment and materials for construction, worker commutes to and from construction sites, and transport of water to construction sites if wells were not available (Table 6-79).

Table 6-78. Impacts to workers from industrial hazards during rail construction and operations for the Valley Modified Corridor.

Group and industrial hazard category	Construction[a]	Operations[b]
Involved worker		
Total recordable cases[c]	32	73
Lost workday cases	16	40
Fatalities	0.04	0.20
Noninvolved worker		
Total recordable cases	1.9	4.1
Lost workday cases	0.7	1.5
Fatalities	0.002	0.004
Totals		
Total recordable cases	34	77
Lost workday cases	16	41
Fatalities	0.05	0.20

a. Totals for 40 months for construction.
b. Totals for 24 years for operations.
c. Total recordable cases includes injuries and illness.

Operations. Incident-free radiological impacts would occur during the routine transportation of spent nuclear fuel and high-level radioactive waste in the Valley Modified rail corridor. Table 6-80 lists the incident-free impacts, which include transportation along the Valley Modified corridor and along railways in Nevada leading to a Valley Modified branch line. The table includes the impacts of 1,079 legal-weight truck shipments from commercial sites that do not have the capability to load rail casks while operational.

6.3.2.2.5.7 Valley Modified Rail Socioeconomics

The following paragraphs discuss potential socioeconomic impacts associated with the construction and operation of a branch rail line in the Valley Modified Corridor.

Construction. The length of the Valley Modified Corridor, 159 kilometers (98 miles), is the most important factor that would determine the number of construction workers required. The construction of a branch rail line in this corridor would require workers laboring for approximately 810,000 hours or 405 worker years during the 40-month construction period. This rail line would require two temporary construction camps to house workers (DIRS 104595-CRWMS M&O 1999, all).

Employment

DOE anticipates that the total (direct and indirect) employment in the region of influence would peak in 2007 at about 245 jobs. Approximately 243 of the workers would come from Clark County, 2 from Nye County, and none from Lincoln County. The increase in employment would represent less than 1 percent of the employment baselines. Employment of Valley Modified Corridor construction workers and some indirect support workers would end in 2009. As a result, the projected total growth (2009 to 2010) of 15,240 jobs in the region of influence would be reduced by 191. The expected addition of 14,886 jobs in Clark County would be reduced by 189, and the expected growth of 330 jobs in Nye County would be reduced by 2. The expected growth of 24 jobs in Lincoln County would be unaffected. DOE anticipates

Table 6-79. Estimated number of fatalities from construction material delivery vehicles and construction and operations worker commuting traffic for the Valley Modified Corridor.

Activity	Kilometers[a]	Traffic fatalities	Emissions fatalities
Construction[b]			
Material delivery vehicles	8,000,000	0.1	0.02
Commuting workers	24,000,000	0.2	0.03
Subtotals	*32,000,000*	*0.4*	*0.05*
Operations[c]			
Commuting workers	52,000,000	0.5	0.07
Totals	***84,000,000***	***0.9***	***0.12***

a. To convert kilometers to miles, multiply by 0.62137.
b. Totals for 40 months for construction.
c. Totals for 24 years for operations.

Table 6-80. Health impacts from incident-free Nevada transportation for the Valley Modified Corridor implementing alternative.[a]

Category	Legal-weight truck shipments	Rail shipments	Totals[b]
Involved workers			
Collective dose (person-rem)	38	670	710
Estimated latent cancer fatalities	0.02	0.27	0.28
Public			
Collective dose (person-rem)	7	20	26
Estimated latent cancer fatalities	0.003	0.01	0.01
Estimated vehicle emission-related fatalities	0.002	0.009	0.011

a. Impacts are totals for 24 years.
b. Totals might differ from sums of values due to rounding.

that project-related workers not moving to Valley Modified Corridor operational jobs would be absorbed in other work in the State. These changes in employment would represent less than 1 percent of the applicable baselines.

Population

Population increases in the region of influence from the construction of a Valley Modified branch rail line, which would lag behind increases in employment, would peak in 2009 at about 219 persons. About 216 persons would reside in Clark County and 3 in Nye County. Population increases would be unlikely in Lincoln County. The impact to the population would be less than 1 percent of the Clark and Nye County population baselines. Because the expected increase in population would be so small and transient, impacts to schools or housing would be unlikely.

Economic Measures

Real disposable income, Gross Regional Product, and State and local government expenditures would rise during construction. The expected peak change in annual levels of these economic measures in the region of influence for a Valley Modified Corridor would be about $7.4 million in 2009 for real disposable income; $12.5 million in 2007 for Gross Regional Product; and $722,000 in 2009 for State and local expenditures. The impacts of these changes would be primarily confined to Clark County, where the workers would live and where they would purchase goods and services. The construction-related impacts would be less than 1 percent of the baseline values for all measures. (Dollar values reported in this section are in 2001 dollars unless otherwise stated.)

Transition and Operations Period. As the economy bridged the period between construction and operation of a Valley Modified branch rail line, the region of influence would continue to experience growth in the labor force and in residential population.

Employment and Population

Estimated direct employment for the operation of a branch rail line in the Valley Modified Corridor would average 36 workers. Total increase in employment in the three-county region of influence would average about 52 jobs over the 24-year operations period (2010 to 2033). DOE anticipates that all jobs would be in Clark County. In the region of influence, the average change in population during operations would be about 137 persons, 134 of whom would reside in Clark County. The impact to Clark County population and employment would be less than 1 percent of the baselines. Because the impact from increases in employment and population would be small, impacts to schools or housing would be unlikely.

Economic Measures

In the region of influence the greatest estimated increase in real disposable income attributable to the operation of a branch rail line in the Valley Modified Corridor ($3.6 million) would occur in 2033; the average increase for the 24-year operation would be $3.1 million. The change in real disposable income would be less than 1 percent of the baseline in the three counties. The average increase in Gross Regional Product would be about $3.6 million, or less than 1 percent of the baselines. The average State and local government expenditures would be approximately $482,000. The impact of additional expenditures by State and local governments would be less than 1 percent of the baselines. Virtually all of the economic activity related to the branch rail line would occur in Clark County.

The results of the detailed analysis performed for the Valley Modified Corridor, driven by the length of the corridor, are representative of the variations listed in Appendix J, Section J.3.1.2. The lengths of the variations are similar those listed in Table 6-71.

6.3.2.2.5.8 Valley Modified Rail Noise and Vibration

The Valley Modified Corridor passes north of Las Vegas and follows U.S. Highway 95 west past the small communities of Indian Springs, Cactus Springs, and Mercury (a Federal installation). Over its full length, the corridor is on Federal land set aside for use by DOE or the U.S. Air Force or managed by the Bureau of Land Management. Land west of the North Las Vegas area has few farms and most of the land is undeveloped.

The corridor meets the Union Pacific mainline near the Apex and Dike sidings in northeast Clark County. The County and the Bureau of Land Management have set aside land for an industrial park in this area. The nighttime noise benchmark of 50 dBA would be exceeded by estimated noise levels north of Las Vegas (Table 6-81). The corridor passes within 1 kilometer (0.6 mile) of the Las Vegas Paiute Indian Reservation. The Indian Hills Alternate (Appendix J, Section J.3.1.2) passes about 0.5 kilometer (0.3 mile) south of the Nevada penal institution at Indian Springs. Estimated noise levels at the penal institution from the Indian Springs Alternate would be 65 dBA.

Because a branch rail line would pass near some communities (including the Indian Springs penal institution), there would be a potential for noise impacts from both construction and operations. Corridor variations west of Indian Springs would not affect rural communities (Appendix J, Section J.3.1.2). The estimated population residing within 2 kilometers (1.3 miles) of the Valley Modified Corridor in 2035 would be about 190 persons. As discussed in Section 6.3.2.1, in areas where a branch rail line or variation passes near a community, train speeds could be limited to the extent necessary to ensure that noise was below levels listed as accepted noise standards.

Vibration. The Valley Modified branch rail line and its variations would be distant [more than 200 meters (660 feet)] from historic structures and buildings. There are no known ruins of cultural significance along the corridor. Therefore, vibration impacts to structures would be unlikely. The small number of trips (two per day) and the small train size would result in low levels of rail-induced ground vibration.

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Table 6-81. Estimated propagation of noise (dBA) from the operation of a waste transport train with two locomotives in communities near the Valley Modified Corridor.[a]

Corridor/community	Distance (kilometers)[a]	Estimated noise (dBA)[b]
Valley Modified		
North Las Vegas	1	57
Indian Springs	1.6	48.1
Cactus Springs	1.8	45.5
Indian Springs Alternate		
Indian Springs	2[c]	43.1
Cactus Springs	4[c]	27.6
Mercury[d]	2[c]	43.1

a. To convert kilometers to miles, multiply by 0.62137.
b. Estimated values do not include noise loss due to interactions with the ground that could account for decreases in estimated noise levels of from 10 to 20 dBA at 100 meters (330 feet) from the tracks.
c. Noise estimates at distances greater than 2 kilometers (1.2 miles) have large uncertainty.
d. Federal installation.

6.3.2.2.5.9 Valley Modified Rail Utilities, Energy, and Materials

Table 6-82 lists the use of fossil fuels and other materials in the construction of a Valley Modified branch rail line.

Table 6-82. Construction utilities, energy, and materials for a Valley Modified branch rail line.

Route	Length (kilometers)[a]	Diesel fuel use (million liters)[b]	Gasoline use (thousand liters)	Steel (thousand metric tons)[c]	Concrete (thousand metric tons)
Valley Modified	160	13 - 14	270 - 280	22 - 23	130

a. To convert kilometers to miles, multiply by 0.62137.
b. To convert liters to gallons, multiply by 0.26418.
c. To convert metric tons to tons, multiply by 1.1023.

6.3.3 IMPACTS OF NEVADA HEAVY-HAUL TRUCK TRANSPORTATION IMPLEMENTING ALTERNATIVES

This section describes the analysis of human health and safety and environmental impacts for five implementing alternatives that would employ heavy-haul trucks to transport rail shipping casks containing spent nuclear fuel and high-level radioactive waste in Nevada. DOE has identified five highway routes in Nevada for potential use by the heavy-haul trucks to transport the casks. The casks would be transported to the repository from an intermodal transfer station along a mainline railroad where they would be loaded onto the heavy-haul trucks from railcars. The trucks would also transport empty casks from the repository back to the intermodal transfer station for loading back onto railcars.

INTERMODAL TRANSFER STATION AND NAVAL SPENT NUCLEAR FUEL

Under the mostly legal-weight truck scenario, DOE would use the services of a commercial intermodal operator for the transfer of naval spent nuclear fuel shipments. This EIS assumed that DOE would not build an intermodal transfer station to handle those shipments. Because only 300 naval spent nuclear fuel casks would arrive in Nevada by rail over 24 years, the impacts of intermodal transfer operations would be considerably less than those for the mostly rail scenario. On average, the intermodal transfers would occur for about 2 weeks every 5 months to remove five casks from each train shipment. A staff of 20 would work only during these rail shipments.

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DOE would locate an intermodal transfer station at one of three potential locations in Nevada near existing rail lines and highways: (1) near Caliente, (2) northeast of Las Vegas (Apex/Dry Lake), or (3) southwest of Las Vegas (Sloan/Jean). Caliente is the originating location for three of the routes that heavy-haul trucks could use to ship spent nuclear fuel and high-level radioactive waste to the repository. There is one potential route each associated with the Apex/Dry Lake and Sloan/Jean locations (Figure 6-20).

For convenience and as shown in the figure, the five highway routes have been named the Caliente, Caliente/Chalk Mountain, Caliente/Las Vegas, Apex/Dry Lake, and Sloan/Jean routes. DOE considers these routes to be feasible for heavy-haul trucks to use in transporting large rail casks to and from the repository. The routes were compiled from a selection of highways in Nevada that the State has designated for use by heavy-haul trucks (DIRS 155347-CRWMS M&O 1999, Request #046). They include highways that were identified in a study by the College of Engineering at the University of Nevada, Reno, for the Nevada Department of Transportation (DIRS 103072-Ardila-Coulson 1989, all). This study provided a "preliminary identification of Nevada highway routes that could be used to transport current shipments of Highway Route-Controlled Quantities of Radioactive Materials and high-level radioactive waste." They also include highways studied by the Transportation Research Center at the University of Nevada, Las Vegas, that characterized "rail and highway routes which may be used for shipments of high-level nuclear waste to a proposed repository at Yucca Mountain, Nevada" (DIRS 103462-Souleyrette, Sathisan, and di Bartolo 1991, all).

This section evaluates impacts in Nevada for each route and associated intermodal transfer station. The evaluation addresses (1) upgrading highways to accommodate frequent heavy-haul truck shipments, (2) constructing and operating an intermodal transfer station, and (3) making heavy-haul truck shipments. With the exception of Interstate System Highways, upgrades to existing Nevada highways would be necessary to accommodate the heavy-haul trucks.

The analysis of impacts for each of the five Nevada heavy-haul truck implementing alternatives assumed the national mostly rail transportation scenario. Therefore, the analysis included the impacts of legal-weight truck transportation from six commercial generators that do not have the capability to handle or load a large rail cask. About 1,079 legal-weight truck shipments would enter Nevada and travel to the repository. These trucks would use the same transport routes and carry about the same amounts of spent nuclear fuel per shipment as those for the mostly legal-weight truck scenario discussed in Section 6.3.1.

The analysis evaluates impacts for the following environmental resource areas: land use and ownership; air quality; hydrology; biological resources and soils; cultural resources; occupational and public health and safety; socioeconomics; noise and vibration; aesthetics; utilities, energy, and materials; and waste management.

Section 6.3.4 discusses the potential for transportation activities to cause environmental justice impacts in Nevada.

6.3.3.1 Impacts Common to Nevada Heavy-Haul Truck Implementing Alternatives

Nevada highways upgraded for heavy-haul truck use would allow routine, safe use in year-round operations. Upgrades would include reconstruction of some highway sections, especially in areas where spring and fall thaws and freezes make the highways susceptible to damage by heavy vehicles (frost-restricted areas). In addition, new turnout lanes at frequent intervals along two-lane highways would allow other traffic to pass the slower heavy-haul vehicles. Highway shoulders would be widened and road surfaces would be improved in many areas. Interstate highways would not be improved because they already meet standards that upgrades to other Nevada highways for heavy-haul truck shipments would follow.

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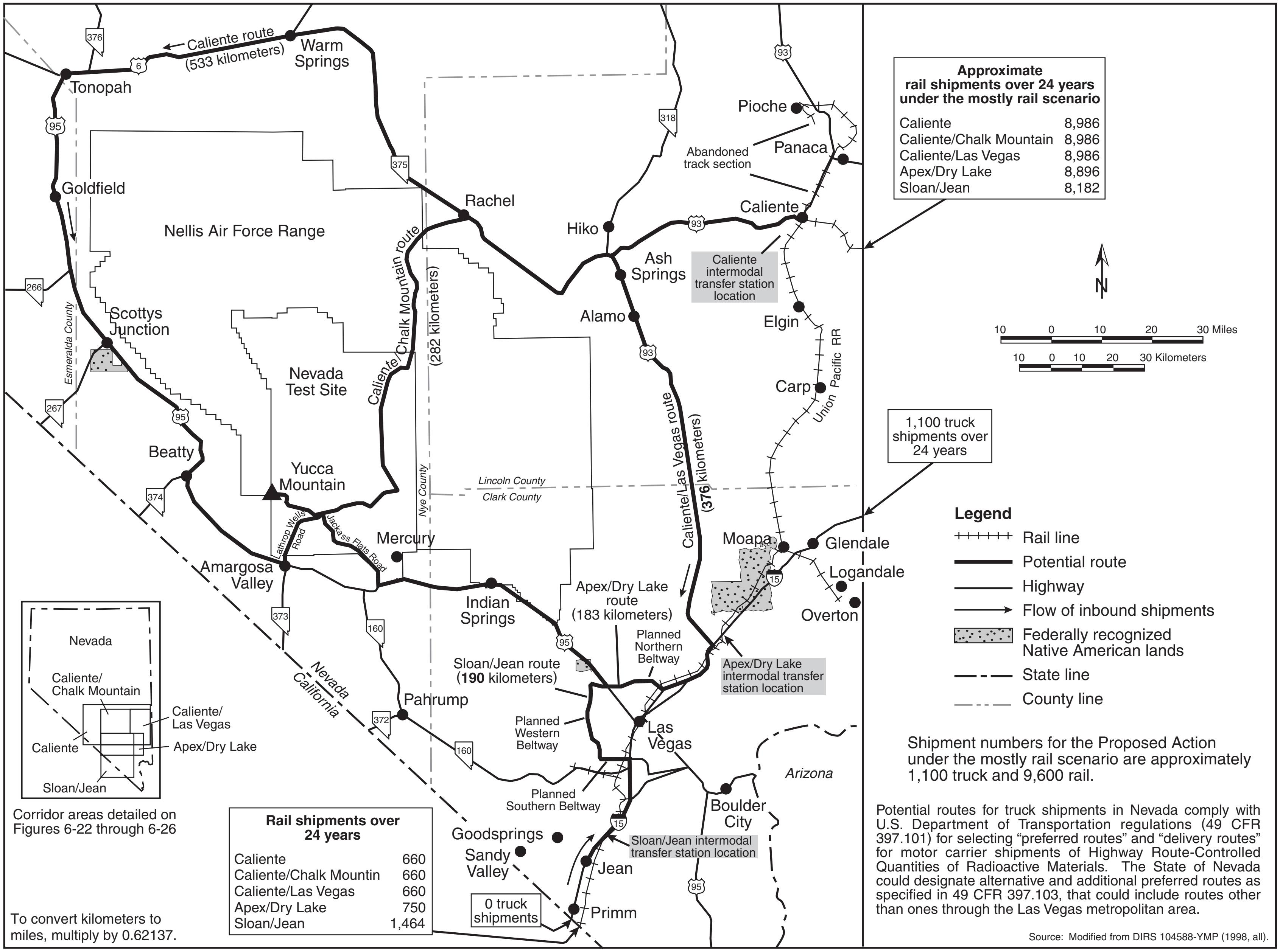

Figure 6-20. Potential routes in Nevada for heavy-haul trucks and estimated number of shipments for each route.

Even with the highway upgrades, heavy-haul trucks would cause delays for other vehicles because of their size and slower travel speeds. On most of the highways in Nevada that heavy-haul shipments would use, traffic volumes are classified as *level of service Class A* (DIRS 103255-CRWMS M&O 1999, p. 3-11), which means that traffic flows freely without delay (see Chapter 3, Section 3.2.2.2.11, for a description of all levels of service). The addition of 11 round trips each week to the traffic flow on these highways would not lead to a change in the average level of service. However, some traffic in lanes traveling with the vehicles would experience delays and short queues could form between turnout areas. In congested areas, such as the Las Vegas metropolitan area, where the level of service for the planned Las Vegas Beltway could be Class C or lower during non-rush-hour times, large slow-moving vehicles with their accompanying escort vehicles could present a temporary but large obstruction to traffic flow. Because disruptions on congested highways often continue after the removal of the cause, the duration of a traffic flow disruption would be longer than the time the vehicle would travel on the highway.

An intermodal transfer station would be common to all five heavy-haul truck implementing alternatives. Figure 6-21 shows the locations in Nevada that DOE is considering for such a station. Station construction would take about 18 months. The station would be a fenced area of about 250 by 250 meters (820 by 820 feet) and a rail siding that would be about 2 kilometers (1.25 miles) long. The estimated total area occupied by the facility and support areas would be 200,000 square meters (50 acres). It would include rail tracks, two shipping cask transfer cranes (one on a gantry rail and a backup rubber-tired vehicle), an office building, and a maintenance and security building. It would also have connecting tracks to an existing mainline railroad and storage and transfer tracks inside the station boundary. The maintenance building would provide space for routine service and minor repairs to the heavy-haul trailers and tractors. The station would have power, water, and other services. Diesel generators would provide a backup electric power source. The station would have the capacity to allow an intermodal transfer rate of 22 rail casks a week (11 loaded casks to the repository, 11 empty casks returned to the commercial and DOE sites).

Operations at an intermodal transfer station would include switching railcars carrying spent nuclear fuel and high-level radioactive waste casks from mainline railroad trains to the station's side track; queuing railcars on the side track for movement to the intermodal transfer area; moving railcars carrying loaded casks from the side track into position to transfer the casks to heavy-haul trucks; and using the facility crane to transfer loaded casks from railcars to heavy-haul trucks. The station would reverse this sequence of operations for empty casks returning from the repository.

The estimated life-cycle cost to construct and operate an intermodal transfer station and to operate heavy-haul trucks in Nevada would range from $387 million to $669 million (2001 dollars), depending on the alternative.

This section discusses impacts for the analysis areas that would be common to all five heavy-haul truck implementing alternatives. It includes impacts for upgrading Nevada highways for use by heavy-haul trucks, constructing and operating an intermodal transfer station, and heavy-haul truck transportation of shipping casks, both loaded and empty. DOE evaluated these impacts as described in Section 6.3. Section 6.3.3.2 discusses impacts that would be unique to each heavy-haul truck transportation implementing alternative.

6.3.3.1.1 *Common Route Land Use and Ownership Impacts*

Intermodal Transfer Station Construction. Land-use impacts from an intermodal transfer station would center on the station itself because the railroad lines and the highways that DOE would use already exist and their intended use would not change. The construction of an intermodal transfer station would change the land uses and ownership (organizational control) of about 0.2 square kilometer (50 acres) of property. This land would become the responsibility of DOE or possibly a transportation operating

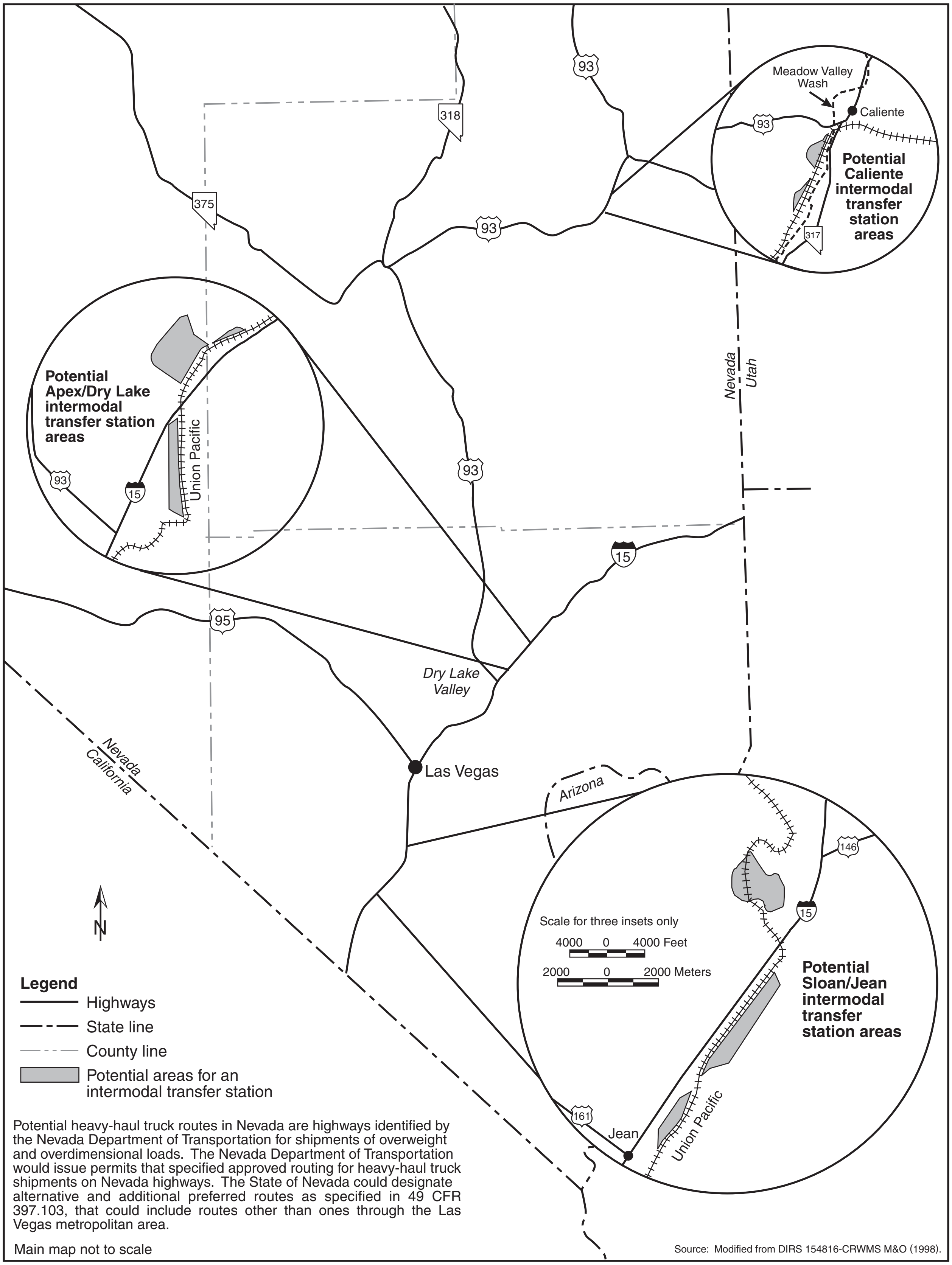

Figure 6-21. Potential locations for an intermodal transfer station.

company. An intermodal transfer station would be in an area used for industrial and commercial activities or adjacent to existing roads and railways. Because the land area would be small, fencing around an intermodal transfer station would have no significant impacts on other land uses. Because of the station's use and proximity to industrial and commercial facilities or existing roads and rail lines, land use impacts would be small. DOE would build a Caliente intermodal transfer station, located near the entrance to Kershaw-Ryan State Park, on lands currently used for industrial and commercial purposes. Because of this, there should be no additional impact to land use.

Heavy-Haul Truck and Intermodal Transfer Station Operations. Intermodal transfer station operations (arriving and departing trains, arriving and departing heavy-haul trucks, intermodal transfers, and maintenance and inspection activities) would be confined to the same areas that were disturbed during construction, so no additional land disturbance would take place. There would be no significant impacts to land use of the proposed facility locations. Only limited land-use impacts would result from heavy-haul truck operations on Nevada highways. Erosion along these highways would be managed as it is now. Because new road construction would not be needed, additional land and soil disturbance would occur only along existing roads and within existing rights-of way. Other land-use and ownership impacts would differ among the implementing alternatives. These impacts are described in Section 6.3.3.2.

6.3.3.1.2 *Common Route Air Quality Impacts*

The emissions of criteria pollutants [carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter (PM_{10}), lead, and ozone] are regulated under the Clean Air Act. Ozone would not be directly released during heavy-haul truck route construction and operation activities. However, ozone precursors (nitrogen dioxide and volatile organic carbon compounds) would be released due to fuel use by construction equipment. The estimated annual emission rates of nitrogen dioxide and volatile organic carbon compounds would be small in comparison with regulatory standards (40 CFR 52.21). In addition, lead emissions would not result from heavy-haul truck route construction and operation activities. The construction and operation activities discussed in this section would not be a significant source of ozone or lead.

DOE conducted a conformity review using the guidance in DIRS 155566-DOE (2000, all) for transportation activities under the heavy-haul truck implementing alternative. This review focused on the emission of carbon monoxide and PM_{10}. The Las Vegas air basin is in nonattainment status for carbon monoxide, which is largely a result of on-road sources (DIRS 156706-Clark County 2000, Appendix A, Table 1-3). During construction, transportation of personnel, materials, and supplies; construction of an intermodal transfer station; and highway construction and upgrade activities in the nonattainment area (including accelerated construction of the Las Vegas Beltway) would result in carbon monoxide emissions in the nonattainment area. During operations, transportation of personnel, materials, and supplies and transportation of spent nuclear fuel and high-level radioactive waste would result in carbon monoxide emissions in the nonattainment area. The review determined that during the construction phase total carbon monoxide emissions would exceed the General Conformity threshold level in the nonattainment area only for the Caliente/Las Vegas route (110 percent of threshold). All other nonattainment area construction and operations emissions in the nonattainment area would not exceed the General Conformity threshold level. The maximum emissions would be 100 metric tons (110 tons) per year (110 percent of threshold) during construction ; this estimate is 0.11 percent of the 2000 daily carbon monoxide inventory of the Las Vegas air basin. Maximum total emissions during operations would be 73 metric tons (80 tons) per year (80 percent of threshold); this estimate is 0.08 percent of the 2000 daily carbon monoxide inventory of the Las Vegas air basin.

The Las Vegas air basin is also in nonattainment status for PM_{10}, which is largely a result of construction activities (DIRS 155557-Clark County 2001, Tables 3-8 and 5-3). The conformity review determined that the fugitive dust emissions from the construction of the intermodal transfer facilities and highway construction and upgrade activities in the nonattainment area (including accelerated construction of the Las Vegas Beltway) would just exceed General Conformity threshold levels for the Caliente/Las Vegas route (100 percent of threshold). The maximum emissions would be 66 metric tons (73 tons) per year (100 percent of threshold) during construction; this estimate is 0.04 percent of the annual and daily 2001 PM_{10} inventory of the Las Vegas air basin.

The General Conformity Threshold levels are exceeded for carbon monoxide (110 percent of threshold) and PM_{10} (100 percent of threshold) during construction of the Caliente/Las Vegas route. The above-threshold emissions would occur over a 1.2-year period in the nonattainment area. During the remaining construction time for this route, construction activities and, therefore, emissions would occur largely outside the nonattainment area. Outside the nonattainment area, emissions levels would be significantly below the Prevention of Significant Deterioration levels (carbon monoxide—43 percent of threshold and PM_{10}—29 percent of threshold).

The DIRS 155112-Berger (2000, p. 56) estimate for transportation of radioactive materials only for heavy-haul truck transport for 2020 is 0.54 metric ton (0.59 ton) per day. The Berger estimate is largely the result of emissions from collateral traffic congestion. Although DOE believes the estimate is high, a value of 0.54 metric ton per day, 11 round trip shipments per week, 52 weeks per year, would result in about 123 metric tons (135 tons) of carbon monoxide per year, which would exceed the 91 metric tons (100 tons) per year General Conformity threshold, but would be 0.08 percent of the annual and daily 2001 PM_{10} inventory of the Las Vegas air basin.

Highway Construction and Upgrades. Construction and upgrade activities would occur in Nevada along any of the five heavy-haul alternatives (see disturbed area estimates under the Land Use and Ownership discussions in Section 6.3.3.2. These activities would result in the release of criteria pollutants. Fuel consumption during construction activities would result in releases of criteria pollutants [carbon monoxide, nitrogen dioxide, sulfur dioxide, and particulate matter (PM_{10})]. Construction activities would also release particulate matter in the form of fugitive dust from such activities as excavation and truck traffic. The analysis for the three heavy-haul truck routes that would pass through the Las Vegas Valley air basin included acceleration of the Las Vegas Beltway project from its scheduled completion in 2020 to a completion date of 2010.

Most of the road upgrades would occur in areas that are in attainment for all criteria pollutants. If construction activities were conducted in the Las Vegas Basin, which is in nonattainment for PM_{10} and carbon monoxide, additional measures would be necessary to reduce the PM_{10} and carbon-monoxide emissions, in accordance with the Clark County PM_{10} State Implementation Plan (DIRS 155557-Clark County 2001, all). Appendix G, Section G.1.4.1, describes the method used to determine PM_{10} emissions from earthmoving activities. This method takes no credit for dust suppression measures. However, the analysis assumed dust suppression for the transportation construction emissions described here and in the conformity review; dust suppression was assumed to reduce PM_{10} emissions by 70 percent. Appendix G, Section G.1.4.5, describes the method used to determine criteria pollutant emissions from construction vehicle activity. Fuel consumption from route-specific construction vehicle use is assumed to be:

Caliente/Las Vegas route:	5.5 million liters (1.5 million gallons) diesel fuel, 110,000 liters (29,000 gallons) gasoline over 46 months
Sloan/Jean route:	1.7 million liters (450,000 gallons) diesel fuel, 29,000 liters (7,700 gallons) gasoline over 48 months
Apex/Dry Lake route:	1.6 million liters (420,000 gallons) diesel fuel, 25,000 liters (7,400 gallons) gasoline over 28 months

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Accelerated Northern Beltway:	1.9 million liters (500,000 gallons) diesel fuel, 35,000 liters (9,200 gallons) gasoline over 28 months (add these emissions to Caliente/Las Vegas and Apex/Dry Lake results)
Accelerated Southern and Western Beltway:	3.9 million liters (1 million gallons) diesel fuel, 72,000 liters (19,000 gallons) gasoline over 48 months (add these emissions to Sloan/Jean results)

However, activities at any location would generate transient emissions that would be spread over a very large area because construction would be a moving source along various portions of the route. Construction activities in or near the nonattainment area would include intermodal transfer facility construction at Sloan/Jean and Apex/Dry Lake; highway upgrade activities for the Caliente/Las Vegas, Sloan/Jean, and Apex/Dry Lake routes; and accelerated Las Vegas Beltway construction.

Intermodal Transfer Station Construction. Construction of an intermodal transfer station would also generate emissions of criteria pollutants from fuel use and earthmoving activities. Each heavy-haul truck route would require the construction of such a facility. The Caliente intermodal transfer station could serve the Caliente, Caliente/Chalk Mountain, or Caliente/Las Vegas route. The Caliente station would be in an area in attainment of the National Ambient Air Quality Criteria (attainment area) and construction emissions would adhere to the Prevention of Significant Deterioration regulations (40 CFR 52.21). The Sloan/Jean or Apex/Dry Lake station would be in or near the Las Vegas Basin PM_{10} and carbon monoxide nonattainment area. New stationary emission sources in nonattainment areas are regulated under the General Conformity Rule (40 CFR 93.153).

Table 6-83 lists estimated annual emissions from the construction of an intermodal transfer station. These estimates would apply to each of the three potential site areas. Building an intermodal transfer station would disturb about 0.2 square kilometer (50 acres) over 18 months. Construction of the station would require about 130,000 liters (34,000 gallons) of diesel fuel and about 2,600 liters (690 gallons) of gasoline. The analysis used the method described above for highway construction and upgrades to estimate emissions from earthmoving and fuel use.

Table 6-83. Annual criteria pollutant releases from construction of an intermodal transfer station (kilograms per year).[a]

Pollutant	Construction emission (annual)	PSD limit[b]	Percent of limit[b]	GCR[c] emission threshold	Percent of GCR emission threshold
Nitrogen dioxide	3,400	230,000	1.4	NA[d]	NA
Sulfur dioxide	320	230,000	0.14	NA	NA
Carbon monoxide	2,100	230,000	0.91	91,000	2.3
PM_{10}	9,400	230,000	4.1	64,000 (serious)	15

a. To convert kilograms to tons, multiply by 0.0011023.
b. Prevention of Significant Deterioration (40 CFR 52.21).
c. GCR = General Conformity Rule (40 CFR 93). Applies for releases of pollutants in areas in nonattainment.
d. NA = not applicable.

Table 6-83 lists the percentage of each pollutant in relation to the Prevention of Significant Deterioration limit and the General Conformity Rule emission threshold. The estimated annual releases from the construction of the intermodal transfer station would be almost 4 percent of the Prevention of Significant Deterioration limit and 15 percent of the General Conformity Rule emission threshold (see 40 CFR 93) for PM_{10} and 2.3 percent for carbon monoxide. Construction activities in the Las Vegas nonattainment area would have to follow more stringent fugitive dust (PM_{10}) control measures described in the Clark County PM_{10} State Implementation Plan (DIRS 155557-Clark County 2001, all).

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Heavy-Haul Truck and Intermodal Transfer Station Operations. Operations at the intermodal transfer station would include locomotive and heavy-haul truck emissions. Fuel use by heavy-haul trucks would result in emissions of carbon monoxide, nitrogen dioxide, sulfur dioxide, and PM_{10}. Based on the Federal standards for switch locomotives (40 CFR 92.006), there are no emission standards for sulfur dioxide. The locomotive would operate about 30 hours per week at the intermodal transfer station. The pollutant concentration in the area around the route would increase slightly during the passage of the heavy-haul trucks but would not exceed the General Conformity thresholds. About 11 heavy-haul trucks per week would travel to and from the intermodal transfer station.

Table 6-84 lists estimated annual emissions from the operation of an intermodal transfer station. These estimates would apply to each location.

Table 6-84. Annual emissions of criteria pollutants from operation of an intermodal transfer station over 24 years (kilograms per year).[a]

Pollutant	Operation[b] emissions (annual)	PSD limit[c]	Percent of PSD limit	GCR[d] emission threshold	Percent of GCR emission threshold
Nitrogen dioxide	38,000	230,000	17	NA[e]	NA
Sulfur dioxide	(f)	230,000	(f)	NA	NA
Carbon monoxide	11,000	230,000	4.8	91,000	12
Particulate matter (PM_{10})	1,100	230,000	0.48	64,000	1.7

a. To convert kilograms to tons, multiply by 0.0011023.
b. Operations emissions from a switchyard locomotive and heavy-haul trucks.
c. PSD limit = Prevention of Significant Deterioration definition of a major stationary source (40 CFR 52.21); applies for releases of criteria pollutants during operation.
d. GCR = General Conformity Rule (40 CFR Part 93); applies for releases of pollutants in areas in nonattainment.
e. NA = not applicable.
f. 40 CFR 92.006 does not define sulfur dioxide emission standards for locomotives.

The estimated annual releases for the operation of the intermodal transfer station would be about 17 percent or less of the definition of a major stationary source (see Chapter 3, Section 3.1.2.1, or 40 CFR 52.21). The operation of a midroute stopover would result only in small releases of pollutants.

The operation of a yard locomotive would not emit ozone directly, but would emit ozone precursors (nitrogen dioxide and hydrocarbons). The estimated annual releases of the ozone precursors would be small; nitrogen dioxide would be about 17 percent of a major stationary source. Therefore, DOE does not expect the operation of the intermodal transfer facility to be a significant source of ozone.

Because the shipping casks would not be opened, there would be no radiological air quality impacts from normal operations at an intermodal transfer station.

Other air quality impacts would differ among the implementing alternatives (see Section 6.3.3.2).

6.3.3.1.3 *Common Route Hydrology Impacts*

This section describes impacts common to the five heavy-haul truck implementing alternatives (including upgrades to Nevada highways and construction of a midroute stopover and an intermodal transfer station at one of three locations) for surface water and groundwater.

Surface Water

Highway Construction and Upgrades. For road improvement work and construction of a midroute stopover, a contractor could place fuel tank trucks or trailers along the route to support equipment operations. Such a practice would present some potential for spills and releases. As long as the contractor met the regulatory requirements for reporting and remediating spills and properly disposing of or recycling used materials, the probability of unrecovered spills due to negligence or improper work practices would be low. If a release occurred, the potential for chemical contaminants (principally petroleum products) to enter flowing surface water before cleanup would be the largest risk. Surface-water resources along routes for heavy-haul trucks and in the vicinity of intermodal transfer station sites are identified in Chapter 3, Section 3.2.2.2.3. Among all the routes and station sites, three identified surface-water resources cross or run immediately adjacent to a route and two others are as close as 10 to 30 meters (30 to 100 feet). Otherwise, all of the identified surface-water resources are at least 100 meters (330 feet) from the existing roads or intermodal transfer station sites. Two of the station sites and their associated routes for heavy-haul trucks (Sloan/Jean and Apex/Dry Lake) have no identified surface-water resources within 1 kilometer (0.6 mile). The potential for released contaminants to reach flowing surface water would be very low.

A portable asphalt plant to support roadway improvement work would be located along the paving area. Aggregate crushing plants would be located in borrow areas. DOE assumes that the borrow areas would be those normally used by the Nevada Department of Transportation. Spills and releases of asphalt materials, which are predominantly petroleum products but include chemical additives, could occur in the course of operating an asphalt plant. Spill reporting and remediation requirements would be in place for these operations, as described above. Once asphalt was in place, it would be susceptible to minor leaching or bleeding while it cured, similar to the leaching or bleeding that occurs during road construction for other highway projects.

Intermodal Transfer Station Construction. Potential impacts to surface water would include (1) the possible spread of contamination by precipitation, intermittent runoff events, or, where present, releases to flowing water in the single perennial stream, and (2) the alteration of natural drainage patterns or runoff rates that could affect downgradient resources.

Materials that could contaminate surface water would be present during construction; these would consist primarily of petroleum products (fuels and lubricants) and coolants (antifreeze) to support equipment operations. There would not be much bulk storage of these materials. Fuel for vehicles would be purchased from nearby commercial vendors. Minor amounts of building materials such as paints, solvents, and thinners could be present during construction.

The construction of an intermodal transfer station would include stormwater runoff control, as necessary; the completed station would have a stormwater detention basin. These measures would minimize the potential for contaminated runoff to reach a stream.

Appendix L contains a floodplain/wetlands assessment that examines the effects of highway route construction, operation, and maintenance (see Section L.4.1) on the following floodplains in the vicinity of Yucca Mountain: Fortymile Wash, Busted Butte Wash, Drill Hole Wash, and Midway Valley Wash. There are no delineated wetlands at Yucca Mountain.

The assessment in Appendix L compares what is known about the floodplains, springs, and riparian areas at the three candidate intermodal transfer station sites (see Sections L.3.2.6, L.3.2.7, L.3.2.8, and L.4.2.2). In general, wetlands have not been delineated at the three sites. The Appendix L assessment does not evaluate potential floodplain or wetland effects along routes for heavy-haul trucks because these are existing roads and DOE assumed upgrades would be limited to those construction activities necessary to accommodate the heavy-haul vehicles. If DOE selected heavy-haul trucks to transport spent nuclear fuel and high-level radioactive waste to the Yucca Mountain site, it would also select one of five routes (Figure 6-20) and one of three alternative intermodal transfer station sites (Figure 6-21). DOE would then prepare a more detailed floodplain/wetlands assessment of the selected alternatives to determine to what extent the routes and station locations might be subject to flooding and whether the upgrades would affect wetlands.

Heavy-Haul Truck and Intermodal Transfer Station Operations. Surface-water impacts during operations would be limited to those from maintaining and resurfacing highways and parking areas at a midroute stopover that the heavy-haul trucks would use. As discussed above, good construction practices overseen by the Nevada Department of Transportation would limit impacts that could result from spills of chemical contaminants in the course of highway maintenance and resurfacing activities. Contamination of surface water caused by contaminants leached from new asphalt would be similar to that which occurs in the periodic resurfacing of asphalt highways.

Operations at a completed intermodal transfer station would have little impact on surface waters beyond any permanent drainage alterations that occurred during construction. The station area runoff rates would differ from those of the natural or existing terrain but, given the relatively small size [0.2 square kilometer (50 acres)] of the potentially affected area, they would add little to overall runoff quantities for the area.

The general design criteria for a station would consider the potential for a 100-year flood. Because the spent nuclear fuel and high-level radioactive waste shipping casks would not be opened or otherwise disassembled, the use of industrial design standards for this facility would be appropriate. The analysis assumes that the station would have a diesel-powered generator to provide standby electric power and an associated diesel storage tank. The diesel tank would present a minor potential for spills and releases. Runoff retention areas would limit impacts of potential oil and diesel spills in parking areas.

6.3.3.1.4 *Common Route Groundwater Impacts*

Highway Construction and Upgrades. For highway upgrades, the most likely impacts would be changes to infiltration rates and new sources of contamination that could migrate to groundwater during construction. In this case, however, the potential for impacts would be small due to the relatively small areas affected by upgrading and the fact that highway construction [with the exception of 2 kilometers (1.2 miles) of new highway near Beatty, Nevada, and a midroute stopover], would be a modification of existing roadways. In addition, there would be no large sources of contamination.

Construction activities would disturb and loosen the ground, which could produce greater infiltration rates. However, this impact would be minor and short-lived as contractors completed their work and stabilized the disturbed areas.

Intermodal Transfer Station Construction. Construction activities for an intermodal transfer station would disturb and loosen the ground for some time, which could cause higher infiltration rates. However, this impact would be minor and short-lived as contractors completed the facility and stabilized the disturbed areas.

Water needs for construction would be met by trucking water to the site, installing a well (which would also be used for operations), or possibly by connection to a local water distribution system. In any case, water demand would be small for construction.

Heavy-Haul Truck and Intermodal Transfer Station Operations. The use of highways by heavy-haul trucks would have little impact on groundwater resources. There would be no continued need for water along the route, and there would be no changes to recharge beyond those at the completion of construction.

The operation of a completed midroute stopover and an intermodal transfer station would have little impact on groundwater. Infiltration rates would be as described above for the completion of construction;

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the relatively small size of the facilities would minimize changes. Potential sources of contamination at the intermodal transfer station would consist primarily of a diesel fuel tank for the standby generator and heavy equipment. Water demand at the station and the midroute stopover would be small, consisting primarily of the needs of the operators, and would be obtained by the methods described above for construction. This demand would cause no noticeable change in water consumption rates for the area.

Other impacts to hydrology would differ among the implementing alternatives, as described in Section 6.3.3.2.

6.3.3.1.5 *Common Route Biological Resources and Soils Impacts*

Highway Construction and Upgrades. Highway upgrade activities would involve improving existing road surfaces and possibly building a bridge near Beatty, Nevada (Caliente route), a midroute stopover (Caliente routes), and about 2 kilometers (1.2 miles) of new highway to handle heavier vehicles (DIRS 155347-CRWMS M&O 1999, Request #048). Areas disturbed by these activities would be in, adjacent to, or near existing rights-of-way. These areas would consist of habitats previously degraded by human activities, which would limit impacts associated with the routes. Clearing of vegetation and soil disturbance would create habitat for colonization by exotic plant species that are present along the candidate routes. This could result in an increase in abundance of exotic species along the routes, which could result in suppression of native species and increased fuel loads for fire. Reclamation of disturbed areas would enhance the recovery of native vegetation and reduce colonization by exotic species. Slight alterations of habitat immediately adjacent to existing roads would have only small impacts on desert tortoises because work would occur in the existing right-of-way. Tortoise populations are depleted for more than a kilometer on either side of roads having average daily traffic greater than 180 vehicles (DIRS 103160-Bury and Germano 1994, pp. 57 to 72). Game species, wild horses and burros, and other animals could temporarily avoid habitat adjacent to roads during highway upgrades, but upgrades would not otherwise add to the effects of these roads on the movement patterns or behavior of these animals. The modification of bridges and culverts over perennial streams, if necessary, could temporarily disrupt stream flow and increase sedimentation in downstream aquatic environments. DOE anticipates that preconstruction surveys of potentially disturbed areas would identify and locate sensitive biological resources and best management practices would minimize the impacts of highway upgrades.

All of the heavy-haul truck implementing alternatives cross perennial or ephemeral streams that may be classified as jurisdictional waters of the Unites States. Discharge of dredged or fill material into those waters is regulated under Section 404 of the Clean Water Act. After the selection of a heavy-haul truck implementing alternative, if requested, DOE would assist the Nevada Department of Transportation to identify any jurisdictional waters of the United States that highway upgrades would affect; develop a plan to avoid when possible, and otherwise minimize, impacts to those waters; and obtain, as appropriate, an individual or regional permit from the U.S. Army Corps of Engineers for the discharge of dredged or fill material. By implementing the mitigation plan and complying with other permit requirements, the Nevada Department of Transportation would ensure that impacts to wetlands and other waters of the United States would be small.

The primary soil impacts from improvements to highways would be land disturbance. Road improvements would consist of widening existing roadways, constructing turnouts and truck lanes at designated stretches along the routes, and improving existing intersections. Water would be applied during construction to suppress dust and compact the soil; this would reduce the potential for erosion. Drainage control along the route probably would remain as it is now. These combined measures would minimize the potential for adverse impacts to soils.

Intermodal Transfer Station Construction. The biological settings of the three potential sites for an intermodal transfer station differ; Section 6.3.3.2 addresses impacts for each of the Nevada heavy-haul transportation implementing alternatives.

Soil impacts from the construction of an intermodal transfer station would arise primarily from the direct impacts of land disturbance and would apply to each station site and route. Chapter 3, Section 3.2.2.2.1, lists estimates of land area required for an intermodal transfer station. The disturbed areas probably would be subject to increased erosion for at least some of the construction phase. Water would be applied during construction to suppress dust and compact the soil; this would reduce the potential for erosion. At the beginning of station construction, the topsoil would be stripped and stockpiled; during construction, temporary erosion control systems would minimize erosion impacts. At the completion of construction, the topsoil would be replaced over areas not used for station facilities, the area disturbed surrounding the station would be revegetated, and other permanent erosion control systems would be installed as appropriate.

Heavy-Haul Truck and Intermodal Transfer Station Operations. Impacts to biological resources from operations along any of the five possible routes would be very small. Because existing roadways would not be greatly altered, operations and maintenance would not lead to additional habitat losses. Heavy-haul truck operations could kill individuals of some species, but losses would be unlikely to have a detectable impacts on the regional population of any species and would be small in comparison to losses caused due to other traffic on the highways. Passing trucks could disrupt wildlife, but such effects would be transitory. The use of an upgraded highway would have only a small impact on soils.

Impacts to biological resources from operations at an intermodal transfer station and a midroute stopover would be very small. Operations would not lead to additional habitat losses. Individuals of some species could be disturbed or killed by human activities at the station and stopover, but such losses would be unlikely to have a detectable impact on the regional population of any species.

The use of a completed intermodal transfer station and midroute stopover should have only small impacts on soils. The station and stopover would be maintained throughout the operations period, including the repair of erosion damage to the grounds around the station and the rail siding.

Other impacts to biological resources would differ among the heavy-haul truck implementing alternatives, as described in Section 6.3.3.2.

6.3.3.1.6 *Common Route Cultural Resources Impacts*

Highway Construction and Upgrades and Intermodal Transfer Station Construction. Impacts (such as disturbing sites or damaging artifacts) could occur, primarily from surface-disturbing activities, to archaeological, historic, and traditional Native American cultural sites from upgrading highways, constructing a midroute stopover, and building an intermodal transfer station. Cultural resource inventories by the Nevada Department of Transportation and others identify certain archaeological and historic sites in established rights-of-way [generally about 60 meters (200 feet) wide]. Section 6.3.3.2 discusses the impacts of individual routes.

Heavy-Haul Truck and Intermodal Transfer Station Operations. After the identification, evaluation, and mitigation of impacts to significant cultural sites prior to construction activities associated with the upgrading of highways or construction of an intermodal transfer station, there would be no additional impacts to these resources from the operation of a heavy-haul truck route.

Although existing highways would be used, American Indians have expressed concern about the transport of spent nuclear fuel and high-level radioactive waste through tribal lands and through the larger region that comprises their traditional holy lands (DIRS 102043-AIWS 1998, all). Use of the Caliente/Las Vegas, Apex/Dry Lake, or Sloan/Jean route would include travel on U.S. 95 across a 1.6-kilometer (1-mile) section of the Las Vegas Paiute Indian Reservation. The Caliente/Las Vegas and Apex/Dry Lake routes pass near the Moapa Indian Reservation. The Caliente route along U.S. Highway 95 runs adjacent to the Scottys Junction trust lands parcel that Congress recently transferred to the Timbisha Shoshone tribe.

Other impacts to cultural resources would differ among the heavy-haul truck implementing alternatives, as described in Section 6.3.3.2.

6.3.3.1.7 *Common Route Occupational and Public Health and Safety Impacts*

Highway Construction and Upgrades. Traffic-related fatalities could occur among workers and members of the public during the upgrading of Nevada highways for heavy-haul truck use. The number of fatalities would depend on the amount of construction activity needed to upgrade a route. There would be no other common impacts for highway construction under any of the implementing alternatives. Section 6.3.3.2 describes impacts for each of the implementing alternatives. The construction of a midroute stopover for routes originating in Caliente would not add much to the impacts of highway construction discussed in Section 6.3.3.2.

Intermodal Transfer Station Construction. Impacts to workers from industrial hazards during the construction of an intermodal transfer station would be the same for all three possible locations. These impacts would be small (see Table 6-85). The analysis estimated impacts to workers in terms of total recordable cases of injury or illness, lost workday cases, and fatalities to workers. In addition, it estimated that there would be less than 1 (0.03) construction and construction workforce traffic-related fatality.

Table 6-85. Health impacts to workers from industrial hazards during construction of an intermodal transfer station.

Group	Total recordable cases[a]	Lost workday cases	Fatalities
Involved	3.8	1.8	0.01
Noninvolved[b]	0.3	0.1	0
Totals[c]	4.1	1.9	0.01

a. Total recordable cases includes injuries and illness.
b. Noninvolved worker impacts based on 25 percent of the involved worker level of effort.
c. Impacts are totals for 18 months.

Heavy-Haul Truck and Intermodal Transfer Station Operations. Section 6.3.3.2 discusses impacts for heavy-haul truck transportation and operations for each of the heavy-haul truck implementing alternatives. Common impacts for intermodal transfer station operations would include those to workers from industrial hazards and exposure to ionizing radiation (radiological impacts). DOE has determined that, because worker exposures to hazardous or toxic materials would be unlikely, workers at the station would incur no impacts from such materials. Table 6-86 lists potential impacts to workers from industrial hazards. In addition, there would be less than one (0.38) traffic-related fatality involving intermodal transfer station workers during operations.

Table 6-86. Health impacts to workers from industrial hazards during operation of an intermodal transfer station.

Group	Total recordable cases[a]	Lost workday cases	Fatalities
Involved	52	29	0.14
Noninvolved[b]	3.0	1.1	0.003
Totals[c]	55	30	0.15

a. Total recordable cases includes injuries and illness.
b. Noninvolved worker impacts based on 25 percent of the involved worker level of effort.
c. Totals for 24 years of operations.

Intermodal transfer station workers would be exposed to direct radiation from the shipping casks the station would handle. Involved worker exposures would occur during both the inbound (to the proposed repository) and outbound (to the commercial and DOE sites) portions of the

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shipment campaign. The involved worker group would include as many as 20 personnel performing station operational tasks over a total shipment campaign of about 19,300 casks (9,650 inbound and 9,650 outbound).

The analysis assumed that noninvolved workers would not be exposed to direct radiation during intermodal transfer station operations. To assess potential radiological impacts at the intermodal transfer stations, the EIS analysis assumed that noninvolved workers would be persons involved with the day-to-day operations of the facility and would have no direct involvement with handling spent nuclear fuel and high-level radioactive waste.

Table 6-87 lists doses and radiological impacts to an individual worker and the involved worker population. The estimated doses are based on involved worker doses from DIRS 104791-DOE (1992, p. 4.2).

Table 6-87. Doses and radiological impacts to involved workers from intermodal transfer station operations.[a]

Group	Dose	Latent cancer fatality
Maximum individual worker	12 rem[b]	0.005[c]
Involved worker population	260 person-rem	0.11[d]

a. Totals for 24 years of operations.
b. Based on 500-millirem-per-year administrative dose limit.
c. The estimated probability of a latent cancer fatality in an exposed individual.
d. The estimated number of latent cancer fatalities in an exposed involved worker population.

Table 6-87 indicates that the involved group of workers could incur a collective dose of about 260 person-rem over the operating period of the intermodal transfer station. The analysis estimated that about 0.1 latent cancer fatality would occur in the exposed worker population. The maximum individual dose accumulated by these workers was assumed to be 500 millirem per year or 12 rem for a worker who worked at the facility for the 24-year operating period. This dose would result in a 0.005 probability of a latent cancer fatality (about a 1-in-200 chance). The assumed annual average dose to an involved worker is the administrative limit on occupational dose that DOE established for its facilities (DIRS 156764-DOE 1999, Article 211). Because vehicles would not be loaded or unloaded at a midroute stopover (Caliente routes), workers at the stopover would receive only small radiation doses.

Incident-Free Transportation. Incident-free impacts of heavy-haul truck transportation in Nevada to individual workers and the public would be unique for each of the five Nevada heavy-haul truck transportation implementing alternatives; these are discussed for each implementing alternative in Section 6.3.3.2. In addition, the incident-free impacts that would occur in Nevada from 1,079 legal-weight truck shipments, although common among the heavy-haul truck implementing alternatives, are reported along with the incident-free impacts for heavy-haul truck transportation in Section 6.3.3.2 for each heavy-haul truck implementing alternative.

Incident-free impacts to hypothetical maximally exposed individuals would be similar among the Nevada heavy-haul truck transportation implementing alternatives. Table 6-88 lists the impacts to maximally exposed individuals including a Nevada-specific individual exposed to heavy-haul truck shipments. Appendix J, Section J.1.3.2.2 describes assumptions for estimating doses to maximally exposed individuals along routes in Nevada.

Accidents. Accident risks and maximum reasonably foreseeable accidents for heavy-haul truck shipments of spent nuclear fuel and high-level radioactive waste would be similar among the Nevada heavy-haul truck transportation implementing alternatives, so this section discusses them.

Table 6-89 lists the accident risks from the transportation of spent nuclear fuel and high-level radioactive waste for the five Nevada heavy-haul truck transportation implementing alternatives. The data show that

Table 6-88. Estimated doses and radiological impacts to a maximally exposed individual for heavy-haul truck implementing alternatives.[a,b]

Individual	Dose (rem)	Probability of latent fatal cancer
Involved workers		
Crew member (rail, heavy-haul truck or legal-weight truck)	48[c]	0.02
Inspector	34	0.013
Railyard crew member	4.2	0.002
Public		
Resident along route (rail)	0.002	0.000001
Nevada resident along route (heavy-haul)[d]	0.53	0.00027
Person in traffic jam[e] (legal-weight truck)	0.02	0.000008
Person at service station[f] (legal-weight truck)	0.08	0.00004
Resident near rail stop[g]	0.002	0.000001

a. The assumed external dose rate is 10 millirem per hour at 2 meters (6.6 feet) from the vehicle for all shipments.
b. Totals for 24 years of operations.
c. Based on 2-rem-per-year administrative dose limit. If a lower dose limit, for example 500 millirem per year, was imposed for transportation workers or state inspectors, maximally exposed individual doses would be lower. See DIRS 156764-DOE (1999, Article 211) for DOE guidance on occupational dose limits.
d. This represents a Nevada resident approximately 15 meters (49 feet) from an intersection. This individual would be exposed for 1 minute per shipment plus 30 minutes per year due to traffic delays.
e. Person in a traffic jam is assumed to be exposed one time only.
f. Assumes the person works at the service station for all 24 years of operations. Mitigation would be required to reduce doses to members of the public to below 100 millirem per year.
g. This represents a Nevada resident approximately 30 meters (98 feet) from the branch rail line. See Section J.1.3.2.2.

Table 6-89. Health impacts[a] to the public from accidents for Nevada heavy-haul truck implementing alternatives.

Risk	Caliente	Caliente/Chalk Mountain	Caliente/Las Vegas	Apex/Dry Lake	Sloan/Jean
Radiological accident risk					
Dose risk (person-rem)	0.01	0.0019	0.056	0.056	0.12
LCF[b]	0.000005	0.000001	0.0000009	0.000028	0.00006
Traffic fatalities	0.6	0.33	0.43	0.23	0.25

a. Impacts are reported for 24 years of operations.
b. LCF = latent cancer fatality.

the risks, which are for 24 years of operations, are low for all five alternatives. These risks include those associated with transporting 1,079 legal-weight truck shipments from the commercial sites that would not have the capability to load rail casks while operational. Small variations in the risk values, principally evident for a Sloan/Jean route, are in part a result of the risks associated with transporting rail casks arriving from the east on the Union Pacific Railroad's mainline through the Las Vegas metropolitan area to a Sloan/Jean intermodal transfer station. The values that would apply for a Caliente/Chalk Mountain or Apex/Dry Lake route are lower because of a shorter route (Apex/Dry Lake), or a more remote and mid-length route (Caliente/Chalk Mountain).

Consequences of Maximum Reasonably Foreseeable Accident Scenarios. DOE evaluated the impacts of maximum reasonably foreseeable accident scenarios for national transportation (see Section 6.2). The results for the national transportation mostly rail scenario apply to transportation in Nevada.

6.3.3.1.8 *Common Route Socioeconomic Impacts*

DOE analyzed five Nevada heavy-haul truck transportation implementing alternatives for potential socioeconomic impacts from expenditures to upgrade and maintain Nevada highways, operate heavy-haul trucks, and construct and operate an intermodal transfer station.

Highway Construction and Upgrades. The dynamics of specific construction projects include a period of brief, intense elevation in project-related employment, followed by an abrupt decrease in associated employment opportunities as construction workers move on to other projects. Project dynamics can also include population increases followed by net declines in population as related employment requirements diminish. In general, increases in population lag behind increases in employment. For the most part, the projected impacts of highway upgrade work would occur in Clark County, which the analysis assumed would be the home county for construction workers because of its large workforce. Section 6.3.3.2 discusses the analysis of impacts to counties along each of the five candidate routes. The time and employment required to complete road upgrades would depend on the route.

Intermodal Transfer Station Construction. If a decision was made to construct an intermodal transfer station, DOE anticipates that preliminary architecture and engineering work would begin in 2007, followed by the start of construction at the selected site in 2008. Construction would last about 18 months. For this analysis, DOE assumed that construction workers would probably come from Clark County.

Although there would be small differences among the three candidate locations for an intermodal transfer station, the total statewide increase in employment (direct and indirect) that would result from the project would peak in 2008 and would be about 135 workers. Population increases resulting from a net influx of new workers would peak in 2009 with about 65 additional residents. These employment and population increases, which would occur mostly in Clark County, would be small and temporary for the affected counties.

Increases in real disposable income from constructing an intermodal transfer station would peak in 2008 at between about $3.6 million and $4.1 million. The increase in Gross Regional Product would also peak in 2008 at between $10.8 million and $11.4 million. State and local government expenditures would peak in 2009 between $198,000 and $243,000. These increases to real disposable income, Gross Regional Product, and government expenditures from construction would be short-term and less than 0.5 percent of the baselines in the affected counties. (All dollar values reported in this section are in 2001 dollars unless otherwise stated.)

Highway Maintenance for Heavy-Haul Truck Operations. If DOE decided to use heavy-haul trucks, annual maintenance would be required after the completion of the highway upgrades. In addition, DOE assumed the routes would be resurfaced approximately every 8 years. Thus, highway expenditures for resurfacing a selected route would occur in approximately 2016, 2024, and 2032. The employment required for road maintenance would depend on the selected route. Section 6.3.3.2 discusses route-specific impacts for each of the five candidate routes.

Heavy-Haul Truck and Intermodal Transfer Station Operations. The socioeconomic impacts of operating heavy-haul trucks and an intermodal transfer station largely would occur in the county in which the station was located. Section 6.3.3.2 discusses these impacts for each of the five candidate routes.

6.3.3.1.9 *Common Route Noise and Vibration Impacts*

Highway Construction and Upgrades and Intermodal Transfer Station Construction. Impacts would occur from construction noise associated with upgrading road surfaces, constructing a midroute stopover, and constructing an intermodal transfer station. The upgrades and construction would include the use of earth-moving equipment (bulldozers, graders, loaders, dump trucks) and asphalt-laying equipment. Earthmoving equipment would dominate maximum noise levels from construction and would achieve levels of 70 to 80 dBA at 15 meters (50 feet) from the source. The potential for noise impacts from construction would depend on the presence of humans along the routes and near the intermodal transfer station location. These persons would live in communities and possibly individual residences. Noise impacts from road upgrades and general construction would be transient, move with the construction, and end when the construction ended. The impacts, therefore, would be temporary for any location along affected highways. Construction noise, which would not occur at night, would be equivalent to the daytime standard (60 dBA) at distances of about 2,000 meters (6,600 feet). Construction upgrades of heavy-haul truck routes and construction of branch rail lines would be unlikely to cause vibration damage to historic buildings because of the distance of potentially sensitive buildings from construction sites.

The American Indian Writers Subgroup (DIRS 102043-AIWS 1998, p. 2-19) has identified noise generated along transportation routes as a concern because it could affect ceremonies and the solitude necessary for healing and praying. Areas or sites of interest to Native Americans have not been identified along these routes.

Heavy-Haul Truck and Intermodal Transfer Station Operations. Heavy-haul trucks would be double-tractor vehicles that this analysis assumed would travel at speeds of 32 to 80 kilometers (20 to 50 miles) an hour. Noise levels probably would be greatest when loaded heavy-haul trucks were moving up grades at speeds as slow as 8 kilometers (5 miles) an hour. This would occur as the trucks approached the proposed repository site and on portions of the Caliente route (see Chapter 2, Section 2.1.3.3). At 48 kilometers (30 miles) an hour, the estimated noise from a single heavy-haul truck moving up a 5-percent grade would be 45 dBA at a distance of 630 meters (about 2,100 feet) from the road with no background traffic. Elevated truck noise would not be a consideration on the Nevada Test Site, the Nellis Air Force Range, or the repository site. Transportation workers would use hearing protection as required by Occupational Safety and Health Administration regulations.

To assess the impact noise generated by heavy-haul trucks, DOE based the estimated increase in the 1-hour average sound level on traffic volumes along the routes for heavy-haul trucks (DIRS 156930-NDOT 2001, all). Noise estimates were based on a total of three double-tractor vehicles passing through a community or past a given point on a highway within 1 hour (DIRS 155778-Melnick 1998, all). The estimated increase in the 1-hour average sound level would not be perceptible in areas with high traffic volume and would be as high as 0.3 to 4.7 dBA in areas of low traffic volume. The estimated noise levels in this analysis were dominated by commercial tractor-trailers (20 percent of total traffic volume) on the open highway and in smaller communities.

During operations, DOE would transport 11 shipments a week of spent nuclear fuel and high-level radioactive waste to the proposed repository and 11 empty casks from the repository. Because the heavy-haul trucks probably would travel individually, elevated noise would occur during the brief time when a vehicle passed through communities. There would be no nighttime noise because trucks of this size would be restricted to operating during daylight hours. Truck noise at a midroute stopover would be similar to noise along the adjacent route. Therefore, the potential for adverse noise impacts from heavy-haul trucks would be low.

Noise associated with operations at an intermodal transfer station would occur as it received shipments and transferred them from railcars to heavy-haul trucks for transport to the proposed repository site. However, the baseline noise level is already elevated because of existing rail line operations at the potential station locations. Additional sources of noise at a station would include transferring railcars from trains into the station, moving the railcars in the station, and receiving returning empty

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transportation casks. Railcars could come to the station at night, so there would be a potential for nighttime sources of noise. However, shipments in the station could be handled during daylight hours, minimizing the potential for noise impacts.

Ground vibration resulting from the operation of heavy-haul trucks or trains would be unlikely to produce vibration levels of a magnitude sufficient to cause building damage. Heavy-haul trucks can create potentially damaging vibration if the vehicle hits a bump or pothole in the road. The magnitude of vibration produced depends on the speed of the vehicle and the size of the bump. Most of the energy of impact is absorbed by the inflated tires; as a consequence, ground vibration would not be a major impact for these operations. Heavy-haul trucks would operate at reduced speeds when operated at intermodal transfer stations. There are no known historic buildings or ruins of cultural significance that ground vibration could affect near intermodal transfer stations.

Other noise impacts would differ among the implementing alternatives, as described in Section 6.3.3.2.

6.3.3.1.10 *Common Route Aesthetics Impacts*

Highway Construction and Upgrades and Intermodal Transfer Station Construction. There could be impacts on visual resources during these activities because of the presence of workers, camps, vehicles, large earth-moving equipment, laydown yards, large cranes, and dust generation. However, this phase would be of limited duration (approximately 18 months for an intermodal transfer station and as long as 46 months for highway improvements). An intermodal transfer station would be in an already developed area, either for industrial or commercial use or adjacent to existing roads or rail corridors. Therefore, the facility would not change the character of land use in its vicinity. Dust generation during construction would be controlled by implementing best management practices such as misting or spraying disturbed areas. Construction activities would conform with the Bureau of Land Management Visual Resources Management guidelines (DIRS 101505-BLM 1986, all). If a route crosses Class II lands, more stringent management requirements would be necessary to retain the existing character of the landscape. However, the short duration of highway modification or construction activities, combined with the use of best management practices, would mitigate the impacts of activities, which could exceed the management requirements on any Class II lands.

Heavy-Haul Truck and Intermodal Transfer Station Operations. As many as 22 shipments would leave or arrive at the intermodal transfer station each week. Visual impacts would result from the presence of the station, increased worker activity in the area, the arrival and departure of trains, loading and unloading operations, and the arrival and departure of heavy-haul trucks. Noise and lighting impacts would occur at an intermodal transfer station but, due to the remote locations, there would be no significant impacts. Impacts would not exceed Bureau of Land Management Visual Resource Management Class III objectives, which require only the partial retention of the existing character of the landscape.

Other aesthetic impacts would differ among the implementing alternatives, as described in Section 6.3.3.2.

6.3.3.1.11 *Common Route Utilities, Energy, and Materials Impacts*

Highway Construction and Upgrades. The amounts of utilities, energy, and materials needed would depend on the amount of upgrading to be done, which would be specific to each route. The amount of utilities, energy, and materials for each route is given in the following sections. All of the required amounts are much less than current use rates in Nevada. For example, fossil-fuel consumption in Nevada was about 3.8 billion liters (1 billion gallons) in 1996 and none of the routes would require more than 0.5 percent of the annual consumption (DIRS 148094-BTS 1997, all).

Intermodal Transfer Station Construction. Intermodal transfer station design would be the same for any of the three sites and would include a small railyard with several sidings, a 180-metric-ton (200-ton) bridge crane, two steel prefabricated buildings (one for administration and one for maintenance), and a large paved area for heavy-haul truck parking and maneuvering. The basic facility would be a light industrial site with moderate utility requirements. During construction the electrical requirements would be supplied by portable generating equipment. Table 6-90 lists the materials that would be consumed during construction. The quantities of concrete, asphalt, and steel listed in the table are not substantial in comparison to annual use rates and would not affect the regional supply system. For example, the concrete required for an intermodal transfer station would be less than 1 percent of the concrete used in Nevada in 1998 (DIRS 104926-Bauhaus 1998, all). Similarly, the demand for electricity and fossil fuel during construction would not be great. The construction of a midroute stopover for heavy-haul trucks (routes originating in Caliente) is accounted for in the specific route data included in the following sections.

Table 6-90. Construction utilities, energy, and materials for an intermodal transfer station.

Electrical demand (kilowatts)	Fossil fuel (liters)[a]	Concrete (thousand metric tons)[b]	Asphalt (thousand metric tons)	Steel (thousand metric tons)
Onsite generation	Small	7.9	16	1.4

a. To convert liters to gallons, multiply by 0.26418.
b. To convert metric tons to tons, multiply by 1.1023.

Highway Maintenance for Heavy-Haul Truck Operations. Highways used by heavy-haul trucks would be maintained annually and resurfaced, on average, every 8 years. The amounts of utilities, energy, and materials for the annual and 8-year maintenance activities would be less than the initial amounts for upgrading the highways.

Heavy-Haul Truck and Intermodal Transfer Station Operations. The current estimate of electrical demand during the operation of an intermodal transfer station would be 165 kilowatts (DIRS 155347-CRWMS M&O 1999, Request #38). This would include 30 kilowatts for lighting, 50 kilowatts for each of the two buildings, 5 kilowatts for the guard station, and 30 kilowatts for the crane. The actual rate would be substantially less than peak capacity because operations would be intermittent. Only small amounts of fossil fuel would be used at an intermodal transfer station. Chapter 10 discusses fossil-fuel use for heavy-haul truck operations.

Other impacts on utilities, energy, and materials would differ among the implementing alternatives, as described in Section 6.3.3.2.

6.3.3.1.12 *Common Route Waste Management Impacts*

Highway Construction and Upgrades. Highway construction results in minimal waste. Excavated soil is used for fill elsewhere along the route and asphalt is recycled (DIRS 152538-Hoganson 2000, all; DIRS 152535-Hoganson 2000, all). Upgrading highways, including constructing a midroute stopover with a security trailer, could generate waste such as vegetation from land clearing (DIRS 152538-Hoganson 2000, all), construction debris from the trailer setup, and waste from onsite equipment maintenance (DIRS 152537-Hoganson 2000, all) that an independent contractor would dispose of in permitted landfills, or would recycle in the case of lubricants. In addition, construction materials for upgrading engineered structures such as bridges and culverts would be in correct sizes and numbers to minimize waste. Residual materials would be saved for reuse. A commercial vendor would provide portable restroom facilities and would manage the sanitary sewage. Waste would be handled in accordance with applicable environmental, occupational safety, and public health and safety requirements to minimize the possibility of adverse impacts to vegetation, wildlife, soils, surface and groundwater, and air quality from construction inside or outside of the region of influence.

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Intermodal Transfer Station Construction. The administration building would be a prefabricated building and the maintenance building would be built on the site. Construction of the maintenance building would require traditional materials such as steel, lumber, and concrete that would result in debris requiring disposal or recycling. Excess construction materials would be salvaged. A maximum of 23 metric tons (26 tons) of construction debris would be disposed of in a local construction debris landfill. Approximately 750,000 metric tons (820,000 tons) of construction debris was disposed of in Nevada in 2000 (DIRS 155565-NDEP 2001, Section 2.1), so the maintenance building construction would add less than 0.01 percent. In addition, construction could require paints and resins that could become hazardous if discarded. Hazardous waste would be shipped to a permitted treatment and disposal facility. A commercial vendor would provide portable restroom facilities as necessary and manage the resulting sanitary sewage. Waste quantities from construction would be about the same for all sites. Impacts to treatment and disposal capacity from disposing of the construction debris, hazardous waste, and sanitary sewage would be small and consistent for all station locations.

Highway Maintenance for Heavy-Haul Truck Operations. Periodic maintenance of highways and resurfacing every 8 years would be unlikely to generate wastes, and asphalt would be recycled (DIRS 152535-Hoganson 2000, all). Environmental impacts from waste would be unlikely.

Heavy-Haul Truck Operations. Heavy-haul truck operations along any of the four routes would result in similar wastes from vehicle maintenance. Maintenance wastes are included in the intermodal transfer station operation discussion below.

The operation of a midroute stopover would generate sanitary solid waste and sanitary sewage at the security trailer. The waste would be proportional to the number of persons using the facility, about 5 kilograms (11 pounds) per day per person of solid waste (DIRS 155567-NDEP 2001, p. 5) and about 57 liters (15 gallons) of wastewater per day per person (DIRS 152492-Gibson 1974, p. 55) if potable water is supplied or less if chemical toilets are used. DOE would dispose of the sanitary solid waste in a permitted municipal landfill; the sanitary sewage would be trucked to a municipal sewage facility. The small quantities of solid and sanitary wastes would have a very small impact on treatment and disposal capacity. Management and disposition of the wastes from operations would comply with applicable environmental and occupational and public safety regulations to minimize the possibility of adverse impacts to vegetation, wildlife, air quality, soils, and water resources.

Intermodal Transfer Station Operations. Operations, regardless of the location, would generate (1) sanitary solid waste such as waste paper from office and personnel activities, (2) waste from maintenance activities, and (3) potentially a small amount [0.71 cubic meter (25 cubic feet) per month] of low-level radioactive waste such as the smear wipes from radiological surveys of shipping casks and vehicles (DIRS 104849-CRWMS M&O 1997, p. 10). The routine maintenance and minor repair of the estimated 20 tractor-trailers assigned to an intermodal transfer station would generate waste and recyclable materials. Lubricants, lead-acid batteries, tires, fuel, antifreeze, refrigerant, and miscellaneous used parts would be generated (DIRS 152534-Hoganson 2000, all). The majority of these wastes could be recycled, as is the case at another DOE fleet operation facility (DIRS 152532-Hoganson 2000, all). Estimated annual recyclable material would be 5.5 metric tons (6.0 tons), primarily lubricating oil. Waste requiring disposal would consist of 1,400 kilograms (3,000 pounds) of nonrecyclable tires per year and 23 kilograms (50 pounds) of drained oil filters per year (DIRS 152534-Hoganson 2000, all). About 83,000 metric tons (91,000 tons) of this type of waste was disposed of in Nevada in 2000 (DIRS 155565-NDEP 2001, Section 2.1), so the truck maintenance waste would add less than 0.01 percent. In addition, the intermodal transfer station would generate sanitary sewage that would be disposed of in an onsite septic system or through connection to a municipal sewage facility.

The intermodal transfer station operator would dispose of nonhazardous solid waste in a local permitted landfill with available capacity. Hazardous waste such as nonrecyclable lead-acid batteries and low-level radioactive waste, if any, would be shipped to treatment and disposal facilities with appropriate permits. The small quantities would have very little impact on the treatment and disposal facilities. Treatment and disposal capacity for hazardous waste would be above the expected demand until 2013 (DIRS 103245-EPA 1996, pp. 32, 33, 36, 46, 47, and 50). Disposal capacity for a broad range of low-level radioactive wastes would be available at two currently licensed facilities (DIRS 152583-NRC 2000, section on U.S. Low-level Radioactive Waste Disposal).

There would be no unique environmental impacts of waste management for any of the heavy-haul truck implementing alternatives. Waste would be managed in accordance with applicable environmental, occupational safety, and public health and safety requirements to minimize the possibility of adverse impacts to vegetation, wildlife, air quality, soils, and water resources. Impacts to the capacity of treatment and disposal facilities receiving wastes generated during Nevada transportation would be small due to the small quantities of waste expected.

6.3.3.2 Impacts Specific to Individual Nevada Heavy-Haul Truck Implementing Alternatives

6.3.3.2.1 *Caliente Route Implementing Alternative*

The Caliente route (Figure 6-22) is approximately 533 kilometers (331 miles) long. Heavy-haul trucks and escorts leaving an intermodal transfer station in the Caliente area would travel directly from the intermodal transfer station to U.S. Highway 93. The trucks would travel west on U.S. 93 to State Route 375, then on State Route 375 to the intersection with U.S. 6. The trucks would travel on U.S. 6 to the intersection with U.S. 95 in Tonopah. The trucks would travel into Beatty on U.S. 95 where a short alternative truck route would be built on the west side of town because an existing intersection is too constricted to allow a heavy-haul truck to turn. Heavy-haul vehicles would then travel south on U.S. 95 to Lathrop Wells Road at Amargosa Valley, which would access the Yucca Mountain site.

DOE would construct a parking area along a Caliente route to enable heavy-haul vehicles to park overnight. This parking area could be needed because the travel time (vehicle in motion plus periodic short stops for inspections) associated with a Caliente route would be as much as 16 hours and because DOE anticipates that the State of Nevada would issue special travel permits for the trucks that would include time-of-day and day-of-the-week travel restrictions that could preclude completing a trip in 1 day. This parking area would probably be near U.S. 6 between Warm Springs and Tonopah.

The potential siting areas for an intermodal transfer station are south of the City of Caliente in the Meadow Valley Wash area. DOE has identified two areas along the west side of the canyon, with a combined area of 0.74 square kilometer (180 acres). Areas along the east side of the canyon would not be used to avoid disrupting Meadow Valley Wash and because of poor access to the Union Pacific rail line. The estimated life-cycle cost to construct and operate an intermodal transfer station and to operate heavy-haul trucks along the Caliente route would be about $669 million in 2001 dollars.

The following sections address impacts that would occur to land use; biological resources and soils; cultural resources; hydrology including surface water and groundwater; occupational and public health and safety; socioeconomics; noise and vibration; aesthetics; and utilities, energy, and materials. Impacts that would occur to air quality and waste management would be the same as those discussed in Section 6.3.3.1 and are, therefore, not repeated here. Section 6.3.4 discusses the potential for transportation activities to cause environmental justice concerns in Nevada.

6.3.3.2.1.1 Caliente Route Land Use and Ownership

This section describes land-use impacts that could occur from the construction and operation of a Caliente intermodal transfer station and upgrade of highways and heavy-haul truck operation over the

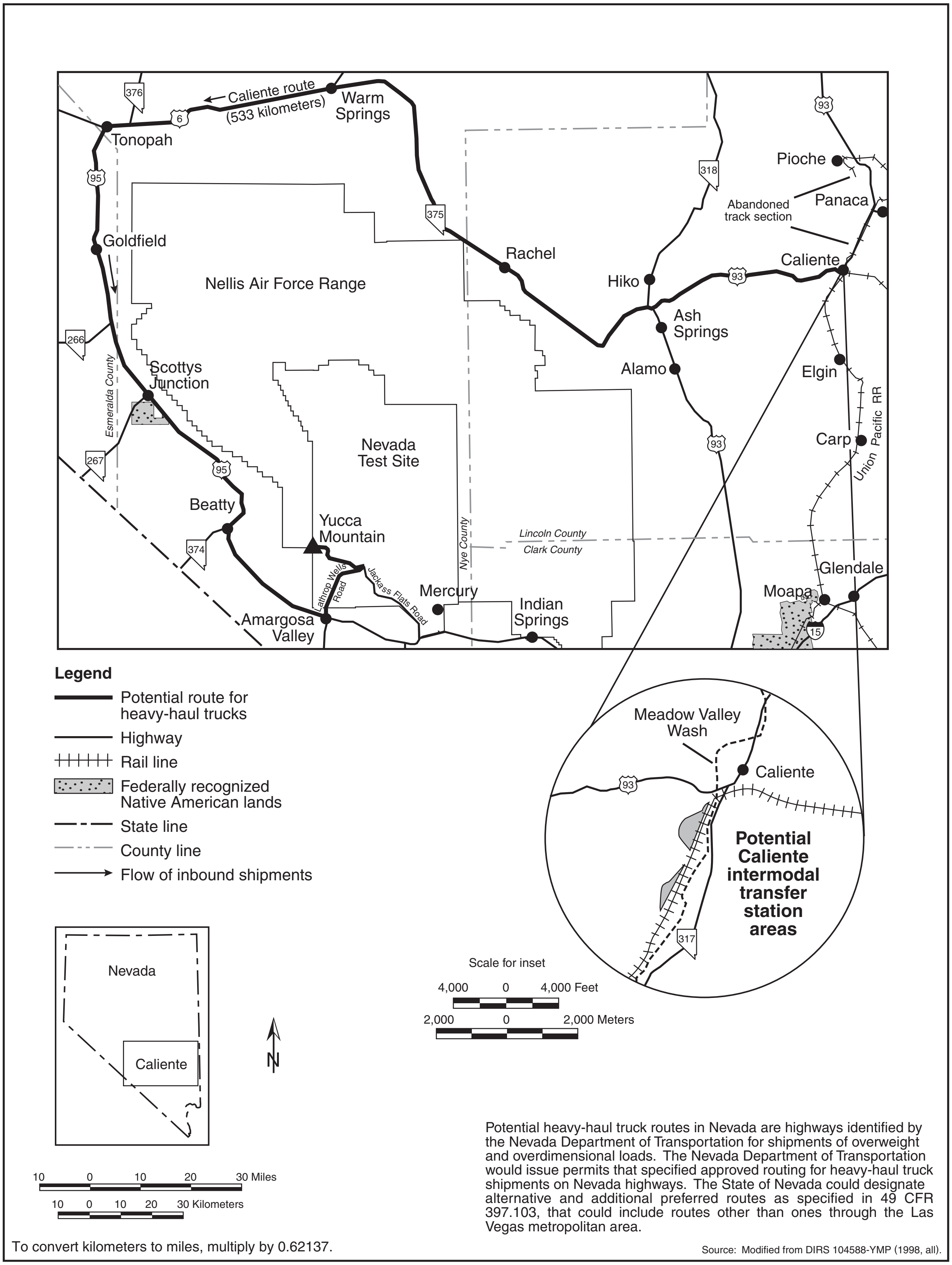

Figure 6-22. Caliente heavy-haul truck route.

Caliente route. Chapter 3, Section 3.2.2.2.1, describes the Caliente intermodal transfer station site and associated route.

With the exception of a small portion of the most northern part of the site area for an intermodal transfer station, the area is on patented land owned by the City of Caliente. The remaining part of the northern site is administered by the Bureau of Land Management. The northern site also includes an existing wastewater treatment plant (DIRS 104993-CRWMS M&O 1999, p. 21). A transfer of property from the Bureau, the City of Caliente, or other entities to DOE would be required.

Highway Construction and Upgrades. Land-use impacts that would be common to all locations are discussed in Section 6.3.3.1. The Caliente intermodal transfer station, located near the entrance to Kershaw-Ryan State Park, would be built on lands currently used for industrial or commercial purposes. Because of this, there should be no additional impacts to land use. Park visitors would receive short-term visual impacts from construction activities. In addition, park visitors could be affected by noise from construction activities that could lessen their recreational experience. These short-term impacts would exist only during construction.

In addition to the impacts on land use discussed in Section 6.3.3.1 for upgrading Nevada highways, approximately 3.4 square kilometers (834 acres) of land would be disturbed by the road upgrades and additional construction activities required for this route. Table 6-91 summarizes these disturbances. Approximately 0.04 square kilometer (10 acres) of land near Beatty, Nevada, would be acquired to construct approximately 2 kilometers (1.2 miles) of new highway. This section of highway would be needed to avoid conflicts between the requirement of wide turning areas for heavy-haul trucks and existing land uses in Beatty where U.S. 95 makes a 90-degree turn. In addition, approximately 0.04 square kilometer (10 acres) of land in the vicinity of Tonopah would be acquired for a midroute stopping area for heavy-haul trucks. This additional land requirement could require the purchase by or transfer of land to DOE.

Table 6-91. Land disturbances along the Caliente heavy-haul truck route.

Disturbance	Area disturbed[a] (square kilometers)[b]
Haul road disturbed area	1.9
Aggregate plants	0.3
Road widening	0.7
Passing lanes	0.2
Truck turnouts	0.08
Beatty truck alternate	0.04
Fortymile Wash new road	0.04
Overnight stops	0.04
Total disturbed area	3.4

a. Numbers approximate due to rounding.
b. To convert square kilometers to acres, multiply by 247.1.

Operations. There would be no direct land-use impacts associated with the operation of the Caliente intermodal transfer station or the Caliente route for heavy-haul trucks other than those described in Section 6.3.3.1.

6.3.3.2.1.2 Caliente Route Hydrology

DOE anticipates that limited impacts to surface water and groundwater would occur in the course of improving Nevada highways so they could accommodate daily use by heavy-haul trucks. This section discusses these potential impacts as well as those from the construction and operation of an intermodal transfer station and heavy-haul truck operations over the Caliente route. Section 6.3.3.1 discusses the hydrology impacts that would be common to all of the heavy-haul truck implementing alternatives. This section focuses on the hydrology impacts that are unique to the Caliente route.

Surface Water

Section 6.3.3.1 discusses impacts to surface water from the construction and operation of an intermodal transfer station and upgrades to highways. The common impacts discussed apply to surface water along the Caliente route.

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Appendix L contains a comparison of what is known about the floodplains, springs, and riparian areas at the three candidate intermodal transfer station sites (see Sections L.3.2.6 and L.4.2.2). As noted in Section L.3.2.6, the two locations being considered for the Caliente intermodal transfer station are outside the 100-year flood zone of Meadow Valley Wash, but inside the 500-year flood zone.

Groundwater

Highway Construction and Upgrades. Section 6.3.3.1 discusses the impacts to groundwater from the construction of an intermodal transfer station. Groundwater impacts from upgrading highways would be limited to those caused by the use of water from construction wells. The upgrades to the Caliente route would require about 126,000 cubic meters (100 acre-feet) (DIRS 104917-LeFever 1998, all) of water which, for planning purposes, was assumed to come from 16 wells.

The average amount of water withdrawn from each well would be about 7,900 cubic meters (6 acre-feet). Chapter 3, Section 3.2.2.2.3, identifies the hydrographic areas over which the Caliente route would pass, their perennial yields, and whether the State considers each a Designated Groundwater Basin. Table 6-92 summarizes the status of the hydrographic areas associated with the Caliente route. It also identifies the approximate portion of the route that would pass over Designated Groundwater Basins.

Table 6-92. Hydrographic areas along Caliente route.

	Designated Groundwater Basins	
Hydrographic areas	Number	Percent of corridor length
19	8	40

The withdrawal of 7,900 cubic meters (6 acre-feet) a year from a well would have little impact on the hydrographic areas associated with the Caliente route based on their perennial yields (Chapter 3, Section 3.2.2.2.3), even if multiple wells were placed in the same hydrographic area. As indicated in Table 6-92, about 40 percent of the route's length would be in areas with Designated Groundwater Basins, where the Nevada State Engineer's office carefully watches the potential for groundwater depletion. This does not mean that a contractor could not obtain water appropriations in these areas; the State Engineer would have the authority to approve such appropriations. Requests for water appropriations under this action would be for minor amounts and for a short-term construction action, which should provide the State Engineer even more discretion. Other options would be to lease temporary water rights from individuals along the route, ship water from other permitted resources by truck to construction sites (about 7,000 truckloads), or use a combination of these two actions. Obtaining a water appropriation from the State Engineer for short-term construction use or using an approved allocation would ensure that groundwater resources would not be adversely affected.

Operations. Section 6.3.3.1 discusses the impacts to groundwater from the operation of an intermodal transfer station, highway maintenance, and heavy-haul truck operations.

6.3.3.2.1.3 Caliente Route Biological Resources

Section 6.3.3.1 discusses the impacts to biological resources from the construction and operation of an intermodal transfer station and upgrades to highways that would be common to all candidate sites for an intermodal transfer station and associated routes. This section discusses the construction- and operations-related impacts that would be unique to the Caliente intermodal station and route.

Highway Construction and Upgrades. Potential Caliente intermodal transfer station siting locations include two areas along the west side of the Meadow Valley Wash canyon. The land cover types are agriculture and salt desert scrub (DIRS 104593-CRWMS M&O 1999, pp. 3-30 and D-1). The construction site would disturb approximately 0.2 square kilometer (50 acres). No special status species occur in the proposed location of the Caliente intermodal transfer station. However, two species classified as sensitive by the Bureau of Land Management—the Meadow Valley Wash speckled dace and the Meadow Valley Wash desert sucker—occur in the adjacent Meadow Valley Wash (DIRS 104593-CRWMS M&O 1999, p. K-1). The construction of an intermodal transfer station could affect these fish by increasing the sediment load in the wash during construction. This construction would not affect southwestern willow flycatchers or their habitat in Meadow Valley Wash (DIRS 152511-Brocoum 2000, pp. A-9 to A-13). There is no designated game habitat at the proposed location for the intermodal transfer station, but the adjacent Meadow Valley Wash is classified as important habitat for water fowl and Gambel's quail (DIRS 104593-CRWMS M&O 1999, p. 3-30). Impacts to this habitat would be small.

Moist areas in the proposed location and the adjacent perennial stream and riparian habitat along Meadow Valley Wash could be classified as jurisdictional wetlands or other waters of the United States, although no formal wetlands delineation of the area has been conducted. If this site was selected, DOE would delineate the boundaries of any jurisdictional wetlands, develop a plan to mitigate impacts, and consult with the U.S. Army Corps of Engineers regarding the need to obtain a regional or individual permit under Section 404 of the Clean Water Act.

The predominant land cover types along the Caliente route are salt desert scrub, sagebrush, and creosote-bursage (DIRS 104593-CRWMS M&O 1999, p. 3-30). The regional area for each vegetation type is extensive (DIRS 104593-CRWMS M&O 1999, pp. C1 to C5). Because areas disturbed by upgrade activities would be in or adjacent to the existing rights-of-way, and have been previously degraded by human activities, impacts would be small. In addition, vegetation would be removed from approximately 0.04 square kilometer (10 acres) of undisturbed land for development of a midroute stopover. This area would be east of the City of Tonopah. The precise location is not known at this time, so the land cover type that would be disturbed cannot be identified. However, as noted above, all land cover types along the route are extensive and often degraded in the region, so loss of this area would be unlikely to cause adverse effects to the population of any plant or animal species.

Three threatened or endangered species occur along the Caliente route (DIRS 104593-CRWMS M&O 1999, p. 3-30). The desert tortoise occurs along the southern part of the route along U.S. 95 from Beatty to Yucca Mountain. Construction activities could kill or injure some tortoises; however, their abundance is low in this area (DIRS 103281-Karl 1981, pp. 76 to 92; DIRS 101914-Rautenstrauch and O'Farrell 1998, pp. 407 to 411), so losses would be small. One endangered species—the Hiko White River springfish—occurs in Crystal Springs (50 CFR 17.95). The outflow of the spring comes within about 10 meters (33 feet) of State Route 375 near its intersection with State Route 318 near U.S. 93 (DIRS 104593-CRWMS M&O 1999, p. 3-30). Therefore, any upgrading of the road in this area could have the potential to affect critical habitat. DOE would ensure that construction activities avoided the spring outflow channel and would implement mitigation measures to ensure that no sediment entered the stream. In addition, formal consultation with the U.S. Fish and Wildlife Service would be initiated if this heavy-haul truck route was selected, and DOE would implement all terms and conditions required by the Service.

An introduced population of the threatened Railroad Valley springfish occurs in Warm Springs (DIRS 103261-FWS 1996, p. 20), the outflow of which crosses U.S. 6. If improvements to the highway in the vicinity of the Warm Springs outflow were necessary, there could be temporary adverse impacts to this introduced population due to habitat disturbance and siltation if not properly mitigated. Six other special status species occur along this route (DIRS 104593-CRWMS M&O 1999, pp. 3-30 and 3-31) but, because construction activities would be limited to the road and adjacent areas and care would be taken to ensure no sediments entered the streams, species should not be affected.

This route would cross eight areas designated as game habitat (DIRS 104593-CRWMS M&O 1999, p. 3-31). The amount of habitat in these areas would be reduced slightly due to construction activities alongside existing roads. Game animals in these areas during construction could be disturbed.

Nineteen springs occur near this route (DIRS 104593-CRWMS M&O 1999, p. 3-31). Areas around these springs may be jurisdictional wetlands or waters of the United States. However, no formal delineation has been made. Construction could increase sedimentation in these areas. The corridor crosses a number of ephemeral streams that may be classified as waters of the United States. DOE would work with the State of Nevada and the U.S. Army Corps of Engineers to minimize impacts to these areas, and would obtain individual or regional permits, as appropriate.

Impacts on soils would be transitory and small and would occur only along the shoulders of existing roads.

Operations. Impacts from operations would include periodic disturbances of wildlife from activities at the intermodal transfer station and additional truck traffic along the route. Trucks probably would kill individuals of some species but losses would be few and unlikely to affect regional populations of any species. No additional habitat loss would occur during operations. Impacts to soils would be small.

6.3.3.2.1.4 Caliente Route Cultural Resources

Highway Construction and Upgrades. Previous surveys have recorded a total of 178 archaeological sites within the existing rights-of-ways of the highways that make up this alternative. Upgrade of highways associated with the Caliente heavy-haul truck route would affect (by disturbing the sites or crushing artifacts) two known archaeological sites in the existing highway right-of-way [about 60 meters (200 feet)] that have been evaluated as potentially significant (DIRS 155826-Nickens and Hartwell 2001, p. 12). In addition, another 20 archaeological sites occur in areas in the existing right-of-way that would experience upgrade activities. These sites have been recorded but not evaluated, and include one historic grave along the highway south of Tonopah. This route passes through the southern area of the Tonopah Multiple Resource Area historic mining district and the Goldfield Historic District, both of which are listed on the *National Register of Historic Places*. At Tonopah, the historic district lies north of the junction of U.S. Highways 6 and 95, and heavy-haul truck traffic would not affect the historic components of this district. Although U.S. 95 passes through the heart of the historic district at Goldfield, which includes commercial and private residence buildings in the downtown area, adverse effects from heavy-haul traffic would be unlikely. Two listed historic properties are located in downtown Caliente, near the highways leading from the Caliente intermodal transfer station site. Both of these, the State-listed Smith Hotel and the National Register-listed Union Pacific Depot, are far enough from the highway route that potential impacts are unlikely.

Preliminary studies have identified several areas important to Native Americans along the Caliente heavy-haul truck route that would require additional field ethnographic studies (DIRS 155826-Nickens and Hartwell 2001, Table 8). These include Oak Springs Summit and Six-Mile Flat/Pahroc Summit along U.S. 93 west of Caliente; Crystal Springs, at the junction of U.S. 93 and State Route 375; Twin Springs, Twin Springs slough, and Echo Lakes area, along State Route 375 between Rachel and Warm Springs; and the Warm Springs/Hot Creek Valley area, at the junction of State Route 375 and U.S. 6.

Archaeological surveys at the candidate Caliente intermodal transfer station site just south of the City of Caliente recorded four sites, none of which has been evaluated for eligibility to the *National Register of Historic Places.* Native Americans are familiar with some of these sites, which include a series of painted and pecked rock art, along the cliff immediately west of the candidate intermodal transfer station site (DIRS 155826-Nickens and Hartwell 2001, Table 8). The rock art is adjacent to the flat area where DOE could construct an intermodal transfer station. Although direct impacts to the site would be unlikely, indirect impacts are a possibility. Native Americans would view the presence of an intermodal transfer station near a traditional site as an impact to their cultural values.

Operations. The use of existing highways for heavy-haul truck transport of spent nuclear fuel and high-level radioactive waste would be unlikely to affect historic buildings listed in the National Register

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district in the Town of Goldfield. Transport of these materials could affect Native American feelings for the potentially significant cultural areas identified along the highways.

The operation of a Caliente intermodal transfer station could have a lasting impact on the cultural integrity of the location, which Native Americans have identified as an important place.

6.3.3.2.1.5 Caliente Route Occupational and Public Health and Safety

This section addresses potential impacts to occupational and public health and safety from upgrading highways and heavy-haul truck operations on the Caliente route. Impacts of the associated intermodal transfer station are the same for each heavy-haul truck implementing alternative and are in Section 6.3.3.1.

Highway Construction and Upgrades. Industrial safety impacts on workers from the upgrade of highways and use of the Caliente route would be small (see Table 6-93). The analysis evaluated the potential for impacts in terms of total reportable cases of injury, lost workday cases, fatality risks for workers, and traffic-related fatalities due to commuting workers and transporting construction materials and equipment. Table 6-94 lists the estimated fatalities from construction vehicle and commuter traffic.

Operations. The incident-free radiological impacts listed in Table 6-95 would occur during the routine transportation of spent nuclear fuel and high-level radioactive waste using the Caliente route. These impacts include transportation along the highway route as well as transportation along railways in Nevada to the Caliente intermodal transfer station. The table includes the impacts of 1,079 legal-weight truck shipments from commercial sites that do not have the capability to load rail casks while operational.

Table 6-93. Impacts to workers from industrial hazards during the Caliente route construction upgrades.

Group and industrial hazard category	Construction[a]	Operations[b]
Involved workers		
Total recordable cases[c]	66	220
Lost workday cases	33	120
Fatalities	0.09	0.61
Noninvolved workers[d]		
Total recordable cases	4.0	13
Lost workday cases	1.5	4.7
Fatalities	0.004	0.01
Totals[e]		
Total recordable cases	70	240
Lost workday cases	34	127
Fatalities	0.1	0.6

a. Impacts are totals for about 35 months.
b. Includes impacts from periodic resurfacing and maintenance; impacts are totals for 24 years.
c. Total recordable cases includes injury and illness.
d. The noninvolved worker impacts are based on 25 percent of the involved worker level of effort.
e. Totals might differ from sums due to rounding.

Table 6-94. Estimated number of fatalities from construction material delivery vehicles and construction and operations worker commuting traffic for the Caliente route for heavy-haul trucks.[a]

Activity	Kilometers[b]	Traffic fatalities	Vehicle emissions fatalities
Construction[c]			
Material delivery vehicles	60,000,000	1.0	0.12
Commuting workers	50,000,000	0.5	0.07
Subtotals[d]	*110,000,000*	*1.5*	*0.19*
Operations[e]			
Commuting workers	200,000,000	2.0	0.26
Totals	***310,000,000***	***3.5***	***0.45***

a. Includes impacts from the construction and operation of an intermodal transfer station.
b. To convert kilometers to miles, multiply by 0.62137.
c. Impact totals are for about 35 months.
d. Totals might differ from sums of values due to rounding.
e. Impact totals are for 24 years.

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Table 6-95. Health impacts from incident-free Nevada transportation for the Caliente route implementing alternative.[a]

Category	Legal-weight truck shipments[b]	Rail and heavy-haul truck shipments[c]	Totals[d]
Involved workers			
Collective dose (person-rem)	38	1,600	1,600
Estimated latent cancer fatalities	0.02	0.64	0.66
Public			
Collective dose (person-rem)	7	70	77
Estimated latent cancer fatalities	0.003	0.04	0.04
Estimated vehicle emission-related fatalities	0.0016	0.015	0.016

a. Impacts are totals for 24 years.
b. Impacts of 1,079 legal-weight truck shipments from six commercial sites.
c. Includes impacts to workers at an intermodal transfer station and impacts to escorts.
d. Totals might differ from sums of values due to rounding.

6.3.3.2.1.6 Caliente Route Socioeconomics

This section describes potential socioeconomic impacts that would occur from upgrading highways on the Caliente route and building an intermodal transfer station for heavy-haul truck transportation. The discussion includes impacts from the operation of an intermodal transfer station at the Caliente site and periodic resurfacing of highways.

Highway Construction and Upgrades. Socioeconomic impacts from upgrading highways for a Caliente route and building an intermodal transfer station would be temporary, occurring over a short period and spread among the counties along the route. Upgrading the roads for the route would cost about $125 million, and would require about 653,000 worker hours and 35 months to complete. Constructing an intermodal transfer station would cost $25 million and require approximately 18 months to complete. (Dollar values reported in this section are 2001 dollars unless stated otherwise.)

Employment. In the region of influence, increased employment of construction workers involved with upgrading highways or with building an intermodal transfer station (direct workers) and other workers employed as a result of the economic activity generated by the project (indirect workers) would peak in 2008 at about 856 workers. The increase in employment in Clark County would be about 748 workers; Nye and Lincoln Counties would each gain 54. The increases in Clark and Nye Counties would be less than 1 percent of the employment baseline for each county. The increase in Lincoln County employment would be 2.2 percent of the county's employment baseline.

In the three-county region of influence, employment of Caliente route construction workers and of indirect workers would decrease by 738 jobs when the construction of an intermodal transfer station and highway upgrades ended in 2009. At the completion of the construction phase, Clark County would lose 720 of these jobs, Nye County would lose 6, and Lincoln County would lose 12. The impacts would be less than 1 percent of the baselines in Clark and Nye Counties. DOE anticipates that project-related workers would be absorbed in other work in Nevada. Employment projections for the State estimate 1.4 million jobs in 2010.

Population. Projected population increases in the region of influence as a consequence of upgrading highways and constructing an intermodal transfer station for the Caliente route would peak in 2009. During that year, the incremental increase in population would be about 688 individuals. Ninety-one percent (627) of these individuals would live in Clark County, 42 in Nye County, and 18 in Lincoln County. Population changes for Clark, Lincoln, and Nye Counties that would arise from increased employment opportunities would be less than 1 percent of each county's population baseline. Because the increases in each county could be small and transient, impacts to schools or housing would be unlikely.

Economic Measures. Economic measures would rise during the construction of an intermodal transfer station and upgrading of highways, and would decline at the project's end. The temporary change in real disposable income of people in the three-county region of influence would peak in 2008 at $26.5 million. The region-wide change in Gross Regional Product would peak in 2008 at $45.3 million. Increased State and local government expenditures resulting from activities to upgrade highways and construct an intermodal transfer station would peak in 2009 at $2.3 million. The Gross Regional Product, real disposable income, and expenditures by local and State governments would be less than 1 percent higher than the baseline for Clark and Nye Counties. Lincoln County would experience a less-than-1-percent increase in real disposable income and government spending. The increase in Gross Regional Product ($1.4 million) would be 1.2 percent of the county's baseline. (Dollar values reported in this section are in 2001 dollars unless otherwise stated.)

Transition to Operations. In the region of influence, employment of Caliente heavy-haul truck route workers and indirect (support) workers would decrease by 738 when construction of the intermodal transfer station and highway upgrades ended in 2009. Clark County would lose 721 (98 percent) of these jobs. Nye County would lose 5 jobs, and Lincoln County would lose 12 jobs. DOE anticipates that some of the displaced workers would move into operational positions on the Caliente route while others would find other work in the State. While this project would lose jobs, employment projections for the State estimate approximately 1.4 million jobs in 2010, or about 999,500 in the region of influence.

Operations. Operations at an intermodal transfer station and the use of heavy-haul trucks would begin in 2010 and continue until 2033. An annual operations workforce of about 26 would be required for an intermodal transfer station, which would operate throughout the year. The direct workforce for heavy-haul truck operations over a Caliente route, including shipment escorts, would be about 120 workers. The analysis assumed that operations workers would reside in Clark, Lincoln, or Nye Counties.

Employment. Employment probably would remain relatively level throughout the operations period. Total employment (direct and indirect) in the region of influence associated with heavy-haul truck transportation and an intermodal transfer station would average about 274 workers. The baseline employment in the region of influence in the 24-year operations period would be about 1.1 million. Firms in the region of influence would employ about 94 percent of these workers. Clark County would gain 111 workers. Nye County would gain 74, and Lincoln County would gain 88. The increases in Clark and Nye Counties would be less than 1 percent of the respective baselines. The increase in Lincoln County would represent 3.3 percent of the county's employment baseline.

Because of the periodic need to resurface highways used by heavy-haul trucks (every 8 years starting in 2016), employment would increase in the years these projects occurred. For these projects, employment (direct and indirect) in the region would increase by about 250 workers. Employment changes from periodic highway-resurfacing projects would be less than 1 percent of the baseline in Clark County. DOE assumed that Clark County-based firms would employ the resurfacing project workers. DOE included the employees who would resurface the roads and their families in the employment and population estimates discussed above for the operations period. Overall impacts to employment and population as a result of highway maintenance and shipment operations would be less than 1 percent of the baselines in each county.

Population. The average annual increase in population in the region of influence as a result of employment associated with a Caliente heavy-haul truck route would be about 638 persons. DOE estimates that about 387 of these would reside in Clark County, about 134 in Nye County, and 117 in Lincoln County. Population increases for Lincoln County, which would experience the largest change as a percentage of the baseline, would be about 2.4 percent.

The change in population in Lincoln County would include an average annual increase of approximately 27 school-aged children. The impact to housing in the county would be negligible given the county's historically high housing vacancy rates (see Chapter 3, Section 3.1.7.4). Impacts attributable to the operation of the Caliente heavy-haul truck route would be within the range of historic changes in the county.

Economic Measures. In the region of influence, real disposable income from the operation of an intermodal transfer station in Caliente, operation of heavy-haul trucks based in Caliente, and periodic resurfacing of the roads would rise during operations, starting at $4.1 million in 2010 and rising to $22 million in 2033. The average annual impact in real disposable income would be $12.9 million. Gross Regional Product would also rise during operations, increasing to $29 million in 2033 and averaging $15.3 million. Annual State and local government expenditures attributable to this heavy-haul truck implementing alternative would increase from $2.2 million in 2010 to $4.0 million in 2033, with an annual average of $2.9 million. The impact of changes in the economic measures of Gross Regional Product, real disposable income, and expenditures by State and local governments would be less than 1 percent for Clark and Nye Counties. The impact in Lincoln County would be more visible. Changes in real disposable income would average 2.4 percent of the baseline, the impact in Gross Regional Product would average 3.7 percent of the baseline, and the change in expenditures by State and local governments would average 2.9 percent of the baseline in the county.

In addition, DOE analyzed a sensitivity case that assumed all Lincoln County socioeconomic impacts would occur only in the City of Caliente. Under this assumption, City population would rise by 3 percent during construction and by about 8.7 percent during operations. Employment would rise by about 11 percent during construction and about 12 percent during operations.

6.3.3.2.1.7 Caliente Route Noise and Vibration

Section 6.3.3.1 discusses the noise impacts common to all heavy-haul truck implementing alternatives. This section focuses on noise impacts that would be unique to the Caliente heavy-haul truck implementing alternative.

Highway Construction and Upgrades. The Caliente intermodal transfer station would border a wastewater-treatment facility consisting of drain fields and ponds. There is a single dwelling about 500 meters (1,600 feet) to the northeast of a 0.26-square kilometer (64-acre) parcel that has been identified as a potential site for the Caliente intermodal transfer station. However, this residence is behind a small rise and would be partially shielded from operations at an intermodal transfer station. As a consequence, the potential for noise impacts from construction and operations would be very low at this location.

Operations. Existing traffic on the candidate routes for heavy-haul trucks includes a significant component of tractor-trailer vehicles. Because the intermodal transfer station would be on the western edge of Caliente, traffic to and from the station would not travel through town. Traffic noise impacts in Caliente would be inconsequential. The increase in 1-hour average noise levels would be greatest near Rachel, where traffic volumes are lowest. The estimated elevation of background traffic noise would be 4.7 dBA 15 meters (49 feet) from the road. The estimated baseline traffic noise level of 59.2 dBA would increase to 63.9 dBA when heavy-haul trucks passed Rachel. Estimated traffic noise levels in Tonopah, Goldfield, and Beatty would increase by 0.3 to 2.0 dBA. These small increases in noise levels would not be discernable when compared to existing background levels of current tractor-trailer noise in these communities. Heavy-haul trucks would add only a small increment to the existing baseline noise level associated with traffic on these routes. U.S. 95 is a major transportation corridor for the trucking industry from central California to Las Vegas. U.S. 6, State Route 373 and U.S. 93 (from Crystal Springs to Caliente) carry less traffic than U.S. 95. Ground vibrations would not affect any historic buildings because of the low speeds that heavy-haul trucks would use when passing through Goldfield. No sensitive ruins of cultural significance have been identified along this route.

The Caliente route passes the northeastern border of the Timbisha Shoshone Trust Lands parcel on U.S. 95. Estimated mean 1-hour increases in traffic noise due to heavy-haul trucks in this area would be 0.8 dBA over existing background traffic noise (DIRS 155825-Poston 2001, all). This level of increase would not cause adverse impacts.

6.3.3.2.1.8 Caliente Route Aesthetics

A Caliente intermodal transfer station would be located near the entrance to Kershaw-Ryan State Park. In addition, park visitors would receive short-term visual impacts from construction activities. Park visitors could also be affected by noise from construction activities that could lessen their recreational experience. These short-term impacts would exist only during construction.

During operation of the intermodal transfer station, noise and lighting probably would be discernible from Kershaw-Ryan State Park, especially during night operations, and would probably detract from the recreational experience. The use of shielded and directional-lighting would limit the amount of viewable light from outside the facility operational area.

6.3.3.2.1.9 Caliente Route Utilities, Energy, and Materials

Section 6.3.3.1 discusses the utilities, energy, and materials impacts that would be common to the heavy-haul truck implementing alternatives. This section focuses on the utilities, energy, and materials impacts that would be unique to the Caliente heavy-haul truck implementing alternative.

Highway Construction and Upgrades. The construction of the Caliente intermodal transfer station would have the same utilities, energy, and materials impacts as those discussed in Section 6.3.3.1.

Table 6-96 lists the estimated quantities of primary materials for the upgrade of Nevada highways for the Caliente route. These quantities are not likely to be very large in relation to the southern Nevada regional supply capacity (see Section 6.3.3.1).

Table 6-96. Utilities, energy, and materials required for upgrades along the Caliente route.

Route	Length (kilometers)[a]	Diesel fuel (million liters)[b]	Gasoline (thousand liters)	Asphalt (million metric tons)[c]	Concrete (thousand metric tons)	Steel[d] (metric tons)
Caliente	533	13	220	1.4	1.8	49.3

a. To convert kilometers to miles, multiply by 0.62137.
b. To convert liters to gallons, multiply by 0.26418.
c. To convert metric tons to tons, multiply by 1.1023.
d. Steel includes rebar only.

Operations. Section 6.3.3.1 discusses the utilities, energy, and material needs for operation of an intermodal transfer station.

Fossil fuel that would be consumed by heavy-haul trucks during operations is discussed in Chapter 10, which addresses irreversible commitments of resources.

6.3.3.2.2 *Caliente/Chalk Mountain Route Implementing Alternative*

The Caliente/Chalk Mountain route (Figure 6-23) is approximately 282 kilometers (175 miles) long. Heavy-haul trucks and escorts leaving an intermodal transfer station in the Caliente area would travel directly from the station to U.S. 93. The trucks would travel on U.S. 93 to State Route 375, then on State Route 375 to the Town of Rachel. Next they would head south on Valley Road through the Nellis Air Force Range past Chalk Mountain to the Groom Pass Gate to the Nevada Test Site.

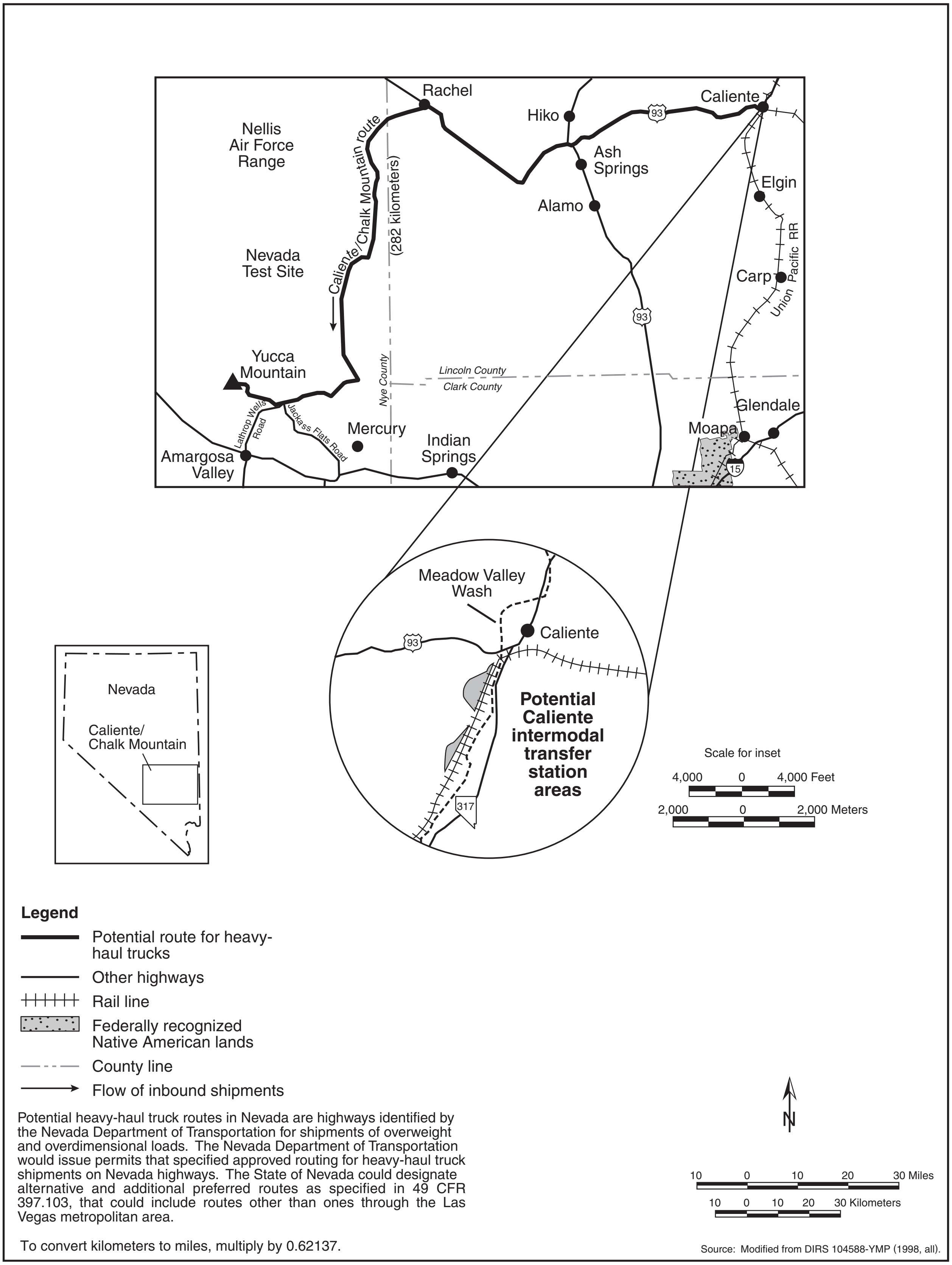

Figure 6-23. Caliente/Chalk Mountain heavy-haul truck route.

DOE would construct a parking area along a Caliente/Chalk Mountain route near the northern boundary of the Nellis Air Force Range to enable heavy-haul vehicles to park overnight. This parking area could be needed because the travel time (vehicle in motion plus periodic short stops for inspections) associated with a Caliente/Chalk Mountain route would be as much as 8 hours and because (1) DOE anticipates restrictions on the times trucks could travel across the Nellis Air Force Range and (2) special travel permits issued by the State of Nevada for the trucks would include time-of-day and day-of-the-week travel restrictions. The estimated life-cycle cost to construct and operate an intermodal transfer station and to operate heavy-haul trucks along the Caliente/Chalk Mountain route would be about $548 million in 2001 dollars.

Section 6.3.3.2.1 discusses the Caliente siting areas for an intermodal transfer station.

The following sections address impacts that would occur to land use; biological resources and soils; cultural resources; hydrology including surface water and groundwater; occupational and public health and safety; socioeconomics; noise and vibration; aesthetics and utilities, energy, and materials. Impacts that would occur to air quality, and waste management would be the same as those discussed in Section 6.3.3.1 and are, therefore, not repeated here. Section 6.3.4 discusses the potential for transportation activities to cause environmental justice impacts in Nevada.

6.3.3.2.2.1 Caliente/Chalk Mountain Route Land Use and Ownership

This section describes anticipated land-use impacts that could occur from the construction and operation of the Caliente intermodal transfer station, upgrades of highways, and heavy-haul truck operations over the Caliente/Chalk Mountain route. Chapter 3, Section 3.2.2.2.1, describes the Caliente intermodal transfer station site and the associated route to the Yucca Mountain site.

Highway Construction and Upgrades. Section 6.3.3.2.1 discusses Caliente intermodal transfer station impacts in relation to the current use of the land and the surrounding area. Section 6.3.3.1 describes impacts on land use from upgrading highways for use by heavy-haul trucks.

In addition to the impacts on land use discussed in Section 6.3.3.1 for upgrading Nevada highways, approximately 1.3 square kilometers (310 acres) of land would be disturbed by the road upgrades and additional construction activities required for this route. Table 6-97 summarizes these disturbances. Approximately 0.04 square kilometer (10 acres) of land in the vicinity of the northern boundary of the Nellis Air Force Range would be acquired for a midroute stopping area for heavy-haul trucks.

Table 6-97. Land disturbances along the Caliente/Chalk Mountain heavy-haul truck route.

Disturbance	Area disturbed[a] (square kilometers)[b]
Haul road disturbed area	0.6
Aggregate plants	0.1
Road widening	0.3
Passing lanes	0.1
Truck turnouts	0.02
Fortymile Wash new road	0.04
Overnight stops	0.04
Total disturbed area	1.3

a. Numbers approximate due to rounding.
b. To convert square kilometers to acres, multiply by 247.1.

The Caliente/Chalk Mountain route would involve land controlled by the Nellis Air Force Range (also known as the Nevada Test and Training Range), which, according to the Air Force, would affect Air Force operations. Because the Military Lands Withdrawal Act of 1999 (Public Law 106-65, 113 Stat. 885) withdraws and reserves the Nellis Air Force Range for use by the Secretary of the Air Force, the Secretary would need to concur with a decision to operate a heavy-haul truck route through any part of the Range. The Air Force has identified national security issues regarding a Caliente/Chalk Mountain route, citing interference with Nellis Air Force Range testing and training activities. In response to Air Force concerns, DOE has stated that it is acutely conscious of the security issues such a route would present and, because of the concerns expressed by the Air Force, regards the route as a "non-preferred alternative."

Operations. The Air Force has identified national security issues regarding operations of heavy-haul trucks on the Caliente/Chalk Mountain route, citing interference with Nellis Air Force Range testing and training activities. There would be no other direct land-use impacts associated with the operation of the Caliente intermodal transfer station or the Caliente/Chalk Mountain route except those described above and in Section 6.3.3.1.

6.3.3.2.2.2 Caliente/Chalk Mountain Route Hydrology

DOE anticipates that limited impacts to surface water and groundwater would occur in the course of improving Nevada highways so that they could accommodate daily use by heavy-haul trucks. This section discusses these potential environmental impacts as well as those from the construction and operation of an intermodal transfer station and operation of the Caliente/Chalk Mountain route. Section 6.3.3.1 discusses the hydrological impacts that would be common to all the heavy-haul truck implementing alternatives. This section focuses on the hydrology impacts that would be unique to the Caliente/Chalk Mountain route.

Surface Water

Section 6.3.3.1 discusses the impacts to surface water from the construction and operation of an intermodal transfer station and upgrades to highways.

Appendix L contains a comparison of what is known about the floodplains, springs, and riparian areas at the three candidate intermodal transfer station sites (see Sections L.3.2.6 and L.4.2.2). As noted in Section L.3.2.6, the two locations being considered for the Caliente intermodal transfer station are outside the 100-year flood zone of Meadow Valley Wash, but inside the 500-year flood zone.

Groundwater

Highway Construction and Upgrades. Section 6.3.3.1 discusses the impacts to groundwater from the construction of an intermodal transfer station. Groundwater impacts from upgrading highways would be limited to those caused by the use of water from construction wells. Upgrades to the Caliente/Chalk Mountain route would require about 75,000 cubic meters (60 acre-feet) of water (DIRS 104917-LeFever 1998, all) that the analysis assumed would come from five wells.

The average amount of water withdrawn from each well would be about 15,000 cubic meters (12 acre-feet). Chapter 3, Section 3.2.2.2.3, identifies hydrographic areas over which the Caliente/Chalk Mountain route would pass, their perennial yields, and whether the State considers each a Designated Groundwater Basin. Table 6-98 summarizes the status of the hydrographic areas associated with the Caliente/Chalk Mountain heavy-haul truck route. It also identifies the approximate percentage of the route that would pass over Designated Groundwater Basins.

Table 6-98. Hydrographic areas along Caliente-Chalk Mountain route.

Hydrographic areas	Designated Groundwater Basins: Number	Designated Groundwater Basins: Percent of corridor length
10	2	20

The withdrawal of 15,000 cubic meters (12 acre-feet) a year from a well would have little impact on the hydrographic areas associated with the Caliente/Chalk Mountain route based on their perennial yields (Chapter 3, Section 3.2.2.2.3), even if multiple wells were placed in the same hydrographic area. As indicated in Table 6-98, about 20 percent of the route's length would be in areas with Designated Groundwater Basins, which the Nevada State Engineer's office watches carefully for the potential for groundwater depletion. This does not mean that a contractor could not obtain water appropriations in these areas; the State Engineer would have the authority to approve such appropriations. The fact that requests for water appropriations under this action would be for minor amounts and for a short-term construction action should provide the State Engineer even more discretion. Other options would be to lease temporary water rights from individuals along the route, ship water from other permitted resources by truck (4,000 truckloads) to construction sites, or use a combination of these two actions. Obtaining a water appropriation from the State Engineer for short-term construction use or using an approved allocation should ensure that groundwater resources would not be adversely affected.

Operations. Section 6.3.3.1 discusses the impacts to groundwater from the operation of an intermodal transfer station, highway maintenance, and heavy-haul truck operations.

6.3.3.2.2.3 Caliente/Chalk Mountain Route Biological Resources and Soils

Section 6.3.3.1 discusses impacts to biological resources from the construction and operation of an intermodal transfer station and upgrades to highways that would be common to all candidate sites for an intermodal transfer station and routes. This section discusses the construction- and operations-related impacts that would be unique to the Caliente intermodal station and Caliente/Chalk Mountain route.

Highway Construction and Upgrades. Section 6.3.3.2.1 discusses potential Caliente intermodal transfer station site locations and impacts to biological resources from station construction.

The predominant land cover types along the Caliente/Chalk Mountain route are salt desert scrub, blackbrush, sagebrush, and creosote-bursage (DIRS 104593-CRWMS M&O 1999, p. 3-31). The regional area for each vegetation type is extensive (DIRS 104593-CRWMS M&O 1999, pp. C1 to C5). Because areas disturbed by highway upgrade activities would be in or adjacent to existing rights-of-way, and because these areas have been previously degraded by human activities, impacts would be small. In addition, vegetation would be removed from approximately 0.04 square kilometer (10 acres) of undisturbed land for development of a midroute stopover. This area would be near or outside the boundary of Nellis Air Force Range. The precise location is not known at this time, so the land cover type that would be disturbed cannot be identified. However, as noted above, all land cover types along the route are extensive and often degraded in the region, so the loss of this area would be unlikely to cause adverse effects to the population of any plant or animal species.

Two threatened or endangered species occur along the route (DIRS 104593-CRWMS M&O 1999, p. 3-32). The desert tortoise occurs along the southern part of the route from the northern end of Frenchman Flat to Yucca Mountain. Construction activities could kill or injure desert tortoises; however, their abundance is low in this area (DIRS 101914-Rautenstrauch and O'Farrell 1998, pp. 407 to 411), so losses would be few. One endangered species—the Hiko White River springfish—occurs in Crystal Springs (DIRS 103262-FWS 1998, p. 16), which is about 10 meters (33 feet) south of State Route 375 near its intersection with State Route 318 near U.S. 93. Construction or widening of the road would be unlikely to affect this species because construction activities would avoid the spring outflow channel, and DOE would implement mitigation measures to ensure that no sediment would enter the stream, which is critical habitat for this fish (50 CFR 17.95). Three other special status species occur along this route, but because construction activities would occur along existing roads, they should not be affected. Standard construction practices would be used to reduce erosion and runoff. In addition, formal consultation with the U.S. Fish and Wildlife Service would be initiated if this heavy-haul truck route was selected, and DOE would implement all terms and conditions required by the Service.

This route would cross six areas designated as game habitat (DIRS 104593-CRWMS M&O 1999, p. 3-32). The amount of habitat in these areas would be reduced very slightly due to construction activities along existing roads. Game animals could be disturbed if they were in these areas during construction.

Three springs or riparian areas occur near this route (DIRS 104593-CRWMS M&O 1999, p. 3-32). These springs and riparian areas may be jurisdictional wetlands or other waters of the United States; however,

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no formal delineation has been made. DOE would implement mitigation measures to ensure that construction would not increase sedimentation in these areas. The route crosses a number of ephemeral streams that may be classified as waters of the United States. DOE would work with the State of Nevada and the U.S. Army Corps of Engineers to minimize impacts to these areas and would obtain individual or regional permits, as appropriate.

Impacts to soils would be transitory and small and would occur only along the shoulders of existing roads.

Operations. Impacts from operations would include periodic disturbances of wildlife from additional truck traffic along this route. Trucks probably would kill individuals of some species but losses would be few and unlikely to affect regional populations of any species. No additional habitat loss would occur during operations. Impacts to soils would be small.

6.3.3.2.2.4 Caliente/Chalk Mountain Route Cultural Resources

Highway Construction and Upgrades. Upgrades to U.S. 93 and State Route 375 would create similar impacts (such as disturbing sites or crushing artifacts) for archaeological, historic, and Native American resources as those identified with the use of the Caliente heavy-haul truck route. Potential impacts at the Caliente intermodal transfer station would also be the same.

Surveys have recorded 31 archaeological sites, five of which have been evaluated as being potentially significant. One is a historic mining camp that has not been evaluated. Additional field surveys would be necessary to record and evaluate cultural resource sites along the route segment from State Route 375 to Yucca Mountain, along with field ethnographic studies. Within the Nevada Test Site, the National Register-listed historic property of Sedan Crater would be located close to, but at a presently unspecified distance, from the proposed new route heavy-haul segment. If this route is selected, final engineering of the alignment would determine if there would be any potential impacts to this historic property.

Table 6-99. Impacts to workers from industrial hazards from upgrading highways along the Caliente/Chalk Mountain route.

Group and industrial hazard category	Construction[a]	Operations[b]
Involved workers		
Total recordable cases[c]	35	220
Lost workday cases	17	120
Fatalities	0.05	0.61
Noninvolved workers		
Total recordable cases	2.1	13
Lost workday cases	0.8	4.7
Fatalities	0.002	0.01
otals[d]		
Total recordable cases	37	240
Lost workday cases	18	130
Fatalities	0.05	0.62

a. Impacts are totals over about 2 years.
b. Includes impacts from periodic maintenance and resurfacing. Impacts are totals over 24 years.
c. Total recordable cases includes injury and illness.
d. Totals might differ from sums due to rounding.

Operations. Impacts from the use of the Caliente/Chalk Mountain route from the Caliente intermodal transfer station to the point at which it leaves State Route 375 would be the same as those identified for the Caliente route in Section 6.3.3.2.1.

6.3.3.2.2.5 Caliente/Chalk Mountain Route Occupational and Public Health and Safety

This section addresses potential impacts to occupational and public health and safety from upgrading highways and heavy-haul truck operations on the Caliente/Chalk Mountain route. Impacts of the associated intermodal transfer station in Caliente would be the same as those discussed in Section 6.3.3.1.

Highway Construction and Upgrades. Industrial safety impacts to workers from upgrading highways for the Caliente/Chalk Mountain route would be small (Table 6-99). The analysis evaluated the potential for impacts in terms of total reportable cases of injury, lost workday cases, fatality risks for workers, and traffic-related fatalities related to commuting workers and the movement of construction materials and equipment. Table 6-100 lists the estimated fatalities from construction and commuter vehicle traffic.

Table 6-100. Estimated number of fatalities from construction material delivery vehicles and construction and operations worker commuting traffic for the Caliente/Chalk Mountain route for heavy-haul trucks.

Activity	Kilometers[a]	Traffic fatalities	Vehicle emissions fatalities
Construction[b]			
Material delivery vehicles	18,000,000	0.3	0.04
Commuting workers	30,000,000	0.3	0.04
Subtotals	*48,000,000*	*0.6*	*0.08*
Operations[c]			
Commuting workers	180,000,000	1.8	0.24
Totals[d]	***230,000,000***	***2.4***	***0.32***

a. To convert kilometers to miles, multiply by 0.62137.
b. Impacts are totals over about 2 years.
c. Impacts are totals over about 24 years.
d. Totals might differ from sums of values due to rounding.

Operations. The incident-free radiological impacts listed in Table 6-101 would occur during the routine transportation of spent nuclear fuel and high-level radioactive waste using the Caliente/Chalk Mountain route. These impacts include transportation along the route and along railways in Nevada leading to an intermodal transfer station. The table includes the impacts of 1,079 legal-weight truck shipments from commercial sites that do not have the capability to load rail casks while operational.

Table 6-101. Impacts from incident-free transportation for the Caliente/Chalk Mountain heavy-haul truck implementing alternative.[a]

Category	Legal-weight truck shipments	Rail and heavy-haul truck shipments[b]	Totals[c]
Involved workers			
Collective dose (person-rem)	38	1,200	1,200
Estimated latent cancer fatalities	0.02	0.48	0.5
Public			
Collective dose (person-rem)	7	60	70
Estimated latent cancer fatalities	0.003	0.03	0.03
Estimated vehicle emission-related fatalities	0.0016	0.0063	0.0079

a. Impacts are totals for 24 years.
b. Includes impacts to workers at an intermodal transfer station and impacts to escorts.
c. Totals might differ from sums of values due to rounding.

6.3.3.2.2.6 Caliente/Chalk Mountain Route Socioeconomics

This section describes potential socioeconomic impacts that would occur from upgrading highways along the Caliente/Chalk Mountain route and building an intermodal transfer station for heavy-haul truck transportation. The discussion includes the impacts from the operation of an intermodal transfer station at Caliente and periodic resurfacing of the highways.

Highway Construction and Upgrades. Socioeconomic impacts from upgrading public highways, roads on the Nellis Air Force Range, and roads on the Nevada Test Site for a Caliente/Chalk Mountain route and for building an intermodal transfer station would be temporary, occurring over a short period and spread among the counties along the route. Employment for highway upgrades and intermodal transfer station construction would involve workers laboring for about 241,000 worker hours. Upgrading the highways along this route would cost about $65.6 million and would require 26 months to complete.

Constructing an intermodal transfer station would cost $25 million and require 18 months. (Dollar values reported in this section are 2001 dollars unless otherwise stated.)

Employment

In the region of influence, increased employment of construction workers involved with upgrading the highways or with building an intermodal transfer station (direct workers) and of other workers employed as a result of the economic activity generated by the project (indirect workers) would peak in 2008 at about 751 new jobs. The increase in employment for Clark County would be about 650 workers and Nye County would gain 44 workers. These increases represent less than 1 percent of each county's employment baseline. For Lincoln County, the increase in employment would be as much as 57 workers or 2.3 percent of the employment baseline. Changes in Lincoln County would be primarily the result of indirect employment created by the spending of construction workers.

Population

Changes in population in the region of influence as a consequence of construction work would peak in 2009. During that year, the incremental increase in population would be about 463 individuals. Clark County would experience 91 percent of the change. Population changes for Clark, Lincoln, and Nye Counties from increased employment would be less than 1 percent of each county's baseline. Because employment and population impacts arising from highway upgrade and the construction of an intermodal transfer station for the Caliente/Chalk Mountain route projects would be small and transient, impacts to schools or housing would be unlikely.

Economic Measures

Economic measures would rise during the construction of an intermodal transfer station and upgrading of highways. The increase in real disposable income in the three counties in the region of influence would peak at about $21.8 million in 2009. Gross Regional Product would peak in 2008 at $39.8 million. Increased State and local government expenditures resulting from highway upgrades and the construction of an intermodal transfer station would reach their peak in 2009 at $1.6 million. Changes to government expenditures and real disposable income would be less than 1 percent of the respective baselines for Clark, Lincoln, and Nye Counties. Changes to Gross Regional Product in Clark and Nye Counties would also be less than 1 percent of the baselines. The increase in Gross Regional Product in Lincoln County would be about 1.2 percent of the county's baseline for that economic measure. (Dollar values reported in this section are in 2001 dollars unless otherwise stated.)

Transition to Operations. In the region of influence, employment of Caliente/Chalk Mountain heavy-haul truck route workers and indirect (support) workers would decrease by 677 when construction of the intermodal transfer station and highway upgrades ended in 2009. Clark County would lose 506 (83 percent) of these jobs. Nye County would lose 41 jobs, and Lincoln County would lose 33 jobs. DOE anticipates that some of the displaced workers would move into operational positions on the Caliente/Chalk Mountain route while others would find other work in the State. While this project would lose jobs, employment projections for the State estimate approximately 1.4 million jobs in 2010, or about 999,500 in the region of influence.

Operations. Operations at an intermodal transfer station and the use of heavy-haul trucks would begin in 2010 and would continue until 2033. An annual operations workforce of 26 would be required for the intermodal transfer station. The workforce for heavy-haul truck operations over a Caliente/Chalk Mountain route, including shipment escorts, would be 110 workers.

Employment

Employment probably would remain relatively level throughout operations. Total employment (direct and indirect) attributable to the Caliente/Chalk Mountain route in the region of influence would average about 237 jobs. Clark County would supply about 87 of the workers, Nye County about 17, and Lincoln

County about 133. The increase in employment in Clark and Nye Counties would be less than 1 percent of each county's employment baseline. The increase in employment in Lincoln County would represent an impact of 4.9 percent of the county's employment baseline.

Because of the periodic need to resurface highways used by heavy-haul trucks (every 8 years starting in 2016), employment would increase in the years during which these projects occurred. For these projects, total employment in the region of influence would increase by about 100 workers for a Caliente/Chalk Mountain route. Employment changes from periodic highway-resurfacing projects would be less than 1 percent of the baseline in Clark County. DOE assumed that resurfacing project workers would live in Clark County. DOE included the workers employed to resurface the roads and their families in the employment and population estimates for the operations period. Impacts to employment and population for the three counties in the region of influence as a consequence of the resurfacing projects would be less than 1 percent of the baselines.

Population

The impact on population in the region of influence would be approximately 506 additional residents. Clark County would gain 296 residents, Nye County would gain 43, and Lincoln County would gain 167. The impact from a population increase in Clark and Nye Counties would be less than 1 percent of each county's baseline. There would no impacts to housing or schools in Clark and Nye Counties. Population increases for Lincoln County, which would experience the largest change, would be approximately 3.5 percent of the baseline. These impacts to employment and population during the operations phase would be within the range of historic changes in the County.

The population change in Lincoln County would include an average annual increase of approximately 38 school-aged children. The impact to housing attributable to the Caliente/Chalk Mountain heavy-haul route would be negligible given the County's historically high housing vacancy rates (see Chapter 3, Section 3.1.7.4).

Economic Measures

In the region of influence, additional real disposable income from the operation of an intermodal transfer station in Caliente, operation of heavy-haul trucks, and periodic resurfacing of the roads would rise throughout operations, starting at $3.9 million in 2010 and increasing to $15.8 million in 2033. The average annual increment in real disposable income would be $11.1 million. Increments to Gross Regional Product would also rise during operations, starting at $2.4 million in 2010, increasing to $20.4 million in 2033, and averaging $13.7 million. Additional annual State and local government expenditures would increase from $1.6 million in 2010 to $3.8 million in 2033, and would average $2.8 million. The increases in real disposable income, Gross Regional Product, and expenditures by governments would be less than 1 percent of the applicable baseline in Clark and Nye Counties. Increases to real disposable income, Gross Regional Product, and government expenditures attributable to the Caliente/Chalk Mountain route would be more visible in Lincoln County. Changes in real disposable income and government expenditures for the county would be about 3.3 and 4.2 percent, respectively, of the baselines. The projected change in Gross Regional Product for the County would be 5.1 percent of the baseline.

In addition, DOE analyzed a sensitivity case that assumed all Lincoln County socioeconomic impacts would occur only in the City of Caliente. Under this assumption, City population would rise by 3 percent during construction and by about 8.7 percent during operations. Employment would rise by about 11 percent during construction and about 12 percent during operations.

6.3.3.2.2.7 Caliente/Chalk Mountain Route Noise and Vibration

Section 6.3.3.1 discusses the noise impacts common to all the heavy-haul truck implementing alternatives. This section focuses on noise impacts that would be unique to the Caliente/Chalk Mountain heavy-haul truck implementing alternative.

Noise impacts of the Caliente intermodal transfer station would be the same as those discussed in Section 6.3.3.2.1. A large portion of the route would be inside the boundaries of the Nevada Test Site and the Nellis Air Force Range. The small rural communities of Crystal Spring and Rachel and the Town of Caliente would be within the 2,000-meter (6,600-foot) region of influence for construction noise.

Existing traffic on the candidate routes for heavy-haul trucks includes a significant component of tractor-trailer vehicles. The increase in 1-hour average noise levels would be greatest near Rachel, where traffic volumes are lowest. The estimated elevation of background traffic noise would be 0.6 dBA 15 meters (49 feet) from the road. The estimated baseline traffic noise level would be 61.4 dBA, which would increase to 62.4 dBA with three heavy-haul trucks passing Rachel. Because the proposed intermodal transfer station would be on the western edge of Caliente and traffic would not travel through town, traffic noise impacts in Caliente would be inconsequential. No historic buildings would be affected by ground vibration.

6.3.3.2.2.8 Caliente/Chalk Mountain Route Aesthetics

A Caliente intermodal transfer station would be near the entrance to Kershaw-Ryan State Park. Park visitors would receive short-term visual impacts from construction activities. In addition, park visitors could be affected by noise from construction activities that could lessen their recreational experience. These short-term impacts would exist only during construction.

During operation of the intermodal transfer station, noise and lighting probably would be discernible from Kershaw-Ryan State Park, especially during night operations, and would probably detract from the recreational experience. The use of shielded and directional lighting would limit the amount of viewable light from outside the facility operational area.

6.3.3.2.2.9 Caliente/Chalk Mountain Route Utilities, Energy, and Materials

Section 6.3.3.1 discusses utilities, energy, and materials impacts that would be common to all the heavy-haul truck implementing alternatives. This section focuses on the utilities, energy and materials impacts that would be unique to the Caliente/Chalk Mountain heavy-haul truck implementing alternative.

Highway Construction and Upgrades. The construction of the Caliente intermodal transfer station would have the same utilities, energy and materials impacts as those discussed in Section 6.3.3.1.

Table 6-102 lists the estimated quantities of primary materials for the upgrade of highways for the Caliente/Chalk Mountain route. These quantities are not likely to be very large in relation to the southern Nevada regional supply capacity (see Section 6.3.3.1).

Table 6-102. Utilities, energy, and materials required for upgrades along the Caliente/Chalk Mountain route.

Route	Length (kilometers)[a]	Diesel fuel (million liters)[b]	Gasoline (thousand liters)	Asphalt (million metric tons)[c]	Concrete (thousand metric tons)	Steel[d] (metric tons)
Caliente-Chalk Mountain	282	4.7	77	0.41	0.5	14

a. To convert kilometers to miles, multiply by 0.62137.
b. To convert liters to gallons, multiply by 0.26418.
c. To convert metric tons to tons, multiply by 1.1023.
d. Steel includes rebar only.

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Fossil fuel that would be consumed by heavy-haul trucks during operations is discussed in Chapter 10, which addresses irreversible commitment of resources.

Operations. Section 6.3.3.1 discusses the utilities, energy, and materials needs for the operation of an intermodal transfer station.

6.3.3.2.3 *Caliente/Las Vegas Route Implementing Alternative*

The Caliente/Las Vegas route (Figure 6-24) is approximately 377 kilometers (234 miles) long. Heavy-haul trucks and escorts leaving an intermodal transfer station in the Caliente area would travel directly from the station to U.S. 93. The trucks would travel south on U.S. 93 to the intersection with I-15 northeast of Las Vegas. The trucks would then travel south on I-15 to the exit for the proposed Las Vegas Beltway, and would travel west on the beltway. They would exit the beltway to U.S. 95, and travel north on U.S. 95 to the Mercury entrance to the Nevada Test Site. The trucks would travel on Jackass Flats Road on the Nevada Test Site to the Yucca Mountain site.

DOE would construct a parking area along a Caliente/Las Vegas route to enable heavy-haul vehicles to park overnight. This parking area could be needed because the travel time (vehicle in motion plus periodic short stops for inspections) associated with a Caliente/Las Vegas route would be as much as 9 hours and because DOE anticipates (1) requirements to coordinate travel times with time of reduced traffic flow on the northern portion of the Las Vegas Beltway and (2) special travel permits issued by the State of Nevada for the trucks would include time-of-day and day-of-the-week travel restrictions that could preclude completing a trip in 1 day. This parking area would be near the U.S. 93 and I-15 intersection at Apex. The estimated life-cycle cost of constructing and operating an intermodal transfer station and of operating heavy-haul trucks along the Caliente/Las Vegas route would be about $607 million in 2001 dollars.

Section 6.3.3.2.1 discusses the Caliente siting areas for an intermodal transfer station.

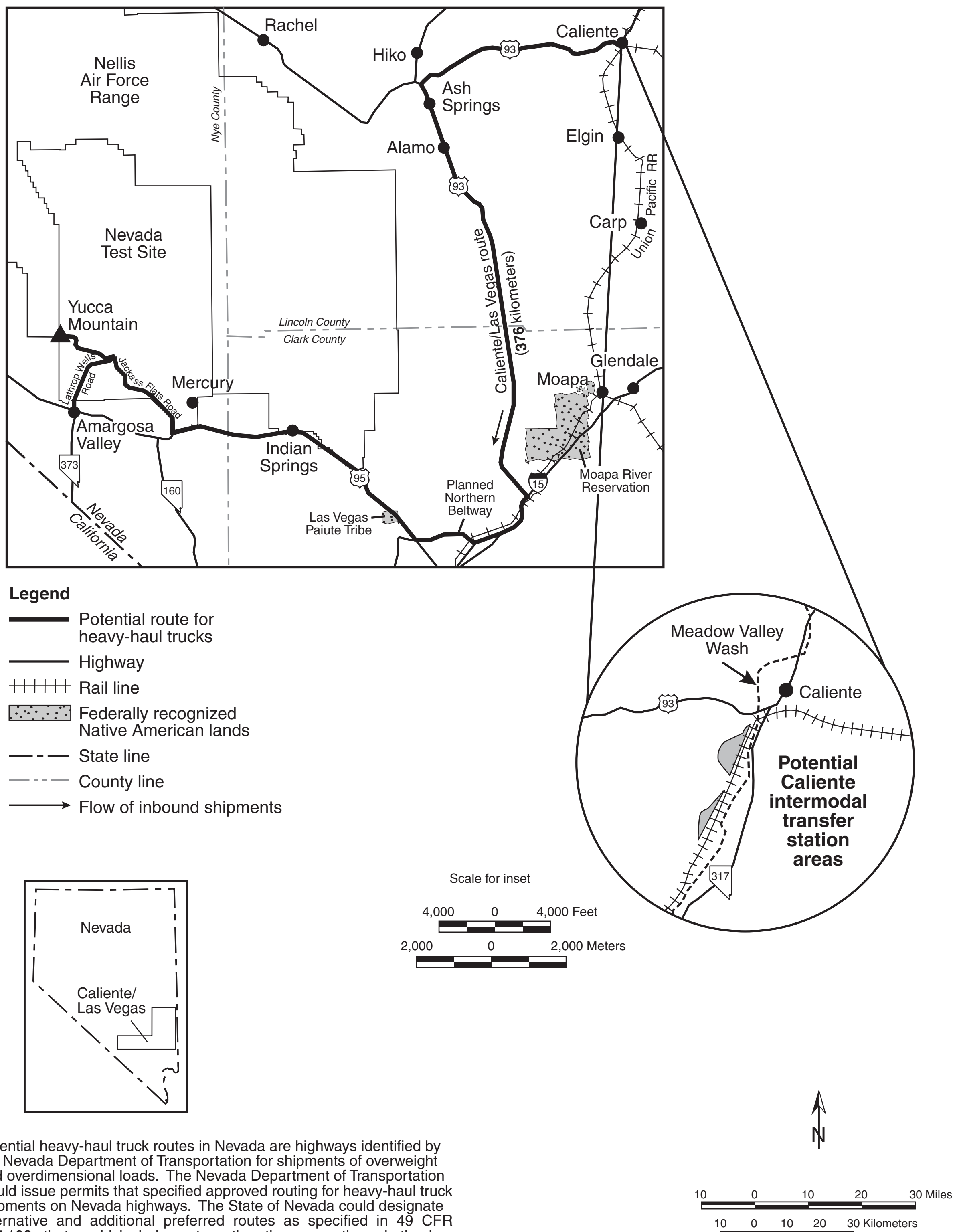
The following sections address impacts that would occur to land use; air quality; biological resources and soils; hydrology including surface water and groundwater; cultural resources; occupational and public health and safety; socioeconomics; noise and vibration; aesthetics; and utilities, energy, and materials. Impacts that would occur to waste management would be the same as those discussed in Section 6.3.3.1 and are, therefore, not repeated here. Section 6.3.4 discusses the potential for transportation activities to cause environmental justice impacts in Nevada.

6.3.3.2.3.1 Caliente/Las Vegas Route Land Use and Ownership

Chapter 3, Section 3.2.2.2.1, describes the Caliente intermodal transfer station site and associated truck route.

Highway Construction and Upgrades. Section 6.3.3.2.1 discusses the Caliente intermodal station site area and impacts related to the current use of the land. Section 6.3.3.1.1 discusses the impacts on land use from upgrading Nevada highways for use by heavy-haul trucks.

In addition to the impacts on land use discussed in Section 6.3.3.1 for upgrading Nevada highways, approximately 2.1 square kilometers (520 acres) of land would be disturbed by the road upgrades and additional construction activities required. Table 6-103 summarizes these disturbances. Approximately 0.04 square kilometer (10 acres) of land in the vicinity of Apex northeast of Las Vegas would be acquired for a midroute stopping area for heavy-haul trucks.



Potential heavy-haul truck routes in Nevada are highways identified by the Nevada Department of Transportation for shipments of overweight and overdimensional loads. The Nevada Department of Transportation would issue permits that specified approved routing for heavy-haul truck shipments on Nevada highways. The State of Nevada could designate alternative and additional preferred routes as specified in 49 CFR 397.103, that could include routes other than ones through the Las Vegas metropolitan area.

To convert kilometers to miles, multiply by 0.62137.

Source: Modified from DIRS 104588-YMP (1998, all).

Figure 6-24. Caliente/Las Vegas heavy-haul truck route.

Operations. There would be no direct land-use impacts associated with the operation of the Caliente intermodal transfer station or use of the Caliente/Las Vegas route other than those described in Section 6.3.3.1.

Table 6-103. Land disturbances along the Caliente/Las Vegas heavy-haul truck route.

Disturbance	Area disturbed[a] (square kilometers)[b]
Haul road disturbed area	1.2
Aggregate plants	0.2
Road widening	0.5
Passing lanes	0.08
Truck turnouts	0.02
Fortymile Wash new road	0.04
Overnight stops	0.04
Mercury turnoff road	0.03
Total disturbed area	2.1

a. Numbers approximate due to rounding.
b. To convert square kilometers to acres, multiply by 247.1.

6.3.3.2.3.2 Caliente/Las Vegas Route Air Quality

This section describes anticipated nonradiological air quality impacts from the construction and operation of an intermodal transfer station and upgrades and heavy-haul truck operation along the Caliente/Las Vegas route. Such impacts would result from releases of criteria pollutants, including nitrogen dioxide, sulfur dioxide, carbon monoxide, and particulate matter (PM_{10}) (see Section 6.3.3.1).

Carbon dioxide and PM_{10} are of particular interest along the Caliente/Las Vegas heavy-haul truck route because highway construction and upgrades and operation of heavy-haul trucks would occur through the Las Vegas Valley air basin, which is classified as a serious nonattainment area for these pollutants (DIRS 101826-FHWA 1996, pp. 3-53 and 3-54).

Highway Construction and Upgrades. Section 6.3.3.1 discusses the method of evaluation of air quality impacts from these activities. The intermodal transfer station for this route would be outside the Las Vegas air quality nonattainment area.

PM_{10} emissions would be an estimated 66 metric tons (73 tons) per year, including estimated emissions for accelerated construction activities for the Northern Beltway. These emissions are 100 percent of the General Conformity threshold level. Extending the construction time and more diligent dust control measures would decrease annual emissions.

Carbon monoxide emissions would be an estimated 54 metric tons (59 tons) per year. These emissions are 59 percent of the General Conformity threshold level.

Operations. Section 6.3.3.1 discusses air quality impacts associated with the operation of the Caliente intermodal transfer station and from emissions of heavy-haul trucks. The Caliente/Las Vegas route would involve heavy-haul trucks passing through the Las Vegas Valley air basin. The air quality impacts to this air basin would be small [0.48 metric ton (0.53 ton) per year of carbon monoxide] with emissions of less than 1 percent of the General Conformity threshold level. These emissions would result from 11 round trips per week through the basin.

6.3.3.2.3.3 Caliente/Las Vegas Route Hydrology

DOE anticipates that limited impacts to surface water and groundwater would occur in the course of improving Nevada highways so they could accommodate daily use by heavy-haul trucks. This section discusses these potential impacts as well as those from the construction and operation of an intermodal transfer station and operation of the Caliente/Las Vegas route. Section 6.3.3.1 discusses the hydrology impacts that would be common to all the heavy-haul truck implementing alternatives. This section focuses on the hydrology impacts that would be unique to the Caliente/Las Vegas heavy-haul truck implementing alternative.

Surface Water

Section 6.3.3.1 discusses impacts to surface water from the construction and operation of an intermodal transfer station and upgrades to highways. The common impacts discussed would apply to surface water along the Caliente/Las Vegas route.

Appendix L contains a comparison of what is known about the floodplains, springs, and riparian areas at the three candidate intermodal transfer station sites (see Sections L.3.2.6 and L.4.2.2). As noted in Section L.3.2.6, the two locations being considered for the Caliente intermodal transfer station are outside the 100-year flood zone of Meadow Valley Wash, but inside the 500-year flood zone.

Groundwater

Highway Construction and Upgrades. Section 6.3.3.1 discusses impacts to groundwater from the construction of an intermodal transfer station. Groundwater impacts from upgrading highways would be limited to those caused by the use of water from construction wells. The upgrades to the Caliente/Las Vegas route would require about 54,000 cubic meters (44 acre-feet) of water (DIRS 104917-LeFever 1998, all) that the analysis assumed would come from seven wells.

Table 6-104. Hydrographic areas along Caliente/ Las Vegas route.

Hydrographic areas crossed	Designated Groundwater Basins: Number	Designated Groundwater Basins: Percent corridor length represented
13	5	50

The average amount of water withdrawn from each well would be about 7,700 cubic meters (6 acre-feet). Chapter 3, Section 3.2.2.2.3, identifies the hydrographic areas over which the Caliente/Las Vegas route would pass, their perennial yields, and whether the State considers each a Designated Groundwater Basin. Table 6-104 summarizes the status of the hydrographic areas associated with the Caliente/Las Vegas route and identifies the approximate portion of the route that would pass over Designated Groundwater Basins.

The withdrawal of 7,700 cubic meters (6 acre-feet) a year from a well would have little impact on the hydrographic areas associated with the Caliente/Las Vegas route based on their perennial yields (Chapter 3, Section 3.2.2.2.3), even if multiple wells were placed in the same hydrographic area. As indicated in Table 6-104, about 50 percent of the route's length would be in areas with Designated Groundwater Basins, where the potential for groundwater depletion is watched carefully by the Nevada State Engineer's office. This does not mean that a contractor could not obtain water appropriations in these areas; the State Engineer would have the authority to approve such appropriations. The fact that requests for water appropriations under this action would be for minor amounts and for a short-term construction action should provide the State Engineer even more discretion. Other options would be to lease temporary water rights from individuals along the route, ship water from other permitted resources by truck (about 3,000 truckloads) to construction sites, or use a combination of these two actions. Obtaining a water appropriation from the State Engineer for a short-term construction use or using an approved allocation should ensure that groundwater resources would not be adversely affected.

Operations. Section 6.3.3.1 discusses impacts to groundwater from the operation of an intermodal transfer station, highway maintenance, and heavy-haul truck operations.

6.3.3.2.3.4 Caliente/Las Vegas Route Biological Resources and Soils

Section 6.3.3.1 discusses impacts to biological resources from the construction and operation of an intermodal transfer station and upgrades to highways that would be common to all potential sites for an intermodal transfer station and routes. This section discusses construction- and operations-related impacts that would be unique to the Caliente intermodal station and Caliente/Las Vegas route.

Highway Construction and Upgrades. Section 6.3.3.2.1 discusses potential Caliente intermodal transfer station siting locations and impacts to biological resources and soils from construction of the station.

The predominant land cover types along the Caliente/Las Vegas route are creosote-bursage and Mojave mixed scrub (DIRS 104593-CRWMS M&O 1999, p. 3-32). The regional area for each vegetation type is extensive (DIRS 104593-CRWMS M&O 1999, pp. C1 to C5). Because areas disturbed by upgrade activities would be in or adjacent to the existing rights-of-way and the areas have been previously degraded by human activities, impacts would be small.

Four threatened or endangered species occur along the route (DIRS 104593-CRWMS M&O 1999, p. 3-33). The desert tortoise occurs along the southern part of the route from near Alamo to Yucca Mountain (DIRS 103160-Bury and Germano 1994, pp. 57 to 72). An approximately 100-kilometer (62-mile) section of U.S. 93 from Maynard Lake to the junction with I-15 is critical habitat for the desert tortoise (50 CFR 17.95). Slight alterations of habitat immediately adjacent to existing roads would affect desert tortoises because work would occur in the existing right-of-way. Tortoise populations are depleted for more than 1 kilometer (0.6 mile) on either side of roads with average daily traffic greater than 180 vehicles (DIRS 103160-Bury and Germano 1994, pp. 57 to 72). Two endangered species—the Pahranagat roundtail chub and the White River springfish—occur in Ash Springs or its outflow. The route crosses the outflow of Ash Springs, which is designated critical habitat for the White River springfish (50 CFR 17.95). Because improvements would occur on the existing roadway and the Nevada Department of Transportation would use standard practices to reduce erosion and runoff, road improvements would not adversely affect the species living there. Improvements to the existing highway would not affect southwestern willow flycatchers or their habitat in Pahranagat Valley (DIRS 152511-Brocoum 2000, pp. A-9 to A-13). Nine other special status species occur within 100 meters (330 feet) of this route (DIRS 104593-CRWMS M&O 1999, p. 3-33). Four of these species occur at Ash Springs or its outflow, and would not be affected for the reasons stated above for this site. The other five species would not be affected because construction activities would be restricted to the existing right-of-way, so occupied habitat would not be destroyed.

This route would cross eight areas designated as game habitat (DIRS 104593-CRWMS M&O 1999, p. 3-33). Habitat in these areas would be reduced slightly due to construction activities along existing roads. Game animals could be disrupted if they were in these areas during construction and would probably move away until the higher level of activity ceased.

Seven springs, riparian areas, or other wet areas occur near this route (DIRS 104593-CRWMS M&O 1999, p. 3-33). These areas may be jurisdictional wetlands or other waters of the United States. However, no formal delineation has occurred. Construction could increase sedimentation in these areas. The corridor crosses a number of ephemeral streams that may be classified as waters of the United States. DOE would work with the State of Nevada and the U.S. Army Corps of Engineers to mitigate impacts to these areas and would obtain individual or regional permits, as appropriate.

Impacts (such as increased water erosion and removal of land cover resulting in wind erosion) to soils would be transitory and small and would occur only along the shoulders of existing roads.

Operations. Impacts from operations would be minimal but would include periodic disturbances of wildlife by noise from the additional truck traffic along this route. Trucks probably would kill individuals of some species, but losses would be few and unlikely to affect regional populations of any species. No additional habitat loss would occur during operations.

6.3.3.2.3.5 Caliente/Las Vegas Route Cultural Resources

Section 6.3.3.1 discusses impacts to cultural resources that would be common to all the heavy-haul truck implementing alternatives.

Highway Construction and Upgrades. Highway upgrades and construction of the Caliente/Las Vegas heavy-haul truck route would be the same from the Caliente intermodal transfer station to the junction of U.S. 93 and State Route 375, just south of Hiko, as for the Caliente route (see discussion in Section 6.3.3.2.1). Following U.S. 93 south to the Apex area, the route passes through several sites and areas that have been tentatively identified as being important to American Indians (DIRS 155826-Nickens and Hartwell 2001, Table 8). The following places have been identified in the Pahranagat National Wildlife Refuge: the Black Canyon area, the Storied Rocks site farther south, and the Maynard Lake vicinity. The Black Canyon sites are listed on the *National Register of Historic Places.*

Archaeological surveys of the highway rights-of-way along this route have identified 128 archaeological sites, seven of which have been recommended as potentially significant (DIRS 155826-Nickens and Hartwell 2001, Appendix A). Three of the potentially significant archaeological sites are located in areas identified for highway upgrades. Another 86 remain unevaluated. Two of the unevaluated sites are historic graves.

Native Americans have identified the entire Pahranagat Valley, once home to the Pahranagat Paiutes, as an important cultural landscape (DIRS 155826-Nickens and Hartwell 2001, all). Earlier studies with Native Americans identified the Coyote Springs area and the Arrow Canyon Range valley south of Pahranagat as places of cultural importance.

Operations. Operation of the Caliente intermodal transfer station and the highways along Caliente/Las Vegas heavy-haul truck route would transport spent nuclear fuel and high-level radioactive waste through several areas identified as culturally important to Native Americans. In addition, the route passes through approximately 1.6 kilometers (1 mile) of the Las Vegas Paiute Reservation, and the U.S. 93 segment passes near the Moapa Reservation.

6.3.3.2.3.6 Caliente/Las Vegas Route Occupational and Public Health and Safety

This section addresses potential impacts to occupational and public health and safety from upgrading highways and heavy-haul truck operations on the Caliente/Las Vegas route. Impacts from the associated intermodal transfer station in Caliente would be the same as those discussed in Section 6.3.3.2.1.

Highway Construction and Upgrades. Industrial safety impacts on workers from upgrading highways for the Caliente/Las Vegas route would be small (Table 6-105). The analysis evaluated the potential for impacts in terms of total reportable cases of injury, lost workday cases, fatality risks for workers, and traffic-related fatalities from commuting workers and the

Table 6-105. Impacts to workers from industrial hazards from upgrading highways along the Caliente/Las Vegas route.

Group and industrial hazard category	Construction[a]	Operations[b]
Involved workers		
Total recordable cases[c]	44	200
Lost workday cases	22	110
Fatalities	0.06	0.55
Noninvolved workers[d]		
Total recordable cases	2.6	11
Lost workday cases	1.0	4.3
Fatalities	0.003	0.01
Totals[e]		
Total recordable cases	47	210
Lost workday cases	23	110
Fatalities	0.06	0.56

a. Impacts are totals over about 46 months.
b. Includes impacts from periodic maintenance and resurfacing activities. Impacts are totals over 24 years.
c. Total recordable cases includes injury and illness.
d. The noninvolved worker impacts are based on 25 percent of the involved worker level of effort.
e. Totals might differ from sums due to rounding.

movement of construction materials and equipment. Table 6-106 lists the estimated fatalities from construction and commuter vehicle traffic.

Table 6-106. Estimated number of fatalities from construction material delivery vehicles and construction and operations worker commuting traffic for the Caliente/Las Vegas route for heavy-haul trucks.[a]

Activity	Kilometers[b]	Traffic fatalities	Vehicle emissions fatalities
Construction[c]			
Material delivery vehicles	41,000,000	0.7	0.09
Commuting workers	37,000,000	0.4	0.05
Subtotals	*78,000,000*	*1.1*	*0.13*
Operations[d]			
Commuting workers	200,000,000	2.0	0.26
Totals	***280,000,000***	***3.0***	***0.39***

a. Includes impacts from construction and operations of an intermodal transfer station.
b. To convert kilometers to miles, multiply by 0.62137.
c. Impacts are totals over about 46 months.
d. Impacts are totals over about 24 years.

Operations. Incident-free radiological impacts listed in Table 6-107 would occur during the routine transportation of spent nuclear fuel and high-level radioactive waste on the Caliente/Las Vegas route. These impacts would include those from transportation along the route and along railways in Nevada leading to the Caliente intermodal transfer station. The table includes the impacts of 1,079 legal-weight truck shipments from commercial sites that do not have the capability to load rail casks while operational.

Table 6-107. Health impacts from incident-free Nevada transportation for the Caliente/Las Vegas route heavy-haul truck implementing alternative.[a]

Category	Legal-weight truck shipments	Rail and heavy-haul truck shipments	Totals[b]
Involved workers			
Collective dose (person-rem)	38	1,400	1,400
Estimated latent cancer fatality	0.02	0.56	0.58
Public			
Collective dose (person-rem)	7	220	230
Estimated latent cancer fatality	0.003	0.11	0.11
Estimated vehicle emission-related fatalities	0.002	0.062	0.064

a. Impacts are totals for 24 years.
b. Totals might differ from sums of values due to rounding.

6.3.3.2.3.7 Caliente/Las Vegas Route Socioeconomics

This section describes potential socioeconomic impacts that would occur from upgrading highways along the Caliente/Las Vegas route and building an intermodal transfer station for heavy-haul truck transportation. The discussion includes impacts from the operation of an intermodal transfer station at Caliente and periodic resurfacing of the highways and the planned Las Vegas Beltway.

The analysis of socioeconomic impacts assumed that Clark County would secure a loan to advance the construction schedule of the portion of the Las Vegas Beltway that would be part of the Caliente/Las Vegas route. The analysis based the estimates of impacts on two sources of information from Clark County on the cost of building a section of the Beltway. These sources estimate that modifications to the Northern Beltway would cost between $43.6 million (DIRS 103710-Clark County 1997, p. 2-7) and $463 million (DIRS 155112-Berger 2000, p. 29) (about $43.6 to $463 million in 2001 dollars). DOE believes the actual impact will be between the two values. The loan to Clark County for $43.6 million or $463 million, at a real rate of 3 percent, with repayment of the loan starting in 2010 and lasting for 30 years, is a part of the modeling to determine impacts to employment, population, real disposable income, and expenditures by State and local governments. (A *real* percentage rate is the premium paid in addition to the rate of inflation; a real rate plus the rate of inflation equals the nominal or quoted rate.) Clark County would repay the loan from tax revenues.

Highway Construction and Upgrades. Socioeconomic impacts from upgrading public highways for the Caliente/Las Vegas route, advancing the scheduled completion of a portion of the Las Vegas Beltway, and building an intermodal transfer station would be temporary, occurring over a short period and spread among the counties along the route. Employment for highway upgrades, excluding the Beltway, and construction of an intermodal transfer station would be about 832,000 worker-hours or 416 worker-years. The highway upgrades, excluding the Beltway, would cost $96.8 million, would take approximately 46 months, and would occur during the 48-month construction period anticipated for the Beltway. The analysis assumed that if DOE selected this route, Clark County would advance the construction schedule of the Beltway and would reconfigure the design to accommodate use by heavy-haul trucks. Constructing an intermodal transfer station would cost $25 million and require 18 months to complete. (Dollar values reported in this section are 2001 dollars unless otherwise stated.)

This section expresses values for socioeconomic measures (employment, population, real disposable income, Gross Regional Product, and State and local government expenditures) and for the potential impacts of change in those measures as a range of values. The first value refers to the outcome if the Beltway cost is $43.6 million; the second refers to the outcome if the cost is $463 million. DOE anticipates that the actual change would fall between the two values.

Employment

In the region of influence, increased employment of construction workers involved with upgrading the highways (including the Beltway) and with building an intermodal transfer station (direct workers) and other workers employed as a result of the economic activity generated by the project (indirect workers) would peak in 2008 at between 588 and 1,979 persons. The increase in employment in Clark County would be between 544 and 1,910 workers, Nye County would gain between 8 and 29 workers, and Lincoln County would gain between 36 and 40 workers. The increases in Clark and Nye Counties would be less than 1 percent of the employment baseline for each county. The increase in Lincoln County would be less than 2 percent of the County's employment baseline.

Population

Projected population increases in the region of influence that would result from construction work related to the Caliente/Las Vegas route would peak in 2009. During that year, population would be more than the baseline by between 500 and 2,002 individuals. The change in population for Clark County would be between 477 and 1,943 people, for Lincoln County between 13 and 17 people, and for Nye County between 10 and 42 people. The impacts from an increase in population as a result of increased employment opportunities would be less than 1 percent of each county's population baseline. Because the increases in population in each county would be so small and transient, impacts to schools or housing would be unlikely.

Economic Measures

Economic measures would rise during the construction of an intermodal transfer station and the upgrading of highways and the Las Vegas Beltway. The increase above the baseline in real disposable income of people in the region of influence would peak in 2008 at between $19.0 million and $65.3 million. The region-wide increase in Gross Regional Product would peak in 2008 at between $33.1 million and $104.1 million. Increased State and local government expenditures resulting from highway upgrades and the intermodal transfer station construction project would peak in 2009 at between $1.7 million and $6.6 million. The Gross Regional Product, real disposal personal income, and expenditures

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by State and local governments would rise by less than 1 percent in Clark, Nye, and Lincoln Counties. (Dollar values reported in this section are in 2001 dollars unless otherwise stated.)

Transition to Operations. In the region of influence, employment of Caliente/Las Vegas heavy-haul truck route workers and indirect (support) workers would decrease by 516 to 2,123 when construction of the intermodal transfer station and highway upgrades (including the Beltway portion) ended in 2009. Clark County would lose between 506 and 2,087 of these jobs, Nye County would lose between 5 and 27 of these jobs, and Lincoln County would lose between 4 and 9 jobs. DOE anticipates that some of the displaced workers would move into operational positions on the Caliente/Las Vegas route while others would find other work in the State. While this project would lose jobs, employment projections for the State estimate approximately 1.4 million jobs in 2010, or about 999,500 in the region of influence.

Operations. If DOE selected this route, operations at an intermodal transfer station near the City of Caliente and use of heavy-haul trucks would begin in 2010 and continue until 2033. A workforce of 26 would be required for the intermodal transfer station. Direct employment for heavy-haul truck operations, including escorts, would be 120 workers.

To analyze impacts of operations for a Caliente/Las Vegas heavy-haul truck route, DOE considered three activities: operation of the intermodal transfer station, operation of heavy-haul trucks, and maintenance of highways and the Las Vegas Beltway.

Employment and Population

Employment associated with an intermodal transfer station and heavy-haul trucks would remain relatively level throughout operations. Total employment in the region of influence attributable to operation of a Caliente/Las Vegas route would average about 209 workers. The analysis determined that about 110 workers would come from Clark County, about 11 from Nye County, and 88 from Lincoln County. The impact on population would be about 359 additional residents in the region. About 224 persons would live in Clark County, about 25 in Nye County, and about 110 in Lincoln County. Additional employment and population for Lincoln County, which would experience the largest changes as a percentage of the baselines, would be about 3.3 percent of the employment baseline and 2.3 percent of the population baseline. These impacts would be within the range of historic changes in the county.

During the operational period of heavy-haul truck shipments, periodic road resurfacing would be needed. Employment (direct and indirect) in the region would increase by about 191 workers during the 2-year duration of resurfacing projects. DOE assumed that all the workers would come from Clark County-based employers. Overall, employment increases from periodic (every 8 years starting in 2016) highway resurfacing projects would be less than 1 percent of the baseline for Clark County. Given the short duration of each resurfacing project, there would be no perceptible change in the region's population. Employees hired to resurface the highways and their families are included in the averages discussed below.

The net changes to employment and population from three operational activities associated with a Caliente/Las Vegas route during the 24 years of operations can be summarized. If the cost of the beltway was approximately $43.6 million, there would be an incremental increase of 225 jobs in the region of influence, 119 in Clark County, 13 in Nye County, and 93 in Lincoln County. This impact would be less than 1 percent of the baselines in Clark and Nye Counties, and 3.5 percent of the baseline in Lincoln County. If the cost of the beltway reaches $463 million, employment in the region of influence, while continuing to grow to approximately 1,137,000 positions, would have 108 fewer employment opportunities. Clark County would have 211 fewer positions, but Nye County would gain 10 positions and Lincoln County would gain 93 positions during the operations phase. Impacts to the baselines in Clark and Nye Counties would be less than 1 percent, but the change in Lincoln County would be 3.4 percent of the baseline.

The region of influence would experience a growth in population of an additional 440 residents, 292 in Clark County, 29 in Nye County, and 119 in Lincoln County. This impact would be less than 1 percent of the baselines in Clark and Nye Counties, but 2.5 percent of the baseline in Lincoln County. Because the impacts would be small in Clark and Nye Counties, impacts to housing or schools would be unlikely. The increase in population in Lincoln County would include an annual average of 32 school-age children. There would be no impact in the housing market in Lincoln County given the chronically high vacancy rate in housing (see Chapter 3, Section 3.1.7.4).

Economic Measures

Changes in employment and population would drive changes in economic measures attributable to the project. If the final loan amount was $43.6 million, real disposable income in the region of influence would rise throughout operations, starting at $3.9 million in 2010 and increasing to $14.7 million in 2033. The average would be $8.6 million. Gross Regional Product would also rise during operations; the average annual increase would be $13.4 million. State and local government expenditures would also increase with an average annual increase of $2.3 million. Increases to real disposable income, Gross Regional Product, and government expenditures would be less than 1 percent of the baselines for Clark and Nye Counties. The changes in Lincoln County would be more visible. Changes in real disposable income ($3.0 million annually) and government expenditures for the County would be approximately 2.5 and 3.0 percent of the baselines, respectively. The projected change in Gross Regional Product ($5.6 million annually) for the County would be 3.9 percent of the baseline. These changes would be within the range of historic short-term changes for Lincoln County.

If the final loan amount was $463 million, growth in real disposable income in the region of influence would slow throughout the operations period as the loan is repaid. Starting at $5.3 million above the baseline in 2010 and declining to $26.8 million below the baseline in 2033, growth in real disposable income would decline by an average of $24.2 million, or 0.043 percent of the region of influence’s baseline during the operations phase. Real disposable income in Lincoln County would increase by an average of $3.0 million. This change would represent 2.5 percent of the County’s baseline. Increases in Gross Regional product would average $468,000 in Nye County and $5.5 million in Lincoln County. The increase in Nye County would be less than 1 percent, but the change represents 3.8 percent of the baseline in Lincoln County. The rate of growth in Gross Regional Product would decline by an average of $12.1 million in Clark County and $6.1 million in the region of influence. These impacts would be less than 1 percent of the applicable baselines. Expenditures by State and local governments attributable to the project would average $100,000 in Nye County and $1.2 million in Lincoln County. The increase in Nye County would be less than 1 percent of the baselines, but the increase in Lincoln County would be 3.0 percent of the baseline. Growth in expenditures by State and local governments would slow by an average of $1.3 million in Clark County, an impact of less than 1 percent of the County’s baseline. As population growth slows, there would also be a slowing in the rate of tax revenue collected and a slowing in the rate of population growth that would require a given level of public services.

In addition, DOE analyzed a sensitivity case in which all Lincoln County socioeconomic impacts were assumed to occur only in the City of Caliente. Under this assumption, city population would rise by 3 percent during construction and by about 8.7 percent during operations. Employment would rise by about 11 percent during construction and about 12 percent during operations.

6.3.3.2.3.8 Caliente/Las Vegas Route Noise and Vibration

Section 6.3.3.1 discusses noise impacts common to all the heavy-haul truck implementing alternatives. This section focuses on the noise impacts that would be unique to the Caliente/Las Vegas heavy-haul truck implementing alternative.

Noise impacts of the Caliente intermodal transfer station would be the same as those discussed in Section 6.3.3.2.1.

Highway Construction and Upgrades. Construction activities for upgrading highways along the Caliente/Las Vegas route would occur on all sections with the exception of the section of I-15 between its intersection with U.S. 93 and the planned North Las Vegas Beltway. North Las Vegas, the Towns of Caliente and Indian Springs, and the small rural communities of Crystal Springs, Ash Springs, and Alamo would fall within the 2,000-meter (6,600-foot) region of influence for construction noise. The potential number of inhabitants would be highest near the greater Las Vegas area. There are scattered residences along U.S. 93 in the Pahranagat Valley.

Because the shipments would pass through a large population area, there would be a potential for noise impacts along the route.

Operations. The Caliente/Las Vegas route would by pass mostly rural communities, and would be confined to established highway systems. Three public schools in Alamo are in the region of influence along U.S. 93 and the Indian Springs school is in the region of influence along U.S. 95. However, the incremental noise increase due to the infrequent heavy-haul truck shipments would not alter the existing noise environment. Because the proposed intermodal transfer station would be on the western edge of Caliente and traffic would not travel through the city, traffic noise impacts in Caliente would be inconsequential. Estimated noise levels (1-hour average sound levels) in Crystal Springs, Ash Springs, Alamo, Indian Springs and Cactus Springs would increase by 0.3 to 2.0 dBA due to heavy-haul truck traffic. A potential *receptor* is the public school in Indian Springs, which also serves students from Cactus Springs. The Indian Springs school is about 300 meters (980 feet) south of U.S. 95. The incremental contribution of heavy-haul trucks at this distance from the highway would not be perceptible. Background traffic noise levels would be greatest along I-15 and the North Las Vegas Beltway, reducing the potential for heavy-haul truck noise to produce adverse effects to public receptors during daylight hours. No historic buildings would be affected by ground vibration. No sensitive ruins of cultural significance have been identified along this route.

On the Caliente/Las Vegas heavy-haul truck route, U.S. 93 passes within 5 kilometers (3 miles) of the Moapa Reservation. However, the distance from the highway to the reservation makes noise impacts unlikely. The estimated mean 1-hour increase in traffic noise due to heavy-haul trucks in this area would be 0.1 dBA over existing background traffic noise (DIRS 155825-Poston 2001, all). This increase would not be perceptible on the reservation. The heavy-haul truck route on U.S. 95 passes through about 1.6 kilometer (1 mile) of the Las Vegas Paiute Reservation. Because of the relatively large traffic volume on U.S. 95, the increase in traffic noise due to heavy-haul trucks in this area would not be perceptible (DIRS 155825-Poston 2001, all).

6.3.3.2.3.9 Caliente/Las Vegas Route Aesthetics

The Caliente intermodal transfer station would be near the entrance to Kershaw-Ryan State Park. Park visitors would receive short-term visual impacts from construction activities. In addition, park visitors could be affected by noise from construction activities that could lessen their recreational experience. These short-term impacts would exist only during construction.

During operation of the intermodal transfer station, noise and lighting probably would be discernible from Kershaw-Ryan State Park, especially during night operations, and would probably detract from the recreational experience. The use of shielded and directional lighting would limit the amount of viewable light from outside the facility operational area.

6.3.3.2.3.10 Caliente/Las Vegas Route Utilities, Energy, and Materials

Section 6.3.3.1 discusses utilities, energy, and materials impacts that would be common to the heavy-haul truck implementing alternatives. This section focuses on the utilities, energy, and materials impacts that would be unique to the Caliente/Las Vegas heavy-haul truck implementing alternative.

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Highway Construction and Upgrades. The construction of the Caliente intermodal transfer station would produce the same utilities, energy, and materials impacts as those discussed in Section 6.3.3.1.

Table 6-108 lists the estimated quantities of primary materials for the upgrade of Nevada highways for the Caliente/Las Vegas route. These quantities would be unlikely to be large in relation to the southern Nevada regional supply capacity (see Section 6.3.3.1).

Table 6-108. Utilities, energy, and materials required for upgrades along the Caliente/Las Vegas route.

Route	Length (kilometers)[a]	Diesel fuel (million liters)[b]	Gasoline (thousand liters)	Asphalt (million metric tons)[c]	Concrete (thousand metric tons)	Steel[d] (metric tons)
Caliente-Las Vegas	377	5.5	110	0.55	0.80	21

a. To convert kilometers to miles, multiply by 0.62137.
b. To convert liters to gallons, multiply by 0.26418.
c. To convert metric tons to tons, multiply by 1.1023.
d. Steel includes rebar only.

Operations. Section 6.3.3.1 discusses the utilities, energy, and materials needs for the operation of an intermodal transfer station.

Fossil fuel that would be consumed by heavy-haul trucks during operations is discussed in Chapter 10, which addresses irreversible commitments of resources.

6.3.3.2.4 *Sloan/Jean Route Implementing Alternative*

The Sloan/Jean route (Figure 6-25) is about 188 kilometers (117 miles) long. Heavy-haul trucks and escorts leaving a Sloan/Jean intermodal transfer station would enter I-15 at the Sloan interchange. The trucks would travel on I-15 to the exit to the southern portion of the proposed Las Vegas Beltway, and then travel northwest on the beltway. They would leave the beltway at U.S. 95, and travel north on U.S. 95 to the Mercury entrance to the Nevada Test Site. The trucks would travel on Jackass Flats Road on the Nevada Test Site to the Yucca Mountain site. The travel time (vehicle in motion plus periodic short stops for inspections) associated with a Sloan/Jean route would be as much as 4 hours.

The three potential areas for an intermodal transfer station southwest of Las Vegas are between the existing Union Pacific sidings at Sloan and Jean. One area is on the east side of I-15, south of the Union Pacific rail underpass at I-15, and has an area of 3.3 square kilometers (811 acres). The second, which has an area of 3.1 square kilometers (758 acres), is south of the Sloan rail siding along the east side of the rail line. A third area is south of the second, directly north of the Jean interchange on I-15, and has an area of 1.0 square kilometer (257 acres). The estimated life-cycle cost of constructing and operating an intermodal transfer station and of operating heavy-haul trucks along the Sloan/Jean route would be about $444 million in 2001 dollars.

The following sections address impacts that would occur to land use; air quality; biological resources and soils; hydrology including surface water and groundwater; cultural resources; occupational and public health and safety; socioeconomics; noise and vibration; and utilities, energy, and materials. Impacts that would occur to aesthetics and waste management would be the same as those discussed in Section 6.3.3.1 and are, therefore, not repeated here. Section 6.3.4 discusses the potential for transportation activities to cause environmental justice impacts in Nevada.

6.3.3.2.4.1 Sloan/Jean Route Land Use and Ownership

This section describes anticipated land-use impacts that could occur from the construction and operation of the Sloan/Jean intermodal transfer station, upgrades of highways, and heavy-haul truck operations over

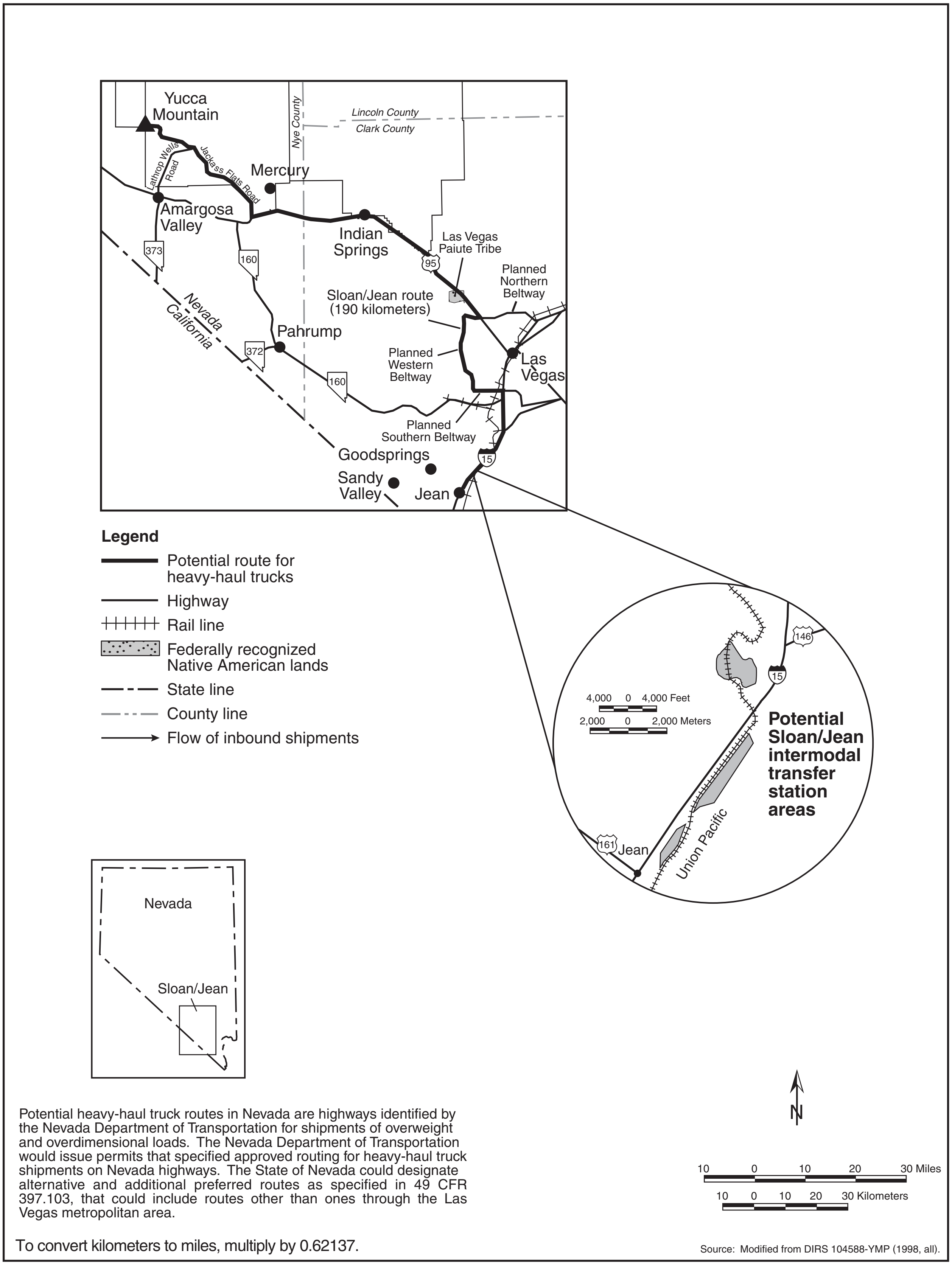

Figure 6-25. Sloan/Jean heavy-haul truck route.

the Sloan/Jean route. Chapter 3, Section 3.2.2.2.1, describes the Sloan/Jean intermodal transfer station site and the associated truck route.

Highway Construction and Upgrades. At the Sloan/Jean intermodal station area there could be potential impacts related to the current use of the land. All three Sloan/Jean candidate sites are on land administered by the Bureau of Land Management. The northernmost area is in the Spring Mountain grazing allotment and the Ivanpah Valley desert tortoise area of critical environmental concern. The Bureau of Land Management has designated land east of the railroad as a gravel pit (community pit), but that land has not been worked; the area is open to fluid mineral leasing but closed to mining claims. The two southern areas are in the Jean Lake grazing allotment, a special recreation management area, and an area designated as available for sale or transfer. Both southern areas are open to fluid mineral leasing and mining claims (DIRS 104993-CRWMS M&O 1999, p. 21).

This route would require the disturbance of approximately 0.63 square kilometer (160 acres) of land from road upgrades and additional construction activities. Table 6-109 summarizes these disturbances.

The land under consideration would require a change in ownership from the Bureau of Land Management to DOE. The amount of land transferred from grazing lands to DOE would result in a small loss to the allotment. Because of the relatively small size of the required parcels and their proximity to roads and railways, the removal of these lands would be unlikely to affect livestock management. A potential loss of desert tortoise habit is discussed below. The amount of land that would be removed from fluid mineral leases is small and would be unlikely to cause long-term impacts. If the areas under consideration were already under lease, DOE would negotiate a transfer with the lessee.

Table 6-109. Land disturbances along the Sloan-Jean heavy-haul truck route.

Disturbance	Area disturbed[a] (square kilometers)[b]
Haul road disturbed area	0.47
Aggregate plants	0.08
Road widening	<0.01
Passing lanes	None
Truck turnouts	None
Fortymile Wash new road	0.04
Overnight stops	None
Mercury turnoff road	0.03
Total disturbed area	0.63

a. Numbers approximate due to rounding.
b. To convert square kilometers to acres, multiply by 247.1.

The removal of land from a special recreational management area would be unlikely to cause long-term impacts to recreational activities. The Bureau of Land Management could make other lands available for the recreational activities. This would require agreement between the Bureau and DOE before the start of construction activities.

The potential loss of lands from the Bureau of Land Management land sale/transfer program could cause a loss of potential tax revenue.

The Sloan/Jean route would require considerable improvements at the interchange with I-15. A small amount of land would be converted for the improvements. Section 6.3.3.1 discusses other impacts on land use from upgrading Nevada highways for use by heavy-haul trucks.

Operations. There would be no direct land-use impacts associated with the operation of the Sloan/Jean intermodal transfer station or the Sloan/Jean route other than those described in Section 6.3.3.1.

6.3.3.2.4.2 Sloan/Jean Route Air Quality

This section describes anticipated nonradiological air quality impacts from construction activities and operations of an intermodal transfer station, highway construction and upgrades, and operation of heavy-haul trucks along the Sloan/Jean route. Such impacts would result from releases of criteria pollutants, including nitrogen dioxide, sulfur dioxide, carbon monoxide, and particulate matter (PM_{10}) (see Section 6.3.3.1).

Carbon monoxide and PM_{10} are of particular interest along the Sloan/Jean route because some construction activities as well as heavy-haul truck transport would occur through the Las Vegas Basin, which is classified as a serious nonattainment area for those pollutants, and because the intermodal transfer station locations would be in or near the nonattainment area. PM_{10} and carbon monoxide emissions from intermodal transfer station construction are presented in Section 6.3.3.1. Intermodal transfer station construction emissions would be 15 percent of the PM_{10} General Conformity threshold and would be 2.3 percent of the carbon monoxide General Conformity threshold level.

Highway Construction and Upgrades. Section 6.3.3.1 discusses the methods used to estimate the air quality impacts for the construction activities for the Sloan/Jean route. PM_{10} emissions would be an estimated 41 metric tons (45 tons) per year, including estimated emissions for the accelerated construction activities of the southern and western portions of the Las Vegas Beltway. These emissions would be 64 percent of the General Conformity threshold level. Carbon monoxide emissions for highway construction and upgrades would be an estimated 33 metric tons (36 tons) per year. These emissions are 36 percent of the carbon monoxide General Conformity threshold level.

Operations. Section 6.3.3.1 discusses the air quality impacts associated with the operation of a locomotive at the Sloan/Jean intermodal transfer station. In addition to these operations, the operation of heavy-haul trucks along the Sloan/Jean route would affect the Las Vegas Valley air basin. Air quality impacts from heavy-haul trucks to this air basin would be small [0.62 metric tons (0.68 ton) per year of carbon monoxide] with emissions at less than 1 percent of the General Conformity threshold level. These emissions would result from 11 round trip heavy-haul trucks traveling through the Las Vegas Valley each week.

6.3.3.2.4.3 Sloan/Jean Route Hydrology

DOE anticipates limited impacts to surface water and groundwater during upgrades to Nevada highways so they could accommodate daily use by heavy-haul trucks. This section discusses these impacts as well as those from the construction and operation of an intermodal transfer station and operation of trucks on the Sloan/Jean route. Section 6.3.3.1 discusses the hydrology impacts that would be common to all of the heavy-haul truck implementing alternatives. This section focuses on the hydrology impacts that would be unique to the Sloan/Jean heavy-haul truck implementing alternative.

Surface Water

Section 6.3.3.1 discusses the impacts to surface water from the construction and operation of an intermodal transfer station and upgrades to highways. The common impacts discussed in Section 6.3.3.1 apply to surface water along the Sloan/Jean route.

The assessment in Appendix L compares what is known about the floodplains, springs, and riparian areas at the three candidate intermodal transfer station sites (see Sections L.3.2.8 and L.4.2.2). The southernmost of the three locations for the Sloan/Jean station appears to be, at least in part, in a 100-year flood zone of a normally dry drainage channel (see Section L.3.2.8).

Groundwater

Highway Construction and Upgrades. Section 6.3.3.1 discusses the impacts to groundwater from the construction of an intermodal transfer station. Upgrades to the Sloan/Jean route would not require any water wells. The road upgrades would require an estimated total of about 9,200 cubic meters (8 acre-feet) of water (DIRS 104917-LeFever 1998, all). Options for obtaining this water would be to lease temporary water rights from individuals along the route, ship water from other permitted resources by truck (about 500 truckloads) to construction sites, or use a combination of these two actions.

Operations. Section 6.3.3.1 discusses impacts to groundwater from the operation of an intermodal transfer station, highway maintenance, and heavy-haul truck routes.

6.3.3.2.4.4 Sloan/Jean Route Biological Resources and Soils

Section 6.3.3.1 discusses impacts to biological resources from the construction and operation of an intermodal transfer station and upgrades to highways that would be common to all intermodal transfer stations and routes. This section discusses the construction- and operations-related impacts that would be unique to the Sloan/Jean intermodal station and route.

Highway Construction and Upgrades. Potential Sloan/Jean intermodal transfer station site locations are between the existing Union Pacific rail sidings at Sloan and Jean. The dominant land cover type in these areas is creosote-bursage (DIRS 104593-CRWMS M&O 1999, p. 3-36). The land cover type at the site is extensive in the region (DIRS 104593-CRWMS M&O, pp. C1 to C5).

The three sites that DOE is considering for a Sloan/Jean intermodal transfer station are in the range of the desert tortoise, but none of the areas are critical habitat for the tortoise (50 CFR 17.95). The construction site would disturb approximately 0.2 square kilometer (50 acres) of tortoise habitat. The likelihood of tortoise death or injury due to construction activities would be small if DOE moved tortoises in the immediate area to a safe habitat. The pinto beardtongue (classed as sensitive by the Bureau of Land Management) occurs in two of the proposed locations of the Sloan/Jean intermodal transfer station (DIRS 104593-CRWMS M&O 1999, p. 3-36). If one of these sites was selected, DOE would conduct pre-activity surveys for this plant species and would avoid disturbance of occupied areas if possible. The construction of an intermodal transfer station at a site southwest of Sloan could cause bighorn sheep to avoid the eastern edge of their winter range in that area. There are no springs or other areas that could be classified as wetlands at the location of the intermodal transfer station (DIRS 104593-CRWMS M&O 1999, p. 3-36).

Predominant land cover types in nonurban areas along the route are creosote-bursage and Mojave mixed scrub (DIRS 104593-CRWMS M&O 1999, p. 3-36). The regional area for each vegetation type is extensive. Because areas disturbed by upgrade activities would be in or adjacent to existing rights-of-way and the areas have been previously degraded by human activities, impacts would be small.

The only threatened or endangered species that occurs along the route is the desert tortoise. Desert tortoise habitat occurs throughout the length of the route (DIRS 103160-Bury and Germano 1994, pp. 57 to 72; 50 CFR 17.95). Construction activities could kill or injure desert tortoises; however, losses would be few because construction would occur only on the right-of-way and desert tortoises are uncommon along heavily traveled roads (DIRS 103160-Bury and Germano 1994, Appendix D, p. D12). Four other special status species occur along this route (DIRS 104593-CRWMS M&O 1999, p. 3-36), but construction activities would be limited to the road and adjacent areas; occupied habitat would not be destroyed and these species should not be affected.

This route would not cross any areas designated as game habitat and there are no springs or wetlands near the route. The corridor crosses a number of ephemeral streams that may be classified as waters of the United States. DOE would work with the State of Nevada and the U.S. Army Corps of Engineers to minimize impacts to these areas, and obtain individual or regional permits, as appropriate (DIRS 104593-CRWMS M&O 1999, p. 3-36). Impacts to soils would be transitory and small and would occur only along the shoulders of existing roads.

Operations. Impacts from operations would include periodic disturbances of wildlife from activities at the intermodal transfer station and additional truck traffic along this route. Trucks probably would kill individuals of some species but losses would be few and unlikely to affect regional populations of any species. No additional habitat loss would occur during operations. Impacts to soils would be small.

6.3.3.2.4.5 Sloan/Jean Route Cultural Resources

Highway Construction and Upgrades. A total of 59 archaeological and historic sites have been recorded along existing highway rights-of-way along the Sloan/Jean heavy-haul truck route (DIRS 155826-Nickens and Hartwell 2001, Appendix A). None of these occur in areas along roads that would require upgrades.

There are seven archaeological sites near the location of the Sloan/Jean intermodal transfer station, none of which has been evaluated for potential eligibility for the *National Register of Historic Places* (DIRS 155826-Nickens and Hartwell 2001, Appendix A). Possible unrecorded sites in the intermodal transfer station location include some associated with the original construction of the railroad in the early part of the 20th century, such as construction camps. The location of the "Last Spike," where the last two segments of the railroad were joined occurs in the vicinity of the site.

No areas or sites of cultural importance to Native Americans have been identified along the Sloan/Jean route or at the intermodal transfer station location, although field studies have not been completed. The route follows a portion of U.S. 95 that passes though approximately 1.6 kilometers (1 mile) of the Las Vegas Paiute Reservation.

Operations. Based on currently available information, operation of a Sloan/Jean intermodal transfer station and heavy-haul truck route would have no impacts on cultural resources.

6.3.3.2.4.6 Sloan/Jean Route Occupational and Public Health and Safety

This section addresses potential impacts to occupational and public health and safety from upgrading highways and heavy-haul truck operations on the Sloan/Jean route. Impacts from the associated intermodal transfer station in the Sloan/Jean area would be the same as those discussed in Section 6.3.3.1.

Highway Construction and Upgrades. Industrial safety impacts on workers from upgrading highways for the Sloan/Jean route would be small (Table 6-110). The analysis evaluated the potential for impacts in terms of total reportable cases of injury, lost workday cases, fatality risks for workers, and traffic fatalities related to commuting workers and the movement of construction materials and equipment. Table 6-111 lists the estimated fatalities from construction and commuter vehicle traffic.

Operations. The incident-free radiological impacts listed in Table 6-112 would occur during the routine transportation of spent nuclear fuel and high-level radioactive waste on the Sloan/Jean route. These impacts would include transportation along the Sloan/Jean route as well as transportation along railways in Nevada leading to the Sloan/Jean intermodal transfer station. The table includes the impacts of 1,079 legal-weight truck shipments from commercial sites that do not have the capability to load rail casks while operational.

Table 6-110. Health impacts to workers from industrial hazards from upgrading highways along the Sloan/Jean route.

Group and industrial impact category	Construction[a]	Operations[b]
nvolved workers		
Total recordable cases[c]	23	120
Lost workday cases	11	66
Fatalities	0.032	0.33
Noninvolved workers[d]		
Total recordable cases	1.4	6.8
Lost workday cases	0.5	2.5
Fatalities	0.001	0.007
otals[e]		
Total recordable cases	24	130
Lost workday cases	12	68
Fatalities	0.033	0.34

a. Impacts are totals over about 48 months.
b. Includes impacts for periodic maintenance and resurfacing. Impacts are totals over about 24 years.
c. Total recordable cases includes injury and illness.
d. The noninvolved worker impacts are based on 25 percent of the involved worker level of effort.
e. Totals might differ from sums due to rounding.

Table 6-111. Estimated number of fatalities from construction material delivery vehicles and construction and operations worker commuting traffic for the Sloan/Jean route for heavy-haul trucks.

Activity	Kilometers[a]	Traffic fatalities	Vehicle emissions fatalities
Construction[b]			
Material delivery vehicles	17,000,000	0.3	0.04
Commuting workers	21,000,000	0.2	0.03
Subtotals	*38,000,000*	*0.5*	*0.06*
Operations[c]			
Commuting workers	120,000,000	1.2	0.16
Totals	*170,000,000*	*1.7*	*0.23*

a. Includes impacts of construction and operation of an intermodal transfer station.
b. To convert kilometers to miles, multiply by 0.62137.
c. Impacts are totals over about 48 months.
d. Impacts are totals over 24 years.

Table 6-112. Health impacts from incident-free Nevada transportation for the Sloan/Jean heavy-haul truck implementing alternative.[a]

Category	Legal-weight truck shipments	Rail and heavy-haul truck shipments[b]	Totals[c]
Involved workers			
Collective dose (person-rem)	38	1,200	1,200
Estimated latent cancer fatalities	0.02	0.48	0.50
Public			
Collective dose (person-rem)	7	330	340
Estimated latent cancer fatalities	0.003	0.17	0.17
Estimated vehicle emission-related fatalities	0.002	0.19	0.19

a. Impacts are totals for 24 years.
b. Includes impacts to workers at an intermodal transfer station.
c. Totals might differ from sums of values due to rounding.

6.3.3.2.4.7 Sloan/Jean Route Socioeconomics

This section describes potential socioeconomic impacts that would occur from upgrading highways along the Sloan/Jean route, constructing and modifying a section of the planned Las Vegas Beltway, and building an intermodal transfer station for heavy-haul truck transportation. The discussion includes the impacts of operating an intermodal transfer station near Sloan/Jean in Clark County and of periodic resurfacing of the highways and Beltway.

This analysis of socioeconomic impacts assumed that Clark County would secure a loan to advance the construction schedule of the portion of the Las Vegas Beltway that would be part of this heavy-haul truck route. DOE estimates that modifications to the Beltway would cost between $98.1 million and $790 million in 2001 dollars. DOE believes the actual impacts would be between the two values. A loan to Clark County for $98.1 or $790 million, at a real rate of 3 percent, with repayment of the loan starting in 2010 and lasting for 30 years, is a part of the modeling to determine the impacts to employment, population, real disposable income, and expenditures by State and local governments. (A *real* percentage rate is the premium paid in addition to the rate of inflation; a real rate plus the rate of inflation equals the nominal or quoted rate.) Clark County would repay the load from tax revenues. DOE assumes most repayment funds would be from sources the county has already identified for completion of the Beltway.

Highway Construction and Upgrades. Socioeconomic impacts from upgrading existing highways for a Sloan/Jean route, advancing the construction schedule for modifying a portion of the planned Las Vegas Beltway, and building an intermodal transfer station would be temporary, occurring over a short period and spread among the counties along the route. Upgrading the existing highways for the route, excluding the Beltway, would cost about $20.8 million and would require 48 months to complete. The upgrades to the highways would occur during the 48-month construction period for the planned portion of the Beltway. Building an intermodal transfer station would cost $25 million and would require 18 months. If DOE selected this route, the Beltway construction schedule would be advanced to accommodate use by heavy-haul trucks. (Dollar values reported in this section are in 2001 dollars unless otherwise stated.)

Employment

The dynamics of specific construction projects include a period of brief, intense elevation in project-related employment, followed by an abrupt decrease in associated employment opportunities as construction workers move to other projects. Composite employment would peak in the region of influence in 2008, would be approximately 631 workers under the $98.1 million beltway assumption, and would peak in 2006 at 3,047 workers under the estimated $790 million assumption. Under the entire range of estimated costs, Clark County would provide more than 96 percent of the workers. Clark County would gain 620 to 2,996 workers, Nye County would gain 9 to 42 workers, and Lincoln County would gain 2 to 9 workers. The change in employment for Clark, Nye, and Lincoln Counties would be less than 1 percent of their employment bases.

Population

Population increases in the region of influence due to a Sloan/Jean route and intermodal transfer station construction would peak in 2009. During that year, the incremental increase in population for Clark County would be between 532 and 2,951 people, for Lincoln County between 1 and 8 people, and for Nye County between 11 and 63 people. The impacts due to an increase in population as a result of increased employment opportunities would be less than 1 percent of each county's population baseline. Because the increases in population in each county would be small and transient, impacts to schools or housing would be unlikely.

Economic Measures

Economic measures would rise during the construction of an intermodal transfer station, upgrading of highways, and construction of the Las Vegas Beltway. The increase in real disposable income of people in the three-county region of influence would peak in 2008 at between $20.7 million and $97.3 million. The region-wide increase in Gross Regional Product would peak in 2008 at between $36.0 million and $153.2 million. Increased State and local government expenditures would peak in 2009 at between $1.8 million and $9.9 million. The Gross Regional Product, real disposal personal income, and expenditures by State and local governments would rise by less than 1 percent of the baselines in Clark, Nye, and Lincoln Counties. (Dollar values reported in this section are in 2001 dollars unless otherwise stated.)

Transition to Operations. In the region of influence, employment of Sloan/Jean heavy-haul route workers and indirect (support) workers would decrease by 588 to 3,240 when construction of the intermodal transfer station and highway upgrades (including the Beltway portion) ended in 2009. Clark County would lose between 579 and 3,185 of these jobs, Nye County would lose between 8 and 45 of these jobs, and Lincoln County would lose between 1 and 10 jobs. DOE anticipates that some of the displaced workers would move into operational positions on the Sloan/Jean route while others would find other work in the State. While this project would lose jobs, employment projections for the State estimate approximately 1.4 million jobs in 2010, or about 999,500 in the region of influence.

Operations. Operations at an intermodal transfer station near Sloan/Jean and the use of heavy-haul trucks would begin in 2010 and last until 2033. A workforce of about 26 would be required for the intermodal transfer station. Direct employment for heavy-haul truck operations over a Sloan/Jean route, including shipment escorts, would be about 66 workers. The analysis assumed that operations workers would reside in Clark County.

To analyze the impacts of using a Sloan/Jean route for heavy-haul trucks, DOE considered three activities: the operation of the intermodal transfer station, the operation of heavy-haul trucks, and the maintenance of the highways and the Las Vegas Beltway.

Employment and Population

Employment associated with the operations of an intermodal transfer station and heavy-haul trucks would remain relatively level throughout operations. Total employment in the region of influence attributable to a Sloan/Jean route would average about 107 workers. The analysis determined that about 99 workers would come from Clark County and that the other 8 would come from outside the three-county region of influence. The impact on the population from operating heavy-haul trucks and the intermodal transfer station would be about 129 additional residents in the region. About 127 persons would live in Clark County, and 2 people would live in Nye County. Lincoln County would be unlikely to gain population as a result of this project. Impacts to the employment and population baselines in Nye and Clark Counties would be less than 1 percent. Because the incremental increase in population would be so small, impacts to housing and the school system would be unlikely.

Because of the periodic need to resurface highways used by heavy-haul trucks, construction maintenance employment would increase in the years during which these projects occurred. Resurfacing would occur from 2016 to 2017, 2024 to 2025, and 2032 to 2033. During these years, total employment in the region of influence would increase by about 42 jobs and decline as maintenance activities ended. DOE assumed that virtually all of the resurfacing construction employees would come from Clark County employers. Employment changes from periodic (every 8 years) highway-resurfacing projects would be less than 1 percent of the employment baseline in Clark County. The employees who would resurface the roads and their families are included in the employment and population averages discussed above for the operations phase.

Net changes to employment and population from all three portions of the Sloan/Jean heavy-haul truck route during the 24-year operations phase can be summarized. There would be an incremental average annual increase of 48 positions in the region of influence, 47 of them in Clark County if the cost of the beltway was approximately $98.1 million. The region of influence would experience a growth in population of 53 additional residents, 48 in Clark County and 5 in Nye County. These impacts would be less than 1 percent of the baselines. If the cost of the beltway reaches $790 million, the region of influence, while continuing to grow to an average of 1.1 million jobs, would have 501 fewer employment positions. Approximately 497 of these positions would have been in Clark County. Population, which is driven by employment opportunities, would be affected. The region of influence (with an average of 2.29 million residents) would have 1,016 fewer residents, all of whom would have lived in Clark County. Impacts to populations and employment at the upper range of the cost estimates would be less than 1 percent of the baselines.

Economic Measures

Changes in employment and population would drive changes in economic measures attributable to the project. If the final loan amount was $98.1 million, real disposable income in the region of influence would oscillate above and below the baseline throughout the operations period. The average would be $616,000 below the region of influence’s $55.7 million average baseline. Gross Regional Product would rise during operations, with the average increase being $5.8 million. Annual State and local government expenditures would increase, with the average increase being $176,000. Increases to real disposable income, Gross Regional Product, and government expenditures would be less than 1 percent of the baselines for Clark, Nye, and Lincoln Counties.

If the final loan amount was $790 million, impacts would be more visible, but still less than 1 percent of the economic measure baselines for each county. Growth in real disposable income in the region of influence would slow throughout the operations period as the loan is repaid. Growth in real disposable income would decline by an average of $54.7 million, or 0.0981 percent of the region of influence's baseline during the operations phase. Decreases in Gross Regional Product would average $26.3 million in the three-county region of influence. The decline in the growth rate would be less than 1 percent of each county's baseline. A slowing in expenditures by State and local governments attributable to the project would average $3.7 million annually region-wide. As population growth slowed, there would be slowing in the rate of tax revenue collected and a slowing in the rate of population growth that would require a given level of public services.

6.3.3.2.4.8 Sloan/Jean Route Noise and Vibration

Section 6.3.3.1 discusses noise impacts common to all the heavy-haul truck implementing alternatives. This section focuses on the noise impacts that would be unique to the Sloan/Jean heavy-haul truck implementing alternative.

Highway Construction and Upgrades. There are residences and commercial businesses near the three potential sites for an intermodal transfer station in the Sloan/Jean area. Construction noise would occur during daylight hours and would be a temporary source of elevated noise in the area. Nighttime noise impacts would be unlikely because construction activities would not occur at night.

For the Sloan/Jean route, southern and western Las Vegas, the Town of Indian Springs, and the small rural community of Jean would be within the 2,000-meter (6,600-foot) region of influence for construction noise. Construction activities would occur on all sections of the route with the exception of I-15 between its interchange at Sloan and the planned Southern Las Vegas Beltway. Because the number of inhabitants of the region of influence would be high because the route passes around the greater Las Vegas area and includes other small rural communities and towns, there is a potential for construction noise impacts.

Operations. The presence of residences and commercial businesses near the Sloan/Jean location would make an intermodal transfer station a potential source of more noise complaints than the more remote locations. However, because operational noise in the vicinity of Sloan/Jean would not be much higher than the levels associated with most other light industrial areas, noise impacts would be unlikely. Railcar switching would be the greatest source of noise.

The Sloan/Jean route would use established highway systems with wide shoulders. The incremental noise increase due to the infrequent heavy-haul truck shipments would not alter the existing noise environment. Estimated noise levels (1-hour average sound levels) at Indian Springs and Cactus Springs would increase by about 0.4 dBA [at 15 meters (50 feet) from the road] due to heavy-haul truck traffic. Background traffic noise levels would be greatest along the western Beltway, reducing the potential for heavy-haul truck noise to cause adverse effects to public receptors during daylight hours. A potential receptor is the public school in Indian Springs which also serves students from Cactus Springs. The Indian Springs school is about 300 meters (980 feet) south of U.S. 95. The incremental contribution of heavy-haul trucks at this distance from the highway would not be perceptible. No historic buildings would be affected by ground vibration. No sensitive ruins of cultural significance have been identified along this route.

The Sloan/Jean heavy-haul truck route on U.S. 95 passes through about 1.6 kilometer (1 mile) of the Las Vegas Paiute Reservation. Because of the relatively large traffic volume on U.S. 95, the increase in traffic noise due to heavy-haul trucks in this area would not be perceptible (DIRS 155825-Poston 2001, all).

6.3.3.2.4.9 Sloan/Jean Route Utilities, Energy, and Materials

Section 6.3.3.1 discusses utilities, energy, and materials impacts that would be common to all the heavy-haul truck implementing alternatives. This section focuses on the utilities, energy, and materials impacts that would be unique to the Sloan/Jean heavy-haul truck implementing alternative.

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Highway Construction and Upgrades. The construction of the Sloan/Jean intermodal transfer station would have the same utilities, energy and materials impacts as those discussed in Section 6.3.3.1.

Table 6-113 lists the estimated quantities of primary materials for the upgrade of Nevada highways for the Sloan/Jean route. These quantities are not likely to be very large in relation to the southern Nevada regional supply capacity (see Section 6.3.3.1).

Table 6-113. Utilities, energy, and materials required for upgrades along the Sloan/Jean route.

Route	Length (kilometers)[a]	Diesel fuel (million liters)[b]	Gasoline (thousand liters)	Asphalt (million metric tons)[c]	Concrete (thousand metric tons)	Steel[d] (metric tons)
Sloan/Jean	188	1.7	27	0.24	0.1	2.3

a. To convert kilometers to miles, multiply by 0.62137.
b. To convert liters to gallons, multiply by 0.26418.
c. To convert metric tons to tons, multiply by 1.1023.
d. Steel includes rebar only.

Operations. Section 6.3.3.1 discusses utilities, energy, and materials needs for operation of an intermodal transfer station.

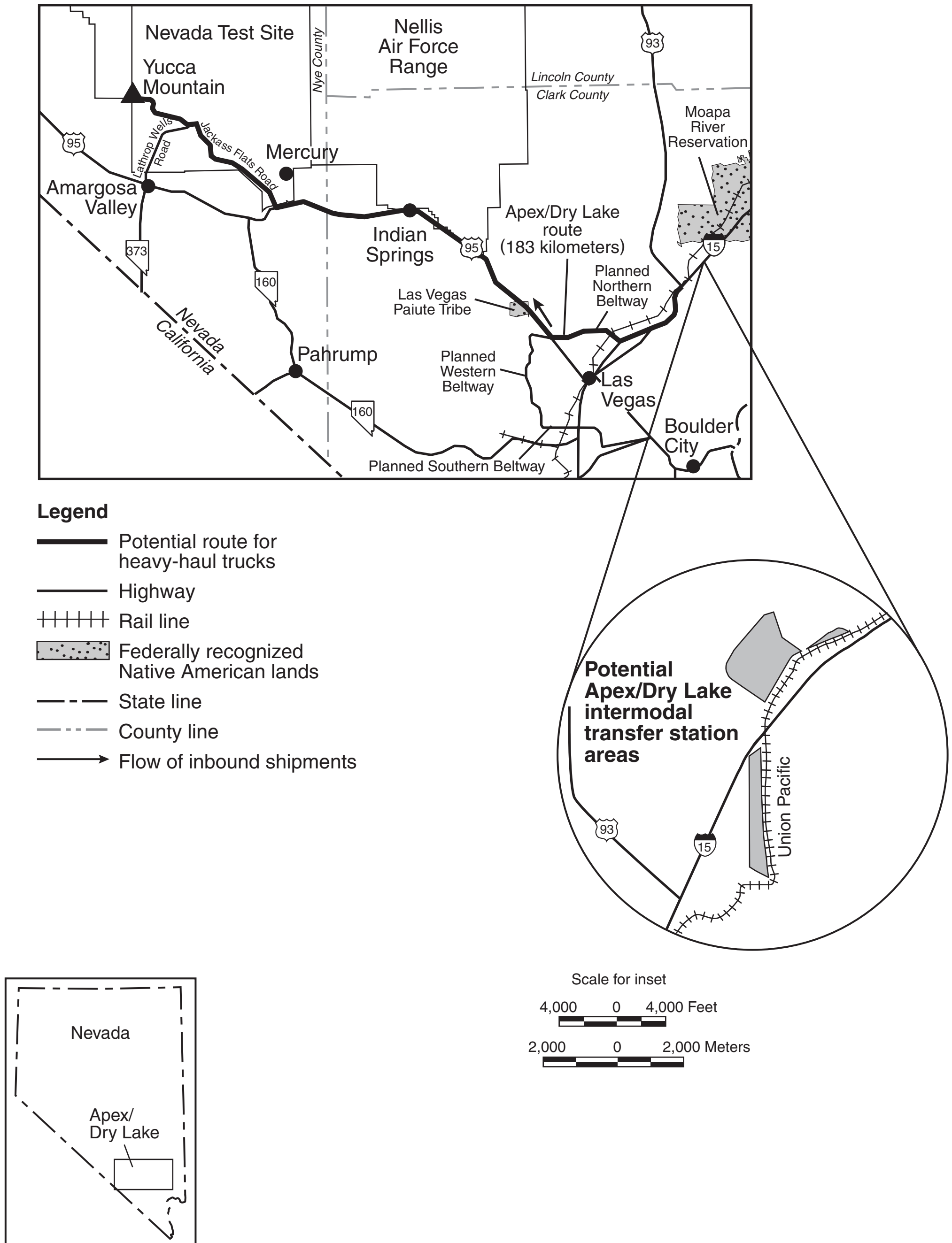
Fossil fuel that would be consumed by heavy-haul trucks during operations is discussed in Chapter 10, which addresses irreversible commitments of resources.

6.3.3.2.5 *Apex/Dry Lake Route Implementing Alternative*

The Apex/Dry Lake route (Figure 6-26) is about 183 kilometers (114 miles) long. Heavy-haul trucks and escorts would leave the intermodal transfer station at the Apex/Dry Lake location and enter I-15 at the Apex interchange. The trucks would travel south on I-15 to the exit to the proposed northern Las Vegas Beltway and travel west on the Beltway. They would leave the Beltway at U.S. 95, and travel north on U.S. 95 to the Mercury entrance to the Nevada Test Site. The trucks would travel on Jackass Flats Road on the Nevada Test Site to the Yucca Mountain site. The travel time (vehicle in motion plus periodic short stops for inspections) associated with an Apex/Dry Lake route would be as much as 4 hours.

The potential sites for the Apex/Dry Lake intermodal transfer station are in areas northeast of Las Vegas between the Union Pacific rail sidings at Dry Lake and at Apex. Three areas are available for station siting (see Figure 6-26). The first area is directly adjacent to the Dry Lake siding. This area is large [3.5 square kilometers (880 acres)] and has flat topography; it is adjacent to and west of the Union Pacific line. The second is a smaller area [0.18 square kilometer (45 acres)] on the same side of the Union Pacific mainline, a short distance northeast of the 3.5-square-kilometer area, and also has flat topography. This area would be used in combination with a portion of the first area. These two areas are bounded by hills to the north and by a wash and private land to the south. The third area, which is east of I-15, is adjacent to and west of the Union Pacific line and south of where the line crosses I-15. This location has an area of 0.96 square kilometer (240 acres). Because this area is between the Dry Lake and Apex sidings, the construction of an additional rail siding would be necessary. The estimated life-cycle cost to build and operate an intermodal transfer station and to operate heavy-haul trucks along the Apex/Dry Lake route would be about $387 million in 2001 dollars.

The following sections address impacts that would occur to land use; air quality; hydrology; biological resources and soils; cultural resources; occupational and public health and safety; socioeconomics; noise and vibration; and utilities, energy, and materials. Impacts to hydrology from the construction and operation of an intermodal transfer station, upgrading of highways, and operation of heavy-haul trucks on an Apex/Dry Lake route would be the same as those discussed in Section 6.3.3.2.4 for a Sloan/Jean route.



Potential heavy-haul truck routes in Nevada are highways identified by the Nevada Department of Transportation for shipments of overweight and overdimensional loads. The Nevada Department of Transportation would issue permits that specified approved routing for heavy-haul truck shipments on Nevada highways. The State of Nevada could designate alternative and additional preferred routes as specified in 49 CFR 397.103, that could include routes other than ones through the Las Vegas metropolitan area.

To convert kilometers to miles, mulitiply by 0.62137.

Source: Modified from DIRS 104588-YMP (1998, all).

Figure 6-26. Apex/Dry Lake heavy-haul truck route.

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Impacts to aesthetics and waste management would be the same as those discussed in Section 6.3.3.1 and are, therefore, not repeated here. Section 6.3.4 discusses the potential for transportation activities to cause environmental justice impacts in Nevada.

6.3.3.2.5.1 Apex/Dry Lake Route Land Use and Ownership

This section describes estimated land-use impacts that could occur from the construction and operation of the Apex/Dry Lake intermodal transfer station, upgrades of highways, and heavy-haul truck operations on the Apex/Dry Lake route. Chapter 3, Section 3.2.2.2.1, describes the Apex/Dry Lake intermodal transfer station site and associated truck route.

Highway Construction and Upgrades. The Apex/Dry Lake intermodal transfer station site could have potential impacts related to the current use of the land. The southern intermodal transfer station parcel east of I-15 at the Apex/Dry Lake site is on land administered by the Bureau of Land Management. Transfer of the property to DOE would be necessary. The northern areas have several infrastructure corridors (power line, telephone, and road rights-of-way). Right-of-way access through these areas would have to be leased by, purchased by, or transferred to DOE. The northern parcels are in the Dry Lake grazing allotment and a planned utility corridor. It is also open to mineral leasing and mining claims. One area has been designated as available for sale or transfer. This site also is in the area of the Apex Industrial Park that began development in mid-1999.

The parcel in the grazing allotment would lose a small parcel of land, if chosen. However, due to the proximity of the parcel to existing roads and rail lines, the transfer of this land to DOE would not divide the grazing allotment and would cause no livestock movement or watering problems.

The relatively small area of an intermodal transfer station location would not create long-term impacts to mineral exploration or mining claims unless the lands are already leased. If there were leases, DOE would negotiate with the lease holders for use of the property.

Because the transfer station parcels are in an area designated for sale or transfer by the Bureau of Land Management, the Bureau would have to remove the lands from this program to transfer them to DOE. The removal of these lands from the sale/transfer program could affect private, municipal or county, or other stakeholders. Tax revenue could be lost through the loss of economic development. This impact could be mitigated by the replacement of removed land with other parcels with similar characteristics. This route would require the disturbance of 0.63 square kilometer (155 acres) of land for road upgrades and additional construction activities. Table 6-114 summarizes these disturbances.

The Apex/Dry Lake route would require considerable improvements at the interchange at I-15. A small amount of land would be converted for the improvements. Section 6.3.3.1 discusses impacts on land use from upgrading Nevada highways for use by heavy-haul trucks.

Operations. There would be no direct land-use impacts associated with the operation of the Apex/Dry Lake intermodal transfer station or the Apex/Dry Lake route other than those described in Section 6.3.3.1.

Table 6-114. Land disturbances along the Apex/Dry Lake heavy-haul truck route.

Disturbances	Area disturbed[a] (square kilometers)[b]
Haul road disturbed area	0.47
Aggregate plants	0.08
Road widening	None
Passing lanes	None
Truck turnouts	None
Fortymile Wash new road	0.04
Overnight stops	None
Mercury turnoff road	0.03
Total disturbed area	0.63

a. Numbers approximate due to rounding.
b. To convert square kilometers to acres, multiply by 247.1.

6.3.3.2.5.2 Apex/Dry Lake Route Air Quality

This section describes anticipated nonradiological air quality impacts from the construction and operation of an intermodal transfer station, highway construction and upgrades, and operation of heavy-haul trucks along the Apex/Dry Lake route. Such impacts would result from releases of criteria pollutants, nitrogen dioxide, sulfur dioxide, carbon monoxide, and particulate matter (PM_{10}) (see Section 6.3.3.1). Carbon monoxide and PM_{10} are of particular interest along the Apex/Dry Lake Route because heavy-haul truck transport would occur through the Las Vegas Basin, which is classified as a nonattainment area for these pollutants. PM_{10} and carbon monoxide emissions from intermodal transfer station construction are presented in Section 6.3.3.1. Intermodal transfer station construction emissions would be 15 percent of the PM_{10} General Conformity threshold level and would be 2.3 percent of the carbon monoxide General Conformity threshold level.

Highway Construction and Upgrades. Section 6.3.3.1 discusses the methods used to estimate air quality impacts from the construction activities for the Apex/Dry Lake route. PM_{10} emissions would be an estimated 45 metric tons (50 tons) per year, including estimated emissions for the accelerated construction activities of the northern portion of the Las Vegas Beltway. These emissions would be 71 percent of the General Conformity threshold level. Carbon monoxide emissions for highway construction and upgrades would be an estimated 35 metric tons (39 tons) per year. These emissions are 39 percent of the carbon monoxide General Conformity threshold level.

Operations. The air quality impacts for the operations of an intermodal transfer station locomotive at the Apex/Dry Lake intermodal transfer station would be identical to those described for the Sloan/Jean station (see Section 6.3.3.2.4). In addition, heavy-haul trucks would pass through the Las Vegas Valley air basin. The air quality impacts from the heavy-haul trucks to this air basin would be small [0.46 metric tons (0.51 ton] per year carbon monoxide) with emissions at less than 1 percent of the General Conformity threshold level. These emissions would result from 11 roundtrip heavy-haul trucks traveling through the Las Vegas Valley each week.

6.3.3.2.5.3 Apex/Dry Lake Route Hydrology

DOE anticipates limited impacts to surface water and groundwater during upgrades to Nevada highways so they could accommodate daily use by heavy-haul trucks. This section discusses these impacts as well as those from the construction and operation of an intermodal transfer station and operation of trucks on the Apex/Dry Lake route. Section 6.3.3.1 discusses the hydrology impacts that would be common to all of the heavy-haul truck implementing alternatives. This section focuses on the hydrology impacts that would be unique to the Apex/Dry Lake heavy-haul truck implementing alternative.

Surface Water

Section 6.3.3.1 discusses the impacts to surface water from the construction and operation of an intermodal transfer station and upgrades to highways. The common impacts discussed in that section apply to surface water along the Sloan/Jean route.

The assessment in Appendix L presents a comparison of what is known about the floodplains, springs, and riparian areas at the three candidate intermodal transfer sites (see Sections L.3.2.7 and L.4.2.2) The southern most of the three locations considered for the Apex/Dry Lake intermodal transfer site appears to be, at least in part, within a 100-year flood zone of a normally dry drainage channel (see Section L.3.2.7).

Groundwater

Highway Construction and Upgrades. Section 6.3.3.1 discusses the impacts to groundwater from the construction of an intermodal transfer station. Upgrades to the Apex/Dry Lake route would not require any water wells. The road upgrades would require an estimate total of about 9,200 cubic meters (8 acre-feet) of water (DIRS 104917-LeFever 1998, all). Options for obtaining this water would be to lease temporary water rights from individuals along the route, ship water from other permitted resources by truck (about 500 truckloads) to construction sites, or use a combination of these two actions.

Operations. Section 6.3.3.1 discusses impacts to groundwater from the operation of an intermodal transfer station, highway maintenance, and heavy-haul routes.

6.3.3.2.5.4 Apex/Dry Lake Route Biological Resources and Soils

Section 6.3.3.1 discusses impacts to biological resources from the construction and operation of an intermodal transfer station and upgrades to highways that would be common to all intermodal transfer stations and routes. This section discusses the construction- and operations-related impacts that would be unique to the Apex/Dry Lake intermodal station and route.

Highway Construction and Upgrades. DOE has identified three areas for the construction of an Apex/Dry Lake intermodal transfer station. The predominant land cover type at these sites (creosote-bursage) and it is extensively distributed in the region (DIRS 104593-CRWMS M&O 1999, pp. 3-36 and C1 to C5). Considerable industrial development has occurred near the potential sites. The three sites are in the range of the threatened desert tortoise, although none is in an area considered to be critical habitat for the tortoise (50 CFR 17.95). The construction site would disturb approximately 0.2 square kilometer (50 acres) of desert tortoise habitat. The likelihood of death or injury to tortoises due to construction activities would be small if DOE conducted surveys for tortoises in areas to be disturbed and moved tortoises in the immediate area out of harm's way. Geyer's milk vetch (BLM sensitive) occurs on the southern edge of one of the proposed locations of the Apex/Dry Lake intermodal transfer station (DIRS 104593-CRWMS M&O 1999, p. 3-37). If this location for an intermodal transfer station was selected, DOE would conduct pre-activity surveys for this plant's species and would avoid occupied habitat if possible. There are no designated game habitats at the proposed locations for the intermodal transfer station, or any springs or other areas that could be classified as wetlands (DIRS 104593-CRWMS M&O 1999, p. 3-37).

The predominant land cover types along the Apex/Dry Lake heavy-haul truck route are creosote-bursage and Mojave mixed scrub, which are common throughout this region (DIRS 104593-CRWMS M&O 1999, pp. 3-34, and C1 to C5). Because areas disturbed by upgrade activities would be in or adjacent to the existing rights-of-way and the areas have been previously degraded by human activities, impacts would be small.

The only resident threatened or endangered species that occurs along the Apex/Dry Lake route is the desert tortoise. Desert tortoise habitat occurs along the entire length of the route (DIRS 103160-Bury and Germano 1994, pp. 57 to 72; 50 CFR 17.95). Construction activities could kill or injure desert tortoises; however, losses would be few because construction would occur only on the right-of-way and desert tortoises are uncommon adjacent to heavily traveled roads (DIRS 103160-Bury and Germano 1994, Appendix D, p. D12). Three other special status species occur along this route (DIRS 104593-CRWMS M&O 1999, p. 3-35) but because construction activities would be limited to the road and adjacent areas, occupied habitat would not be destroyed and these species should not be affected.

This route would not cross any areas designated as game habitat or springs or possible wetlands (DIRS 104593-CRWMS M&O 1999, p. 3-35). The corridor crosses a number of ephemeral streams that may be classified as waters of the United States. DOE would work with the State of Nevada and the U.S. Army Corps of Engineers to minimize impacts to these areas, and obtain individual, regional, or nationwide permits, as appropriate. Impacts to soils would be transitory and small and would occur only along the shoulders of existing roads.

Operations. Impacts from operations would include periodic disturbances of wildlife from activities at the intermodal transfer station and additional truck traffic along this route. Trucks probably would kill individuals of some species but losses would be few and unlikely to affect regional populations of any species. No additional habitat loss would occur during operations. Impact to soils would be small.

6.3.3.2.5.5 Apex/Dry Lake Route Cultural Resources

Highway Construction and Upgrades. A total of 51 archaeological and historic sites have been recorded along the highway rights-of-way that comprise the Apex/Dry Lake intermodal transfer station site and heavy-haul truck route (DIRS 155826-Nickens and Hartwell 2001, all). None of these previously recorded cultural sites are in locations proposed for upgrades.

There are no recorded cultural resources that would be affected by the construction of an Apex/Dry Lake intermodal transfer station. However, an original segment of the historic Arrowhead Trail Highway passes through the northern intermodal transfer station site location, and includes the archaeological remains of a motel and gas station. Based on previous archaeological studies in the larger area, there is a probability that there are one or more construction camps from the initial railroad construction era in the proposed intermodal transfer station locations as well.

The route follows a portion of U.S. 95 that passes though approximately 1.6 kilometers (1 mile) of the Las Vegas Paiute Reservation. The intermodal transfer station would be along I-15, about 3 kilometers (2 miles) south of the Moapa Paiute Reservation. Construction of the intermodal transfer station and use of U.S. 95 for this route would not have adverse impacts on Native American sites or values.

Operations. Use of an Apex/Dry Lake intermodal transfer station and heavy-haul truck route would not involve impacts (such as disturbing the sites or crushing artifacts) to known cultural resource sites.

6.3.3.2.5.6 Apex/Dry Lake Route Occupational and Public Health and Safety

This section addresses potential impacts to occupational and public health and safety from upgrading highways and heavy-haul truck operations on the Apex/Dry Lake route. The impacts of the Apex/Dry Lake intermodal transfer station would be the same as those discussed in Section 6.3.3.1.

Table 6-115. Impacts to workers from industrial hazards from upgrading highways along the Apex/Dry Lake route.

Group and trauma category	Construction[a]	Operations[b]
Involved workers		
Total recordable cases[c]	22	120
Lost workday cases	11	66
Fatalities	0.03	0.33
Noninvolved workers[d]		
Total recordable cases	1.3	6.8
Lost workday cases	0.5	2.5
Fatalities	0.001	0.007
Totals[e]		
Total recordable cases	23	130
Lost workday cases	11	68
Fatalities	0.032	0.34

a. Impacts are totals over about 28 months.
b. Includes periodic maintenance and resurfacing. Impacts are totals over about 24 years.
c. Total recordable cases includes injury and illness.
d. The noninvolved worker impacts are based on 25 percent of the involved worker level of effort.
e. Totals might differ from sums due to rounding.

Highway Construction and Upgrades. Industrial safety impacts on workers from upgrading highways for the Apex/Dry Lake route would be small (see Table 6-115). The analysis evaluated the potential for impacts in terms of total reportable cases of injury, lost workday cases, fatalities for workers, and traffic fatalities related to commuting workers and the movement of construction materials and equipment. Table 6-116 lists the estimated fatalities from construction and commuter vehicle traffic.

Operations. Incident-free radiological impacts listed in Table 6-117 would occur during the routine transportation of spent nuclear fuel and high-level radioactive waste on the route. These impacts would include transportation along the route as well as transportation along railways in Nevada leading to an Apex/Dry Lake intermodal transfer station. The table includes the impacts of 1,079 legal-weight truck shipments from commercial sites that do not have the capability to load rail casks while operational.

Table 6-116. Estimated number of fatalities from construction material delivery vehicles and construction and operations worker commuting traffic for the Apex/Dry Lake route for heavy-haul trucks.[a]

Activity	Kilometers[b]	Traffic fatalities	Vehicle emissions fatalities
Construction[c]			
Material delivery vehicles	15,000,000	0.3	0.03
Commuting workers	20,000,000	0.2	0.03
Subtotals	*35,000,000*	*0.5*	*0.06*
Operations[d]			
Commuting workers	120,000,000	1.2	0.16
Totals	***160,000,000***	***1.7***	***0.22***

a. Includes impacts of construction and operation of an intermodal transfer station.
b. To convert kilometers to miles, multiply by 0.62137.
c. Impacts are totals over about 28 months.
d. Impacts are totals over 24 years.

Table 6-117. Health impacts[a] from incident-free Nevada transportation for the Apex/Dry Lake heavy-haul truck implementing alternative.

Category	Legal-weight truck shipments	Rail and heavy-haul truck shipments[b]	Totals[c]
Involved workers			
Collective dose (person-rem)	38	1,100	1,100
Estimated latent cancer fatalities	0.02	0.44	0.46
Public			
Collective dose (person-rem)	7	150	160
Estimated latent cancer fatalities	0.003	0.08	0.08
Estimated vehicle emission-related fatalities	0.002	0.064	0.066

a. Impacts are totals for 24 years.
b. Includes impacts to workers at an intermodal transfer station.
c. Totals might differ from sums of values due to rounding.

6.3.3.2.5.7 Apex/Dry Lake Route Socioeconomics

This section describes potential socioeconomic impacts that would occur from upgrading highways along an Apex/Dry Lake route, advancing the construction schedule for a section of the planned Las Vegas Beltway to accommodate heavy-haul trucks, and building an intermodal transfer station. The section also describes socioeconomic impacts from the operation of an intermodal transfer station in Clark County and the periodic resurfacing of highways.

This analysis of economic measures assumed that Clark County would secure a loan to advance the construction schedule of the section of the Las Vegas Beltway that would be part of this heavy-haul truck route. The analysis based the estimates for a range of impacts on two sources of information from Clark County about the cost of building a section of the Beltway. Modifications to the Beltway would cost between $40 million (DIRS 103710-Clark County 1997, p. 2-7) and $425 million in 1998 dollars (DIRS 155112-Berger Group 2000, p. 29) (about $43.6 million to $463 million in 2001 dollars). DOE believes the actual cost would be between these values. A loan to Clark County for $43.6 million or $463 million, at an annual rate of 3 percent, with the repayment of the loan starting in 2010 and lasting for 30 years, is a part of the modeling to determine the impacts to employment, population, real disposable income, and expenditures by State and local governments. (A *real* percentage rate is the premium paid in addition to the rate of inflation; a real rate plus the rate of inflation equals the nominal or quoted rate.) Clark County would repay the loan from tax revenues. DOE assumes most repayment funds would be from sources the county has already identified for completion of the Beltway.

Highway Construction and Upgrades. Socioeconomic impacts from upgrading highways for an Apex/ Dry Lake route, advancing the schedule for construction of a portion of the Las Vegas Beltway, and building an intermodal transfer station would be temporary, occurring over a short period and spread among the counties along the route. The highway upgrades, excluding the Beltway, would cost $20.8 million, require about 28 months to complete, and occur during the 48-month construction period for the Beltway. Building an intermodal transfer station would cost about $25.0 million and take 18 months to complete. If this route was selected, the construction schedule of the planned Las Vegas Beltway would be advanced. (Dollar values reported in this section are 2001 dollars unless otherwise stated.)

This discussion expresses values for socioeconomic measures (employment, population, real disposable income, Gross Regional Product, and State and local government expenditures) and for potential impacts that would change in those measures as a range of values. The first value refers to the outcome if the Beltway cost is $43.6 million; the second refers to the outcome if the Beltway cost is $463 million. DOE anticipates that the actual change would be between the two values.

Employment

Employment in the region of influence of construction workers involved with upgrading the highways (including the Beltway) or with building an intermodal transfer station (direct workers) and other workers who would be employed as a result of the economic activity generated by the project (indirect workers) would peak in 2008. Employment increases would be between 490 and 1,882 jobs. The increase in employment in Clark County would be between 482 and 1,848 workers, Nye County would gain between 6 and 27 workers, and Lincoln County would gain between 1 and 5 workers. The increases in Clark, Nye, and Lincoln Counties would be less than 1 percent of the employment baseline for each county.

Population

The increase in employment would also bring population increases in the region of influence that would peak in 2009. During that year, the incremental increase in population would be between 356 and 1,857 individuals. Clark County would experience about 97 percent of this impact. The increase in population for Clark County would be between 347 and 1,812, for Lincoln County between 0 and 5, and for Nye County between 7 and 39. The impact from an increase in population as a result of increased employment opportunities would be less than 1 percent of each county's population baseline. Because the increases in population in each county would be small and transient, impacts to schools or housing would be unlikely.

Economic Measures

Economic measures would rise during the construction of an intermodal transfer station and the upgrading of highways and Las Vegas Beltway. The increase in real disposable income of people in the three-county region of influence would peak in 2008 at between $15.7 million and $62.0 million. The region-wide increase in Gross Regional Product would peak in 2008 at between $28.9 million and $99.8 million. Increased State and local government expenditures would peak in 2009 at between $1.2 million and $6.1 million. More than 97 percent of this economic activity would be concentrated in Clark County. The Gross Regional Product, real disposable income, and expenditures by State and local governments would rise by less than 1 percent in Clark, Nye, and Lincoln Counties. (All dollar values reported in this section are in 2001 dollars unless otherwise stated.)

Transition to Operations. In the region of influence, employment of Apex/Dry Lake heavy-haul truck route workers and indirect (support) workers would decrease by 419 to 2,026 when construction of the intermodal transfer station and highway upgrades (including the Beltway portion) ended in 2009. Clark County would lose between 412 and 1,993 of these jobs, Nye County would lose between 6 and 28 of these jobs, and Lincoln County would lose between 1 and 5 jobs. DOE anticipates that some of the displaced workers would move into operational positions on the Apex/Dry Lake route while others would find other work in the State. While this project would lose jobs, employment projections for the State estimate approximately 1.4 million jobs in 2010, or about 999,500 in the region of influence.

Operations. Operations at an intermodal transfer station and the use of heavy-haul trucks would begin in 2010 and continue until 2033. A direct workforce of about 26 would be required for the intermodal transfer station. Direct employment for heavy-haul truck operations over an Apex/Dry Lake route, including Clark County-based shipment escorts, would be about 66 workers. DOE assumed that operations workers would reside in Clark County.

To analyze the socioeconomic impacts of operations for an Apex/Dry Lake route, DOE considered three activities: operation of the intermodal transfer station, operation of the heavy-haul trucks, and maintenance of the highways and the Las Vegas Beltway.

Employment and Population

Employment in the region of influence associated with the operations of an intermodal transfer station and heavy-haul trucks would average about 99 workers, all of whom would work in Clark County. The impact on population from these two activities would be an average of 129 workers of whom 127 would live in Clark County. These impacts to employment and population would be less than 1 percent of the baseline in Clark County. During periodic road resurfacing, employment (direct and indirect) in the region would increase by about 107 workers for 2 years. DOE assumed that all of these workers would come from Clark County-based firms. Overall, employment increases from periodic highway resurfacing projects (every 8 years starting in 2016) would be less than 1 percent of the baseline for Clark County. Given the short duration of each resurfacing project, there would be no perceptible change in the region's population.

Net changes to employment and population from all three portions of the Apex/Dry Lake heavy-haul truck route during the 24-year operations phase can be summarized. There would be an incremental increase of 90 positions in the region of influence, with 89 of the additional positions in Clark County if the cost of the beltway was approximately $43.6 million. The region of influence would experience a growth in population of an additional 137 residents, 132 of them in Clark County. This impact would be less than 1 percent of the baseline. If the cost of the beltway reaches $463 million, the region of influence (while continuing to grow to an average of 1.1 million jobs), would have 242 fewer employment positions, with 241 of these in Clark County. Population, which is driven by employment, would be affected. The region of influence would have 511 fewer residents and Clark County would have 519 fewer residents. The impacts at the upper range of the cost estimates would be less than 1 percent of the baselines. Because the impacts would be so small, impacts to housing or schools would be unlikely.

Economic Measures

Impacts from changes to the economic measures of real disposable income, Gross Regional Product, and expenditures by State and local governments from operating an intermodal transfer station at Apex/Dry Lake, operating heavy-haul trucks, and maintaining the highways would fluctuate throughout the operations period and would depend partially on changes in population and employment. If the beltway cost was at the lower end of the cost estimate, real disposable income and Gross Regional Product in the region of influence would rise during the operations period. The increase in real disposable income would average $3.6 million and in Gross Regional Product would average $8.2 million. Expenditures by governments would increase over the 24-year period by an average of $479,000. Virtually all of the activity would be concentrated in Clark County and would be less than 1 percent of the various baselines. If the final cost of the beltway was $463 million, the impacts would be more visible but still less than 1 percent of the applicable baselines. Real disposable income would decline from $4.0 million above the baseline in 2010 to $35.6 million below the baseline by 2033, an average of slowing growth in this area of $29.2 million. The region of influence would have an average real disposable income of $55,797,000 during this period. Gross Regional Product would remain below the baseline, averaging $11.2 million

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annually. Expenditures by government would decline from $5.4 million above the baseline in 2010 to $4.5 million below the baseline in 2033. The average would be a slowing of spending by $1.9 million. As population growth slows, there would be a slowing in the rate of tax revenues collected and a slowing in the rate of population growth that would require a given level of services.

6.3.3.2.5.8 Apex/Dry Lake Route Noise and Vibration

Section 6.3.3.1 discusses noise impacts common to all the heavy-haul truck implementing alternatives. This section focuses on noise impacts that would be unique to the Apex/Dry Lake heavy-haul truck implementing alternative.

Highway Construction and Upgrades. There is one residence near the Dry Lake site of the three tracts of land identified for an intermodal transfer station. Construction noise would occur during daylight hours and would be a temporary source of elevated noise in the area. Nighttime noise impacts would be unlikely because construction activities would not occur at night.

For the Apex/Dry Lake route, northern Las Vegas, the Town of Indian Springs, and the rural community of Cactus Springs are within the 2,000-meter (6,600-foot) region of influence for construction noise. Construction activities would occur at the I-15 interchange at Apex and along sections of U.S. 95. The route, which passes north of Las Vegas, is not heavily populated and the potential for noise-related construction impacts would be low.

Operations. An Apex/Dry Lake intermodal transfer station would be isolated, with one residence (DIRS 155825-Poston 2001, all) in the vicinity, adjacent to an existing rail line. The potential for noise impacts is unlikely unless operations were close to this residence.

The Apex/Dry Lake route would be confined to established highways with wide shoulders. Background traffic noise levels would be greatest along the planned northern Beltway, reducing the potential for heavy-haul truck noise to affect public receptors adversely during daylight hours. The incremental noise increase due to the infrequent heavy-haul truck shipments would not alter the existing noise environment. Estimated noise levels (1-hour average sound levels) at Indian Springs and Cactus Springs would increase by about 0.4 dBA [at 15 meters (44 feet) from the road] due to heavy-haul truck traffic. A potential receptor is the public school in Indian Springs, which also serves students from Cactus Springs. The Indian Springs school is about 300 meters (980 feet) south of U.S. 95. The incremental contribution of heavy-haul trucks at this distance from the highway would not be perceptible. No historic buildings would be affected by ground vibration. No sensitive ruins of cultural significance have been identified along this route.

The Apex/Dry Lake intermodal transfer station is about 3 kilometers (2 miles) from the Moapa Reservation. Assuming that the greatest source of noise would be locomotives, estimated noise levels at 520 meters (1,700 feet) would be 45 dBA. Noise generated at the intermodal transfer station would not be perceptible 910 meters (3,000 feet) away at the border of the Moapa Reservation. The Apex/Dry Lake heavy-haul truck route on U.S. 95 also passes through about 1.6 kilometers (1 mile) of the Las Vegas Paiute Reservation. Because of the relatively large traffic volume on U.S. 95, the increase in traffic noise due to heavy-haul trucks in this area would not be perceptible (DIRS 155825-Poston 2001, all).

6.3.3.2.5.9 Apex/Dry Lake Route Utilities, Energy, and Materials

Section 6.3.3.1 discusses the utilities, energy, and materials impacts that would be common to all the heavy-haul truck implementing alternatives. This section focuses on the utilities, energy and materials impacts that would be unique to the Apex/Dry Lake heavy-haul truck implementing alternative.

Highway Construction and Upgrades. The construction of the Apex/Dry Lake intermodal transfer station would have the same utilities, energy, and materials impacts as those discussed in Section 6.3.3.1.

Table 6-118 lists the estimated quantities of primary materials for the upgrade of Nevada highways for the Apex/Dry Lake route. These quantities are not likely to be very large in relation to the southern Nevada regional supply capacity (see Section 6.3.3.1).

Table 6-118. Utilities, energy, and materials required for upgrades along the Apex/Dry Lake route.

Route	Length (kilometers)[a]	Diesel fuel (million liters)[b]	Gasoline (thousand liters)	Asphalt (million metric tons)[c]	Concrete (thousand metric tons)	Steel[d] (metric tons)
Apex/Dry Lake	182	1.6	29	0.23	0.1	2.3

a. To convert kilometers to miles, multiply by 0.62137.
b. To convert liters to gallons, multiply by 0.26418.
c. To convert metric tons to tons, multiply by 1.1023.
d. Steel includes rebar only.

Operations. Section 6.3.3.1 discusses the utilities, energy, and materials needs for the operation of an intermodal transfer station.

Fossil fuel that would be consumed by heavy-haul trucks during operations is discussed in Chapter 10, which addresses irreversible commitments of resources.

6.3.4 ENVIRONMENTAL JUSTICE IMPACTS IN NEVADA

The analysis considered existing highways and railroads that DOE would use in Nevada—I-15, the proposed Las Vegas Beltway; U.S. 95; five possible highway routes for heavy-haul trucks; the Union Pacific Railroad's mainlines in northern and southern Nevada; and five corridors with variations for a possible branch rail line in the State. If DOE constructed and operated the repository, it would use combinations of these routes for shipments of spent nuclear fuel and high-level radioactive waste. DOE would use alternative preferred routes designated by the State of Nevada for highway shipments to the repository.

In general, the consequences of using a transportation route would occur close to the route. Thus, for transportation on a highway or railroad to affect a census block group for which environmental justice concerns could exist, the route would have to cross or be adjacent to the block group. Chapter 3, Section 3.1.13 discusses and depicts the minority and low-income populations in Nevada.

Portions of some routes would cross or be adjacent to Native American tribal lands. Existing or proposed highway routes avoid census block groups with high fractions of minority, low-income, or Native American populations with the exceptions of:

- Sections of I-15 that pass through the center of the Moapa Reservation northeast of Las Vegas, Nevada
- A 1.6-kilometer (1-mile) section of U.S. 95 across the southwest corner of the Las Vegas Paiute Indian Reservation that could be used by legal-weight trucks as well as either the Caliente/Las Vegas or Apex/Dry Lake heavy-haul truck route
- The Caliente/Las Vegas and Apex/Dry Lake routes for heavy-haul trucks, which would pass near the Moapa Reservation
- Sparsely populated areas of census block groups in the northern parts of Clark County

Existing or proposed rail routes could cross census block groups with high populations of minority, low-income, or populations of Native Americans only at the following points:

- The Union Pacific Railroad's mainline tracks pass through the center of the Moapa Reservation and through the center of Las Vegas, Nevada, crossing census block groups with high fractions of minority and low-income populations.
- The Bonnie Claire Alternate of the Caliente and Carlin Corridors would pass through 4.5 kilometers (2.8 miles) covering 1.8 square kilometers (450 acres) of the Scottys Junction portion of the newly designated Timbisha Shoshone Trust Lands parcel planned for residential use and tourist-related business.

Also, a branch rail line in the Valley Modified Corridor would pass near the Las Vegas Paiute Reservation. None of the potential intermodal transfer station sites that DOE could use would be near a census block group with high minority or low-income populations, but an intermodal transfer station in the Apex/Dry Lake area could be as close as about 3 kilometers (2 miles) to the Moapa Reservation.

Impacts to resource areas other than environmental justice along Nevada highways and railroads from the transportation of spent nuclear fuel and high-level radioactive waste would be small. The number of shipments in the mostly legal-weight truck and mostly rail scenarios would be small in comparison to the number of all other commercial shipments in southern Nevada. For comparison, under the mostly legal-weight truck scenario as many as five trucks carrying spent nuclear fuel would pass through the Moapa Indian Reservation on I-15 each day compared to daily traffic of more than 3,000 commercial trucks that use this section of highway (DIRS 156930-NDOT 2001, p. 6; DIRS 104727-Cerocke 1998, all). Under the mostly rail scenario as many as 11 railcars per week carrying spent nuclear fuel could travel into southern Nevada compared to about 1,000 railcars each day for other commodities. Thus, impacts from truck and rail traffic and emissions would be small for these shipments. The potential for accidents that could result in injuries or fatalities involving the shipments would also be small in comparison to the overall risk of accidents that would occur from other commercial traffic.

As much as 10 percent of travel in southern Nevada by legal-weight trucks or railcars carrying spent nuclear fuel would be through populations of Native Americans and census block groups with high fractions of minorities or low-income populations, depending on the selected route and transportation mode. Public health and safety impacts to all populations in Nevada would be small (about 1 fatality from cancer and other causes for incident-free transportation and 0.00006 latent cancer fatality for accidents over 24 years).

The public health and safety impacts to minority and low-income populations along the routes of travel would also be small. Because the probability would be small at any single location, the risk of an accident at a specific location would also be small. Thus, impacts to minority or low-income populations or to populations of Native Americans in small communities along the routes would also be small and, therefore, unlikely to be disproportionately high and adverse.

Unique practices and activities could create opportunities for increased impacts from transportation of spent nuclear fuel and high-level radioactive waste associated with the Proposed Action. One such practice could be the use of subsistence diets (that is, consumption of homegrown or naturally available plant and animal food). Because no radioactive materials would be released to the environment during incident-free transportation, the implementation of new or existing transportation routes in Nevada would not affect food sources likely to be involved in subsistence diets. If an accident resulted in the release of radioactive materials, food sources, both agricultural and subsistence, could be affected and mitigative actions would have to be taken to prevent contamination or consumption of contaminated food.

The American Indian Writers Subgroup identified noise from transportation as a concern because of its effects on ceremonies and the solitude necessary for healing and praying (DIRS 102043-AIWS 1998, p. 2-19). DOE is not aware of traditional cultural properties or other areas along the candidate rail corridors or routes for heavy-haul trucks, including variations, where noise from trains, construction of a branch rail line or intermodal transfer station, or conduct of heavy-haul or other trucking operations could interfere with conditions necessary for meditation by, or religious ceremonies of, Native Americans, with the exception of the Caliente Intermodal Transfer Station, as noted below. Similarly, no known ruins or other culturally sensitive structures have been identified that could be affected by ground vibration.

The analysis of transportation-related construction or upgrades identified potentially adverse impacts pertaining to certain routes or transportation modes. DOE could lessen some of these impacts through mitigation, as discussed in Chapter 9. Adverse impacts could include the following:

- The Valley Modified Corridor and some of its variations would involve construction in the Las Vegas Valley air basin, which is in serious nonattainment for particulate matter (PM_{10}) and carbon monoxide (DIRS 155557-Clark County 2001, Tables 3-8 and 5-3). Emission rates would exceed the General Conformity threshold (established by Environmental Protection Agency regulations that implement the Clean Air Act) for PM_{10} for a serious nonattainment area and would qualify the construction as a major source of emissions when evaluated under the Prevention of Significant Deterioration threshold. Comparison of this corridor with known locations of minority and low-income populations indicates that effects on such populations would not be disproportionately high and adverse in comparison with effects on the rest of the population. No unique practices or pathways have been identified that would increase impacts to minority or low-income populations. PM_{10} and carbon monoxide emissions are susceptible to mitigation.

- The northernmost site for a Sloan/Jean intermodal transfer station is in a PM_{10} nonattainment area. Emission rates would exceed the PM_{10} General Conformity threshold for a serious nonattainment area. Comparison of the Sloan/Jean route with known locations of minority and low-income populations indicates that effects on such populations would not be disproportionately high and adverse in comparison with effects on the rest of the population. No unique practices or pathways have been identified that would increase impacts to minority or low-income populations. PM_{10} and carbon monoxide emissions are susceptible to mitigation.

- Most of the road upgrades for a Sloan/Jean heavy-haul truck route would occur in areas that are in attainment for criteria pollutants. However, portions of the upgrades would occur in the Las Vegas Valley air basin, which is in nonattainment for carbon monoxide and PM_{10}. Comparison of the route with known locations of minority and low-income populations indicates that effects from road upgrades on such populations would not be disproportionately high and adverse in comparison with effects on the rest of the population. No unique practices or pathways have been identified that would increase impacts to minority or low-income populations. PM_{10} and carbon monoxide emissions are susceptible to mitigation.

- Construction and operation of a Caliente intermodal transfer station could cause aesthetic impacts to users of Kershaw-Ryan State Park. Impacts could result from construction activities and from noise, traffic, and lighting during operations. Impacts would be similar for all park users and, therefore, would not be disproportionately high and adverse for members of minority or low-income populations. Some of these impacts would be susceptible to mitigation.

- Biology and soils impacts from construction and from corridor and route occupancy and use would include long-term vegetation disturbance in corridors or at an intermodal transfer station and stopover sites. Short-term or individual impacts to threatened and endangered and special-status species could occur. The Valley Modified Corridor crosses two wilderness study areas and a national wildlife refuge. DOE has found no location-related or unique practices and pathways information to indicate that effects on minority or low-income populations would be disproportionately high and adverse in comparison with effects on the rest of the population.

- The construction and operation of a branch rail line in the Caliente or Carlin Corridor along the Bonnie Claire Alternate would cross the Scottys Junction parcel of the Timbisha Shoshone Trust Lands. Sections 6.3.2.2.1 and 6.3.2.2.2 discuss land-use and noise consequences for potential residents. Information available to DOE indicates that the Timbisha Shoshone have not developed residential areas on the parcel. Because residential development of the parcel has not occurred, there is no population present, no way to measure the likelihood of disproportionately high and adverse impacts on a possible minority or low-income population, and no present data indicating a potential for environmental justice concerns from the Bonnie Claire Alternate.

- The construction and operation of a branch rail line in any of the candidate rail corridors could present the potential for direct and indirect impacts to archaeological and historic resources related to Native American culture. Additional archaeological surveys and ethnographic studies are needed for the placement of an alignment within any of the rail corridors, including variations, to determine specific potential impacts and mitigation needs. Records searches indicate that only a small percentage of potentially affected lands in designated rights-of-way have been inspected.

- The operation of a heavy-haul truck route along any of the candidate routes could present the potential for direct and indirect impacts to archaeological and historic resources related to Native American culture. The determination of the potential for impacts to Native American cultural values from the upgrading and use of Nevada highways for heavy-haul truck shipments would require more study. The American Indian Writers Subgroup has commented that ethnographic field studies would be necessary to determine specific potential impacts to Native American cultural properties and values (DIRS 102043-AIWS 1998, p. 4-6) for candidate rail corridors and the use of existing highways as routes for heavy-haul trucks to Yucca Mountain.

- Construction of a Carlin branch rail line could affect two known historic-period Native American cemeteries, one in Crescent Valley and the other in Grass Valley (DIRS 155826-Nickens and Hartwell 2001, p. 27).

- Several rail corridors and routes for heavy-haul trucks pass through or are proximate to significant places for Native Americans. For example, in the Pahranagat National Wildlife Refuge, the Black Canyon area, the Storied Rocks site farther south, and the Maynard Lake vicinity have been identified. The entire Pahranagat Valley is an important cultural landscape (DIRS 155826 Nickens and Hartwell 2001, Appendix A). The Coyote Springs area and the Arrow Canyon Range valley south of the Pahranagat Valley are places of cultural importance. The operation of a Caliente intermodal transfer station could have a lasting impact on the cultural integrity of the location, which Native Americans have identified as an important place. The overall significance of such places and the potential for impacts from the transportation of spent nuclear fuel and high-level radioactive waste cannot be fully understood until a rail alignment or heavy-haul truck route is identified and ethnographic field studies and consultation have been completed.

In the viewpoint of Native Americans, the construction and operation of a branch rail line would constitute an intrusion on the holy lands of the Southern Paiute and Western Shoshone. In addition, some corridors pass through or near several significant places (see Chapter 3, Section 3.2.2.1.5). The American Indian Writers Subgroup has commented that the overall significance of these places and potential impacts from operation of a rail line on them cannot be fully understood until DOE has identified the rail alignment and completed ethnographic field studies and consultations (DIRS 102043-AIWS 1998, p. 4-6). If DOE selected a rail corridor, it would initiate additional engineering and environmental studies (including cultural resource surveys), conduct consultations with Federal agencies, the State of Nevada, and tribal governments, and perform additional National Environmental Policy Act reviews as a basis for final alignment selection and construction. DOE would address the mitigation of potential impacts to archaeological and historic sites during the identification, evaluation, and treatment planning phases of the cultural resource surveys.

For existing highways and mainline railroads, the added traffic would be minimal and shipments of spent nuclear fuel and high-level radioactive waste would be unlikely to affect land use, air quality, hydrology, biological resources and soils, cultural resources, socioeconomics, noise and vibration, or aesthetics, except as noted above. The analyses discussed in the preceding sections also determined that impacts to these resource areas from construction and operation of a branch rail line in any of the five potential rail corridors or construction of an intermodal transfer station and upgrading of highways in Nevada would be low.

Because the analyses did not identify large impacts for railroad and highway transportation of spent nuclear fuel and high-level radioactive waste in Nevada that would constitute credible adverse impacts on populations, workers, or individuals, adverse effects would be unlikely for any specific segment of the population, including minorities, low-income groups, and Native American tribes, except as noted above. Chapter 4, Section 4.1.13.4, contains an environmental justice discussion of a Native American perspective on the Proposed Action.

REFERENCES

Note: In an effort to ensure consistency among Yucca Mountain Project documents, DOE has altered the format of the references and some of the citations in the text in this Final EIS from those in the Draft EIS. The following list contains notes where applicable for references cited differently in the Draft EIS.

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103455	Saricks and Tompkins 1999	Saricks, C.L. and Tompkins, M.M. 1999. *State-Level Accident Rates of Surface Freight Transportation: A Reexamination.* ANL/ESD/TM-150. Argonne, Illinois: Argonne National Laboratory. TIC: 243751.
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104735	YMP 1991	YMP (Yucca Mountain Site Characterization Project) 1991. *The Nevada Railroad System: Physical, Operational, and Accident Characteristics.* YMP 91-19. Las Vegas, Nevada: Yucca Mountain Site Characterization Office. ACC: NNA.19920608.0151. In the Draft EIS, this reference was cited as DOE 1991b in Chapter 12.
104737	YMP 1997	YMP (Yucca Mountain Site Characterization Project) 1997. *Location of Alternative Heavy-Haul Routes and Future Las Vegas Beltway.* YMP-97-262.0. Las Vegas, Nevada: Yucca Mountain Site Characterization Office. ACC: MOL.19990610.0306.
104560	YMP 1998	YMP (Yucca Mountain Site Characterization Project) 1998. *Potential Rail Alignments.* YMP/98-104.0. Las Vegas, Nevada: Yucca Mountain Site Characterization Office. ACC: MOL.19990526.0034. In the Draft EIS, this reference was cited as DOE 1998f in Chapter 12.
104588	YMP 1998	YMP (Yucca Mountain Site Characterization Project) 1998. *Nevada Routes for Heavy-Haul Truck Shipments of SNF and HLW to Yucca Mountain.* YMP/97-263.9. Las Vegas, Nevada: Yucca Mountain Site Characterization Office. ACC: MOL.19990526.0035. In the Draft EIS, this reference was cited as DOE 1998g in Chapter 12.
104743	YMP 1998	YMP (Yucca Mountain Site Characterization Project) 1998. *Nevada Routes for Legal-Weight Truck Shipments of SNF and HLW to Yucca Mountain.* YMP/97-310.3. Las Vegas, Nevada: Yucca Mountain Site Characterization Office. ACC: MOL.19990526.0033. In the Draft EIS, this reference was cited as DOE 1998f in Chapter 12.
101483	Yuan et al. 1995	Yuan, Y.C.; Chen, S.Y.; Biwer, B.M.; and LePoire, D.J. 1995. *RISKIND - A Computer Program for Calculating Radiological Consequences and Health Risks from Transportation of Spent Nuclear Fuel.* ANL/EAD-1. Argonne, Illinois: Argonne National Laboratory. TIC: 241380.
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7

Environmental Impacts of the No-Action Alternative

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7. ENVIRONMENTAL IMPACTS OF THE NO-ACTION ALTERNATIVE

This chapter describes the potential impacts associated with the No-Action Alternative described in Chapter 2. Under the No-Action Alternative and consistent with the Nuclear Waste Policy Act, as amended [NWPA, Section 113(c)(3)], the U.S. Department of Energy (DOE) would terminate activities at Yucca Mountain and undertake site reclamation to mitigate any significant adverse environmental impacts. Commercial utilities and DOE would continue to manage spent nuclear fuel and high-level radioactive waste at 77 sites in the United States.

DOE analyzed the No-Action Alternative to serve as a basis for comparing the magnitude of potential environmental impacts in the Proposed Action. Under the No-Action Alternative, and consistent with the NWPA, DOE would terminate activities at Yucca Mountain and undertake site reclamation to mitigate any significant adverse environmental impacts. In addition, DOE would prepare a report to Congress, with its recommendations for further action to ensure the safe, permanent disposal of spent nuclear fuel and high-level radioactive waste, including the need for new legislative authority. Under any future course that would include continued storage at the generator sites, commercial utilities and DOE would have to continue managing spent nuclear fuel and high-level radioactive waste in a manner that protected public health and safety and the environment. However, the future course that Congress, DOE, and the commercial utilities would take if Yucca Mountain were not approved is uncertain.

DOE recognizes that a number of possibilities could be pursued, including continued storage of spent nuclear fuel and high-level radioactive waste at its present location, or at one or more centralized location(s); the study and selection of another location for a deep geologic repository (Chapter 1 identifies the process and alternative sites previously selected by DOE for technical study as potential geologic repository locations); the development of new technologies (for example, transmutation); or reconsideration of alternatives to geologic disposal (as discussed in Chapter 2, Section 2.3.1). The environmental considerations of these possibilities have been analyzed in other contexts in other documents to varying degrees. DOE also recognizes that under the No-Action Alternative, there would be an increased probability of shutdown of operating reactors before operating license expiration due to the lack of adequate spent nuclear fuel storage capacity, with an attendant loss of electric power generation for that area or region. While the Department recognizes that many environmental impacts could result from shutting down nuclear power reactors, a full evaluation of such impacts (such as generation of additional air pollution from replacement sources of electricity) would be highly speculative because the choice of a replacement power source (importation, solar, gas, coal, etc.) would be regionally dependent, and the affected utilities would make the ultimate decision. Because the determination of local and regional impacts resulting from the loss of electric generating capacity for shutdown reactors, including the potential for increased electricity prices, would be speculative, the EIS does not include a detailed discussion.

Table 7-1 lists representative studies related specifically to centralized or regionalized interim storage, including alternatives evaluated in DOE National Environmental Policy Act documents, and summarizes the relevant environmental considerations. Those studies contain more information on the potential environmental impacts of centralized or regional interim storage.

In light of these uncertainties, DOE decided to illustrate the possibilities by focusing the analysis of the No-Action Alternative on the potential impacts of two scenarios—long-term storage of spent nuclear fuel and high-level radioactive waste at the current sites with effective institutional control for at least 10,000 years (Scenario 1), and long-term storage with no effective institutional control after about 100 years (Scenario 2). Although the Department agrees that neither of these scenarios is likely, it selected them for analysis because they provide a basis for comparison to the impacts of the Proposed Action and because they reflect a range of the impacts that could occur.

Table 7-1. Documents that address centralized or regionalized storage of spent nuclear fuel and high-level radioactive waste[a] (page 1 of 5).

Title and scope of storage analysis	Environmental and other considerations
Final Environmental Impact Statement, Management of Commercially Generated Radioactive Waste (DIRS 104832-DOE 1980, all)	
Evaluates a proposal to provide interim storage of spent nuclear fuel from U.S. power reactors before final disposal. The proposal would include acceptance of a limited amount of foreign spent fuel if such actions would contribute to U.S. nonproliferation goals. Evaluates several generic interim storage facility alternatives, including centralized storage at a few large ISFS facilities.	Analyses include a description of a *generic interim storage site environment* based primarily on data for the midwestern United States, and potential environmental effects of such a facility for ISFS facilities. Impacts evaluated include: natural resources, radiological impacts, land use, water use, ecological resources, air quality, traffic, noise, socioeconomics, waste management, utilities, aesthetics, transportation (including both to ISFS facilities and from ISFS facilities to the disposition facility), and safeguards and security.
Recommendations on the Proposed Monitored Retrievable Storage Facility (DIRS 103173-Clinch River 1985, all)	
Evaluates DOE proposal to consider the Clinch River Breeder Reactor and ORR sites in Tennessee for an MRS facility. Performed by the Clinch River MRS Task Force, which included three study groups: environmental, socioeconomic, and transportation. Public meetings and site visits were conducted by the study groups. Separate reports by each study group are summarized in findings, concerns, anticipated impacts, and recommended mitigations.	The Environmental Study Group's final report presented concerns and recommended mitigations for MRS construction impacts, damage to ecosystem from construction, special nuclear risks of construction, highway construction impacts, radiation protection of workers and the public, airborne effluents, aqueous releases, hazards from cask rupture, earthquakes, flooding, long-term radionuclide containment, secondary waste stream, local control, offsite emergency response, past contamination of the ORR, environmental data from the ORR, and MRS becoming a permanent waste storage site. The Socioeconomic Study Group's final report identified concerns or potentially negative impacts of an MRS and possible mitigations for business recruitment and expansion, residential recruitment and retention, institutional trust, pre- and postoperational impacts and costs, tourism and aesthetics, site neighbors, and legislative issues. The Transportation Study Group's final report defined areas of potential major impacts (for example, independent inspections, upgrades of railroad tracks, routing and upgrades to preferred highway truck routes, escorts, emergency response plans and training, and requirements applicable to private carriers), and presented findings and recommendations on accident probabilities, barge transport, cask safety and contents, prenotification, and safeguards.

Table 7-1. Documents that address centralized or regionalized storage of spent nuclear fuel and high-level radioactive waste[a] (page 2 of 5).

Title and scope of storage analysis	Environmental and other considerations
Monitored Retrievable Storage Submission to Congress, Volume 2: Environmental Assessment for a Monitored Retrievable Storage Facility (DIRS 104731-DOE 1986, Volume 2, all)	
Evaluates a proposal for the construction of a facility for monitored retrievable storage. Evaluates two facility design concepts at each of three candidate sites in Tennessee (Clinch River Breeder Reactor, ORR, and TVA Hartsville Nuclear Power Plant).	Evaluates impacts common to all three sites and unique to each site, including radiological, air quality, water quality and use, ecological resources, land use, socioeconomics, resource requirements, aesthetics, and transportation. Also evaluates relative advantages and disadvantages of the six site design combinations.
MRS System Study Summary Report (DIRS 104838-DOE 1989, all)	
Evaluates the role of the MRS facility in the waste management system.	Provides additional support to the general conclusion that an MRS facility provides tangible benefits to a waste management system, as articulated in the DOE 1986 MRS proposal to Congress (DIRS 104731-DOE 1986, Volume 2, all). Examines various system configurations in a series of separate publications: • Scenario development and system logistics • Facility design/schedule/cost implications • Alternative MRS storage concepts • Location of high-level radioactive waste packaging • Waste package designs • Transportation impact analyses • Role of waste storage in operations of the waste management system • Licensing impacts of an MRS facility • System reliability
Nuclear Waste Management Systems Issues Related to Transportation Cask Design: At-Reactor Spent Fuel Storage, Monitored Retrievable Storage and Modal Mix (DIRS 104889-Hoskins 1990, all)	
Provides the State of Nevada evaluation of the DOE MRS proposal and the Tennessee studies and position in response.	Addresses the DOE MRS proposal, which evaluated the option of implementing an integral MRS facility as part of a waste management system and the option of "no-MRS facility" as part of the waste management system. The criteria for the evaluation included health and safety, economic, environmental, political (for example, acceptability, public confidence, local and state attitudes), social (for example, fears and anxieties), fairness (for example, equity, intergenerational, utilities/ratepayer, liability, geographic, interutility, and government-utility), repository scheduling, and flexibility (technical and institutional factors).

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Table 7-1. Documents that address centralized or regionalized storage of spent nuclear fuel and high-level radioactive waste[a] (page 3 of 5).

Title and scope of storage analysis	Environmental and other considerations
Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement (DIRS 101802-DOE 1995, all)	
Analyzes transportation and centralized interim storage of existing and projected inventories of DOE spent nuclear fuel (including naval spent nuclear fuel) at one site. Considers five interim storage sites (Hanford, INEEL, ORR, SRS, and the Nevada Test Site).	Focuses on key discriminator disciplines at each of the five sites, including socioeconomics, utilities (electricity), materials and waste management, occupational and public health and safety (radiation effects and accidents), transportation, and uncertainties and conservatism. Discusses cumulative impacts and impacts of no action. Does not provide detailed discussions of land use, cultural resources, aesthetic/scenic resources, geologic resources, air quality, water resources, ecological resources, noise, and utilities and energy because there would be small impacts for these areas that would be indistinguishable among the alternatives.
Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel (DIRS 101812-DOE 1996, all)	
Evaluates a proposal to manage FRR spent nuclear fuel. Evaluates a management alternative for acceptance and management of FRR spent fuel in the United States that includes regionalized storage at SRS, INEEL, Hanford, ORR, and the Nevada Test Site. Basic implementation components of the proposal include policy duration, financing arrangements, amount of FRR spent fuel, location for taking title to FRR spent fuel, marine transport, ports of entry, ground transport, FRR spent fuel management sites, and storage technologies.	Analyzes impacts from policy considerations, marine transport, port activities, ground transport, and fuel management sites. More specifically, for fuel management sites, analyzes impacts for occupational and public health and safety, waste management, cumulative impacts, mitigation measures, and environmental justice. Covers impacts for land use, socioeconomics, cultural resources, aesthetics, scenic resources, geology, water resources, air quality, ecology, noise, utilities and energy, and waste management in general.
Final Waste Management Programmatic Environmental Impact Statement For Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste (DIRS 101816-DOE 1997, all)	
Evaluates programmatic alternatives for managing various DOE wastes including HLW. Regionalized and centralized storage are among the management options evaluated. Under the regionalized alternatives, canisters from West Valley would be transported either to SRS or to Hanford, and HLW canisters would continue to be stored at Hanford, SRS, and INEEL until acceptance at the geologic repository. Under the centralized storage alternative, canisters would be transported from West Valley, INEEL, and SRS to Hanford, where they would be stored until acceptance at a geologic repository.	Describes regionalized and centralized sites based on available site-specific data and existing and planned storage facilities for HLW canisters. Impacts evaluated include health risks (includes transportation), air quality, water resources, ecological resources, economics, population, environmental justice, land use, infrastructure, cultural resources, and costs.

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Table 7-1. Documents that address centralized or regionalized storage of spent nuclear fuel and high-level radioactive waste[a] (page 4 of 5).

Title and scope of storage analysis	Environmental and other considerations
Environmental Report for the Private Fuel Storage Limited Liability Company's (PFS) Proposed Independent Spent Fuel Storage Installation (ISFSI) License Application (DIRS 103436-PFS 1997, all)	
Evaluates the impacts of a privately owned dry fuel storage facility proposed to be built in western Utah on the Skull Valley Goshute Indian Reservation. The facility would receive and store as much as 40,000 MTHM from several commercial nuclear reactor plants. In June of 2000, the NRC published a Draft EIS to support its licensing process for this facility.	Provides detailed descriptions and environmental impact analyses associated with construction and operation of the site and transportation corridors for geography, land use, and demography; ecological resources; climatology and meteorology (including air quality); hydrological resources; mineral resources; seismology; socioeconomics (including environmental justice analysis); noise and traffic; regional historic and cultural resources; scenic and natural resources; background radiological characteristics; and transportation (radiological and nonradiological impacts). Addresses installation siting and design alternatives based on several specific evaluation criteria (geography and demography; ecology; meteorology; hydrology; geology; regional historic/archaeological/architectural/scenic, cultural/natural features; noise; radiological characteristics).
Centralized Interim Storage Facility Topical Safety Analysis Report (DIRS 103375-DOE 1998, all)	
Analyzes an above-ground temporary storage facility for up to 40,000 MTHM of commercial reactor spent nuclear fuel. The non-site-specific analysis concludes that DOE could construct and operate the commercial interim storage facility in a manner that protects public health and safety.	Describes generic site characteristics and design criteria developed to bound, to the extent possible, site-specific values once a CISF is selected. Generic site characteristics include meteorology, surface hydrology, geology, and seismology. Principal design parameters evaluated for normal and accident conditions include type of fuel, storage systems, fuel characteristics, tornado (wind and missile load), straight wind, floods, precipitation, snow and ice, seismicity (ground motion and surface faulting), volcanic eruption (ash fall), explosions, aircraft impact, proximity to uranium fuel cycle operations, ambient temperature, solar load, confinement, radiological protection, nuclear criticality, decommissioning, materials handling, and retrieval capability.

Table 7-1. Documents that address centralized or regionalized storage of spent nuclear fuel and high-level radioactive waste[a] (page 5 of 5).

Title and scope of storage analysis	Environmental and other considerations
Draft Environmental Impact Statement for the Construction and Operation of an Independent Spent Fuel Storage Installation on the Reservation of the Shull Valley Band of Goshute Indians and the Related Transportation Facility in Tooele County, (DIRS 152001-NRC 2000, all)	
Evaluates the impacts of a privately owned dry fuel storage facility proposed to be built in western Utah on the Skull Valley Goshute Indian Reservation. The facility would receive and store as much as 40,000 MTHM from several commercial nuclear reactor plants.	Provides detailed descriptions and environmental impact analyses associated with construction and operation of the site and transportation corridors for geography, land use, and demography; ecological resources; climatology and meteorology (including air quality); hydrological resources; mineral resources; seismology; socioeconomics (including environmental justice analysis); noise and traffic; regional historic and cultural resources; scenic and natural resources; background radiological characteristics; and transportation (radiological and nonradiological impacts). Addresses installation siting and design alternatives based on several specific evaluation criteria (geography and demography; ecology; meteorology; hydrology; geology; regional historic/archaeological/architectural/scenic, cultural/natural features; noise; radiological characteristics). Provides impact analyses for the No-Action Alternative where NRC would not approve the license application to construct and operate the proposed storage facility and utilities would continue to store spent nuclear fuel at their reactor sites until it is shipped to a permanent geological repository.

a. Abbreviations: ISFS = independent spent fuel storage; ORR = Oak Ridge Reservation; MRS = monitored retrievable storage; TVA = Tennessee Valley Authority; INEEL = Idaho National Engineering and Environmental Laboratory; SRS = Savannah River Site; FRR = Foreign Research Reactor; HLW = high-level radioactive waste; MTHM = metric tons of heavy metal; NRC = U.S. Nuclear Regulatory Commission; CISF = centralized interim storage facility.

Chapter 2 describes the scenarios more fully. Appendix K contains detailed descriptions of the assumptions for each scenario. For consistency, the No-Action analysis considered the same spectrum of environmental impacts as the analysis of the Proposed Action. However, because of the DOE commitment to manage spent nuclear fuel and high-level radioactive waste safely and the uncertainties typical in predictions of the outcome of complex physical and biological phenomena over long periods, DOE decided to focus the No-Action analysis on the short- and long-term health and safety of workers and members of the public.

To ensure a consistent comparison with the Proposed Action for the cumulative effects analysis, the analysis included the impacts of the continued storage of spent nuclear fuel and high-level radioactive waste in excess of 70,000 metric tons of heavy metal (MTHM). This additional material, with the 70,000 MTHM under the Proposed Action (collectively called Module 1), includes 105,000 MTHM of commercial spent nuclear fuel, 2,500 MTHM of DOE spent nuclear fuel, and 22,280 canisters of high-level radioactive waste.

In view of the almost unlimited possible future states of society and the importance of these states to future risk and dose, the National Research Council recommended the use of a particular set of assumptions about the biosphere (for example, how people get their food and water and from where) for compliance calculations such as those performed to evaluate long-term repository performance. Further, the National Research Council recommended the use of assumptions that reflect current technologies and living patterns (DIRS 100018-National Research Council 1995, p. 122). For consistency with the methods used to analyze environmental impacts from the proposed repository, the No-Action analysis selected current technologies and living patterns for the long-term impact evaluation, even though they might not represent an accurate prediction of future conditions.

DEFINITION OF
METRIC TONS OF HEAVY METAL

Quantities of spent nuclear fuel are traditionally expressed in terms of *metric tons of heavy metal* (typically uranium), without the inclusion of other materials such as cladding (the tubes containing the fuel) and structural materials. A metric ton is 1,000 kilograms (1.1 tons or 2,200 pounds). Uranium and other metals in spent nuclear fuel (such as thorium and plutonium) are called *heavy metals* because they are extremely dense; that is, they have high weights per unit volume. One metric ton of heavy metal disposed of as spent nuclear fuel would fill a space approximately the size of a typical household refrigerator.

Under Scenario 1, 77 sites around the country would store spent nuclear fuel and high-level radioactive waste. For this scenario, the analysis assumed that institutional control for at least 10,000 years would ensure regular maintenance and continuous monitoring at the facilities, which would safeguard the health and safety of facility employees, surrounding communities, and the environment. All maintenance, including routine industrial maintenance and maintenance unique to a nuclear materials storage facility, would be performed under standard operating procedures or best management practices to ensure minimal releases of contaminants (industrial and nuclear) to the environment and minimal exposures to workers and the public. With institutional control, the facilities would be maintained to ensure that workers and the public received adequate protection in accordance with current Federal regulations such as 10 CFR Part 20 and Part 835 and DOE Order requirements (see Chapter 11, Tables 11-1, 11-3, and 11-4).

In addition, the Scenario 1 analysis assumed that storage facilities would undergo replacement every 100 years and would undergo major repairs halfway through the first 100-year cycle, because the storage facilities at any site would be built for a facility life of less than 100 years. (Federal regulations [10 CFR 72.42(a)] require license renewal every 20 years.) Figure 7-1 shows facility timelines for Scenarios 1 and 2.

DOE and commercial organizations intend to maintain control of the nuclear storage facilities as long as necessary to ensure public health and safety. However, to provide a basis for evaluating the upper limits of potential adverse human health impacts, Scenario 2 assumes no effective institutional control of the storage facilities after approximately the first 100 years. Therefore, after about 100 years and up to 10,000 years, the scenario assumes that spent nuclear fuel and high-level radioactive waste storage facilities at 72 commercial sites and 5 DOE sites would begin to deteriorate and that the radioactive materials in the spent nuclear fuel and high-level radioactive waste would eventually be released to the environment, contaminating the local soil, surface water, and groundwater. Appendix K contains the details of this long-term analysis.

For this environmental impact statement (EIS), DOE performed analyses to 10,000 years from the present. To parallel the repository analysis, the No-Action analysis considered both short- and long-term impacts. Short-term impacts would be those experienced during about the first 100 years, and long-term impacts would be those experienced during the remaining 9,900 years. Short-term impacts would be the

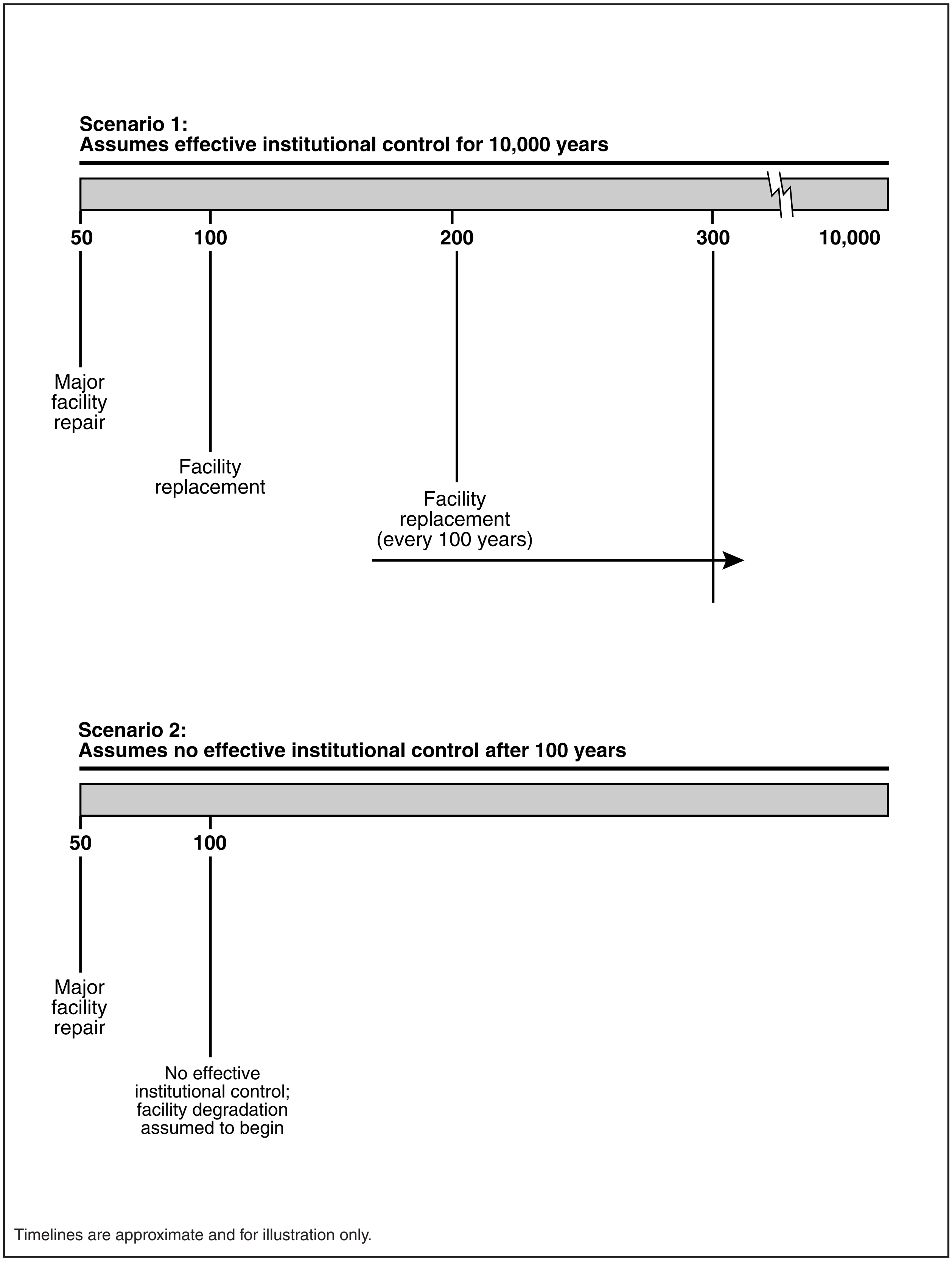

Figure 7-1. Facility timeline assumptions for No-Action Scenarios 1 and 2.

same under Scenarios 1 and 2 because both scenarios assume institutional control during this period. The short-term No-Action Alternative impacts include those resulting from the termination of activities at Yucca Mountain and decommissioning and reclamation of the site, so there would be no long-term impacts at the Yucca Mountain site. In addition, the short-term No-Action Alternative impacts at Yucca Mountain would be the same for both scenarios.

Impacts at the 77 sites after approximately 100 years (long-term) under Scenario 1 primarily would affect facility workers. Long-term impacts at the storage sites after approximately 100 years under Scenario 2 would affect only members of the public because the facility would close and there would be no workers (Scenario 2 assumes no effective institutional control after about 100 years).

To permit a comparison of both short- and long-term impacts from the construction, operation and monitoring, and eventual closure of a proposed repository at Yucca Mountain and from the No-Action Alternative, DOE took care to maintain as much consistency as possible in the methods used to analyze environmental impacts from the proposed repository and the No-Action Alternative. Important consistencies include the following:

- Identical spent nuclear fuel and high-level radioactive waste inventories:
  - Proposed Action: 63,000 metric tons of heavy metal (MTHM) of commercial spent nuclear fuel, 2,333 MTHM of DOE spent nuclear fuel, 8,315 canisters of high-level radioactive waste, and surplus weapons-usable plutonium (as mixed-oxide fuel or immobilized plutonium)
  - Module 1: Proposed Action materials plus an additional 42,414 MTHM of commercial spent nuclear fuel, 167 MTHM of DOE spent nuclear fuel, and 13,965 canisters of high-level radioactive waste resulting in a total of 105,000 MTHM of commercial spent nuclear fuel, 2,500 MTHM of DOE spent nuclear fuel, and 22,280 canisters of high-level radioactive waste.

    This inventory includes surplus plutonium in the form of mixed-oxide fuel or immobilized plutonium (see Appendix A, Figure A-2).
- Identical evaluation periods of 100 years (short-term impacts) and of 100 to 10,000 years (long-term impacts)
- Consistent spent nuclear fuel and high-level radioactive waste corrosion and dissolution models
- Identical radiation dose and risk conversion factors
- Similar assumptions regarding the habits and behaviors of future population groups (that is, they would not be greatly different from those of populations today)

Since issuing the Draft EIS, DOE has continued to evaluate design features and operating modes that would improve long-term repository performance and reduce uncertainty. The result of the design evolution process was the development of the flexible design (DIRS 153849-DOE 2001, all), which was evaluated in the Supplement to the Draft EIS. This design focuses on controlling the temperature of the rock between waste emplacement drifts. As a result of these design changes, this Final EIS evaluates a range of repository operating modes (higher- to lower-temperature). The lower-temperature operating mode has the flexibility to remain open and under *active institutional control* for up to 300 years after emplacement. Although Chapter 4 of this EIS includes an evaluation of impacts for this period, DOE did not evaluate the 300-year institutional control case for the No-Action Alternative. The primary reason for not updating this part of the analysis was because if the institutional control period for the analysis of the No-Action Alternative were extended to 300 years, the short-term environmental impacts would have

INSTITUTIONAL CONTROL

Institutional control implemented by commercial utilities and DOE provides monitoring and maintenance of storage facilities to ensure that radiological releases to the environment and radiation doses to workers and the public remain within Federal limits and DOE Order requirements. Having attained this goal, institutional control ensures the maintenance of incurred doses as low as reasonably achievable, taking social and economic factors into account. Because the future course of action taken by the Nation and by commercial utilities would be uncertain if Yucca Mountain were not recommended as a repository site, the continued storage analysis evaluated two hypothetical scenarios with different assumptions about institutional control to bound potential environmental impacts.

The assumption for Scenario 1 is that DOE and commercial utilities would maintain institutional control of the storage facilities to ensure minimal releases of contaminants to the environment for at least 10,000 years.

Scenario 2 assumes no effective institutional control after approximately 100 years. DOE based the choice of 100 years on a review of generally applicable U.S. Environmental Protection Agency regulations for the disposal of spent nuclear fuel and high-level radioactive waste (40 CFR Part 191), U.S. Nuclear Regulatory Commission regulations for the disposal of low-level radioactive material (10 CFR Part 61), and the National Research Council report on standards for the proposed Yucca Mountain Repository (DIRS 100018-National Research Council 1995, p. 106), which generally discount the consideration of institutional control for longer periods in performance assessments for geologic repositories.

increased by as much as 3 times. DOE did not want to appear to overstate the impacts from the No-Action Alternative.

Since the publication of the Draft EIS, DOE modified the spent nuclear fuel cladding corrosion rates and failure mechanisms used in the performance analysis in Chapter 5 of the Final EIS. DOE did not update these models for the No-Action Alternative Scenario 2 analysis because the outcome would have been an increase in the long-term radiation doses and potential health impacts, however, the increase would be within the uncertainties discussed in Appendix K, Section K.4. In addition, the radionuclide inventories for commercial spent nuclear fuel were updated for the Final EIS (see Appendix A, Tables A-8 and A-9) to reflect the higher initial enrichments and burnup projected for commercial nuclear facilities. Although these revised inventories were used to estimate potential short-term repository impacts in the Final EIS (Chapter 4), DOE chose not to update the No-Action inventories because, again, the effect on the outcome would be about a 15-percent increase in health impacts in this chapter.

Affected populations for the No-Action Alternative were, in general, based on 1990 census estimates and not projected to 2035 as was done for the Proposed Action. However, if the population across the Nation had been projected to 2035, the collective impacts resulting from radiation exposure would have increased by less than a factor of 1.5, which is the average expected increase in national population from 1990 to 2035 (DIRS 152471-Bureau of the Census 2000, all).

7.1 Short-Term Impacts in the Yucca Mountain Vicinity

Chapter 3, Section 3.3, discusses the conditions at the sites that formed the basis for identifying potential impacts associated with the No-Action Alternative. The conditions include the relatively small incremental impacts resulting from continued characterization activities in the Yucca Mountain vicinity until 2002. Under the No-Action Alternative, DOE would terminate characterization activities at the site and would begin site decommissioning and reclamation. Decommissioning and reclamation would include dismantling and removing structures, shutting down some surface facilities, and rehabilitating land disturbed during characterization activities. DOE would salvage usable equipment and materials. Drill holes would be sealed, subsurface drifts and rooms would be left in place, and the portals would be gated. The piles of excavated rock from the tunnel would be landscaped. Areas disturbed by surface studies or used as laydown yards, borrow areas, or the like would be restored. Holding ponds would be backfilled or capped. DOE would not remove foundations or infrastructure such as access roads, parking lots, and sewage systems. The analysis assumed that reclamation activities would take about 1 year. Chapter 2, Section 2.2, describes the No-Action Alternative at Yucca Mountain.

The short-term impacts from reclamation of the Yucca Mountain site would occur regardless of the No-Action Alternative scenario and would be the same for both scenarios.

7.1.1 LAND USE AND OWNERSHIP

Land ownership and control could revert to the original controlling authority.

Under the No-Action Alternative, decommissioning and reclamation would begin as soon as practicable at the Yucca Mountain site, which DOE anticipates would happen in 2002. No new land would be required to support the decommissioning and reclamation activities. Because DOE stored topsoil and material from the mountain during site characterization, it would need no additional land to provide soil for reclaiming the material taken from the mountain or for backfilling holding ponds or the reclamation of other previously disturbed areas. Therefore, the No-Action Alternative would not require the disturbance of additional land at the site. The disturbed land would be restored to its approximate preconstruction condition about 100 years earlier than would occur under the Proposed Action.

7.1.2 AIR QUALITY

Transient effects on air quality would result from the exhausts of the heavy equipment that DOE would use during the decommissioning and reclamation activities that the Department expects to complete over a 1-year period. Recontouring and revegetation activities would generate dust containing particulate matter less than 10 micrometers in diameter (PM_{10}). Impacts on air quality would be about the same as those associated with the construction phase during the Proposed Action for the flexible design, as discussed in Chapter 4, Section 4.1.2, because less land would be disturbed by fewer vehicles during decommissioning and reclamation activities. Because the air quality impacts described in Section 4.1.2 represent a small fraction of the regulatory limit (that is, less than 10 percent of regulatory limits), the No-Action Alternative would not adversely affect air quality.

7.1.3 HYDROLOGY

7.1.3.1 Surface Water

The No-Action Alternative would not adversely affect surface water. During decommissioning and reclamation, adherence to such best management practices as stormwater pollution prevention plans would ensure that cleared areas and exposed earth would be seeded, graveled, or paved to control runoff and minimize soil erosion. To prevent contamination from heavy equipment, workers would monitor the equipment for leaks and would contain and clean up inadvertent spills of industrial fluids following established spill prevention and cleanup plans. DOE would dismantle and remove most surface structures, equipment, and building materials (DIRS 102188-YMP 1995, p. 2-8), including such items as fuel storage tanks and facilities where petroleum products or potentially hazardous materials like paints and solvents were stored before removal. Hazardous materials removed or generated during decommissioning would be taken from the site and reused, recycled, or disposed of in accordance with applicable regulations (DIRS 102188-YMP 1995, p. 2-8). After closure, contaminant sources would be gone so there could be no movement of contaminants to surface water. The analysis assumed that reclamation activities would be complete about 1 year after the decision to implement the No-Action Alternative, which DOE anticipates would occur in 2002.

As part of the reclamation activities, DOE would recontour the landscape to match its precharacterization conditions, ensuring natural drainage patterns. Because the North and South Portal ramps of the Exploratory Studies Facility slope upward to prevent ingress of surface water, they would not appreciably affect natural drainage patterns. Seeding and other erosion control measures would ensure normal infiltration rates. Under the No-Action Alternative, DOE anticipates that the restoration of natural drainage patterns would be complete about 100 years earlier than under the Proposed Action.

7.1.3.2 Groundwater

The No-Action Alternative would not adversely affect groundwater. DOE would remove all sources of contaminants (such as petroleum products and potentially hazardous materials like paints and solvents) from the site. The entrance ramps of the open portals of the Exploratory Studies Facility are sloped such that surface water would drain away from the openings. During reclamation activities (which would take about 1 year), the Exploratory Studies Facility portals would be closed.

7.1.4 BIOLOGICAL RESOURCES AND SOILS

Approximately 1.4 square kilometers (350 acres) of habitat has been disturbed; most of the disturbance is associated with the Exploratory Studies Facility, the storage area for the material removed from the tunnel, the topsoil storage area, borrow pits, boreholes, trenches, and roads. Site reclamation activities would include removal of structures and equipment, soil stabilization, and revegetation plantings at many of the disturbed sites (DIRS 102188-YMP 1995, all). Proper soil stabilization would prevent erosion. Once the area was reclaimed, stabilized, and planted with natural vegetation, and once activities at the site decreased, the precharacterization floral and faunal diversity would begin to reestablish itself. Some animal species could take advantage of abandoned tunnels for shelter; for example, the tunnels could provide attractive roosting and nesting sites for bats. Individuals of the threatened desert tortoise species could be adversely affected during the decommissioning and reclamation of the site. The No-Action Alternative would have no other adverse effects on biological resources or soils. In addition, the reclamation would result in the restoration of 1.4 square kilometers of habitat.

7.1.5 CULTURAL RESOURCES

The potential effects of other uses of the Yucca Mountain site on cultural resources are not known because no other uses have been identified; therefore, no assessment of the effects is possible. If the land were to revert to the previous controlling authorities, the stewardship of cultural resources would be consistent with applicable policies, regulations, and procedures.

Because no additional land would be required for decommissioning and reclamation activities, disturbances to cultural resources on undisturbed land in the area would be unlikely. Leaving access roads in place could have an adverse impact on cultural resources if the site boundaries are not secure. Preserving the integrity of important archaeological sites and resources important to Native Americans could be difficult if the public had increased access to the site.

7.1.6 SOCIOECONOMICS

Many of the repository workers would shift to decommissioning and reclamation tasks. An average annual workforce of about 1,800 would complete decommissioning and reclamation tasks at the repository site. After decommissioning and reclamation, the Nevada Test Site would assume the responsibility of preventing inadvertent entry to the North and South Portal areas. A small workforce would protect these areas after reclamation.

After the 1-year decommissioning and reclamation period, the decommissioning and reclamation workforce, along with about 1,400 project-related workers employed away from the repository site, would lose their jobs. The total direct employment reduction, therefore, would be about 3,200 at the completion of decommissioning and reclamation. For every direct job lost, about 0.46 indirect job would also be lost (DIRS 104508-CRWMS M&O 1999, all). *Indirect jobs* are those created as a result of direct employment; examples would include jobs that provide essential services, such as medical and police protection, to the individuals directly employed by the project. Therefore, the overall impact of the No-Action Alternative would be the loss of approximately 4,700 jobs in the region of influence.

As stated in Chapter 3, Section 3.1.7.1, approximately 79 percent of workers at the Yucca Mountain site reside in Clark County, 19 percent reside in Nye County, and less than 1 percent reside in Lincoln County or elsewhere. Thus, ending characterization activities would have the greatest potential impact in Clark County. If the region (Clark, Lincoln, and Nye Counties) continued to add about 2,800 new jobs every month, impacts would be offset by continued economic growth (Chapter 3, Section 3.1.7.2). Therefore, terminating site characterization activities would have a very minor impact on socioeconomic factors.

The cessation of repository activities would result in the loss of payments by the Federal Government in lieu of taxes. Nye County collects most of the monies associated with the repository project. The 1997 Nye County budget totaled approximately $83.8 million (county government and school district). During the same period, Nye County received approximately $5.4 million as payment in lieu of taxes (DIRS 105001-CRWMS M&O 1999, all).

7.1.7 OCCUPATIONAL AND PUBLIC HEALTH AND SAFETY FOR ROUTINE OPERATIONS

Chapter 2, Section 2.2.1, describes the actions DOE would take at Yucca Mountain under the No-Action Alternative. During the decommissioning and reclamation phase, these actions would expose workers and members of the public to the nonradioactive and radioactive contaminants discussed in Chapter 4, Section 4.1.3.1. In addition, these actions would place workers at risk for occupational (industrial safety) incidents such as illnesses, injuries, and fatalities. Appendix F, Section F.2.2.2, describes the statistics used to estimate health and safety impacts from industrial safety incidents. Because the activities that workers would perform under the No-Action Alternative would involve risks similar to those during the construction and closure phases of the Proposed Action, DOE used these statistics to estimate worker health impacts.

Worker exposures to nonradioactive contaminants of concern (diesel engine exhaust and mineral dusts potentially containing respirable erionite and crystalline silica) during decommissioning and reclamation activities would be limited by administrative and engineering means. Exposures would be maintained below occupational levels that could affect worker health adversely, as specified by the Occupational Safety and Health Administration and detailed in the project health and safety plan (DIRS 105032-CRWMS M&O 1999, all). Accordingly, worker exposures to nonradioactive contaminants would not contribute to adverse health impacts.

Tables 7-2 and 7-3 summarize the estimated total impacts from workplace industrial hazards and from radiological exposure, respectively, for reclamation activities. Table 7-4 summarizes impacts to members of the public.

Involved and noninvolved worker group losses under the No-Action Alternative would be about 94 total recordable cases of injury and illness, resulting in about 45 lost workday cases and no fatalities (Table 7-2).

Table 7-2. Estimated industrial safety impacts for surface and subsurface workers during decommissioning and reclamation activities at Yucca Mountain.[a]

Group	Total recordable cases	Lost workday cases	Fatalities
Involved workers	80	38	0
Noninvolved workers	13	7	0
Totals	***94***	***45***	***0***

a. Source: For impact statistics, Appendix F, Tables F-9 and F-10 (1 year of construction, higher-temperature operating mode, uncanistered packaging scenario).

Worker population radiation exposures during the year of decommissioning and reclamation activities would result from exposure to radioactive radon decay products that would emanate from the tunnel's rock matrix and from ambient radiation. Exposures to the subsurface workers could result in a collective dose of about 150 person-rem (Table 7-3). Doses to the maximally exposed involved subsurface worker and noninvolved worker could be as high as about 260 millirem and 70 millirem, respectively.

Table 7-3. Estimated radiation doses and health effects for surface and subsurface workers from decommissioning and reclamation activities at Yucca Mountain.[a,b]

Group	Maximally exposed individual (millirem)	LCF[c] risk to the maximally exposed individual	Collective worker dose[d] (person-rem)	LCF[e]
Involved workers	260	0.00010	140	0.055
Noninvolved workers	70	0.00027	7.4	0.0030
Totals	***NA***[f]	***NA***	***150***	***0.057***

a. Source: Appendix F, Table F-11; data adjusted for 1 year of construction activity.
b. The impacts listed would be the result of 1 year of decommissioning and reclamation activities; adapted from construction phase impacts. Worker doses would result from exposure to radon and other terrestrial radiation sources.
c. LCF = latent cancer fatality.
d. The calculation of doses and health effects assumes no worker rotation for exposure control purposes.
e. Expected number of cancer fatalities for populations. Based on a risk of 0.0004 latent cancer per rem for workers (DIRS 101857-NCRP 1993, p. 112).
f. NA = not applicable.

Public radiation exposures during decommissioning and reclamation would result from radon emissions from the subsurface facilities. These exposures could result in an annual dose to the hypothetical maximally exposed individual, about 18 kilometers (11 miles) south of the repository, of 0.43 millirem. The maximum collective dose to the projected population of 76,000 within 80 kilometers (50 miles) would be about 1.7 person-rem (Table 7-4).

Table 7-4. Estimated public radiation doses and health effects from decommissioning and reclamation activities at Yucca Mountain.[a]

Group	Maximally exposed individual (millirem per year)	Annual increase in risk for contracting an LCF[b]	Collective public dose[c] (person-rem)	LCF
Public	0.43	0.00000022	1.7	0.00085

a. The impacts listed would be the result of 1 year of decommissioning and reclamation activities (Table 4-2, higher-temperature operating mode, which was assumed to equate to 1 year of initial construction activities).
b. LCF = latent cancer fatality; expected number of cancer fatalities for populations. Based on a risk of 0.0005 latent cancer per rem for members of the public (DIRS 101857-NCRP 1993, p. 112), and a life expectancy of 70 years for a member of the public.
c. The collective dose to 76,000 individuals living within 80 kilometers (50 miles) would be from radon emissions from the subsurface facilities.

The increased likelihood of the maximally exposed individual worker experiencing a latent cancer fatality would be very small.

7.1.8 ACCIDENTS

Under the No-Action Alternative, DOE would not ship spent nuclear fuel and high-level radioactive waste to Yucca Mountain, and there would be only limited quantities of nonradioactive hazardous or toxic substances. Therefore, accident impacts would be limited to those from traffic and industrial hazards.

Table 7-2 lists impacts from industrial accident scenarios and Section 7.1.14 discusses impacts from traffic accident scenarios.

7.1.9 NOISE

Noise levels during decommissioning and reclamation activities would be no greater than those of site characterization activities. After the decommissioning and reclamation activities were complete, ambient noise would return to levels consistent with a desert environment where natural phenomena account for most background noise (see Chapter 3, Section 3.1.9.1). The No-Action Alternative would not adversely affect the noise levels of the Yucca Mountain region.

7.1.10 AESTHETICS

Site decommissioning and reclamation activities would improve the scenic value of the site. Borrow pits and holding ponds would be filled or graded, stabilized, and revegetated. Most structures would be removed down to their foundations. The North and South Portals would be gated. The surface area of these disturbed areas would represent a small fraction of the total surface area of the repository site and, therefore, would be unlikely to cause adverse impacts to the overall scenic value of the area. Under the No-Action Alternative, the site would be returned to a state as close as possible to the predisturbed state; therefore, DOE would not expect adverse impacts to the scenic value of the area. Site restoration would occur about 100 years earlier than under the Proposed Action.

7.1.11 UTILITIES, ENERGY, AND MATERIALS

Decommissioning and reclamation activities would consume electricity, diesel fuel, and gasoline. Much equipment and many materials would be salvaged and recycled. DOE would recycle buildings as practicable. After the site closed, minimal surveillance activities would require some electricity and gasoline. The No-Action Alternative would not adversely affect the utility, energy, or material resources of the region.

7.1.12 WASTE MANAGEMENT

The decommissioning and reclamation of the Yucca Mountain site would generate some waste requiring disposal, including sanitary sewage, sanitary and industrial solid waste, small amounts of demolition debris, and very small amounts of hazardous waste. DOE would dispose of the wastes as it has during the site characterization activities.

DOE would minimize waste generation by salvaging most of the equipment and many materials and redistributing them to other DOE sites or selling them at public auction. Remaining chemical supplies would be redistributed through the DOE excess program, which collects equipment and materials no longer in use for reassignment to other DOE sites or Federal facilities, donation to state governments, or sale to the public. DOE would preserve, rather than demolish, certain facilities that could be useful in the future, such as the electrical distribution and water supply systems. Sanitary sewage would be disposed of in the onsite septic system. At the end of reclamation activities, DOE would cap the inlets to the septic system and leave the system in place. DOE would dispose of sanitary and industrial solid waste and demolition debris in existing Nevada Test Site landfills, where disposal capacity would be available for about 70 years (DIRS 101803-DOE 1995, p. 8).

7.1.13 ENVIRONMENTAL JUSTICE

An examination of analyses from other technical disciplines associated with terminating characterization and construction activities at Yucca Mountain and decommissioning and reclaiming the site shows no potential for large impacts in areas other than cultural resources and socioeconomics. The cultural resources analysis identified the possibility that increased public access (if roads were left open and site boundaries were not secure) could threaten the integrity of archaeological sites and resources important to Native Americans. The socioeconomic analysis identified a potential loss of as many as 4,700 jobs (see Section 7.1.6).

Disproportionate impacts to minority or low-income populations from potential job losses would not be expected because there is no reason to believe that minority or low-income employees would be any more likely to be affected by job loss.

7.1.14 TRAFFIC AND TRANSPORTATION

Fatalities from project-related traffic would be unlikely during decommissioning and reclamation. As a gauge of the probability of 1 fatality, decommissioning and reclamation activities would require about 1 year to complete, or about one-fifth of the time to construct the repository. The analysis in Appendix J estimated less than 0.7 fatality from traffic accidents during repository construction, so less than 0.15 traffic fatality would be likely during decommissioning and reclamation (see Appendix J, Tables J-64 and J-65, for details).

7.1.15 SABOTAGE

There would be no nuclear materials at the Yucca Mountain site, so sabotage concerns would not be pertinent.

7.2 Commercial and DOE Sites

This section analyzes short- and long-term impacts of continued storage of spent nuclear fuel and high-level radioactive waste at 72 commercial and 5 DOE sites for 10,000 years (the period considered for the Proposed Action). The analysis includes No-Action Scenarios 1 and 2.

The following paragraphs discuss short-term impacts under No-Action Scenario 1. Because the analysis assumed that all sites would maintain institutional control for the first approximately 100 years, the short-term impacts for Scenarios 1 and 2 would be the same. For consistency with the Proposed Action, this analysis assumed the No-Action scenarios would begin in 2002. This analysis considered the Idaho National Engineering and Environmental Laboratory to be a site for naval spent nuclear fuel because the Laboratory stores such fuel.

Under the No-Action Alternative, commercial utilities would manage their spent nuclear fuel at 72 facilities. DOE would manage its spent nuclear fuel and high-level radioactive waste at five facilities (the Hanford Site, the Idaho National Engineering and Environmental Laboratory, Fort St. Vrain (spent nuclear fuel only) the West Valley Demonstration Project (high-level radioactive waste only), and the Savannah River Site). The No-Action analysis evaluated the DOE spent nuclear fuel and high-level radioactive waste at existing sites or at sites where existing Records of Decisions have placed or will place these materials. For example, the Record of Decision (60 FR 18589, April 12, 1995) for the Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility (DIRS 103191-DOE 1994, all) decided to complete construction and operate the Defense Waste Processing Facility and associated facilities at the Savannah River Site to pretreat, immobilize, and store high-level radioactive waste. Similarly, the Hanford Site Final Environmental Impact Statement for the Tank Waste Remediation System (DIRS 103214-DOE 1996, all) identified as the preferred alternative ex situ vitrification of high-level radioactive waste with onsite storage until final disposition in a geologic repository. For DOE spent nuclear fuel, the Record of Decision (60 FR 28680, June 1, 1995) for the Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement (DIRS 101802-DOE 1995, all) decided that Hanford production reactor fuel would remain at the Hanford Site; aluminum-clad fuel would be consolidated at the Savannah River Site; and non-aluminum-clad fuels (including spent nuclear fuel from the Fort St. Vrain reactor and naval spent nuclear fuel) would be transferred to the Idaho National Engineering and Environmental Laboratory. Therefore, the analysis evaluated DOE aluminum-clad spent nuclear fuel at the Savannah River Site and DOE non-aluminum-clad fuel at the Idaho National Engineering and Environmental Laboratory; most of the Fort St. Vrain spent nuclear fuel at the Colorado generating site; and high-level radioactive waste at the generating sites (the West Valley Demonstration Project, the Idaho National Engineering and Environmental Laboratory, the Hanford Site, and the Savannah River Site).

The No-Action Alternative assumes that the spent nuclear fuel and high-level radioactive waste would be treated, packaged, and stored in a condition ready for shipment to a repository. The amount (inventory) of spent nuclear fuel and high-level radioactive waste considered in this analysis would be the same as that for the Proposed Action—70,000 metric tons consisting of 63,000 MTHM of commercial spent nuclear fuel, 2,333 MTHM of DOE spent nuclear fuel, 8,315 canisters of solidified high-level radioactive waste. The 70,000 MTHM would include surplus plutonium in the form of mixed-oxide fuel and immobilized plutonium. In addition, DOE recognizes that more than 107,000 MTHM of commercial and DOE spent nuclear fuel and more than 22,000 canisters of high-level radioactive waste could require storage if a disposal site is not available. Section 7.3 describes the assumptions and analytical methods used to estimate impacts for the total projected inventory of spent nuclear fuel and high-level radioactive waste, referred to as Inventory Module 1, and evaluates the potential impacts of the continued storage of the total projected inventory of commercial and DOE spent nuclear fuel and high-level radioactive waste.

Storage Packages and Facilities at Commercial and DOE Sites

A number of designs for storage packages and facilities at the commercial and DOE sites would provide adequate protection from the environment for packages containing spent nuclear fuel and high-level radioactive waste. Because it has not selected specific designs for most locations, DOE selected a representative range of commercial and DOE designs for analysis, as described in the following paragraphs. In addition, for purposes of analysis, the No-Action Alternative assumed that the commercial and DOE sites have sufficient land to construct the initial and replacement storage facilities and that the initial construction of all dry storage facilities would be complete and the facilities filled by 2002.

Spent Nuclear Fuel Storage Facilities

Most commercial sites currently store their spent nuclear fuel in water-filled basins (fuel pools) at the reactor sites. Because they have inadequate storage space, some commercial sites have built what are called *independent spent fuel storage installations,* in which they store dry spent nuclear fuel above ground in metal casks or in welded canisters inside reinforced concrete storage modules. Other commercial sites plan to build independent spent fuel storage installations so they can proceed with the decommissioning of their nuclear plants and termination of their operating licenses (for example, the Rancho Seco and Trojan plants). Because commercial sites could elect to continue operations until their fuel pools became full and then cease operations, the EIS analysis initially considered ongoing wet storage in existing fuel pools to be a potentially viable option for spent nuclear fuel storage. However, dry storage is almost certainly the preferred option for long-term spent fuel storage at commercial sites for the following reasons (DIRS 101899-NRC 1996, pp. 6-76 and 6-85):

- Dry storage is a safe economical method of storage.
- Fuel rods in dry storage are likely to be environmentally secure for long periods.
- Dry storage generates minimal, if any, low-level radioactive waste.
- Dry storage units are simpler and easier to maintain.

Accordingly, this EIS assumes that all commercial spent nuclear fuel would be stored in dry configurations in independent spent fuel storage installations at existing locations (Figure 7-2 is a photograph of a typical independent spent fuel storage installation). This assumption includes spent nuclear fuel at sites that no longer have operating nuclear reactors. Although most utilities and DOE have not constructed independent spent fuel storage installations or designed dry storage containers, this analysis evaluates the impacts of storing all commercial and some DOE spent nuclear fuel in horizontal concrete storage modules (Figure 7-3) on a concrete pad at the ground surface. Concrete storage modules have openings that allow outside air to circulate and remove the heat of radioactive decay. The analysis assumed that spent nuclear fuel from both pressurized-water and boiling-water reactors would be stored in a dry storage canister inside the concrete storage module. Figure 7-4 shows a typical dry storage canister, which would consist of a stainless-steel outer shell, welded end plugs, pressurized helium internal environment, and criticality-safe geometry for 24 pressurized-water or 52 boiling-water reactor fuel assemblies.

The combination of the dry storage canister and the concrete storage module would provide safe storage of spent nuclear fuel as long as the fuel and storage facilities were maintained properly. The reinforced concrete storage module would provide shielding against the radiation emitted by the spent nuclear fuel. In addition, the concrete storage module would provide protection from damage resulting from accidents such as aircraft crashes and from natural hazard phenomena such as earthquakes or tornadoes.

This analysis assumed that DOE would store dry spent nuclear fuel at the Savannah River Site, the Idaho National Engineering and Environmental Laboratory, and Fort St. Vrain in stainless-steel canisters inside above-grade reinforced concrete storage modules. In addition, it assumed that the design of DOE above-ground spent nuclear fuel storage facilities would be similar to the independent spent fuel storage installations at commercial sites.

The analysis assumed that DOE would store spent nuclear fuel at Hanford in a dry cask in below-grade storage facilities. DOE would store Hanford N-Reactor fuel in the Canister Storage Building, which would consist of three below-grade concrete vaults with air plenums for natural convective cooling. The vaults would contain vertical storage tubes made of carbon steel. Each storage tube, which would hold two spent nuclear fuel canisters, would be sealed with a shield plug. DOE would cover the vaults with a structural steel shelter.

High-Level Radioactive Waste Storage Facilities

With one exception, this analysis assumed that DOE would store solidified high-level radioactive waste in dry below-grade, high-level radioactive waste storage facilities (Figure 7-5). At the West Valley Demonstration Project, the analysis assumed that DOE would use a dry storage system similar to a commercial independent spent nuclear fuel storage installation for high-level radioactive waste.

A high-level radioactive waste storage facility consists of four areas: below-grade storage vaults, an operating area above the vaults, air inlet shafts, and air exhaust shafts. The canister cavities are galvanized-steel large-diameter pipe sections arranged in a grid. Canister casings are supported by a concrete base mat. Space between the pipes is filled with overlapping horizontally-stepped steel plates that direct most of the ventilation air through the storage cavities.

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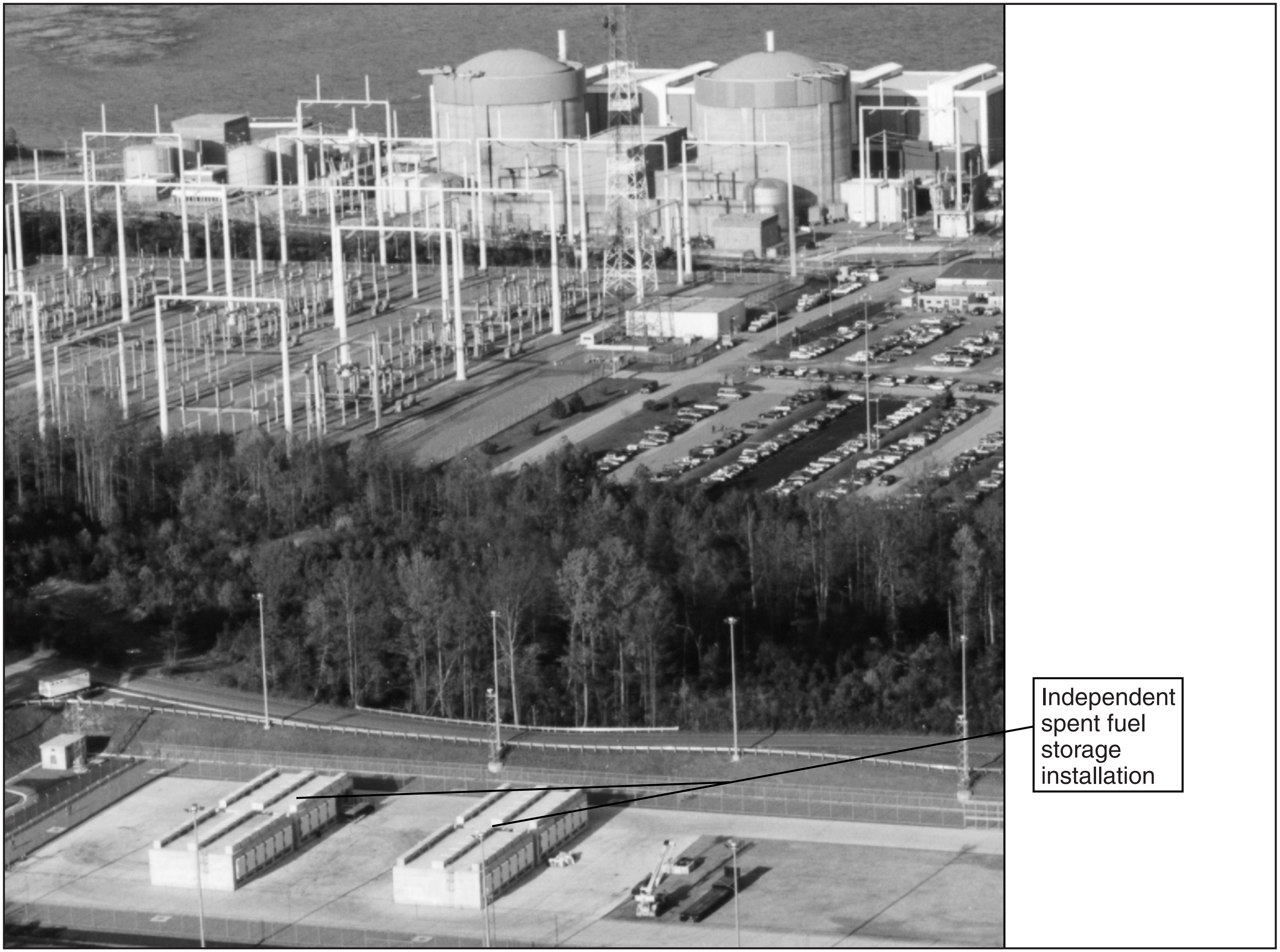
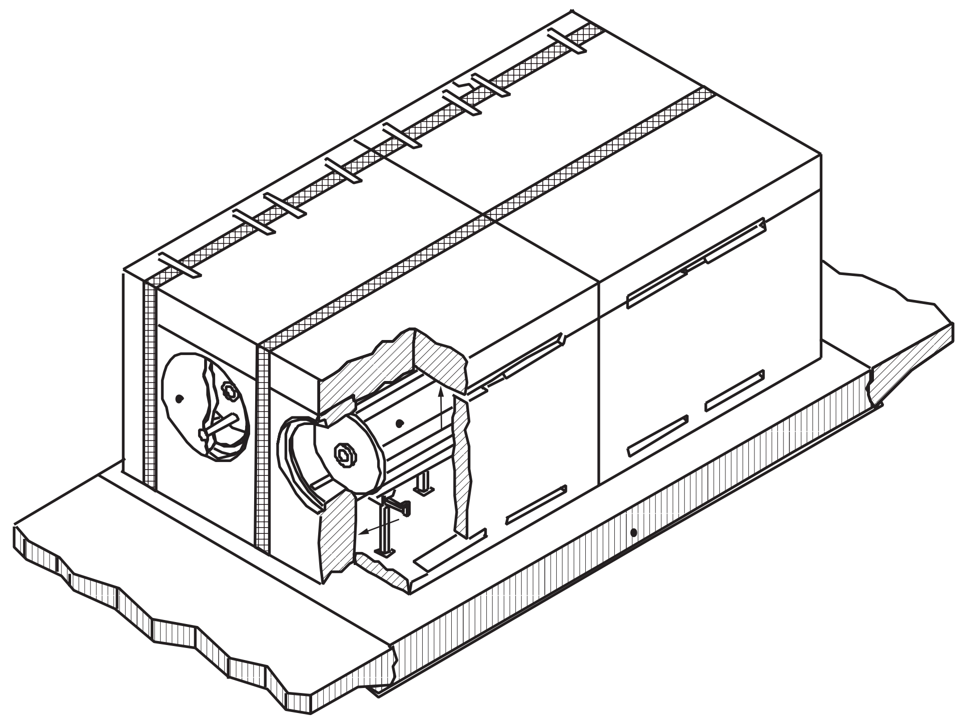


Figure 7-2. Typical independent spent fuel storage installation.



Source: Modified from DIRS 101910-Poe (1998, p. 1-2).

Figure 7-3. Spent nuclear fuel concrete storage module.

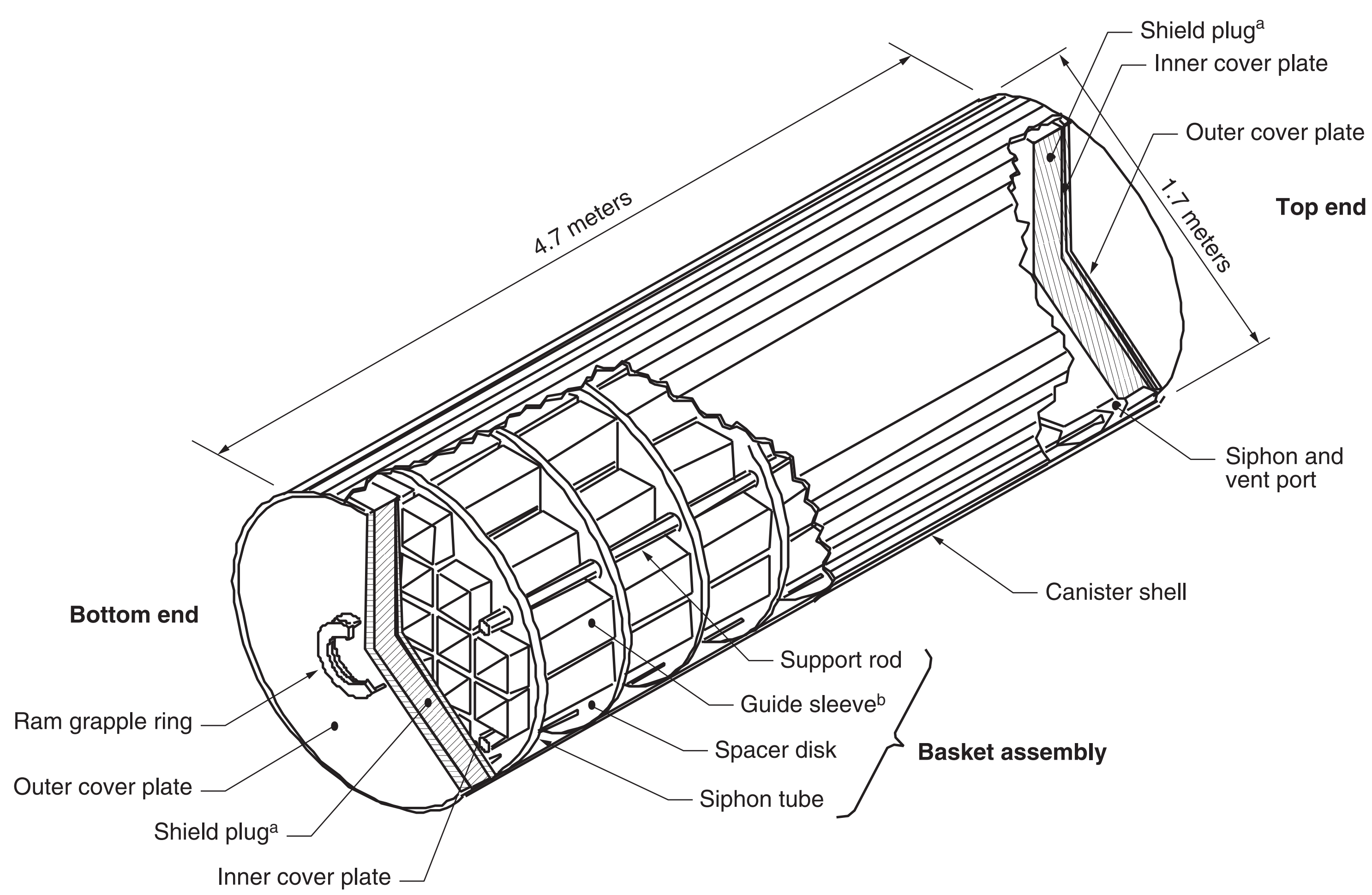
The below-grade storage vault would be below the operating floor, which would be slightly above grade. The storage vault would be designed to withstand earthquakes and tornadoes. In addition, the operating area would be enclosed by a metal building, which would provide weather protection and prevent the infiltration of precipitation. The storage vault would be designed to store the canisters and protect the operating personnel, the public, and the environment for as long as the facilities were maintained. The surrounding earth, concrete walls, and a concrete deck that would form the floor of the operating area would provide radiation shielding. Canister cavities would have individual precast concrete plugs.

Each vault would have an air inlet, air exhaust, and air passage cells. The storage facility's ventilation system would remove the heat of radioactive decay from around the canisters. The exhaust air could pass through high-efficiency particulate air filters before it discharged to the atmosphere through a stack. As an alternative, natural convection cooling without filters could be used. The oversized diameter of the pipe storage cavities would allow air to pass around each cavity.

7.2.1 NO-ACTION SCENARIO 1

Under Scenario 1, 72 commercial sites and 5 DOE sites would store spent nuclear fuel and high-level radioactive waste for 10,000 years. Institutional control, which would be maintained for the entire 10,000-year period, would ensure regular maintenance and continuous monitoring at these facilities that would safeguard the health and safety of facility employees, surrounding communities, and the environment. The spent nuclear fuel and immobilized high-level radioactive waste would be *inert* material encased in durable, robust packaging and stored in above- or below-grade concrete facilities. Release of contaminants to the ground, air, or water would not be expected during routine operations.

DOE and commercial utility workers would perform all maintenance including routine industrial maintenance and maintenance unique to a nuclear materials storage facility under standard operating



All materials 304 stainless steel except as noted.

a. Shield plug would be lead.

b. Borated neutron absorber plate
for boiling-water reactor spent nuclear fuel assemblies.

To convert meters to feet, multiply by 3.2808.

Source: Modified from DIRS 101910-Poe (1998, p. 1-5).

Figure 7-4. Spent nuclear fuel dry storage canister.

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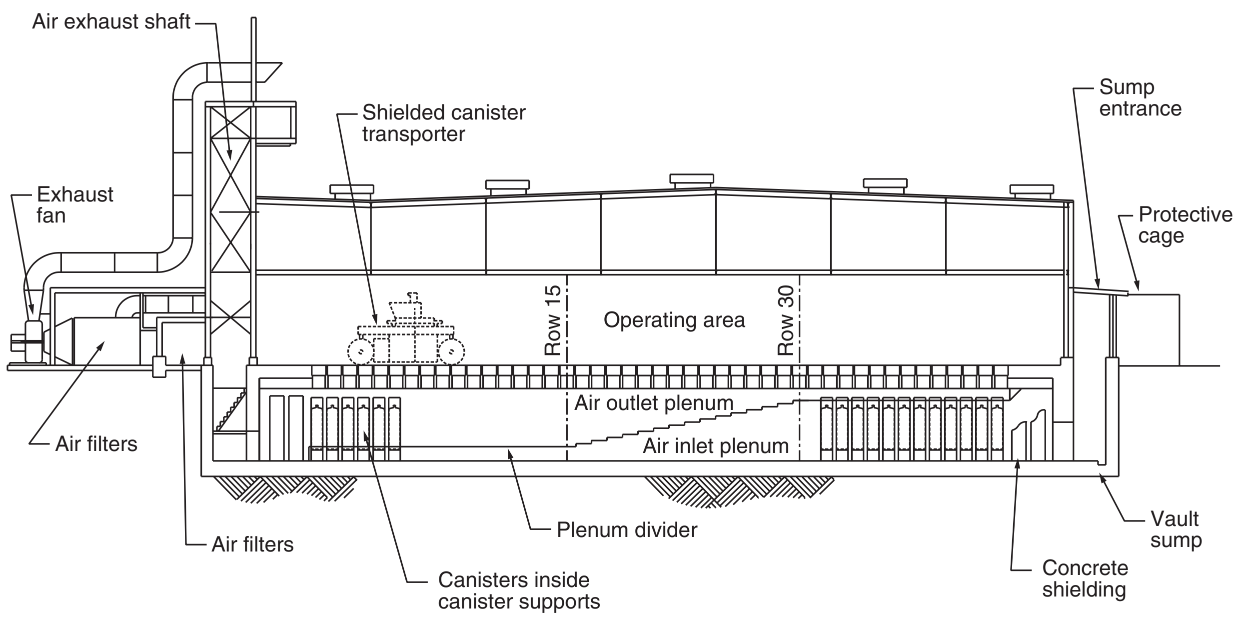

Source: Derived from DIRS 101910-Poe (1998, pp. 4-7, 4-8, and 4-11).

Figure 7-5. Conceptual design for solidified high-level radioactive waste storage facility.

procedures and best management practices to ensure minimal releases of contaminants (industrial and nuclear) to the environment and minimal exposures to workers and the public. This analysis assumed that DOE would manage these facilities in accordance with Departmental rules (10 CFR Part 835) and Orders (see Chapter 11) and that commercial facilities would meet applicable environmental safety and health requirements. It also assumed that storage facilities would require replacement every 100 years and that they would undergo major repairs halfway through the first 100-year cycle. Chapter 2, Section 2.2, provides additional information pertaining to Scenario 1. The following sections treat short- and long-term impacts separately where appropriate.

7.2.1.1 Land Use and Ownership

The storage facilities for spent nuclear fuel and high-level radioactive waste would be at commercial and DOE sites. Facilities would require replacement every 100 years (beginning about 2110), which would occur on land immediately adjacent to the existing facilities. The land required for a storage facility typically would be a few acres, a small percentage of the land available at current sites. An environmental assessment of an independent spent fuel storage installation determined that operation of the facility would require no more land than it occupied (DIRS 101898-NRC 1991, p. 20).

At the end of each 100-year cycle, a new facility constructed next to the old one would contain the spent nuclear fuel or high-level radioactive waste. The old facility would be demolished and the land reclaimed and maintained for the next 100 years. By alternating the facility between two adjacent locations, minimal land would be required.

Storage facilities would be on land owned by either DOE or a utility. Storage at these sites would be unlikely to affect land use and ownership.

7.2.1.2 Air Quality

As a part of routine operations, best management practices and effective monitoring procedures would ensure that any contaminant releases to the air would be minimal and would not exceed current regulatory limits (40 CFR Part 61 for hazardous air pollutant emissions and Part 50 for air quality standards). Therefore, the No-Action Alternative would not produce adverse impacts to air quality during routine operations.

The analysis assumed that the storage facilities would require complete replacement every 100 years. During the construction of the replacement facility, exhaust from construction vehicles would temporarily increase local levels of hydrocarbons, carbon monoxide, and oxides of nitrogen, but these and other atmospheric pollutants would be likely to remain within National Ambient Air Quality Standards (see Chapter 3, Table 3-5). Temporary increases in particulate matter would result from these construction activities. Mitigation measures such as watering unpaved roads would limit the generation of fugitive dust. In addition, after replacement the old site would be seeded, graveled, or paved to reduce air emissions. Detrimental air quality impacts would be short-term, minimal, and transient.

Very small air quality impacts would be likely from repackaging materials removed from dry storage containers that could degrade to the point that they no longer met licensing requirements; these impacts were not included in the overall impact estimates. Long-term dry storage canister degradation would be highly variable and difficult to estimate from site to site, and DOE did not want to overestimate the accompanying air quality impacts from repackaging.

7.2.1.3 Hydrology

7.2.1.3.1 *Surface Water*

As part of routine operations, best management practices such as stormwater pollution prevention plans and stormwater holding ponds would ensure that, in the unlikely event of an inadvertent contaminant release, contaminants did not reach surface-water systems. Effective monitoring procedures would ensure that operation of the facility did not adversely affect surface waters and that no discharges would contaminate surface waters in excess of drinking water regulatory limits (40 CFR Part 141). Detention basins would capture all runoff, which would be monitored for contamination and treated, as necessary, before it was released to the environment. If the storage facility required active cooling systems, those systems would be designed to contain any inadvertent spill of operating fluids so they could not reach the environment. Therefore, No-Action Scenario 1 would be unlikely to produce adverse impacts to surface-water quality during routine operations.

During construction of the replacement storage facilities, adherence to stormwater pollution prevention plans would ensure that cleared areas and exposed earth would be seeded, graveled, or paved to control runoff and minimize soil erosion that could adversely affect surface-water quality. Surface-water runoff detention ponds would prevent eroded material from entering surface water systems. These erosion control practices would ensure minimal impacts to surface-water quality during construction. To prevent contamination from construction equipment, workers would monitor the equipment for leaks. Inadvertent spills of industrial fluids would be contained and cleaned up in accordance with established spill prevention and cleanup plans. Therefore, the No-Action Alternative would be unlikely to produce adverse impacts to surface-water quality during construction operations.

7.2.1.3.2 *Groundwater*

During routine operations, best management practices such as spill prevention and cleanup plans and procedures and effective monitoring procedures would ensure that inadvertent contaminant releases would not reach groundwater. Therefore, the No-Action Alternative would be unlikely to produce adverse impacts to groundwater quality during routine operations.

The spent nuclear fuel storage facilities at the commercial sites would be surface structures with shallow foundations such that their construction would not disturb groundwater systems. Some DOE storage facilities would be subsurface structures for which construction might require minimal dewatering of the groundwater aquifer. However, the area occupied by the structure would be small in relation to the size of the aquifer, so no adverse impacts would be likely to result from dewatering activities.

Excavations would remove the soil buffer between surface activities and groundwater, increasing the likelihood of groundwater contamination from an inadvertent spill or leak of construction-related fluids (for example, diesel fuel, oil, hydraulic fluids). Construction activities would be as described above for surface water; thus, the penetration of spilled construction fluids to groundwater would be unlikely. Therefore, the No-Action Alternative would be unlikely to produce adverse impacts to groundwater quality during construction operations.

7.2.1.4 Biological Resources and Soils

Impacts to biological resources or soils from the construction and operation of spent nuclear fuel and high-level radioactive waste storage facilities would be minimal. Heat from the storage modules would not affect nearby vegetation. The storage facilities would be fenced to keep wildlife out. However, some smaller animal species could take advantage of the warm air from storage facility vents in winter, and individual animals could receive adverse impacts, including death, from direct exposure to radiation. As the heat of radioactive decay decreased, these sites would become less attractive to animals seeking warm environments.

The storage facilities would have a minimal effect on the soil. Because the operating and decommissioned facilities would alternate between two locations, the amount of soil disturbed by construction would be very small. By adhering to best management practices and standard operating procedures, DOE expects that spills would be minimal. A spill would be contained and cleaned up immediately, thus minimizing the area of soil affected.

7.2.1.5 Cultural Resources

Replacement spent nuclear fuel and high-level radioactive waste storage facilities would generally be on undeveloped land in rural areas owned by DOE or the commercial utilities. The size of each facility and supporting infrastructure would be small enough to avoid known cultural resources. If construction activities uncovered previously unknown archaeological sites, human remains, or funerary objects, DOE or the commercial utility would comply with Executive Orders and Federal and state regulations for the protection of cultural resources (see Chapter 11, Section 11.2.5, for details). Therefore, the No-Action Alternative would be unlikely to produce adverse impacts to cultural resources during construction and operations.

7.2.1.6 Socioeconomics

Storage facilities for spent nuclear fuel and high-level radioactive waste would be at existing DOE and commercial sites. A staff of about eight workers (two individuals on duty per shift, 24 hours per day) would monitor and maintain each facility (DIRS 104596-Orthen 1999, Table 2, p. 4). The analysis assumed that facilities would require replacement every 100 years, and that there would be a major facility repair halfway through the first 100-year cycle. Facility replacement every 100 years would require approximately 40 workers for 2 years (DIRS 104596-Orthen 1999, Table 2 and Table 6). Major

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repairs halfway through the first 100-year cycle would require about 40 workers for 1 year (DIRS 104596-Orthen 1999, Table 2 and Table 6).

Each of the 77 sites that stores spent nuclear fuel or high-level radioactive waste employs monitoring and maintenance personnel. Additional staffing for facility replacement [and the one-time major repair (see DIRS 104596-Orthen 1999, Tables 1 and 2)] would be temporary and comprise about 40 employees at a site during construction. (Construction of DOE facilities could require more workers, but the Department would have only five of these facilities reconstructed every 100 years.) This temporary increase in employment would be small in proportion to the existing workforces in affected communities. Therefore, the No-Action Alternative would be unlikely to have adverse effects on socioeconomic factors such as infrastructure and regional economy.

7.2.1.7 Occupational and Public Health and Safety

7.2.1.7.1 *Nonradiation Exposures*

Maintenance, repairs, repackaging, and construction at the storage facilities would be conducted in accordance with requirements of the Occupational Health and Safety Administration and National Institute of Occupational Safety and Health. Administrative controls and design features would minimize worker exposures to industrial nonradioactive hazardous materials during the construction and operation of the storage facilities so exposures would remain below hazardous levels.

7.2.1.7.2 *Industrial Hazards*

The industrial hazards evaluated were (1) total recordable injury and illness cases, (2) lost workday cases associated with workplace injuries and illnesses, and (3) workplace fatalities. The estimates of these traumas were based primarily on the staffing level of involved workers assigned to spent nuclear fuel and high-level radioactive waste management tasks, coupled with representative workplace loss indicators maintained by the Bureau of Labor Statistics (DIRS 148091-BLS 1998, all) or the DOE Computerized Accident/Incident Reporting System database (DIRS 147938-DOE 1999, all). Involved worker risk exposure estimates were based on crew sizes to determine the number of full-time equivalent work years assigned to construction and to operations, surveillance, and maintenance tasks. DOE used representative historic total recordable case, lost workday case, and fatality incident data to project the associated trauma incidence based on the number of workers and their job functions.

This analysis assumed that replacement facilities would be constructed every 100 years and that a major repair and upgrade of the initial facilities would be required once after the first 50 years. Impacts from decommissioning retired facilities were included as part of construction.

For the approximately 100-year construction and operation cycle (2002 to 2116), about 72,000 full-time equivalent work years of effort would be required to maintain and repair about 6,600 concrete storage modules and 4 below-grade storage vaults at the 72 commercial and 5 DOE sites (DIRS 104596-Orthen 1999, Tables 1, 6, and 7). Based on this level of effort, as listed in Table 7-5, about 2,300 industrial safety incidents would be likely, resulting in about 1,000 lost workday cases and 2 fatalities (an average of 1 fatality every 50 years).

In addition, for the remaining 9,900 years, Table 7-5 indicates about 290,000 estimated industrial safety incidents, of which about 130,000 would be lost workday cases and 320 would involve fatalities (an average of 1 fatality every 30 years or about one every 2,500 years at each of the 77 sites). Surveillance tasks would consume 94 percent of the total worker level of effort, construction tasks would consume nearly all of the remaining 6 percent, and operations tasks would consume less than 0.001 percent (DIRS 104596-Orthen 1999, Table 2).

7.2.1.7.3 *Radiation Exposures*

For Scenario 1, the analysis assumed that the facilities would undergo major repairs once during the first 100 years and would be replaced every 100 years thereafter. Very low exposures to future construction workers would occur as they built replacement facilities adjacent to the existing facilities. Transferring the dry storage canisters from old to new concrete storage modules would result in some additional exposures to workers.

Table 7-5. Estimated industrial safety impacts at commercial and DOE sites during the first 100 years and the remaining 9,900 years of the 10,000-year analysis period under Scenario 1.[a]

Industrial safety impacts	Short-term[b] (100 years) construction and operation	Long-term (9,900 years)[c] construction and operation
Total recordable cases	2,300	290,000
Lost workday cases	1,000	130,000
Fatalities	2.4	320

a. Source: DIRS 104596-Orthen (1999, Tables 6 and 7).
b. The estimated impacts would result from a single 100-year period of storage module construction (renovation), operation, surveillance, and repair.
c. Period from 100 to 10,000 years.

During normal operations, facility workers would be exposed to low levels of external radiation while performing routine surveillance and monitoring activities, changing high-efficiency particulate air filters on ventilation systems (for high-level radioactive waste storage facilities), transferring dry storage canisters between concrete storage modules, and maintaining and repairing the facilities. In addition, individuals employed at the nearby nuclear powerplant but not directly involved with activities at the spent nuclear fuel storage facility (noninvolved workers) would be exposed to low levels of external radiation emanating from the filled concrete storage modules. Activities within the facility boundaries would be in accordance with DOE or Nuclear Regulatory Commission guidelines for nuclear facility worker protection (10 CFR Part 835 and 10 CFR Part 20). Table 7-6 lists estimated maximum annual individual doses and the total average collective dose for worker populations during the 100- and 10,000-year analysis periods for commercial and DOE sites.

The Scenario 1 analysis treated the dose rates from DOE spent nuclear fuel as equivalent to commercial spent nuclear fuel on a volume basis. This simplifying assumption had minimal effect on estimated individual and population doses because of the relatively small quantities of DOE spent nuclear fuel (less than 10 percent of the total) and essentially equal radiation exposure rates in comparison to commercial spent nuclear fuel on a volume basis. The analysis separated the calculation of dose rates from high-level radioactive waste because of the difference in source materials.

For Scenario 1, dose rates from high-level radioactive waste were estimated based on the isotopic distributions provided in Appendix A, Tables A-28, A-29, and A-30. As with commercial and DOE spent nuclear fuel, estimated dose rates to facility workers considered shielding provided by the concrete facility structures and decay over the 10,000-year analysis period. However, because of the relatively large distance from the storage facilities to the site boundary [typically more than 3 kilometers (2 miles) at the Hanford Site, the Idaho National Engineering and Environmental Laboratory, and the Savannah River Site], doses to the public were not included. Although the distance to the site boundary at the West Valley Demonstration Project is less than 3 kilometers, not including public exposures from above-grade storage facilities would result in a very small underestimation of impacts because DOE stores only about 4 percent of the high-level radioactive waste at that facility.

Very small air quality impacts would be likely from repackaging materials removed from dry storage containers that could degrade to the point that they no longer met licensing requirements. However, overall impact estimates did not include these impacts because long-term dry storage canister degradation would be highly variable and difficult to estimate from site to site, and DOE did not want to overestimate the accompanying air quality impacts from repackaging.

Table 7-6. Estimated radiological impacts (dose) and consequences from construction and routine operation of commercial and DOE spent nuclear fuel and high-level radioactive waste storage facilities – Scenario 1.[a]

Receptor	Short-term (100 years) construction and operation	Long-term (9,900 years) construction[b] and operation
Population[c]		
MEI[d] (millirem per year)	0.20	0.06
Dose[e] (person-rem)	810	5,200
LCFs[f]	0.41	2.6
Involved worker[g]		
MEI[h] (millirem per year)	170	50
Dose[e] (person-rem)	2,600	24,000
LCFs[f]	1.0	10
Noninvolved workers[i]		
MEI[j] (millirem per year)	13	0[k]
Dose[e] (person-rem)	36,000	0[k]
LCFs[f]	15	0[k]

a. Source: Adapted from DIRS 101898-NRC (1991, all); DIRS 104596-Orthen (1999, all).
b. Assumes construction of 6,600 concrete storage modules and three below-grade vaults at 77 sites every 100 years (DIRS 104596-Orthen 1999, Table 1).
c. Members of the general public living within 3 kilometers (2 miles) of the facilities; estimated to be 140,000 over the first approximately 100 years and approximately 14 million over the duration of the analysis period [estimated using DIRS 102204-Humphreys, Rollstin, and Ridgely (1997, all)].
d. MEI = maximally exposed individual; assumed to be approximately 1.4 kilometers (0.8 mile) from the center of the storage facility (DIRS 101898-NRC 1991, p. 22).
e. Estimated doses account for radioactive decay.
f. LCF = latent cancer fatality; expected number of cancer fatalities for populations. Based on a risk of 0.0004 and 0.0005 latent cancer fatality per rem for workers and members of the public, respectively (DIRS 101857-NCRP 1993, p. 112), and a life expectancy of 70 years for a member of the public and a 50-year career for workers.
g. Involved workers would be those directly associated with construction and operation activities (DIRS 101898-NRC 1991, pp. 23 to 25). For this analysis, the involved worker population would be approximately 1,400 individuals (700 individuals at any one time) at 77 sites over 100 years (DIRS 104596-Orthen 1999, Table 6). This population would grow to about 160,000 over 10,000 years.
h. Based on maximum construction dose rate of 0.11 millirem per hour and 1,500 hours per year (DIRS 101898-NRC 1991, p. 23).
i. Noninvolved workers would be employed at the powerplant but would not be associated with facility construction or operation. For this analysis, the noninvolved worker population would be 80,000 individuals who would receive exposures until the powerplants were decommissioned (50 years).
j. Based on a projected area workforce of 1,200 and an average estimated annual dose of 16 person-rem (DIRS 101898-NRC 1991, p. 24).
k. During this period the powerplants would have ended operation, so there would be no noninvolved workers.

As listed in Table 7-6, the estimated dose to the hypothetical maximally exposed offsite individual during the short-term operational period between 2002 and 2116 would be about 0.20 millirem per year (DIRS 101898-NRC 1991, p. 22). For the remaining 9,900 years of the analysis period (long-term impacts), the dose to the hypothetical maximally exposed individual would decrease to about 0.060 millirem per year because of radioactive decay of the source material. During about the first 100 years, the dose (accounting for radioactive decay) could result over a 70-year lifetime of exposure in an increase of 0.0000043 in the lifetime risk of contracting a fatal cancer, an increase over the lifetime natural fatal cancer incidence rate of 0.0018 percent. During the remaining 9,900 years of the analysis period, the dose could result in an increase of 0.0000013 in the lifetime risk of contracting a fatal cancer, an increase of 0.00055 percent over the lifetime natural fatal cancer incidence rate.

Based on the Nuclear Regulatory Commission computer program SECPOP (DIRS 102204-Humphreys, Rollstin, and Ridgely 1997, all), in 1990 approximately 100,000 people lived within 3 kilometers (2 miles) of some type of commercial nuclear facility (DIRS 101917-Rollins 1998, p. 9). Over the 100-year analysis period, the total number of people that would be exposed would be approximately 140,000 because more than one 70-year lifetime would be spanned during the 100-year period. As listed in Table 7-6, between 2002 and 2116 these people would be likely to receive a total collective dose of 810 person-rem.

Long-term doses and latent cancer fatalities for the approximately 9,900-year period between 2116 and 12010 were based on the assumptions described above, with a few notable exceptions. Impacts to noninvolved workers were not calculated because all of the nuclear powerplants would be closed by the beginning of this period. In addition, the total exposed populations of workers and the public would increase by a factor of 100 above the 100-year exposed population because this period would span 140 lifetimes of 70 years. As noted above, for the first 100 years of operation approximately 140,000 people living within 3 kilometers (2 miles) of the storage facilities (100,000 people multiplied by 1.4 consecutive 70-year average human lifetimes [the average number of 70-year lifetimes in 100 years]) would be exposed to external radiation. Over 10,000 years the exposed population would total approximately 14 million people. Therefore, for the period between 2116 and 12010, the offsite population would receive an estimated total collective dose of 5,200 person-rem (adjusted for radioactive decay).

Population statistics indicate that in 1990 cancer caused about 24 percent of the deaths in the United States (DIRS 153066-Murphy 2000, p. 5). If this percentage of deaths from cancer continued, about 24 people out of every 100 in the U.S. population would contract a fatal cancer from some cause. For approximately the first 100 years, the radiation exposure dose from the storage facilities could cause an additional 0.41 latent cancer fatality in the surrounding populations. This would be in addition to about 33,000 cancer fatalities that would be likely in the exposed population of 140,000 from all other causes, or an increase in the natural incidence rate of 0.0012 percent. For the remaining 9,900 years of the analysis, the radiation exposure dose from the storage facilities could result in an additional 2.6 latent cancer fatalities in the surrounding populations. This would be in addition to about 3.3 million cancer fatalities that would be likely to occur in the exposed population of 14 million, or an increase of 0.000079 percent over the natural incidence rate.

The analysis assumed the maximally exposed individual in the involved worker population would be involved in constructing and loading replacement facilities. Assuming a maximum dose rate of 0.11 millirem per hour and an average exposure time of 1,500 hours per year, this construction worker would receive about 170 millirem per year. During about the first 100 years, the dose could result (over 3 years of construction) in an increase in the lifetime risk of contracting a fatal cancer of 0.00020, an increase of 0.090 percent over the national fatal cancer incidence rate of about 24 percent. During the remaining 9,900 years of the analysis period, the dose could result (over 3 years of construction) in an increase in the risk of contracting a fatal cancer of 0.000060, an increase of 0.030 percent over the natural fatal cancer incidence rate.

For the involved worker population of 1,400 individuals, approximately 330 would be likely to contract a fatal cancer from some cause other than occupational exposure. In this population (during the first 100 years), the collective dose of 2,600 person-rem (correcting for decay) between 2002 and 2116 could result in about 1 additional latent cancer fatality (DIRS 104596-Orthen 1999, Table 6), an increase of 0.33 percent over the natural incidence rate of fatal cancers from all causes. During the remaining 9,900 years of the analysis period, the approximately 160,000 involved workers would receive a collective dose of 24,000 person-rem (corrected for decay). This dose could result in an additional 10 latent cancer fatalities (about 1 every 1,000 years during the 9,900-year analysis period), an increase of 0.027 percent over the natural incidence rate of fatal cancers.

Noninvolved workers would be those employed at an operating nuclear powerplant but not directly involved with the day-to-day operation of the spent nuclear fuel storage facility. The analysis assumed that noninvolved workers (about 800 for each of the approximately 100 reactor units at 72 commercial sites) would be generally several hundred to several thousand feet from the storage facilities. In addition, it assumed that noninvolved workers would be at the sites until 2052 (that is, for 50 years).

The Nuclear Regulatory Commission estimated that the dose to noninvolved workers at a nuclear powerplant from a fully loaded independent spent fuel storage installation would be about 16 person-rem per year (DIRS 101898-NRC 1991, p. 24) for the protected-area workforce of 1,200 individuals (DIRS 101898-NRC 1991, p. 26) at the two-unit station of Calvert Cliffs. This collective dose would result in an average maximum dose to the noninvolved worker of 13 millirem per year. Over a 50-year career, this exposure (accounting for radioactive decay) could result in an increase in lifetime risk of contracting a fatal cancer of 0.00018, an increase of 0.077 percent over the natural incidence rate of fatal cancers.

The analysis made the conservative assumption that there are about 80,000 powerplant workers in the United States (800 per reactor unit and about 100 units currently operating), and that these workers would receive radiation exposure from the adjacent storage facilities until powerplant decommissioning, which the analysis assumed will occur in 2052. In the total noninvolved worker population of 80,000 powerplant workers (all sites), the collective dose of 36,000 person-rem (accounting for radioactive decay) between 2002 and 2116 could result in 15 additional latent cancer fatalities. This would be about 0.079 percent more than the 19,000 cancer fatalities that would be likely to occur from all other causes in the same worker population.

Figure 7-6 shows the calculated dose to these populations as a function of time, expressed as 70-year doses. For the noninvolved worker population, the population dose would occur during only the first 70-year interval. The public dose would decrease over time due to the inherent radioactive decay that will occur in the spent nuclear fuel and high-level radioactive waste as time elapses. Many of the radioactive constituents have half-lives substantially less than 10,000 years; therefore, it is likely that the dose to the public would decrease noticeably over time. The involved worker population dose also would decrease over time because of radioactive decay. The involved worker dose would fluctuate as new concrete storage modules were constructed and radioactive material was transferred from the old to the new modules every 100 years. During those 70-year intervals in which construction and transfer would occur, the dose would be higher; the dose would be lower during those 70-year intervals when these activities did not occur.

Because no liquid or airborne effluents would emanate from the storage facilities, direct and air-scattered radiation would comprise the total source of radiation exposure to the public. For populations more than 3 kilometers (2 miles) from the facilities (as is the case for most DOE facilities), direct and air-scattered external radiation exposure would be small (DIRS 101898-NRC 1991, p. 22).

7.2.1.8 Accidents

For Scenario 1, activities at each facility would include surveillance, inspection, maintenance, and equipment replacement, when required. The facilities and the associated systems, which the Nuclear Regulatory Commission would license, would have certain required features. License requirements would include isolation of the stored material from the environment and its protection from severe accident conditions. The Nuclear Regulatory Commission requires an extensive safety analysis that considers the impacts of plausible accident-initiating events such as earthquake, fire, high wind, and tornado. In addition, the license would specify that facility design requirements include features to provide protection from the impacts of severe natural events. These requirements and analyses must demonstrate that the facilities could withstand the most severe wind loading (tornado winds and tornado-generated missiles) and flooding from the Probable Maximum Hurricane with minimal release of radioactive material. This analysis assumed indefinite maintenance of these features for the storage facilities.

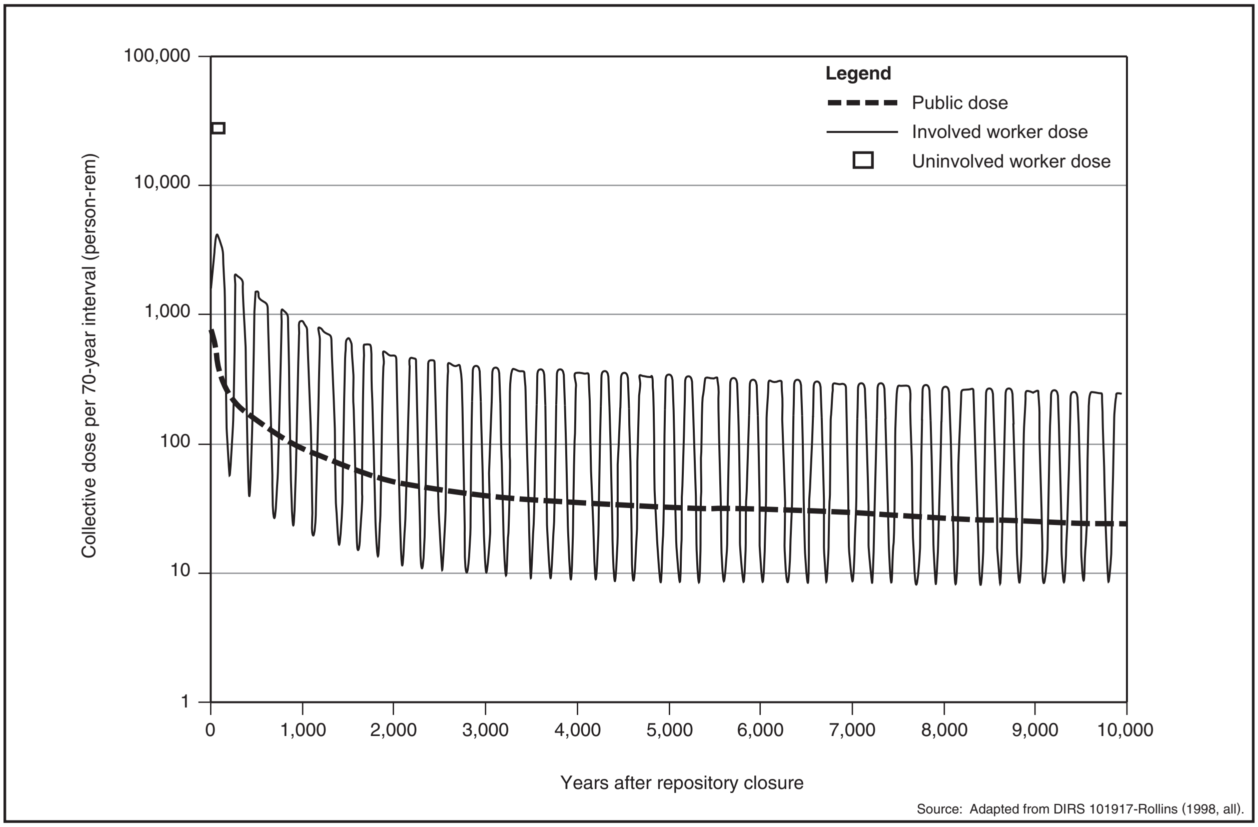

Figure 7-6. Collective dose for 70-year intervals for No-Action Scenario 1.

DOE performed an analysis to identify the kinds of events that could lead to releases of radioactive material to the environment prior to degradation of concrete storage modules and found none. The two events determined to be the most challenging to the integrity of the concrete storage modules would be the crash of an aircraft into the storage facility and a severe seismic event.

- DIRS 103711-Davis, Strenge, and Mishima (1998, all) evaluated the postulated aircraft crash and subsequent fire at a storage facility. The analysis showed that falling aircraft components produced by such an event would not penetrate the storage facility and that a subsequent fire would not result in a facility failure. This conclusion is consistent with representative analyses performed in support of Nuclear Regulatory Commission license applications for above-grade dry storage (DIRS 103449-PGE 1996, all; DIRS 103177-CP&L 1989, all).

  DIRS 103711-Davis, Strenge, and Mishima (1998, all) evaluated aircraft crashes with a velocity of 550 kilometers per hour (340 miles per hour) based on the DOE aircraft crash standard (DIRS 101810-DOE 1996, p. C-7). In a scenario where aircraft velocities could be higher, there would be an increased potential that the intact storage facility could be subject to failure, resulting in a release of radiological materials. DOE has not performed a more detailed analysis of these licensed facilities because the Nuclear Regulatory Commission has a comprehensive program underway to evaluate such events at their licensed facilities, including commercial spent fuel storage facilities. The Commission would be expected to take whatever action is necessary to provide adequate protection to the public from such events.

- For the seismic event, major damage would be unlikely because storage facilities would be designed to withstand severe earthquakes. Even if such an event caused damage, immediate release of radioactive particulates would be unlikely because analyses have identified no mechanism that would cause fuel pellet damage sufficient to create respirable airborne particles (DIRS 103449-PGE 1996, all; DIRS 103177-CP&L 1989, all). Therefore, the source term would be limited to gaseous fission products, carbon-14, and a very small amount of preexisting fuel-pellet dust. Subsequent repairs to damaged facilities or concrete storage modules would preclude the long-term release of radionuclides.

Criticality events are not plausible for Scenario 1 because water, which is required for criticality, could not enter the dry storage canister. The water would have to penetrate several independent barriers, all of which would be maintained and replaced as necessary under Scenario 1. Therefore, DOE determined that potential accident consequences would be bounded by a severe seismic event (see Appendix K, Section K.2.5). DOE analyzed this event and concluded that such an accident scenario would not result in radiological impacts to members of the public in the immediate vicinity of the storage facility. In addition, there would be limited quantities of nonradioactive hazardous or toxic substances stored at the facilities. Therefore, nonradiological accident impacts would be limited to those from industrial hazards and traffic, as discussed in Sections 7.2.1.7.2 and 7.2.1.14, respectively.

7.2.1.9 Noise

During routine operations, noise levels would not affect workers, the public near the facility, or the environment. Most of the storage facilities would have passive cooling, although a few could have active cooling with fans and blowers. Because the storage facilities would be away from population centers or homes, the noise of blowers, if used, would not affect the nearby public. The noise would not be loud enough to produce adverse impacts on the facility workers' hearing.

The analysis assumed for Scenario 1 that the storage facilities would require complete replacement every 100 years. During construction, noise levels due to construction traffic and activities would exceed ambient noise levels. To protect personnel, Occupational Safety and Health Administration standards would be followed (29 CFR 1910.95). The noise could cause wildlife to leave the immediate vicinity of the construction activities, but would not be loud enough to affect individual animals permanently. Adverse impacts to wildlife would be temporary.

7.2.1.10 Aesthetics

Impacts from the storage facilities to aesthetic or scenic resources would be low. There would be two adjacent locations at each site on land that would already be disturbed. Every 100 years, a new facility would be constructed on the idle site, and the storage containers transferred. The old facility would be demolished and the site would remain idle for the next 100 years. Adverse impacts could occur during construction and demolition activities, but these impacts would be short-term and temporary.

7.2.1.11 Utilities, Energy, and Materials

As mentioned above, spent nuclear fuel and high-level radioactive waste storage facilities would have passive cooling, although a few could have active cooling with fans and blowers. Electricity would be required for these cooling systems and to light the storage facilities, but DOE anticipates that the amount of electricity would be small in comparison to the amount available. Fuel and materials would be needed to maintain and repair the facilities and to construct and demolish facilities every 100 years, but DOE expects impacts to these resources to represent a small fraction of the resources available to each of the 77 sites. Therefore, the No-Action Alternative would not produce adverse impacts on these resources during operation and construction activities.

7.2.1.12 Waste Management

Construction of new facilities and demolition of old facilities every 100 years (and the one-time refurbishment of existing facilities after the first 50 years) would generate construction debris and sanitary and industrial solid waste. In addition, routine repairs and maintenance to the facilities and storage containers, routine radiological surveys, and overpacking of failed containers would generate sanitary and industrial solid and low-level radioactive wastes. Because there would not be a dedicated workforce at the storage facilities, only small amounts of sanitary wastes would be generated except during construction periods. The greatest amount of waste would be generated by the demolition of facilities at the 72 commercial and 5 DOE storage sites every 100 years. The demolition of facilities once every 100 years at all the sites would generate, on average, an estimated 770,000 cubic meters (1 million cubic yards) of nonhazardous demolition debris, recyclable steel, and potentially a small amount of low-level waste if a dry storage canister were to fail while in storage (DIRS 104596-Orthen 1999, Table 7). The debris and wastes would be disposed of at commercial or DOE disposal facilities across the Nation. The impacts to available capacity would be spread nationwide, thus minimizing impacts to any one disposal facility. The capacities of the disposal facilities would accommodate the wastes generated at the storage facilities.

7.2.1.13 Environmental Justice

Potential impacts of continued storage with institutional control would be minimal for all populations living near the storage facilities. Because adverse impacts would be unlikely for any population, effects on minority or low-income populations would be unlikely to be disproportionately high and adverse.

Storage facilities would require small areas and would be on lands already owned by commercial utilities or DOE. Therefore, continued storage at these sites would be unlikely to introduce environmental justice concerns. If the United States determines that it will use continued storage at existing sites for the long-term disposition of spent nuclear fuel and high-level radioactive waste, site-specific analyses of storage facilities would be required to determine if environmental justice issues could result. The Nuclear Regulatory Commission has established this approach (DIRS 101899-NRC 1996, p. 9-16).

7.2.1.14 Traffic and Transportation

DOE analyzed short-term impacts (traffic fatalities) that could result from commuting to and from storage facilities for a single 100-year cycle. The amount of travel was determined from estimates of personnel needed to construct the storage facilities, load and reload the canisters into the storage modules, and conduct routine surveillance and repairs (DIRS 104596-Orthen 1999, all). Because the workforce at each storage facility would be small, opportunities for carpooling would be limited. Therefore, the analysis assumed each worker would commute individually.

An estimated 700 workers (see Section 7.2.1.7.3) would commute to and from work approximately 18 million times during the first 100 years. The analysis assumed an average one-way commute of 19 kilometers (12 miles) based on personal travel reported in the Nationwide Personal Transportation Survey by the Oak Ridge National Laboratory (DIRS 102064-FHWA 1999, p. 9). The analysis also used national data to estimate fatalities [in 1994, 1 fatality per 100 million kilometers (about 62 million miles) traveled by automobile (DIRS 148081-BTS 1999, p. 4)] over a single 100-year period. Based on the expected workforce, estimated number of trips, estimated average distance, and fatality data, approximately 7 traffic fatalities would occur in the workforce at the 77 sites in 100 years (or an average of less than 1 fatality every 10 years) (DIRS 104596-Orthen 1999, Table 6).

In addition, the analysis estimated the long-term traffic fatalities for the remaining 9,900-year analysis period. Using the estimated number of full-time equivalent work years of 7.4 million, about 730 traffic fatalities would be likely during the 9,900-year analysis period at the 77 sites (or, on average, less than 1 fatality every 10 years).

The analysis also estimated traffic fatalities and latent cancer fatalities from trucks transporting construction materials to and demolition debris from the 77 sites assuming an 80-kilometer (50-mile) roundtrip distance. For the 9,900-year period, during the construction of replacement facilities, construction vehicles would travel about 1.2 billion kilometers (750 million miles), resulting in approximately 17 prompt traffic fatalities, or less than 1 fatality every 600 years (DIRS 103455-Saricks and Tompkins 1999, Table 4, pp. 34 and 35) and about 0.1 latent fatality from vehicle exhaust emissions.

7.2.1.15 Sabotage

Above-ground storage of spent nuclear fuel and high-level radioactive waste for 10,000 years would entail a continued risk of intruder access at each of the 77 sites. Sabotage could result in a release of radionuclides to the environment around the facility. Under Scenario 1, the analysis assumed that safeguards and security measures currently in place would remain in effect during the 10,000-year analysis period, thereby reducing the risk of sabotage.

As Nuclear Regulatory Commission licensees, the individual sites would be required to comply with Commission regulations and maintain the highest level of security as determined by the Commission, and any results from the reexamination of existing physical security and safeguard systems following the terrorist attack of September 11, 2001.

Because it is not possible to predict whether sabotage events would occur, and if they did, the nature of such events, DOE examined various accident scenarios in this Final EIS, which provide an approximation of the consequences that could occur.

7.2.2 NO-ACTION SCENARIO 2

DOE and commercial utilities intend to maintain control of the nuclear storage facilities as long as necessary to ensure public health and safety. However, Scenario 2 assumes no effective institutional control of the storage facilities after approximately the first 100 years to provide a basis for evaluating an upper limit of potential adverse human health impacts to the public from the continued storage of spent nuclear fuel and high-level radioactive waste. After about 100 years, Scenario 2 assumes that there would be no effective institutional control and that the storage facilities would be abandoned. Therefore, there would be no health risks for workers during that period. For the long-term impacts after about 100 years and for as long as 10,000 years, the analysis assumed that the spent nuclear fuel and high-level radioactive waste storage facilities at 72 commercial and 5 DOE sites would begin to deteriorate and that radioactive materials would be released to the environment, contaminating the local atmosphere, soil, surface water, and groundwater. Appendix K provides details of facility degradation, radioactive material environmental transport, and human radiological exposure and dose models.

Because Scenario 2 assumes effective institutional control during the first 100 years of the 10,000-year analysis period, the short-term impacts of that first 100 years would be the same as the impacts described for Scenario 1 (see Section 7.2.1). Therefore, this discussion focuses on long-term impacts (after the first approximately 100 years). However, after about 100 years under Scenario 2, when there would no longer be effective institutional control, construction and operation activities would not occur at the storage sites; therefore, socioeconomic and cultural resources would be unlikely to receive adverse impacts. In addition, noise would not emanate from the facilities; utilities, energy, or materials would not be expended; waste would not be generated; and workers would not commute to the sites. Thus, after approximately the first 100 years, No-Action Alternative Scenario 2 would not adversely affect socioeconomic and cultural resources; scenic resources; noise; utilities, energy and materials; waste management; or traffic and transportation. Aesthetic resources would not change until the facilities began to degrade, at which time the aesthetic value of the sites would change.

7.2.2.1 Land Use and Ownership

Without maintenance and periodic replacement, facilities, storage containers, and the spent nuclear fuel and high-level radioactive waste would begin to deteriorate. Eventually radioactive materials would contaminate the land surrounding the storage facilities, possibly rendering it unfit for human habitation or agricultural uses for hundreds or thousands of years. The amount of land contaminated would depend on several factors including the climate of the region, the amount of spent nuclear fuel and high-level radioactive waste at the site, and the rate of deterioration. Although the size of the affected area would be impossible to predict accurately for each site, DOE believes it would involve tens to hundreds of acres at each of the 77 sites.

By assuming that there would be no effective institutional control, this scenario also assumes that there would not be an orderly conversion of land use and ownership to other uses or ownership and that all knowledge of the purpose and content of the facilities would be lost. This would increase the likelihood that members of the public would move onto storage facility lands because they would not be aware of the potential radioactive material contamination.

7.2.2.2 Air Quality

As discussed in Appendix K, Section K.2.3, the degraded facilities would provide sufficient protection of the spent nuclear fuel and high-level radioactive waste materials to preclude the release of particulate radioactive materials in sufficient quantities to affect air quality adversely. Small releases of gaseous carbon-14 would be likely in the form of carbon dioxide gas but would not adversely affect ambient air quality.

7.2.2.3 Hydrology

7.2.2.3.1 *Surface Water*

As the concrete storage facilities, storage canisters, and spent nuclear fuel and high-level radioactive waste materials deteriorated, contaminants would enter surface waters from stormwater runoff from the failed facilities and storage containers and exposed radioactive materials. The introduction of contaminants would continue over a long period until the depletion of the source materials. During this release period, contaminant releases to surface waters could be sufficient to produce adverse impacts to human health. Section 7.2.2.5.3 discusses impacts to the public using this water for drinking.

7.2.2.3.2 *Groundwater*

As the concrete storage facilities, storage canisters, and spent nuclear fuel and high-level radioactive waste materials deteriorated, contaminants would enter the groundwater. Once contaminated, aquifers beneath the degraded storage facilities would remain contaminated for the period required for the depletion of the spent nuclear fuel and high-level radioactive waste materials and the migration of the contaminants from the groundwater system. Contaminant concentrations in the groundwater could be sufficient to produce adverse impacts to human health. Section 7.2.2.5.3 discusses impacts to the public using groundwater for drinking, bathing, and irrigation.

7.2.2.4 Biological Resources and Soils

As the concrete storage facilities, storage canisters, and spent nuclear fuel and high-level radioactive waste materials deteriorated, the potential for individual animals to be exposed to radiation at the storage sites would increase. In addition, animals could drink contaminated surface water. Direct radiation from the exposed spent nuclear fuel and high-level radioactive waste storage canisters and concentrations of contaminants in surface waters could produce adverse impacts to animals. While the contaminant exposure could have negative effects, including death, on individual animals, adverse effects to entire populations would be unlikely because the lethal area surrounding the degraded facilities would be limited to a few hundred acres.

Soils at the storage facilities could be contaminated by radioactive materials leaching from the spent nuclear fuel and high-level radioactive waste material. Soils downslope of the facilities could be contaminated by surface-water runoff. Crops grown on these soils would take up some of the contamination, thus making the contaminated soils a pathway for human exposure. Section 7.2.2.5.3 discusses impacts to members of the public from ingesting food grown in or livestock fed from contaminated soils.

7.2.2.5 Occupational and Public Health and Safety

7.2.2.5.1 *Nonradiation Exposures*

Analyses performed for the repository (see Chapter 5, Section 5.6) indicate that concentrations of chemically toxic materials (that is, molybdenum, nickel, vanadium, and chromium) from degraded spent nuclear fuel and high-level radioactive waste packages in the groundwater would be extremely low. Therefore, because of the relatively lower abundance of these materials contained in the stainless steel storage canisters and relatively greater abundance of water and the greater precipitation at the storage locations than at the repository, concentrations of the materials in the groundwater and surface water at the storage sites would likely be much lower than those estimated for the repository. The Department did not attempt to quantify adverse health impacts from chemical toxicity of the waste forms (principally uranium dioxide and *borosilicate glass*) that could occur within the exposed population under Scenario 2. This decision is consistent with the Department’s position that care should be taken not to overestimate impacts from the No-Action Alternative.

7.2.2.5.2 *Industrial Hazards*

For about the first 100 years, industrial hazards would be the same as for the first 100 years under Scenario 1 (see Section 7.2.1.7.2). After about 100 years, Scenario 2 assumes there would be no effective institutional control and that the storage facilities would be abandoned and, therefore, there would be no industrial safety impacts.

7.2.2.5.3 *Radiation Exposures*

To simplify the analysis, DOE divided the United States into five regions (Figure 7-7). Regional radiological impacts were estimated by assuming all spent nuclear fuel and high-level radioactive waste in a particular region was stored at a single hypothetical site in that region. Appendix K, Section K.2.1.6, provides details of the methods and assumptions used in the regional analysis.

Radiological impacts to occupational workers and the offsite public from initial construction, routine maintenance and operations, and refurbishment after the first 50 years would be the same as those for the same period under Scenario 1 (see Section 7.2.1.7.3 and Table 7-6).

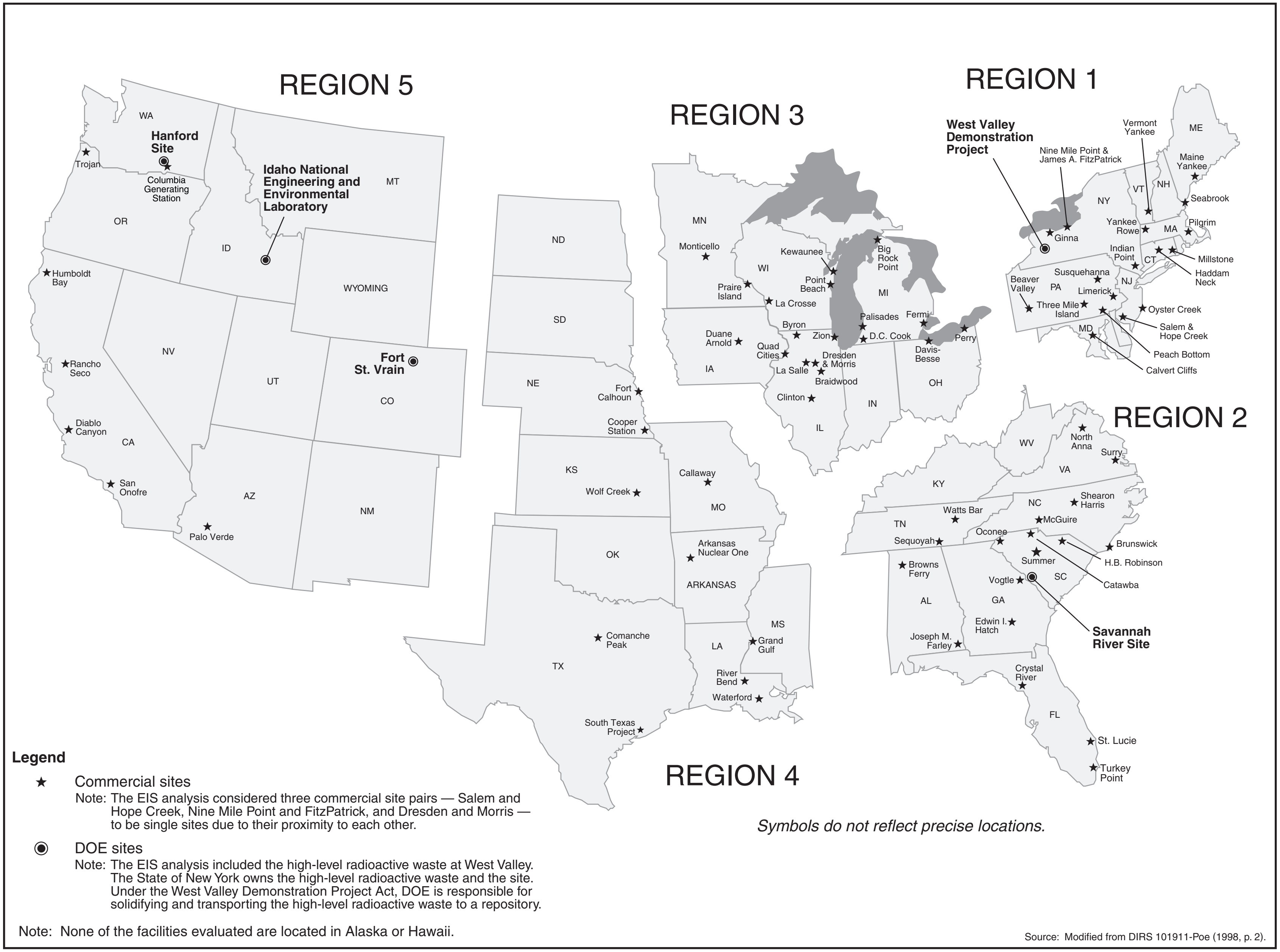

Figure 7-7. Commercial and DOE sites in each No-Action Alternative analysis region.

For Scenario 2 DOE assumed that after approximately the first 100 years there would be no institutional control and that deterioration of the facilities would occur over time. Based on regional climate and degradation models (see Appendix K), the spent nuclear fuel and high-level radioactive waste storage facilities and dry storage containers would corrode and fail over time, exposing radioactive material to the environment (wind and rain). Once exposed to the environment, the spent nuclear fuel and high-level radioactive waste storage packages and facilities would begin releasing small quantities of radioactive material to the atmosphere (gaseous carbon-14), soil, surface water, and groundwater, resulting in exposures to the public. These released materials could produce chronic exposures to the public, which could result in adverse health impacts. Figure 7-8 shows the conceptual timeline for activities and degradation processes at the storage facilities for Scenario 2.

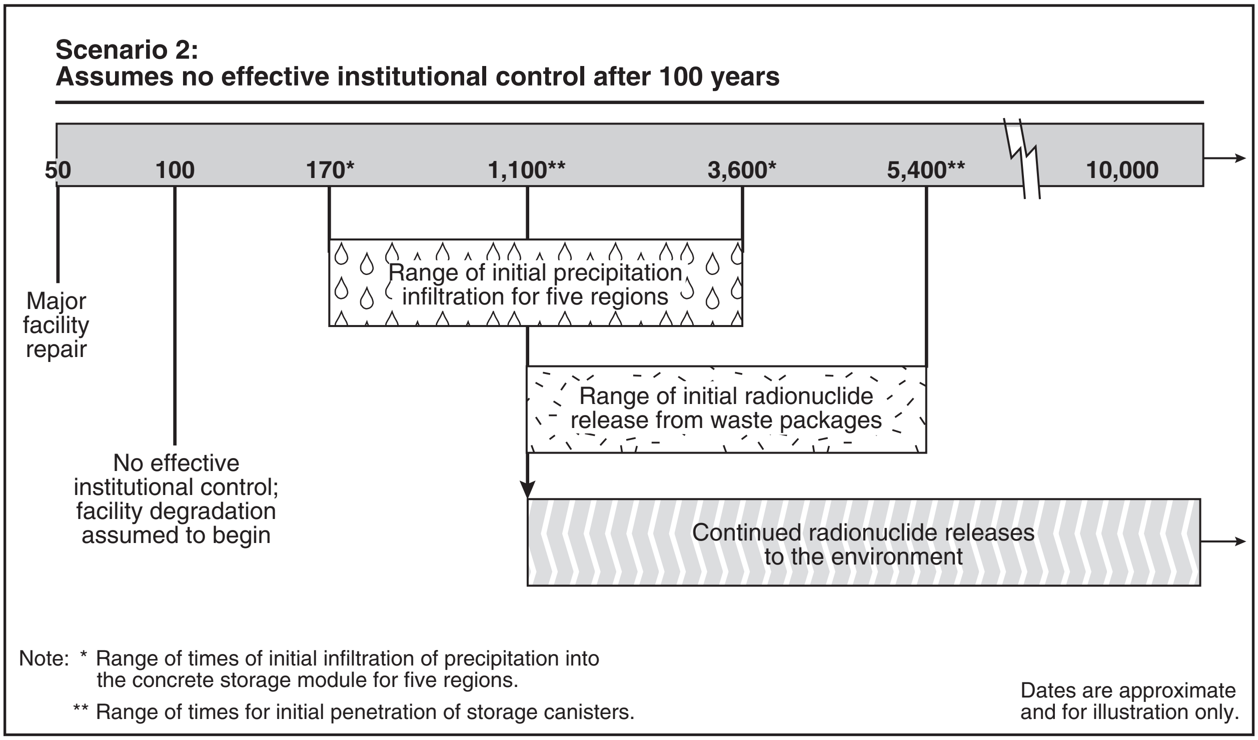

Figure 7-8. Conceptual timeline for activities and degradation processes for No-Action Scenario 2.

Appendix K describes the methods used to estimate impacts to human health from long-term environmental releases and human intrusion. The radiological impacts on human health include internal exposure from intake of radioactive materials in surface water and groundwater.

Table 7-7 lists the estimated radiological drinking water impacts during the 9,900 years under Scenario 2 with the assumption of no effective institutional control. The impacts listed in Table 7-7 are from drinking water only and would result from consuming water from the major waterways contaminated with radioactive materials by groundwater discharge and surface-water runoff from degraded spent nuclear fuel and high-level radioactive waste storage facilities. DOE evaluated

Table 7-7. Estimated long-term collective drinking water radiological impacts to the public from long-term storage of spent nuclear fuel and high-level radioactive waste at commercial and DOE sites – Scenario 2.

9,900-year population dose[a] (person-rem)	9,900-year LCFs[b]	Years to peak impact[c]
6,600,000	3,300	3,400

a. Estimated total population (collective) dose from drinking water pathway (DIRS 101935-Toblin 1999, p. 4).
b. LCFs = latent cancer fatalities; estimated for the exposed population group based on an assumed risk of 0.0005 latent cancer fatality per person-rem of collective dose (DIRS 101857-NCRP 1993, p. 112).
c. Years after period of institutional control when the maximum doses would occur.

other potential impacts to populations (for example, exposure to people living on the contaminated floodplains) and to individuals (for example, consumption of contaminated food) and determined that certain individuals could receive doses as much as three times higher than for drinking water alone but that doses to populations from contaminated floodplains would represent less than 10 percent of the impacts listed in Table 7-7. DOE did not include these impacts in Table 7-7 because the dose to an individual would depend largely on highly variable subsistence habits and because DOE did not want to overestimate the impacts from Scenario 2.

Figure 7-9 shows the locations of the commercial and DOE sites in the United States and the more than 20 major waterways potentially affected. At present, municipal water systems that serve 31 million people have intakes along the potentially affected portions of these waterways. The analysis assumed these populations would remain constant over the entire analysis period (9,900 years). Over the 9,900-year analysis period, about 140 70-year lifetime periods would be affected. Because the analysis estimated that releases would not occur during the first 1,000 years for most regions, the estimated potentially exposed population would be about 3.9 billion.

Table 7-7 indicates that over 9,900 years, a collective drinking water dose of 6.6 million person-rem could result in an additional 3,300 latent cancer fatalities in the total potentially exposed population of 3.9 billion. This latent cancer fatality rate would affect an average of about 24 people per 70-year lifetime, or about 1 latent cancer fatality at each of the 77 sites every 200 years. These radiation-induced latent cancer fatalities would be in addition to about 900 million fatal cancers (using the lifetime fatal cancer risk of 24 percent [DIRS 153066-Murphy 2000, p. 5]) that would be likely from all other causes in the exposed population, an incremental increase over the natural incidence of fatal cancer of about 0.0004 percent.

Figure 7-10 shows the estimated latent cancer fatalities for approximately 140 70-year periods during the 9,900-year period of analysis. The five peaks shown in Figure 7-10 generally result from contributions of each of the five regions (see Appendix K, Figure K-8). The major peak, which would occur about 3,400 years after effective institutional control ended (in 2100), would be due to radionuclide releases at the sites that drain to the Mississippi River and the relatively large populations along the Mississippi and its tributaries.

In addition to the 3,300 potential cancer fatalities under Scenario 2, more than 20 major waterways of the United States that currently supply domestic water to about 31 million people (for example, the Great Lakes; the Mississippi, Ohio, and Columbia Rivers; and many smaller rivers along the Eastern Seaboard) could be contaminated with radioactive material. Under this scenario, the shorelines could be contaminated with long-lived radioactive materials (for example, plutonium, uranium, and americium), resulting in exposures to individuals who came in contact with the sediments and, potentially, an increase in latent cancer fatalities. Because individuals would not be in constant contact with the sediments, these impacts represent a small fraction of the impacts estimated for the drinking water pathways listed in Table 7-7.

For purposes of comparison with impacts associated with the Proposed Action, DOE evaluated potential radiological impacts for a maximally exposed individual by constructing hypothetical exposure scenarios for individuals living near the degraded facilities. The exposure scenarios maximized external and internal exposure over each 70-year lifetime period in the 9,900-year period of analysis. The following paragraphs describe the results of these evaluations.

For Scenario 2, localized impacts to individuals from degraded facilities at the 77 sites could be severe. DOE estimated that within a few hundred years at the several sites where early concrete failure was predicted, hypothetical individuals living close to the storage facilities would receive lethal doses of

Figure 7-9. Major waterways near commercial and DOE sites.

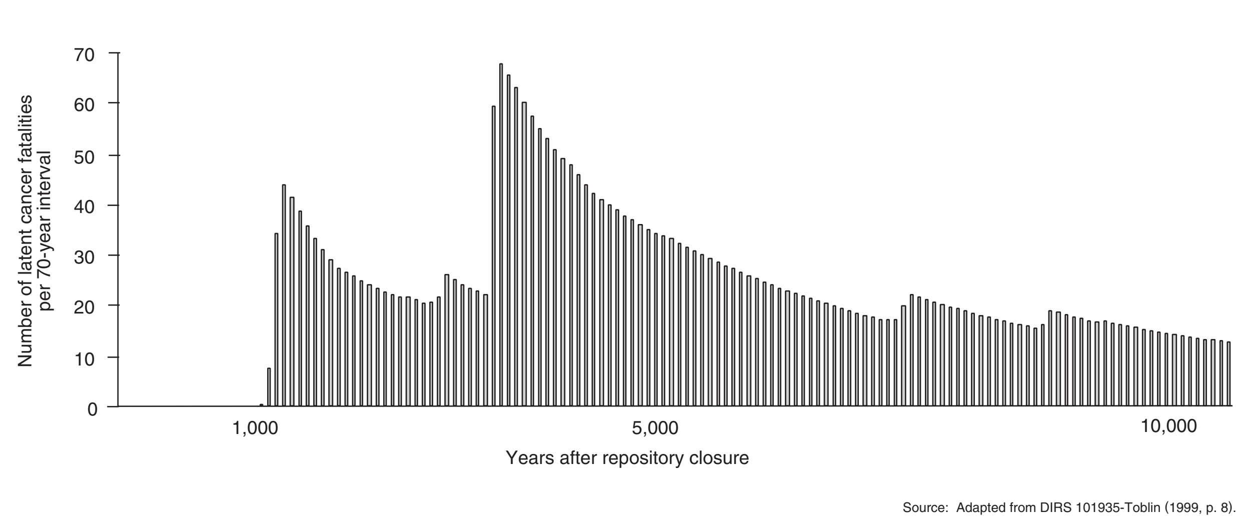

Figure 7-10. Potential latent cancer fatalities throughout the United States from No-Action Scenario 2.

external radiation [800 millirem per hour at a distance of 10 meters (33 feet)] from the exposed dry storage containers (see Appendix K, Section K.2.4.2).

To evaluate impacts from ingestion of radioactive materials, the analysis assumed that individuals would live near the degraded storage facilities and would consume contaminated groundwater and food from gardens irrigated with groundwater withdrawn from the contaminated aquifer directly below their locations. DOE estimated that within 6,000 years from now a hypothetical individual living within several hundred meters of a degraded facility could receive an internal committed effective dose equivalent to several thousand rem per year from ingestion of plutonium-239 and -240 (see Appendix F for further information on committed dose equivalent). Using the National Council on Radiation Protection and Measurements risk factors (DIRS 101857-NCRP 1993, p. 112), ingestion of plutonium at this rate could increase the individual's lifetime risk of contracting a fatal cancer after only a few years of exposure.

In addition, DOE estimated impacts for a hypothetical individual living 5 kilometers (3 miles) from the degraded facility on the downgradient of the contaminated aquifer. Although this individual would be too distant from the facility to receive any appreciable external radiation dose, the internal dose from the consumption of contaminated groundwater and contaminated crops could still be as high as 30 rem per year from ingestion of plutonium-239 and -240. Ingestion of plutonium at this rate could increase the individual's risk of contracting a fatal cancer after several decades of exposure. Appendix K provides details on the methods DOE used to evaluate localized impacts.

Uncertainty

This section contains estimates of the radiological impacts of No-Action Scenario 2, which assumes continued above-ground storage of spent nuclear fuel and high-level radioactive waste at sites across the United States. Associated with the impact estimates are uncertainties typical of predictions of the outcome of complex physical and biological phenomena and of the future state of society and societal institutions over long periods. DOE recognized this fact from the start of the analysis; however, the predictions will be valuable in the decisionmaking process because they provide insight based on the best information and scientific judgments available.

This analysis considered five aspects of uncertainty:

- Uncertainties about the nature of changes in society and its institutions and values, in the physical environment, and of technology as technology progresses

- Uncertainties associated with future human activities and lifestyles
- Uncertainties associated with the mathematical representation of the physical processes and with the data in the computer models
- Uncertainties associated with the mathematical representation of the biological processes involving the uptake and metabolism of radionuclides and the data in the computer models
- Uncertainties associated with accident scenario analysis

For the No-Action Scenario 2 analysis DOE has not attempted to quantify the variability of estimated impacts related to possible changes in climate, societal values, technology, or future lifestyles. To simplify the analysis, DOE did not attempt to quantify these uncertainties even though uncertainties with these changes could undoubtedly affect the total consequences reported in Table 7-7 by several orders of magnitude.

DOE attempted to quantify a range of uncertainties associated with mathematical models and input data, and estimated the effect these uncertainties could have on collective human health impacts. By summing the uncertainties (see Appendix K, Sections K.4.1, K.4.2, and K.4.3 for details), DOE estimated that total collective impacts over 10,000 years could have been underestimated by as much as 3 or 4 orders of magnitude. However, because there are large uncertainties in the models used to quantify the relationship between low doses (less than 10 rem) and the accompanying health impacts (see Appendix F, Section F.1.1.5), especially under conditions in which the majority of the population would be exposed at a very low dose rate, DOE believes the actual collective impact could be small.

On the other hand, impacts to individuals (human intruders) who could move to the storage sites and live close to the degraded facilities could be severe. During the early period (200 to 400 years after the assumed loss of institutional control), acute exposures to external radiation from the spent nuclear fuel and high-level radioactive waste material could result in prompt fatalities. In addition, after a few thousand years onsite shallow aquifers could be contaminated to such a degree that consumption of water from those aquifers could result in severe adverse health effects, including premature death. Uncertainties about these localized impacts are related primarily to the inability to predict accurately how many individuals could be affected at each of the 77 sites over the 10,000-year analysis period. In addition, the uncertainties associated with localized impacts would exist for potential consequences resulting from unusual events, both manmade and natural.

Therefore, uncertainties resulting from surface storage where containers are more readily affected by natural phenomena and human behavior (see Appendix K, Table K-14) that cannot be predicted, process model uncertainties, and dose-effect relationships, taken together, could produce the results listed in Table 7-7, overestimating or underestimating the actual impacts by as much as several orders of magnitude.

7.2.2.6 Atmospheric Radiological Consequences

As discussed in Appendix K, Section K.2.3, the analysis assumed that the configuration of the degraded storage facilities would cause debris to cover the radioactive material, which would remain inside the dry storage canisters. While the dry storage canisters could fail sufficiently to permit water to enter, they would probably retain their structural characteristics, thereby minimizing the dispersion of particulate radioactive material to the atmosphere (DIRS 147905-Mishima 1998, all). However, the radionuclides carbon-14 and iodine-129 would have a potential for gas transport. Although iodine-129 can exist in a gas phase, DOE expects it would dissolve in the precipitation and migrate in surface water and groundwater. DOE also expects the consequences from a release of carbon-14 to be very small based on the low failure rate of zirconium-clad spent nuclear fuel (see Appendix K, Section K.2.1.4.1 for details) and large atmospheric dilution.

7.2.2.7 Accidents

For Scenario 2, the analysis examined the impacts of an accident scenario that could occur during the above-ground storage of spent nuclear fuel and high-level radioactive waste and concluded that the most severe accident scenarios would be an airplane crash into a concrete storage module. The frequency of such an event was estimated to be 0.0000032 (3 in 1 million) crashes per year.

In Scenario 2, the concrete storage modules would deteriorate with time. DOE concluded that an airplane crash into a degraded concrete storage module would dominate the consequences from external initiating events (see Appendix K, Section K.3.2.1). The analysis evaluated the potential for criticality accidents and concluded that an event severe enough to produce large consequences would be extremely unlikely, and that the consequences would be bounded by the airplane crash consequences. Table 7-8 lists the consequences of an airplane crash on a degraded concrete storage module.

Table 7-8. Estimated consequences of an aircraft crash on a degraded spent nuclear fuel concrete storage module.[a]

Factor	High population site[b]	Low population site[c]
Frequency (per year)	3.2×10^{-6}	3.2×10^{-6}
Collective population dose (person-rem)	26,000	6,100
Latent cancer fatalities	13	3

a. Source: DIRS 103711-Davis, Strenge, and Mishima (1998, p. 11).
b. Within 80 kilometers (50 miles) of site, an average of 330 persons per square mile.
c. Within 80 kilometers of site, an average of 77 persons per square mile.

7.2.2.8 Environmental Justice

Deteriorating facilities, storage containers and packaging, and spent nuclear fuel and high-level radioactive waste could produce adverse effects to the nearby public. Any nearby minority or low-income communities could experience disproportionately high and adverse human health impacts. In addition, financial considerations could make it more difficult for members of any affected minority or low-income populations to obtain uncontaminated resources or to move away from contaminated soils and water. Because subsistence patterns for low-income and minority populations could vary from those of persons not in these groups, any affected low-income and minority populations could be exposed to greater than average doses. The result of differing potentials for exposure could be disproportionately high and adverse impacts to minority or low-income populations.

If the United States determines that it will use continued storage at existing sites for the long-term disposition of spent nuclear fuel and high-level radioactive waste, site-specific analyses of storage facilities would be required to identify if environmental justice issues could result. The Nuclear Regulatory Commission established this approach (DIRS 101899-NRC 1996, p. 9-16). With the assumption of no effective institutional control after about 100 years, potential environmental justice issues identified under Scenario 2 probably would be more severe than those identified under Scenario 1 (see Section 7.2.1.13).

7.2.2.9 Sabotage

For Scenario 2, the storage of spent nuclear fuel and high-level radioactive waste for 10,000 years without institutional control would entail a greater risk of intruder access at the 77 sites than exists under current conditions. Due to the lack of institutional control and degraded facilities, sabotage could result in a release of radionuclides to the environment around the facility. The analysis assumed that safeguards and security measures would not be maintained after approximately the first 100 years. For the remaining

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9,900 years of the analysis period, the cumulative risk of intruder attempts would increase. As the *storage containers* degraded, they would become more vulnerable to failure. Any amount of material released from its storage container could contaminate areas with radioactivity. Therefore, the risks of sabotage would increase substantially under this scenario in comparison to Scenario 1.

7.3 Cumulative Impacts for the No-Action Alternative

DOE evaluated the disposal of 70,000 MTHM of spent nuclear fuel and high-level radioactive waste in the Proposed Action analysis. To provide a direct comparison of impacts with the Proposed Action, the No-Action analysis in Sections 7.1 and 7.2 evaluated the impacts of the continued storage of 70,000 MTHM of spent nuclear fuel and high-level radioactive waste at 72 commercial and 5 DOE sites across the United States. DOE chose the volume of 70,000 MTHM for analysis because the NWPA prohibits the Nuclear Regulatory Commission from approving the emplacement of more than 70,000 MTHM in a first repository until a second repository is in operation. This section describes the results of the analysis of the cumulative impacts of the continued storage at the 77 existing sites of all spent nuclear fuel and high-level radioactive waste (called Inventory Module 1) (Table 7-9). Chapter 8 discusses the cumulative impacts of disposing of radioactive waste at the Yucca Mountain Repository in excess of the Proposed Action repository.

Table 7-9. Inventories for Proposed Action and Module 1.[a]

Material	Proposed Action	Module 1
DOE spent nuclear fuel	2,333 MTHM	2,500 MTHM
Commercial spent nuclear fuel[b]	63,000 MTHM	105,000 MTHM
High-level radioactive waste[b]	8,315 canisters	22,280 canisters

a. Source: Appendix A, Section A.1.1.4.1.
b. Surplus plutonium would be included in the inventory in the form of mixed-oxide fuel (treated as commercial spent nuclear fuel) or immobilized plutonium (high-level radioactive waste).

A cumulative impact is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative impact assessment is based on both the geographic (spatial) and time (temporal) considerations of past, present, and reasonably foreseeable actions. Geographic boundaries can vary by discipline depending on the time an effect remains in the environment, the extent to which the effect can migrate, and the magnitude of the potential impact. The proximity of other actions to the spent nuclear fuel storage sites is not the only decisive factor for determining the inclusion of an action in the assessment of cumulative impacts. Another, and for this analysis more important, factor is if the other actions would have some influence on the resources in the same time and space affected by continued storage.

The cumulative impacts of past actions have either passed through the environment or are part of existing baseline conditions. For example, the construction impacts of spent nuclear fuel storage facilities will have passed through the environment before the potential impacts associated with continued storage and refurbishment would first be seen in 2002.

DOE based its estimates of the potential impacts from continued storage of commercial spent nuclear fuel on a representative site. The results of the analysis described in the previous section are consistent with the Nuclear Regulatory Commission's findings in its *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (DIRS 101899-NRC 1996, pp. 6-85 and 6-86). The NRC stated:

> *The Commission's regulatory requirements and the experience with on-site storage of spent fuel in fuel pools and dry storage has been reviewed. Within the context of a license renewal review and*

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determination, the Commission finds that there is ample basis to conclude that continued storage of existing spent fuel and storage of spent fuel generated during the license renewal period can be accomplished safely and without significant environmental impacts. Radiological impacts will be well within regulatory limits; thus radiological impacts of on-site storage meet the standard for a conclusion of small impact. The nonradiological environmental impacts have been shown to be not significant; thus they are classified as small. The overall conclusion for on-site storage of spent fuel during the term of a renewed license is that the environmental impacts will be small for each plant. The need for the consideration of mitigation alternatives within the context of renewal of a power reactor license has been considered, and the Commission concludes that its regulatory requirements already in place provide adequate mitigation incentives for on-site storage of spent fuel.

Although this finding is applicable only to the continued storage of existing spent nuclear fuel and spent nuclear fuel generated during the 20-year license renewal period for the nuclear powerplant, DOE has concluded that potential environmental and radiological impacts for the storage facility would remain small for much longer periods. Environmental impacts would remain small because no additional fuel would be generated beyond the operation of the nuclear powerplant (plants are assumed to be closed after the first 20-year license renewal period), and radiological impacts would remain within regulatory limits specified in the storage facility license (10 CFR Part 72).

In general, the analysis of cumulative effects can exclude future actions if:

- The action is outside the geographic boundaries or timeframe established for the cumulative effects analysis.
- The action will not affect resources that are the subject of the cumulative effects analysis.
- Including the action would be arbitrary.

Because the estimated impacts would be small, DOE has not attempted to speculate on other arbitrary generic actions that could influence the cumulative impacts generated at a given site. However, the total incremental impact nationally of selected parameters is presented in the preceding section. In addition, the potential impacts at each site do not overlap because the storage sites are located throughout the United States. Therefore, cumulative impacts among the sites on resources would be unlikely.

For the 5 DOE sites, there is a long legacy of EISs and annual monitoring reports. The incremental impacts associated with continued storage of spent nuclear fuel can be added to the results reported in these documents to obtain an estimate of total impacts. For the 72 diverse commercial sites, information on other present and reasonably foreseeable actions varies in terms of data availability and quality. As a consequence, a comparison of cumulative assessments would be problematic, even if the impacts were not as small as the analyses indicate.

The cumulative analysis in this section includes the total projected inventory of commercial spent nuclear fuel, DOE spent nuclear fuel, and high-level radioactive waste (referred to as Module 1) that could come to the repository. Table 7-9 lists the inventories for the Proposed Action analysis and the Module 1 cumulative analysis.

For consistency with the cumulative impact analysis in Chapter 8, the No-Action analysis considered the same spectrum of environmental impacts as the Proposed Action. However, because of the DOE commitment to manage spent nuclear fuel and high-level radioactive waste safely, the Department decided to focus the No-Action cumulative analysis on the short- and long-term health and safety of workers and members of the public. Therefore, quantitative estimates of the cumulative impacts in this section include occupational and public health and safety, waste management, and traffic and transportation. The qualitative discussions of other disciplines are included for completeness.

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DOE recognizes that approximately 2,100 cubic meters (74,000 cubic feet) of commercial low-level radioactive waste will exceed Nuclear Regulatory Commission Class C limits (listed in 10 CFR 61.55, Tables 1 and 2 for long and short half-life radionuclides, respectively). This type of waste, called *Greater-Than-Class-C low-level waste*, is generally not suitable for near-surface disposal (see Appendix A, Section A.2.5, for a detailed description). Similarly, DOE low-level radioactive waste that exceeds the Nuclear Regulatory Commission Class C limits (referred to as *Special-Performance-Assessment-Required waste*) will amount to about 4,000 cubic meters (142,000 cubic feet) (see Appendix A, Section A.2.6, for a detailed description). Together these waste types, added to the Module 1 inventory, comprise the Module 2 inventory.

The NWPA does not specifically consider Greater-Than-Class-C or Special-Performance-Assessment-Required wastes. Therefore, DOE has not included either waste type in the Proposed Action inventory for the consideration of potential impacts that could occur from the disposal of spent nuclear fuel and high-level radioactive wastes in a geologic repository at Yucca Mountain. The disposal of these wastes at Yucca Mountain, however, is part of the cumulative impact analysis (see Chapter 8) because the impacts of that disposal are reasonably foreseeable as the results of future actions.

Further, DOE has not included Module 2 in its consideration of potential impacts under the No-Action Alternative. DOE does not have enough information about Module 2 wastes at present to be able to perform a meaningful analysis with respect to the No-Action Alternative. As discussed in Appendix A, Section A.2.5, Greater-Than-Class-C waste could include, for example, certain commercial nuclear powerplant operating and decommissioning wastes and sealed radioisotope sources. DOE Special-Performance-Assessment-Required waste could include certain production reactor operating wastes, production and research reactor decommissioning wastes, sealed radioisotope sources, and isotope production-related wastes (see Appendix A, Section A.2.6). As just one example of the confounding potential sources of these types of wastes, in 1993 DOE estimated that 2,552 Greater-Than-Class-C low-level waste fixed-gauge and X-ray fluorescence sealed sources (general licensees) and 7,582 sealed sources (for example, calibration, medical, well logging sources) were used and stored by private industry at hundreds of locations in the United States (DIRS 101798-DOE 1994, all).

As this example illustrates, a meaningful analysis would need to consider the sites, or combination of sites, at which these waste types are currently in use and storage. The analytic approach used to construct the regional representative sites for which the continued storage of spent nuclear fuel and high-level radioactive waste was evaluated would not apply to the hundreds of additional locations associated with Greater-Than-Class-C and Special-Performance-Assessment-Required wastes.

For the spent nuclear fuel and high-level radioactive waste analysis in this EIS (see Appendix K, Section K.2.1), DOE collected information from published sources for each of the 77 sites where spent nuclear fuel and high-level radioactive waste is located and, to simplify the analysis, divided the country into five regions. The Department then configured a single hypothetical site in each region (see Appendix K, Section K.2.1.6), which enabled it to estimate the potential release rate of the radionuclide inventory from the spent nuclear fuel and high-level radioactive waste, based on forecast interactions of the environment (rainfall, freeze-thaw cycle) with the engineered barrier (concrete storage modules).

Environmental information at the hundreds of sites in which Greater-Than-Class-C and Special-Performance-Assessment-Required wastes are in use and storage is not readily available and DOE could not obtain it without an exorbitant commitment of resources. Relevant environmental evaluations such as those prepared by the Nuclear Regulatory Commission for operating commercial nuclear powerplants or spent nuclear fuel storage installations are not available for most of the locations at which these waste types are in use or storage. Further, the manner in which Greater-Than-Class-C and Special-Performance-Assessment-Required low-level wastes are stored varies by waste types, and the great variety of storage methods could not be simplified for analytical purposes without distorting the resulting potential environmental impacts.

Even if such information were gathered and the means of storage could be reduced by the use of simplifying assumptions, the results of the analysis (the impacts) would tend to reinforce the results of the impact analysis performed for the Module 1 inventory. That is, short-term impacts such as those to socioeconomics and land use would not increase appreciably, but health effects probably would increase over the long term because workers and the public would be exposed to these waste types in addition to spent nuclear fuel and high-level radioactive waste at the many locations across the United States.

7.3.1 SHORT-TERM IMPACTS IN THE YUCCA MOUNTAIN VICINITY

Candidate materials would not be transported to the repository. Therefore, impacts from Module 1 would be the same at the Yucca Mountain site as those presented in Section 7.1.

7.3.2 SHORT- AND LONG-TERM IMPACTS AT COMMERCIAL AND DOE SITES

7.3.2.1 Land Use and Ownership

Under Scenario 1 (long-term institutional control), as discussed in Section 7.2.1.1, the land required for storage facilities typically would be a few acres. For the Module 1 inventory, the analysis assumed that the land required would increase, on average, by about 60 percent (the ratio of Proposed Action and Module 1 inventories). This additional land requirement [less than 0.04 square kilometer (10 acres) per site] would represent a small percentage of the land currently available at the sites; therefore, the incremental impacts on land use would be minimal but larger than those for the Proposed Action facilities. These storage facilities would be on land currently owned by DOE or a utility and, therefore, would be unlikely to affect land ownership.

Under Scenario 2 (assumption of no effective institutional control after about 100 years), as discussed in Section 7.2.2.1, without maintenance and periodic replacement, facilities, storage containers, and the spent nuclear fuel and high-level radioactive waste would begin to deteriorate, eventually contaminating the land surrounding the storage facilities and rendering it unfit for human habitation or agricultural uses for hundreds or thousands of years. The additional inventories of Module 1 probably would increase the concentrations of radioactive materials in the soils and the size of the affected areas over those expected for the Proposed Action inventory. As with the Proposed Action, these concentrations and areas would be difficult to estimate but even with the additional inventories of Module 1, DOE believes it would involve less than several hundred acres at each of the 77 sites.

In addition, as with the Proposed Action, because Scenario 2 assumes no effective institutional control after approximately 100 years, there would not be an orderly conversion of land use and ownership to other uses or ownership. Therefore, the potential for members of the public to move onto storage facility lands with Module 1 inventories would be unchanged from that expected for the Proposed Action.

7.3.2.2 Air Quality

As discussed in Section 7.2.1.2, under Scenario 1 best management practices and effective monitoring procedures would ensure that contaminant releases to the air would be minimal and would not exceed current regulatory limits (40 CFR Part 61 for hazardous air pollutants emissions and Part 50 for air quality standards). In addition, DOE expects that these controls would be effective with the additional inventories of Module 1. Therefore, air quality under Scenario 1, Module 1 would not be adversely affected during routine operations.

As discussed in Section 7.2.1.2, during the construction of replacement facilities, exhaust from construction vehicles would temporarily increase local concentrations of hydrocarbons, carbon monoxide, and oxides of nitrogen for a few years during each 100 years. DOE expects that these temporary increases in particulate matter resulting from construction activities would persist for slightly longer periods because of the additional facilities required to store the additional inventories of Module 1. However, mitigation measures such as watering unpaved roads would limit the generation of fugitive dust. As with the Proposed Action, after replacement the old site would be seeded, graveled, or paved to reduce air emissions. Therefore, although adverse air quality impacts during construction would be slightly higher for the Module 1 inventory, DOE expects them to be minimal and transient.

The Module 1 air quality impacts under Scenario 2, as discussed in Section 7.2.2.2, would be minimal because even degraded facilities would limit the release of radioactive particulate material to the atmosphere.

7.3.2.3 Hydrology

7.3.2.3.1 *Surface Water*

For Scenario 1, as discussed in Section 7.2.1.3.1, under long-term institutional control, best management practices such as stormwater pollution prevention plans and stormwater holding ponds would ensure that, in the unlikely event of an inadvertent release, contaminants would not reach surface-water systems. These controls and monitoring procedures would be effective for the additional inventories of Module 1. Therefore, as with the Proposed Action inventory, surface-water quality would not be adversely affected by routine operations.

For long-term impacts from Scenario 2, after about 100 years when there is an assumption of no effective institutional control, the Module 1 contaminants could enter surface water via stormwater runoff from degraded facilities in quantities greater than those expected for the Proposed Action. Section 7.3.2.7.3 discusses the incremental impacts to the public expected from these additional surface water contaminants resulting from the Module 1 inventory.

7.3.2.3.2 *Groundwater*

Under Scenario 1, Module 1 groundwater impacts from the storage of 105,000 MTHM of commercial spent nuclear fuel, 2,500 MTHM of DOE spent nuclear fuel, and 22,280 canisters of high-level radioactive waste would be minimal because best management practices such as spill prevention and cleanup plans and procedures and effective effluent monitoring procedures would ensure that inadvertent contaminant releases did not reach groundwater.

In addition, although the analysis assumed that the average square footage of storage facilities would increase by about 60 percent for the additional Module 1 inventory, the shallow foundations of these surface structures would not disturb groundwater systems. Some additional DOE storage facilities would be subsurface structures for which construction could require minimal dewatering of the groundwater aquifer. However, the larger square footage of the Module 1 structures would be relatively small (a few acres) in relation to the size of the aquifer, so no adverse impacts would result from dewatering activities.

For long-term impacts from Scenario 2, Module 1 contaminants would be likely to enter the underlying groundwater from degraded facilities in quantities greater than those expected for the Proposed Action. Section 7.3.2.7.3 discusses the incremental impacts to the public from these additional groundwater contaminants resulting from the Module 1 inventory.

7.3.2.4 Biological Resources and Soils

For Scenario 1, as discussed in Section 7.2.1.4, under long-term institutional control, impacts to biological resources or soils from the construction every 100 years and operation of the storage facilities would be minimal for the expanded Module 1 inventory. The facilities necessary to store the expanded Module 1 inventory would be fenced to keep wildlife out and replacement facilities would be constructed on previously disturbed soil. In addition, as with the Proposed Action, spills would be contained and cleaned up immediately, thus minimizing the area of soil affected.

For long-term impacts from Scenario 2, the analysis assumed that the potential for individual animals to be exposed to radiation at the storage sites would increase in proportion to the increased Module 1 inventory in comparison to the Proposed Action inventory (approximately 60 percent). While the increased contaminant exposure could have negative effects, including death, on individual animals, adverse impacts to entire populations would be unlikely because the lethal area surrounding the degraded facilities would be limited to a few hundred acres.

Contamination of soils at the storage facilities by radioactive materials leaching from the spent nuclear fuel and high-level radioactive waste material would be likely to increase in proportion to the increase in Module 1 inventory. Appendix K, Section K.2.4, discusses impacts to members of the public from eating food grown in contaminated soils or livestock fed on such soils.

7.3.2.5 Cultural Resources

For Scenario 1, the analysis assumed that the Module 1 replacement of spent nuclear fuel and high-level radioactive waste storage facilities would increase by about 60 percent over the Proposed Action. However, these additional facilities would generally be on undeveloped land owned by DOE or the commercial utilities in rural areas. As with the Proposed Action, the size of the additional facilities and supporting infrastructure would be small enough that the facility probably would avoid known cultural resources. In addition, if previously unknown archaeological sites, human remains, or funerary objects were uncovered during construction, DOE or the commercial utility would comply with Executive Orders and Federal and state regulations for the protection of cultural resources. Therefore, construction and operations would not affect cultural resources.

For long-term impacts from Scenario 2, construction and operation for about the first 100 years would be as described for Scenario 1. After this time, no construction or operation activities would occur at the generating sites; therefore, cultural resources would not be adversely affected.

7.3.2.6 Socioeconomics

For Scenario 1, the total staff required at 77 sites to monitor, maintain, and replace the Module 1 facilities would increase from about 700 for the Proposed Action inventory of 70,000 MTHM to more than 800 for the Module 1 inventory of 105,000 MTHM (DIRS 104596-Orthen 1999, Table 6). This increase is approximately equivalent to adding no more than two individuals at each of the 77 sites. Therefore, the additional storage requirements of the Module 1 inventory would be unlikely to affect socioeconomic factors such as infrastructure and regional economy.

For long-term impacts from Scenario 2, because there is an assumption of no effective institutional control after about 100 years, there would be no workers for either the Proposed Action or Module 1 inventories. Therefore, the Module 1 socioeconomic impacts would be essentially the same as those for the Proposed Action for the first 100 years, but after that approximately 800 jobs would be lost. Because these jobs would be spread over 72 commercial and 5 DOE sites (about 10 jobs per site), socioeconomic impacts would be very small for a given region.

7.3.2.7 Occupational and Public Health and Safety

7.3.2.7.1 *Nonradiation Exposures*

For Scenario 1, Module 1, as with the Proposed Action, maintenance, repairs, repackaging, and construction at the storage facilities would be conducted in accordance with Occupational Health and Safety Administration and National Institute of Occupational Safety and Health requirements (29 CFR). Worker exposures to industrial nonradioactive hazardous materials during construction and operation of the storage facilities would be minimized through administrative controls and design features such that exposures would remain below hazardous levels.

For long-term impacts from Scenario 2, the increased inventory of Module 1 and resultant increase in stainless steel storage canisters would be likely to result in a proportional increase in concentrations of chemically toxic materials (such as chromium) in the groundwater and surface waters at the storage sites. However, as discussed in Section 7.2.2.5.1, these concentrations would remain extremely low and would not result in adverse human health impacts. In addition, as discussed in Section 7.2.2.5.1, the Department did not attempt to evaluate adverse health impacts resulting from dissolution of chemically toxic waste forms because it did not want to overestimate impacts from the No-Action Alternative.

7.3.2.7.2 *Industrial Hazards*

For Scenario 1, as discussed in Section 7.2.1.7.2, the majority of the industrial accidents would occur as a result of surveillance (about 94 percent) and construction tasks. Operations tasks would contribute less than 0.001 percent of the total number of accidents. Therefore, to estimate the number of industrial accidents that would be likely to occur at the storage sites for the Module 1 inventory, the number of additional concrete storage modules required to store the additional inventory was calculated.

For Module 1 during the approximately 100-year construction and operation cycle (2002 to 2116), about 80,000 full-time equivalent work years would be required to maintain about 11,000 concrete storage modules and 8 below-grade storage vaults at the 77 sites (DIRS 104596-Orthen 1999, Table 1). Based on this level of effort, as listed in Table 7-10, about 2,800 industrial safety incidents would be likely, resulting in about 1,200 lost workday cases and 3 fatalities (an average of about 1 fatality every 30 years).

Table 7-10. Estimated Module 1 industrial safety impacts at commercial and DOE sites during the first 100 years and the remaining 9,900-year period of analysis under Scenario 1.[a]

Industrial safety impacts	Short-term (100 years)[b] construction and operation	Long-term (9,900 years)[c] construction and operation
Total recordable cases	2,800	410,000
Lost workday cases	1,200	180,000
Fatalities	3	490

a. Source: DIRS 104596-Orthen (1999, Tables 6 and 7).
b. The estimated impacts would result from a single 100-year period of storage module construction (renovation), operation, surveillance, and maintenance.
c. Period from 100 to 10,000 years.

In addition, for Module 1, Table 7-10 indicates about 410,000 projected industrial safety incidents, of which about 180,000 would be lost workday cases and 490 would involve fatalities (an average of about 1 fatality every 20 years or about 1 every 1,600 years at each of the 77 sites). Surveillance tasks would provide about 94 percent of the total worker level of effort, construction tasks would provide nearly all of the remaining 6 percent, and operations tasks would provide less than 0.001 percent.

7.3.2.7.3 *Radiation Exposures*

For Scenario 1, radiation exposures to offsite populations, involved workers, and noninvolved workers would increase because of the additional Module 1 inventory and the construction of additional facilities required to store the materials. The analysis assumed that radiation exposures to offsite and noninvolved worker individuals would increase by the ratio of the Module 1 inventory to the Proposed Action inventory, a factor of about 1.7. Radiation dose rates for the involved maximally exposed worker (construction) would not increase because of the self-shielding effect of the concrete storage modules. Table 7-11 lists radiological human health impacts resulting from the Module 1 inventory.

Table 7-11. Estimated Module 1 radiological human health impacts for Scenario 1.[a]

Receptor	Short-term (100 years) construction and operation	Long-term (9,900 years) construction[b] and operation
Population[c]		
MEI[d] (millirem per year)	0.34	0.10
Dose[e] (person-rem)	1,400	8,800
LCFs[f]	0.70	4.4
Involved workers[g]		
MEI[h] (millirem per year)	170	50
Dose (person-rem)	4,700	41,000
LCFs	1.9	16
Noninvolved workers[i]		
MEI[j] (millirem per year)	23	0[k]
Dose (person-rem)	61,000	0[k]
LCFs	25	0[k]

a. Source: Adapted from DIRS 101898-NRC (1991, all); DIRS 104596-Orthen (1999, all).
b. Assumes construction of 11,000 concrete storage modules, 1 above-grade vault, and 8 below-grade vaults at 77 sites (DIRS 104596-Orthen 1999, Table 1) every 100 years.
c. Members of the general public living within 3 kilometers (2 miles) of the facilities; estimated to be 140,000 over the first approximately 100 years and approximately 14 million over the 9,900-year long-term analysis period [estimated using DIRS 102204-Humphreys, Rollstin, and Ridgely (1997, all)].
d. MEI = maximally exposed individual; assumed to be approximately 1.4 kilometers (0.8 mile) from the center of the storage facility (DIRS 101898-NRC 1991, p. 22).
e. Estimated doses account for radioactive decay.
f. LCF = latent cancer fatality; expected number of cancer fatalities for populations. Based on a risk of 0.0004 and 0.0005 latent cancer per rem for workers and members of the public, respectively (DIRS 101857-NCRP 1993, p. 112), and a life expectancy of 70 years for a member of the public and a 50-year career for workers.
g. Involved workers would be those directly associated with construction and operation activities (DIRS 101898-NRC 1991, pp. 23 to 25). For this analysis, the involved worker population would be about 1,600 individuals (800 individuals at any one time) at 77 sites over 100 years (DIRS 104596-Orthen 1999, Table 6). This population would grow to more than 190,000 over 10,000 years.
h. Based on maximum construction dose rate of 0.11 millirem per hour and 1,500 hours per year (DIRS 101898-NRC 1991, p. 23).
i. Noninvolved workers would be employed at the powerplant but would not be associated with facility construction or operation. For this analysis, the noninvolved worker population would be 80,000 individuals who would receive exposure until the powerplants were decommissioned (50 years).
j. Based on a projected area workforce of 1,200 and an average estimated annual dose of 16 person-rem (DIRS 101898-NRC 1991, p. 24).
k. During this period the powerplants would have ended operation, so there would be no noninvolved workers.

As listed in Table 7-11, the estimated dose to the hypothetical maximally exposed offsite individual for the Module 1 inventory during the operational period between 2002 and 2116 would be about 0.34 millirem per year [adapted from DIRS 101898-NRC (1991, p. 22)]. For the remaining 9,900 years of the analysis period, the dose to the hypothetical maximally exposed individual would decrease to about 0.10 millirem per year because of radioactive decay of the source material. During about the first

100 years, the dose (accounting for radioactive decay) could result (over a 70-year lifetime of exposure) in an increase in the lifetime risk of contracting a fatal cancer of 0.0000073, an increase over the lifetime natural fatal cancer incidence rate of 0.0031 percent. During the remaining 9,900 years of the analysis period, the dose (accounting for radioactive decay) could result (over a 70-year lifetime of exposure) in an increase in the lifetime risk of contracting a fatal cancer of 0.0000022, an increase over the lifetime natural fatal cancer incidence rate of 0.00092 percent.

For the short-term impacts, over about the first 100 years the offsite exposed population of approximately 140,000 would be likely to receive a total collective dose of 1,400 person-rem (adjusted for radioactive decay). This dose could result in 0.70 latent cancer fatality in addition to the 33,000 fatal cancers likely in the exposed population from all other causes. This represents an increase of about 0.0021 percent over the estimated number of cancer fatalities that would occur in the exposed population from all other causes.

For the long-term impacts from Scenario 1, the radiation dose of 8,800 person-rem from the storage facilities could result in an additional 4.4 latent cancer fatalities in the surrounding population of about 14 million. This would be in addition to about 3.3 million cancer fatalities that would be likely to occur in the exposed population of 14 million, an increase of 0.00013 percent over the natural incidence rate.

The analysis assumed the maximally exposed individual in the involved worker population would be a construction worker involved with construction and loading of replacement facilities. Assuming a maximum dose rate of 0.11 millirem per hour (unchanged from the Proposed Action) and an average exposure time of 1,500 hours per year, this construction worker would receive about 170 millirem per year. During about the first 100 years, this dose could result (over three years of construction) in an increase in the lifetime risk of contracting a fatal cancer of 0.00020, an increase of 0.09 percent over the natural fatal cancer incidence rate. During the remaining 9,900 years of the analysis period, the dose could result (over three years of construction) in an increase in the risk of contracting a fatal cancer of 0.000060, an increase over the natural fatal cancer incidence rate of 0.03 percent.

For the involved worker population of 1,600 individuals, approximately 380 would be likely to contract a fatal cancer from some cause other than occupational exposure. In the involved population of 1,600 storage facility workers (during the first 100 years), the collective dose of 4,700 person-rem (corrected for radioactive decay) between 2002 and 2116 could result in 1.9 additional latent cancer fatalities (DIRS 104596-Orthen 1999, Table 6), which would result in an increase of 0.51 percent over the natural incidence rate of fatal cancers from all causes. During the remaining 9,900 years of the analysis period, the involved estimated worker population of more than 190,000 would receive a collective dose of about 41,000 person-rem (corrected for radioactive decay). This dose could result in 16 latent cancer fatalities in addition to the 45,000 cancer fatalities that would be likely in the exposed population from all other causes. These additional cancers would represent an increase of 0.036 percent over the natural incidence rate of fatal cancers.

The estimated Module 1 collective dose to noninvolved workers at a nuclear powerplant from the Module 1 inventory would be about 27 person-rem per year [adapted from DIRS 101898-NRC (1991, p. 24)] for the protected area workforce of 1,200 individuals (DIRS 101898-NRC 1991, p. 26) at the two-unit station at Calvert Cliffs. This collective dose would result in an average maximum dose to the noninvolved worker of 23 millirem per year. Over a 50-year career, this exposure (corrected for radioactive decay) could result in an increase in the lifetime risk of contracting a fatal cancer of 0.00032. This incremental increase in risk would represent an increase of 0.13 percent over the incidence of fatal cancers from all other causes.

In the total noninvolved worker population of 80,000 powerplant workers (all sites), the estimated Module 1 collective dose of 61,000 person-rem (corrected for decay) between 2002 and 2116 could result in 25 additional latent cancer fatalities. This increase represents about an 0.13-percent increase over the 19,000 cancer fatalities that would be likely to occur from all other causes in the same worker population.

After about 100 years, Scenario 2 assumes no effective institutional control of the 77 sites and assumes that the storage facilities would be abandoned. Therefore, there would be no health risk for workers during that period. For the long-term impacts from Scenario 2, the analysis estimated human health impacts to the public on a regional basis (DIRS 104924-Poe 1999, p. 15). The estimated total population dose would increase from 6.6 million person-rem to about 7.3 million person-rem, resulting in an increase in the number of latent cancer fatalities from about 3,300 to almost 3,700 over the 9,900-year analysis period. Appendix K (Sections K.2.4.1 and K.3.1) contains details of the Proposed Action analysis.

7.3.2.8 Accidents

For Scenario 1, both short- and long-term accident consequences for the additional inventory of Module 1 would be bounded by the severe seismic event and could result in slightly higher impacts than those predicted for the Proposed Action inventory. However, this accident scenario would probably produce only minor radiological impacts to persons in the immediate vicinity of the storage facility.

For Scenario 2, the long-term impacts for Module 1 would be the same as those for the Proposed Action (see Section 7.2.2.7) because only a single concrete storage module would be affected, regardless of inventory.

7.3.2.9 Noise

For Scenario 1, noise levels for the Module 1 inventory should not be noticeably greater than those for the Proposed Action. Therefore, the noise would not adversely affect the hearing of facility workers or frighten wildlife from the area.

For the long-term impacts from Scenario 2, as with the Proposed Action, no noise would emanate from the facilities; therefore, no adverse impacts would occur. For about the first 100 years, noise levels would be the same as those for Scenario 1.

7.3.2.10 Aesthetics

As for the Proposed Action, Scenario 1 impacts to aesthetic or scenic resources from storage facilities resulting from the Module 1 inventory would be unlikely. Though the inventory would be larger than that for the Proposed Action, Module 1 would still require only two adjacent locations at each site. Every 100 years, a new facility would be constructed on the idle site, and the storage containers would be transferred. The old facility would be demolished and the site would remain idle for the next 100 years.

For the long-term impacts from Scenario 2, aesthetics would not change until facilities began to degrade, at which time the aesthetic value of the sites would change.

7.3.2.11 Utilities, Energy, and Materials

For Scenario 1, decommissioning and reclamation activities every 100 years associated with the increased number of concrete storage modules required for the Module 1 inventory would consume slightly more diesel fuel, gasoline, and materials than those for the Proposed Action. However, as with the Proposed Action, much equipment and many materials would be salvaged and recycled. DOE would recycle building materials as practicable. Minimal surveillance activities would require some gasoline. Therefore, the increased Module 1 inventory would not adversely affect the utility, energy, or material resources of the region or the country.

For the long-term impacts from Scenario 2, as with the Proposed Action, DOE would not use utilities, energy, or materials after about 100 years and, therefore, impacts to these resources would be unlikely.

7.3.2.12 Waste Management

Under Scenario 1, the construction of new facilities and the demolition of old facilities every 100 years (and the one-time refurbishment of existing facilities after the first 50 years) would generate construction debris and sanitary and industrial solid waste. In addition, routine repairs and maintenance to the facilities and storage containers, routine radiological surveys, and overpacking of failed containers would generate sanitary and industrial solid and low-level radioactive wastes. Because there would not be a dedicated workforce at the storage facilities, only small amounts of sanitary wastes would be generated except during periods of construction. The greatest amount of waste would be generated during the demolition of facilities at the 72 commercial and 5 DOE storage sites every 100 years. The demolition of facilities once every 100 years at all the sites would generate, on average, an estimated 1.4 million cubic meters (1.8 million cubic yards) of nonhazardous demolition debris, recyclable steel, and potentially a small amount of low-level waste if a dry storage canister failed while in storage (DIRS 104596-Orthen 1999, Table 7). The debris and wastes would be disposed of at commercial or DOE disposal facilities across the Nation. The impacts to available capacity would be spread nationwide, thus minimizing impacts to a single disposal facility. The capacities of the disposal facilities would accommodate the wastes generated at the storage facilities.

For Scenario 2, demolition activities would terminate after about 100 years and, therefore, no additional long-term waste management impacts would be likely after this period.

7.3.2.13 Environmental Justice

For Scenario 1, the potential impacts of continued storage of the Module 1 inventory with institutional control would be minimal. Therefore, minority or low-income populations would not be disproportionately or adversely affected.

For the long-term impacts from Scenario 2, the increased number of facilities required to store the Module 1 inventory could adversely affect the nearby public to a degree greater than that for the Proposed Action inventory. As with the Proposed Action inventory, nearby minority or economically disadvantaged communities could experience disproportionately high and adverse human health impacts. In addition, financial considerations could make it more difficult for members of minority or low-income populations to obtain uncontaminated resources or to move away from contaminated soils and water. Because subsistence patterns vary for minority or low-income populations, members of these populations could be exposed to greater than average doses. The result of differing potentials for exposure could result in disproportionately high and adverse impacts to minority or low-income populations.

7.3.2.14 Traffic and Transportation

For Scenario 1, the estimated number of workers commuting to and from work would increase from about 700 to about 800 (DIRS 104596-Orthen 1999, Table 7). The analysis assumed that the number of personnel required for round-the-clock surveillance would not increase but would remain at two individuals per shift per site.

The estimated number of traffic fatalities, which DOE calculated using the assumptions of Section 7.2.1.14, would be approximately 7 for the first 100 years and would increase from about 730 to about 900 for the remaining 9,900 years (DIRS 104596-Orthen 1999, Table 7).

For about the first 100 years, there would be no fatalities from exhaust emissions because there would be no construction or demolition of facilities. For the remaining 9,900 years, trucks would travel over 2.2 billion kilometers (1.4 billion miles), resulting in approximately 31 prompt traffic fatalities (DIRS 103455-Saricks and Tompkins 1999, Table 4, p. 25) and about 0.2 latent fatality from vehicle exhaust emissions.

The long-term impacts from Scenario 2 would be the same as those estimated for the first 100 years under Scenario 1 for Module 1. After the first 100 years, there would be no traffic or transportation-related impacts because all activity would cease.

7.3.2.15 Sabotage

For Scenarios 1 and 2, the risk of intruder access at each of the 77 sites would be essentially the same for Module 1 as for the Proposed Action inventory because the number of sites would remain the same. Therefore, the difficulty of maintaining 77 sites over 100 or 10,000 years also would remain essentially unchanged.

REFERENCES

Note: In an effort to ensure consistency among Yucca Mountain Project documents, DOE has altered the format of the references and some of the citations in the text in this Final EIS from those in the Draft EIS. The following list contains notes where applicable for references cited differently in the Draft EIS.

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105032	CRWMS M&O 1999	CRWMS M&O (*Civilian Radioactive Waste Management System Management and Operating Contractor)* 1999. *Safety and Health Plan.* B00000000-01717-4600-00016 REV 03. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990513.0069. In the Draft EIS, this reference was cited as TRW 1999 in Chapter 12.
103711	Davis, Strenge and Mishima 1998	Davis, P.R.; Strenge, D.L.; and Mishima, J. 1998. *Accident Analysis for Continued Storage.* Las Vegas, Nevada: Jason Technologies Corporation. ACC: MOL.20001010.0214.
104832	DOE 1980	DOE (U.S. Department of Energy) 1980. *Final Environmental Impact Statement Management of Commercially Generated Radioactive Waste.* DOE/EIS-0046F. Three volumes. Washington, D.C.: U.S. Department of Energy, Office of Nuclear Waste Management. ACC: HQZ.19870302.0183, HQZ.19870302.0184, HQZ.19870302.0185.
104731	DOE 1986	DOE (U.S. Department of Energy) 1986. *Environmental Assessment for a Monitored Retrievable Storage Facility.* Volume II of *Monitored Retrievable Storage Submission to Congress.* DOE/RW-0035/1. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.19950815.0019.
104838	DOE 1989	DOE (U.S. Department of Energy) 1989. *MRS System Study Summary Report.* DOE/RW-0235. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.19890602.0001.
101798	DOE 1994	DOE (U.S. Department of Energy) 1994. *Greater-Than-Class C Low-Level Radioactive Waste Characterization: Estimated Volumes, Radionuclide Activities, and Other Characteristics.* DOE/LLW-114, Rev. 1. Idaho Falls, Idaho: U.S. Department of Energy. TIC: 231330.
103191	DOE 1994	DOE (U.S. Department of Energy) 1994. *Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility.* DOE/EIS-0082-S. Aiken, South Carolina: U.S. Department of Energy. TIC: 243608.

101802	DOE 1995	DOE (U.S. Department of Energy) 1995. *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement.* DOE/EIS-0203-F. Idaho Falls, Idaho: U.S. Department of Energy, Idaho Operations Office. TIC: 216020.
101803	DOE 1995	DOE (U.S. Department of Energy) 1995. *Final Environmental Assessment for Solid Waste Disposal, Nevada Test Site, Nye County, Nevada.* DOE/EA-1097. Washington, D.C.: U.S. Department of Energy. TIC: 235646.
101810	DOE 1996	DOE (U.S. Department of Energy) 1996. *DOE Standard, Accident Analysis for Aircraft Crash into Hazardous Facilities.* DOE-STD-3014-96. Washington, D.C.: U.S. Department of Energy. TIC: 231519.
101812	DOE 1996	DOE (U.S. Department of Energy) 1996. *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel.* DOE/EIS-0218F. Washington, D.C.: U.S. Department of Energy. TIC: 223998.
103214	DOE 1996	DOE (U.S. Department of Energy) 1996. *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement.* DOE/EIS-0189. Richland, Washington: U.S. Department of Energy. TIC: 226909.
101816	DOE 1997	DOE (U.S. Department of Energy) 1997. *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste.* DOE/EIS-0200-F. Summary and five volumes. Washington, D.C.: U.S. Department of Energy, Office of Environmental Management. TIC: 232988.
103375	DOE 1998	DOE (U.S. Department of Energy) 1998. *Centralized Interim Storage Facility, Topical Safety Analysis Report, Revision 1.* BA0000000-01717-5700-00017. Two volumes. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.19990212.0117.
147938	DOE 1999	DOE (U.S. Department of Energy) 1999. "DOE and Contractor Injury and Illness Experience by Year and Quarter 1993 Through 1998." Data extracted 4/10/99. Washington, D.C.: U.S. Department of Energy. Accessed May 22, 1999. http://tis.eh.doe.gov/cairs/cairs/dataqtr/q984a.html. TIC: 244036.
153849	DOE 2001	DOE (U.S. Department of Energy) 2001. *Yucca Mountain Science and Engineering Report.* DOE/RW-0539. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20010524.0272.

102064	FHWA 1999	FHWA (Federal Highway Administration) 1995. "Technical Appendix, Our Nation's Travel: 1995 NPTS Early Results Report." Washington, D.C.: Federal Highway Administration. Accessed April 5, 1999. http://www-cta.ornl.gov/npts/1995/Doc/index.shtml. TIC: 244043. In the Draft EIS, this reference was cited as ORNL 1999 in Chapter 12.
104889	Hoskins 1990	Hoskins, R.E. 1990. *Nuclear Waste Management Systems Issues Related to Transportation Cask Design: At-Reactor Spent Fuel Storage, Monitored Retrievable Storage and Modal Mix.* NWPO-TN-003-90. Carson City, Nevada: Nevada Agency for Nuclear Projects/ Nuclear Waste Project Office. ACC: NNA.19910510.0131.
102204	Humphreys, Rollstin, and Ridgely 1997	Humphreys, S.L.; Rollstin, J.A.; and Ridgely, J.N. 1997. *SECPOP90: Sector Population, Land Fraction, and Economic Estimation Program.* NUREG/CR-6525. Washington, D.C.: U.S. Nuclear Regulatory Commission. TIC: 241168.
147905	Mishima 1998	Mishima, J. 1998. "Potential Airborne Release of Particulate Materials During Degradation of Commercial Spent Nuclear Fuel." Memorandum from J. Mishima (Jason Technologies Corporation) to E. Rollins (Tetra Tech NUS), August 20, 1998. TIC: 241186.
153066	Murphy 2000	Murphy, S.L. 2000. *Deaths: Final Data for 1998. National Vital Statistics Reports.* Vol. 48, No. 11. Hyattsville, Maryland: National Center for Health Statistics. TIC: 249111.
100018	National Research Council 1995	National Research Council 1995. *Technical Bases for Yucca Mountain Standards.* Washington, D.C.: National Academy Press. TIC: 217588.
101857	NCRP 1993	NCRP (National Council on Radiation Protection and Measurements) 1993. *Risk Estimates for Radiation Protection.* NCRP Report No. 115. Bethesda, Maryland: National Council on Radiation Protection and Measurements. TIC: 232971.
101898	NRC 1991	NRC (U.S. Nuclear Regulatory Commission) 1991. *Environmental Assessment Related to Construction and Operation of the Calvert Cliffs Independent Spent Fuel Storage Installation, Docket No. 72-8 (50-317, -318) Baltimore Gas and Electric Company.* Washington, D.C.: U.S. Nuclear Regulatory Commission. TIC: 241726.
101899	NRC 1996	NRC (U.S. Nuclear Regulatory Commission) 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report, Final Report.* NUREG-1437, Vol. 1. Washington, D.C.: U.S. Nuclear Regulatory Commission. TIC: 233963.

152001	NRC 2000	NRC (U.S. Nuclear Regulatory Commission) 2000. *Draft Environmental Impact Statement for the Construction and Operation of an Independent Spent Fuel Storage Installation on the Reservation of the Skull Valley Band of Goshute Indians and the Related Transportation Facility in Tooele County, Utah.* NUREG-1714. Washington, D.C.: U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards. ACC: MOL.20000828.0030.
104596	Orthen 1999	Orthen, R.F., Jr. 1999. *Health, Safety, and Environmental Impacts During Controlled Long-Term Storage of Spent Nuclear Fuel and High-Level Radioactive Waste in the United States.* Aiken, South Carolina: Tetra Tech NUS. ACC: MOL.19990608.0047.
103436	PFS 1997	PFS (Private Fuel Storage) L.L.C. 1997. *Environmental Report, Private Fuel Storage Facility.* Docket No. 72-22, Rev. 1. Tooele County, Utah: Skull Valley Indian Reservation. TIC: 242887. In the Draft EIS, this reference was cited as NRC 1997 in Chapter 12.
103449	PGE 1996	PGE (Portland General Electric) 1996. *Trojan Independent Spent Fuel Storage Installation, Safety Analysis Report.* PGE-1069. Portland, Oregon: Portland General Electric. TIC: 243815.
101910	Poe 1998	Poe, W.L., Jr. 1998. *Long-Term Degradation of Concrete Facilities Presently Used for Storage of Spent Nuclear Fuel and High-Level Waste.* Revision 1. Las Vegas, Nevada: Jason Technologies. TIC: 244048.
101911	Poe 1998	Poe, W.L., Jr. 1998. *Regional Binning for Continued Storage of Spent Nuclear Fuel and High-Level Wastes.* Las Vegas, Nevada: Jason Technologies. TIC: 244049.
104924	Poe 1999	Poe, W.L., Jr. 1999. *Long Term Environmental Analysis of Total Inventory of Spent Nuclear Fuel and High-Level Waste for No-Action Alternative of Yucca Mountain Environmental Impact Statement.* Aiken, South Carolina: Tetra Tech NUS. ACC: MOL.19990513. 0042.
101917	Rollins 1998	Rollins, E.M. 1998. *Evaluation of Multimedia Environmental Transport Models for Use in the Yucca Mountain Environmental Impact Statement No-Action Alternative.* Aiken, South Carolina: Tetra Tech NUS. ACC: MOL.20001010.0213.
103455	Saricks and Tompkins 1999	Saricks, C.L. and Tompkins, M.M. 1999. *State-Level Accident Rates of Surface Freight Transportation: A Reexamination.* ANL/ESD/TM-150. Argonne, Illinois: Argonne National Laboratory. TIC: 243751.
101935	Toblin 1999	Toblin, A.L. 1999. *Radionuclide Transport and Dose Commitment from Drinking Water from Continued Storage and Degradation of Spent Nuclear Fuel and High-Level Waste Materials Under Loss of Institutional Control.* Gaithersburg, Maryland: Tetra Tech NUS. TIC: 244116.

102188	YMP 1995	YMP (Yucca Mountain Site Characterization Project) 1995. *Reclamation Implementation Plan.* YMP/91-14, Rev. 1. Las Vegas, Nevada: Yucca Mountain Site Characterization Office. ACC: MOL.19970109.0256. In the Draft EIS, this reference was cited as DOE 1995 in Chapter 12.

8

Cumulative Impacts

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8. CUMULATIVE IMPACTS

The Council on Environmental Quality regulations that implement the procedural provisions of the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 *et seq.*), define a cumulative impact as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7). The term reasonably foreseeable refers to future actions for which there is a reasonable expectation that the action could occur, such as a proposed action under analysis, a project that has already started, or a future action that has obligated funding. Cumulative impacts can result from individually minor but collectively important actions taking place over a period of time. An evaluation of cumulative impacts is necessary to an understanding of the environmental implications of implementing the Proposed Action and is essential to the development of appropriate mitigation measures and the monitoring of their effectiveness.

DOE structured the cumulative impact assessments in this chapter by identifying actions that could have effects that coincided in time and space with the effects from the proposed repository and associated transportation activities. The identification of the relevant actions was based on reviews of resource, policy, development, land-use plans prepared by agencies at all levels of government and from private organizations, other environmental impact statements, environmental assessments, and Native American tribal meeting records. Consistent with Council on Environmental Quality regulations 40 CFR 1502.16(c) and 1506.2, in addition to the assessment of potential cumulative impacts, the analysis considered potential conflicts with plans issued by various governmental entities to the extent practicable and to the extent they provided relevant information.

Not all actions identified in this chapter would have cumulative impacts in all discipline areas. Potential impacts for such actions are discussed for the appropriate discipline areas. In some instances for which an action is reasonably foreseeable, quantitative estimates of impacts are not possible because the action is in its early stages. For those actions, DOE acknowledges the project and states that potential cumulative impacts are unknown at this time.

This chapter evaluates the environmental impacts of repository activities coupled with the impacts of other Federal, non-Federal, and private actions. As part of this process, the chapter includes a detailed analysis of nuclear materials in need of permanent disposal in excess of those evaluated in the Proposed Action. It describes and evaluates these waste quantities, referred to as Inventory Modules 1 and 2, evaluated in terms of their environmental impacts in comparison with those of the Proposed Action impacts. The evaluation of these inventories provides sufficient information for future actions and decisionmaking on inventory selection. This chapter evaluates cumulative short-term impacts from the construction, operation and monitoring, and closure of a geologic repository at Yucca Mountain, and cumulative long-term impacts following repository closure. It also evaluates cumulative transportation impacts from the shipment of spent nuclear fuel and high-level radioactive waste to the repository and of other material to or from the repository. The analysis of cumulative transportation impacts includes the possible construction and operation in Nevada of a branch rail line, or of an intermodal transfer station along with highway improvements for heavy-haul trucks. In addition, the analysis considers cumulative impacts from the manufacturing of repository components.

The cumulative impact analysis in this chapter includes as a reasonably foreseeable future action the disposal in the proposed Yucca Mountain Repository of the total projected inventory of commercial spent nuclear fuel, U.S. Department of Energy (DOE) spent nuclear fuel, and high-level radioactive waste, as well as the disposal of commercial Greater-Than-Class-C waste and DOE Special-Performance-Assessment-Required waste. The total projected inventory of spent nuclear fuel and high-level radioactive waste is more than the 70,000 metric tons of heavy metal (MTHM) considered for the

Proposed Action. Its emplacement at Yucca Mountain would require legislative action by Congress unless a second licensed repository was in operation.

There were several reasons to evaluate the potential for disposing of Greater-Than-Class-C waste and Special-Performance-Assessment-Required waste at Yucca Mountain as reasonably foreseeable actions. First, because both materials exceed Class C limits for specific radionuclide concentrations as defined in 10 CFR Part 61, they are generally unsuitable for near-surface disposal. Second, the U.S. Nuclear Regulatory Commission specifies in 10 CFR 61.55(a)(2)(iv) the disposal of Greater-Than-Class-C waste in a repository unless the Commission approved of disposal elsewhere. Finally, during the scoping process for this environmental impact statement (EIS), several commenters requested that DOE evaluate the disposal of other radioactive waste types that might require isolation in a repository. The disposal of Greater-Than-Class-C and Special-Performance-Assessment-Required wastes at the proposed Yucca Mountain Repository could require a determination by the Nuclear Regulatory Commission that these wastes require permanent isolation. In addition to spent nuclear fuel, high-level radioactive waste, surplus plutonium, Greater-Than-Class-C waste, and Special-Performance-Assessment-Required waste (materials such as depleted uranium), other radioactive wastes could be considered in the future for disposal in the Yucca Mountain Repository.

By analyzing the emplacement of Inventory Module 1 or 2, DOE is not stating that the emplacement of materials beyond those prescribed for the Proposed Action would occur. Rather, the Department is being prudent in analyzing a reasonably foreseeable action that could take place. If a future decision was made to emplace additional material included in the Inventory Modules, the Department would ensure that appropriate National Environmental Policy Act reviews were performed.

In general, the analysis of cumulative impacts in this chapter follows the process recommended in the Council on Environmental Quality's handbook *Considering Cumulative Effects Under the National Environmental Policy Act* (DIRS 103162-CEQ 1997, all). This process includes the identification, through research and consultations, of Federal, non-Federal, and private actions with possible effects that would be coincident with those of the Proposed Action on resources, ecosystems, and human communities. Coincident effects would be possible if the geographic and time boundaries for the effects of the Proposed Action and past, present, and reasonably foreseeable future actions overlapped. Using the methods and criteria described in Chapters 4, 5, and 6 of this EIS and their supporting appendixes, DOE assessed the potential cumulative impacts of coincident effects.

This chapter has six sections. Section 8.1 identifies and analyzes past, present, and reasonably foreseeable future actions with impacts that could combine with impacts of the Proposed Action. Sections 8.2 and 8.3 present the analyses of cumulative short-term (the period before the completion of repository closure) and long-term (the first 10,000 and first 1 million years following closure) impacts, respectively, in the proposed Yucca Mountain Repository region. Section 8.4 describes cumulative transportation impacts, nationally and in Nevada. Section 8.5 addresses cumulative impacts associated with the manufacturing of repository components. Section 8.6 presents an overall summary of potential cumulative impacts by discipline area.

8.1 Past, Present, and Reasonably Foreseeable Future Actions

This section identifies past, present, and reasonably foreseeable future actions with impacts that could combine with impacts of the Proposed Action. It describes these actions and their relationships to the Proposed Action that could result in cumulative impacts (see Table 8-1 for a summary). Sections 8.2 through 8.5 present the cumulative impacts from the past, present, and reasonably foreseeable future actions identified in this section.

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Table 8-1. Past, present, and reasonably foreseeable future actions that could result in cumulative impacts (page 1 of 3).

Name and action description	Potential cumulative impact areas: Short-term (Section 8.2)	Long-term (Section 8.3)	Transportation (Section 8.4)[a]	Manufacturing (Section 8.5)
Past and present actions[b]				
Nevada Test Site				
Nuclear weapons testing, waste management, etc.	Air quality and public health and safety[b]	Air quality, groundwater, and public health and safety	Occupational and public radiological health and safety	None
Beatty Waste Disposal Area				
Low-level radioactive and hazardous waste disposal	None	Groundwater and public health and safety	Occupational and public radiological health and safety	None
Reasonably foreseeable future actions				
Inventory Module 1[c]				
Disposal of all spent nuclear fuel and high-level radioactive waste in the proposed Yucca Mountain Repository	Same resource areas as the Proposed Action (see Table 8-5)	Same resource areas as the Proposed Action (see Table 8-5)	Same resource areas as the Proposed Action (see Table 8-5)	Same resource areas as the Proposed Action (see Table 8-5)
Inventory Module 2[c]				
Disposal of all spent nuclear fuel and high-level radioactive waste, as well as Greater-Than-Class C waste and Special-Performance-Assessment-Required waste, in the proposed Yucca Mountain Repository	Same resource areas as the Proposed Action (see Table 8-5)	Same resource areas as the Proposed Action (see Table 8-5)	Same resource areas as the Proposed Action (see Table 8-5)	Same resource areas as the Proposed Action (see Table 8-5)
Nellis Air Force Range				
National testing and training for military equipment and personnel	None	None	Land use	None
Nevada Test Site				
Defense (stockpile stewardship and management, material disposition, nuclear emergency response), waste management, environmental restoration, nondefense research and development, work for others	Air quality, groundwater, socioeconomics, public health and safety. (Note: The accident analysis of potential external events in Appendix H addresses the effects of possible future resumption of nuclear weapons tests).	Groundwater and public health and safety	Occupational and public radiological health and safety	None
Nevada Test Site				
Alternative Energy Generation Facility	*Land use, utilities*	None	None	None
DOE Complex-Wide Waste Management Activities Affecting the Nevada Test Site				
Treatment, storage, and disposal of low-level radioactive waste, mixed waste, transuranic waste, high-level radioactive waste, and hazardous waste from past and future nuclear defense and research activities	No additional[d] beyond those analyzed for Nevada Test Site activities	Groundwater and public health and safety	Occupational and public radiological health and safety	None

Table 8-1. Past, present, and reasonably foreseeable future actions that could result in cumulative impacts (page 2 of 3).

Name and action description	Short-term (Section 8.2)	Long-term (Section 8.3)	Transportation (Section 8.4)[a]	Manufacturing (Section 8.5)
Reasonably foreseeable future actions (continued)				
Low-Level Waste Intermodal Transfer Station				
Construction and operation of an intermodal transfer station for the shipment of low-level radioactive waste to the Nevada Test Site near Caliente	None	None	Same resource areas as the Proposed Action (see Table 8-5) (Caliente intermodal transfer station and highway route for heavy-haul trucks)	None
Timbisha Shoshone Reservation				
Creation and development of a discontiguous reservation in eastern California and southwestern Nevada	Land use, groundwater	None	Water consumption, land use, public safety, environmental justice	None
Cortez Pipeline Gold Deposit Projects				
Continued operation and potential expansion of a gold mine and processing facility	None	None	Land use and ownership (Carlin rail corridor)	None
Apex Bulk Commodities Intermodal Transfer Station				
Construction and operation of an intermodal transfer station for copper concentrate near Caliente	None	None	Same resource areas as the Proposed Action (see Table 8-5) (Caliente intermodal transfer station and highway route for heavy-haul trucks)	None
Shared use of a DOE branch rail line				
Increase in rail operations and traffic resulting from rail service options for nearby mine operators and communities	None	None	Same resource areas as the Proposed Action (see Table 8-5)	None
Private Fuel Storage				
Temporary storage of spent nuclear fuel at the Goshute Reservation in Utah	None	None	Occupational and public radiological health and safety	None
Owl Creek Energy Project				
Temporary storage of spent nuclear fuel	None	None	Potential occupational and public radiological health and safety	None
Ivanpah Airport				
Construction of an airport on previously undisturbed land	None	None	Land use (Jean transportation corridor)	None
Moapa Paiute Energy Center				
Lease land and water use for construction of a coal-fired powerplant	None	None	Land use	None

Table 8-1. Past, present, and reasonably foreseeable future actions that could result in cumulative impacts (page 3 of 3).

Name and action description	Potential cumulative impact areas: Short-term (Section 8.2)	Long-term (Section 8.3)	Transportation (Section 8.4)[a]	Manufacturing (Section 8.5)
Reasonably foreseeable future actions (continued)				
Southern Nevada Public Land Management Act				
Convey approximately 110 square kilometers[e] of Bureau of Land Management lands to commercial and private entities	Land use and ownership	None	Land use and ownership	None
Desert Space Station Science Museum				
Construct an 8,800-square-meter[f] science museum on land acquired from the Bureau of Land Management	Land use	None	None	None

a. In addition to the specific actions identified in Section 8.1 and summarized in this table, the cumulative impacts for national transportation consider the occupational and public radiological health impacts of other past, present, and reasonably foreseeable future shipments of radioactive material.

b. The impacts of most past and present actions are included in the existing environmental baseline described in Chapter 3 and, therefore, are generally encompassed in the analysis of potential impacts of the Proposed Action in Chapters 4, 5, and 6. This includes site characterization activities at Yucca Mountain.

c. As described in Section 8.1.2.1, there would be essentially no difference in the design and operation of the repository for Inventory Module 1 or 2. Therefore, the cumulative impacts from Inventory Module 1 are generally considered the same as those from Inventory Module 2.

d. DOE waste management activities at the Nevada Test Site are included for the continuation of waste management activities at current levels, plus additional wastes that could be received as a result of decisions based on the Waste Management Programmatic EIS (DIRS 101816-DOE 1997, all). This includes cumulative impacts of transportation and disposal.

e. 110 square kilometers = 27,000 acres.

f. 8,800 square meters = 95,000 square feet.

8.1.1 PAST AND PRESENT ACTIONS

The description of existing (baseline) environmental conditions in Chapter 3 includes the impacts of most past and present actions on the environment that the Proposed Action would affect. This includes site characterization activities at Yucca Mountain. The impacts of past and present actions are, therefore, generally encompassed in the Chapter 4, 5, and 6 analyses of potential environmental impacts of the Proposed Action because the baseline for these analyses is the affected environment described in Chapter 3.

Two past actions that are not addressed in the Chapter 3 environmental baseline were identified for inclusion in the cumulative impact analysis in Sections 8.2, 8.3, and 8.4—past DOE activities at the Nevada Test Site (nuclear weapons testing, etc.) and past disposal of low-level radioactive waste at the Beatty Waste Disposal Area. Resources identified where past Nevada Test Site activities could add to impacts from the Proposed Action include air quality, groundwater, public health and safety, and transportation. For the Beatty Waste Disposal Site, the analysis included potential cumulative impacts from past transportation of waste to the Beatty site and from potential groundwater contamination.

Other actions that are presently occurring also have a component that is reasonably foreseeable as a future action. These are discussed in Section 8.1.2.

8.1.2 REASONABLY FORESEEABLE FUTURE ACTIONS

This section describes the reasonably foreseeable future actions that the cumulative impacts analysis considered. The analysis included cumulative impacts from the disposal in the proposed repository of all projected spent nuclear fuel and high-level radioactive waste as well as Greater-Than-Class-C waste and Special-Performance-Assessment-Required waste as reasonably foreseeable future actions (Inventory Modules 1 and 2; see Section 8.1.2.1). Sections 8.1.2.2 and 8.1.2.3 describe other Federal, non-Federal, and private actions that could result in cumulative impacts. This chapter does not discuss cumulative impacts for the No-Action Alternative. Chapter 7, Section 7.3, describes those impacts. Chapters 2 and 7 contain details on the No-Action Alternative and on continued storage of the material at its current locations or at one or more centralized location(s).

DOE gathered information on Federal, non-Federal, and private actions to identify reasonably foreseeable future actions that could combine with the Proposed Action to produce cumulative impacts. The types of documents reviewed included other EISs, resource management plans, environmental assessments, Notices of Intent, Records of Decision, etc. Consultations with Federal agencies, state and local agencies, and Native American tribes (see Appendix C) also contributed to the information used in the cumulative impact analysis.

8.1.2.1 Inventory Modules 1 and 2

Under the Proposed Action, DOE would emplace in the proposed Yucca Mountain Repository as much as 70,000 MTHM of spent nuclear fuel and high-level radioactive waste. Of the 70,000 MTHM, approximately 63,000 MTHM would be commercial spent nuclear fuel. The remaining 7,000 MTHM would consist of approximately 2,333 MTHM of DOE spent nuclear fuel and approximately 8,315 canisters (4,667 MTHM) containing solidified high-level radioactive waste (commercial and defense-related). To determine the number of canisters of high-level radioactive waste included in the Proposed Action waste inventory, DOE used an equivalence of 2.3 MTHM per canister of commercial high-level radioactive waste and 0.5 MTHM per canister of defense high-level radioactive waste as discussed in Appendix A, Section A.2.3.1. DOE has consistently used the 0.5-MTHM-per-canister equivalence since 1985. Using a different approach would change the number of canisters of high-level radioactive waste analyzed for the Proposed Action. Regardless of the number of canisters, the impacts from the entire inventory of high-level radioactive waste are analyzed in this chapter. In addition, the 70,000 MTHM inventory would include an amount of surplus plutonium as spent mixed-oxide fuel or immobilized plutonium.

Inventory Modules 1 and 2 represent the reasonably foreseeable future actions of disposing of all projected commercial and DOE spent nuclear fuel and all high-level radioactive waste as well as Greater-Than-Class-C waste and Special-Performance-Assessment-Required waste in the proposed repository (see Figure 8-1). Under Inventory Module 1, DOE would emplace all projected commercial spent nuclear fuel (about 105,000 MTHM), all DOE spent nuclear fuel (about 2,500 MTHM), and all high-level radioactive waste (approximately 22,280 canisters). Inventory Module 2 includes the Module 1 inventory plus other radioactive material that could require disposal in a monitored geologic repository (commercial Greater-Than-Class-C waste and DOE Special-Performance-Assessment-Required waste). The estimated quantities of these other wastes are about 2,000 cubic meters (71,000 cubic feet) and about 4,000 cubic meters (140,000 cubic feet), respectively. Appendix A contains further details on these inventories.

The following paragraphs summarize the differences in repository facilities and operations to receive, package, and emplace the additional materials in Inventory Module 1 or 2. The information on Modules 1 and 2 in this section is from CRWMS M&O (DIRS 104508-1999, DIRS 104523-1999, and DIRS 102030-1999) unless otherwise noted. Table 8-2 summarizes the increased number of shipments that would be required to transport the Module 1 or 2 inventory to the repository. As for the Proposed Action, the estimated numbers of shipments were based on the characteristics of the materials, shipping capabilities at the commercial nuclear sites and DOE facilities, the assumption that there would be one shipping cask per truck or railcar (a train would normally use multiple rail cars and ship more than one

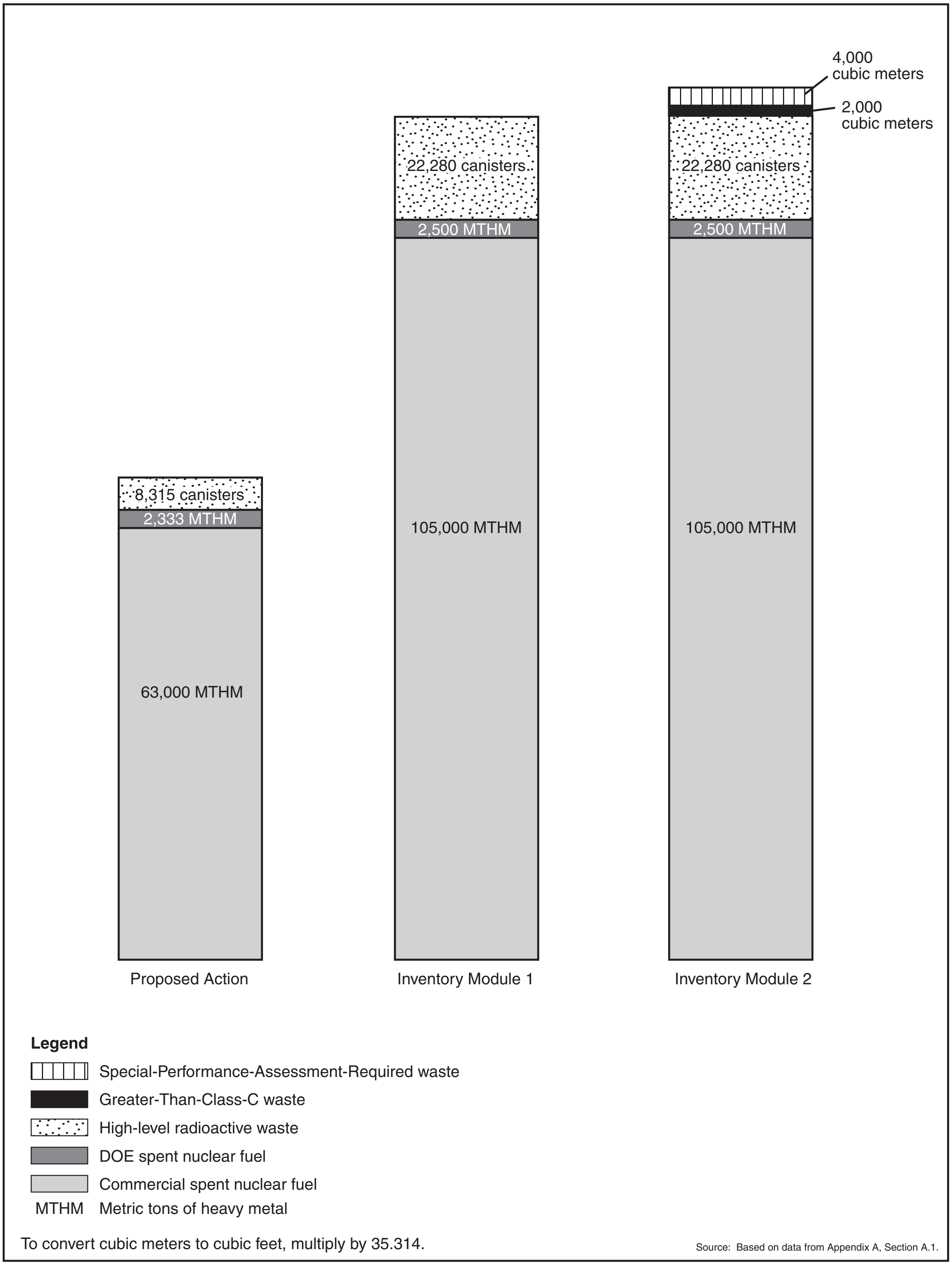

Figure 8-1. Proposed Action, Module 1, and Module 2 inventories evaluated for emplacement in a repository at Yucca Mountain.

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Table 8-2. Estimated number of shipments for the Proposed Action and Inventory Modules 1 and 2.[a,b]

	Proposed Action				Module 1				Module 2			
	Mostly legal-weight truck		Mostly rail		Mostly legal-weight truck		Mostly rail		Mostly legal-weight truck		Mostly rail	
Material	Truck	Rail[c]	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail
Commercial SNF[d]	41,000	0	1,100	7,200	80,000	0	3,100	13,000	80,000	0	3,100	13,000
DOE SNF	3,500	300	0	770	3,700	300	0	800	3,700	300	0	800
HLW[e]	8,300	0	0	1,700	22,000	0	0	4,500	22,000	0	0	4,500
GTCC[f] waste	0	0	0	0	0	0	0	0	1,100	0	0	280
SPAR[g] waste	0	0	0	0	0	0	0	0	1,800	55	0	410
Totals	***53,000***	***300***	***1,100***	***9,700***	***110,000***	***300***	***3,100***	***18,000***	***109,000***	***360***	***3,100***	***19,000***

a. Source: Appendix J, Section J.1.3.1.
b. Totals might differ from sums of values due to rounding.
c. For this EIS, each combination of a shipping cask and railcar is assumed to be a single shipment.
d. SNF = spent nuclear fuel.
e. HLW = high-level radioactive waste.
f. GTCC = Greater-Than-Class-C.
g. SPAR = Special-Performance-Assessment-Required.

cask), various cask designs, and the transportation mode mix (mostly legal-weight truck or mostly rail). Appendix J contains additional details on Inventory Module 1 and 2 transportation requirements.

The following are the major differences between the repository facilities and operations for Inventory Modules 1 and 2 and those for the Proposed Action, which are described in Chapter 2:

- The longer time required to receive, package, and emplace the additional spent nuclear fuel, high-level radioactive waste, Greater-Than-Class-C waste, and Special-Performance-Assessment-Required waste, and to close the repository, for Inventory Module 1 or 2 versus that for the Proposed Action. The periods for the various project phases for Inventory Modules 1 and 2 would be the same.

- The need for more subsurface area to emplace about 17,000 to 26,000 waste packages for the Inventory Modules in comparison to about 11,000 to 17,000 waste packages for the Proposed Action.

Table 8-3 lists the differences in the expected time sequence for the repository construction, operation and monitoring, and closure phases for the Proposed Action and the Inventory Modules. DOE expects the construction phase to last for 5 years. Following this phase, repository development is projected to last for 22 years and emplacement for 24 years for the Proposed Action. During the operation and monitoring phase, development and emplacement is expected to last for 36 and 38 years, respectively, for Module 1 or Module 2. Monitoring activities during this phase would occur concurrently and then would extend beyond the emplacement period for up to 300 years. DOE expects the closure phase to last between 10 and 17 years for the Proposed Action and between 12 and 23 years for the Inventory Modules.

Table 8-3. Expected time sequence (years) of Yucca Mountain Repository phases for the Proposed Action and Inventory Module 1 or 2.

		Operation and monitoring phase			
Inventory	Construction phase	Development	Emplacement[a]	Monitoring	Closure phase
Proposed Action	5	22	24 - 50	76 - 300	10 - 17
Module 1 or 2	5	36	38 - 51	62 - 300	12 - 23

a. Range results from consideration of various operating modes with and without aging.

The amount of land required for surface facilities would increase only slightly for Inventory Module 1 or 2 from that for the Proposed Action (see Table 8-4). The design and operation of the repository surface facilities for Inventory Modules 1 and 2, including a Cask Maintenance Facility if it was at the Yucca Mountain site, would not differ much from those of the Proposed Action. The rate of material receipt,

Table 8-4. Amount of land (in square kilometers) newly disturbed at the proposed Yucca Mountain Repository for the Proposed Action and Inventory Module 1 or 2.[a,b,c]

Area	Proposed Action		Module 1 or 2	
	Higher-temperature	Lower-temperature	Higher-temperature	Lower-temperature
North Portal Operations Area	0.62	0.62	0.62	0.62
South Portal Development Area	0.15	0.15	0.15	0.15
Ventilation Shaft Operations Areas and access roads	0.83 (7 shafts)	1.04 - 1.42 (10 - 17 shafts)	1.13 (11 shafts)	1.38 - 1.89 (16 - 25 shafts)
Excavated rock storage area	0.87	0.87 - 1.51	1.40	1.40 - 2.02
Landfill	0.04	0.04 - 0.06	0.04	0.04 - 0.06
Solar power generating facility	0.22	0.22	0.22	0.22
Concrete batch plant	0.06	0.06	0.06	0.06
Surface aging facility	0	0 - 0.47	0	0 - 0.47
Totals	***2.8***	***3.0 - 4.5***	***3.6***	***3.9 - 5.5***

a. Source: DIRS 152010-CRWMS M&O (2000, Table 6-2, p. 52); DIRS 150941-CRWMS M&O (2000, p. 4-9 and Figure 6-1, p. 6-27); DIRS 155515-Williams (2001, 2.1-m Spacing Option: p. 27 and 29; 6.4-m Spacing Option: p. 24); DIRS 155516-Williams (2001, p. 3); DIRS 153882-Griffith (2001, p. 8).

b. To convert square kilometers to acres, multiply by 247.1.

c. Totals might differ from sums of values due to rounding.

packaging, and emplacement would be approximately the same and would require an extra 14 years beyond the 24-year emplacement period for the Proposed Action. There would be no difference in the duration of the emplacement period between Inventory Modules 1 and 2 because the surface and subsurface facilities could accommodate the small number of additional shipments and waste packages for Module 2.

The repository subsurface facilities for Inventory Module 1 or 2 would require about 60 percent more subsurface excavation than the Proposed Action. About 7.2 square kilometers (1,790 acres) would be required for the higher-temperature repository operating mode for Module 1 or 2, and from 10 to 15.4 square kilometers (2,480 to 3,810 acres) for the lower-temperature mode for Module 1 or 2. This compares to about 4.6 square kilometers (1,150 acres) and from 6.5 to 10.4 square kilometers (1,600 to 2,570 acres) for the higher- and lower-temperature modes, respectively, for the Proposed Action. Additional subsurface area would be needed if maximum spacing was used to achieve the lower-temperature mode. DOE would characterize this additional subsurface area, which would be adjacent to the blocks identified for the Proposed Action, more fully before its use. The subsurface facilities would not differ between Inventory Modules 1 and 2 for the lower-temperature operating mode with maximum-spacing because DOE would place the additional waste packages for Greater-Than-Class C and Special-Performance-Assessment-Required wastes between commercial spent nuclear fuel waste packages. However, total drift length would have to be increased by an estimated 3.7 to 4.9 kilometers (2.3 to 3.0 miles) for the other methods to achieve the lower-temperature operating mode when going from Inventory Module 1 to Module 2. There would be no difference in emplacement operating for Inventory Module 1 or 2 from those described for the Proposed Action in Chapter 2 unless DOE used the lower-temperature mode with surface aging. Because of the extra time involved in receiving and emplacing the Module 1 or 2 waste, there would be no delay in the process with the aging option before movement of the aged waste to the subsurface could begin, and DOE could move it at a faster rate. Monitoring and maintenance activities for Inventory Module 1 or 2 would be comparable to those for the Proposed Action with the exception of their duration in some cases.

Because there would be an increase in the number of waste packages and the increased length of the drifts that would be necessary for Inventory Module 1 or 2, the duration of the closure phase would be longer for Module 1 or 2 (12 to 23 years) compared to 10 to 17 years for the Proposed Action (see Table 8-3).

Inventory Module 1 or 2 closure phase activities would not otherwise differ from those described in Chapter 2 for the Proposed Action.

As discussed in the introduction to this chapter, the Department is not proposing at this time to emplace the additional materials from the Inventory Modules in the repository. If a future proposal was made to emplace these materials, the Department would ensure that appropriate National Environmental Policy Act reviews were performed.

8.1.2.2 Federal Actions

The following paragraphs describe reasonably foreseeable future actions of Federal agencies that could result in cumulative impacts in addition to those from Inventory Module 1 or 2.

Nellis Air Force Range

The Nellis Air Force Range (also referred to as the Nevada Test and Training Range) in south-central Nevada (see Figure 8-2) is a national test and training facility for military equipment and personnel. The *Renewal of the Nellis Air Force Range Land Withdrawal: Legislative Environmental Impact Statement* (DIRS 103472-USAF 1999, all) addresses the potential environmental consequences of the Air Force proposal to continue the Nellis Air Force Range land withdrawal for military use. As part of the actions analyzed in the Legislative EIS, the Air Force would renew its land withdrawal of almost 3 million acres and transfer responsibility to DOE for approximately 127,620 acres of land generally described as Pahute Mesa. Figures 8-2 and 8-3 show Pahute Mesa as part of the Nevada Test Site. The President signed S.1059 in October 1999, making it Public Law 106-65 and authorizing the renewed withdrawals and transfers described in the Legislative EIS.

The Air Force also issued the *Final Environmental Impact Statement F-22 Aircraft Force Development Evaluation and Weapons School Beddown at Nellis Air Force Base* in 1999 (DIRS 155928-Estrada 2001, all) to evaluate the potential impacts of locating F-22 aircraft at the Nellis Air Force Range. The action would entail the construction of some new facilities and other modifications to support the aircraft. The Record of Decision (DIRS 155918-Keck 1999, all) shows that the action "would result in either negligible effects or would not change current environmental conditions at Nellis AFB" for the major discipline areas. Therefore, DOE has not quantified potential cumulative impacts from this action. The descriptions of the affected environment in Chapter 3 and the potential impacts of the Proposed Action in Chapters 4, 5, and 6 include the effects of present activities at the Nellis Air Force Range.

Nevada Test Site

Several actions at the Nevada Test Site would pose a cumulative impact. Figure 8-3 shows a map of the Nevada Test Site to assist in identifying the location of these actions.

The *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DIRS 101811-DOE 1996, all) examines current and future DOE activities in southern Nevada at the Nevada Test Site, Tonopah Test Range, and sites the Department formerly operated in Nevada. The first Record of Decision for that EIS (61 *FR* 65551, December 13, 1996) states that DOE would implement a combination of three alternatives: Expanded Use, No Action (continue operations at current levels) regarding mixed and low-level radioactive waste management, and Alternate Use of Withdrawn Lands regarding public education. On February 18, 2000, the Department issued an Amendment of the Record of Decision (65 *FR* 10061, February 26, 2000). In this Amendment, DOE decided, based on its National Environmental Policy Act reviews for the Nevada Test Site and for the Complex-wide waste management program described in the Programmatic Waste Management EIS (DIRS 101816-DOE 1997, all), to implement the Expanded Use Alternative for waste management activities at the Test Site, including mixed and low-level radioactive waste.

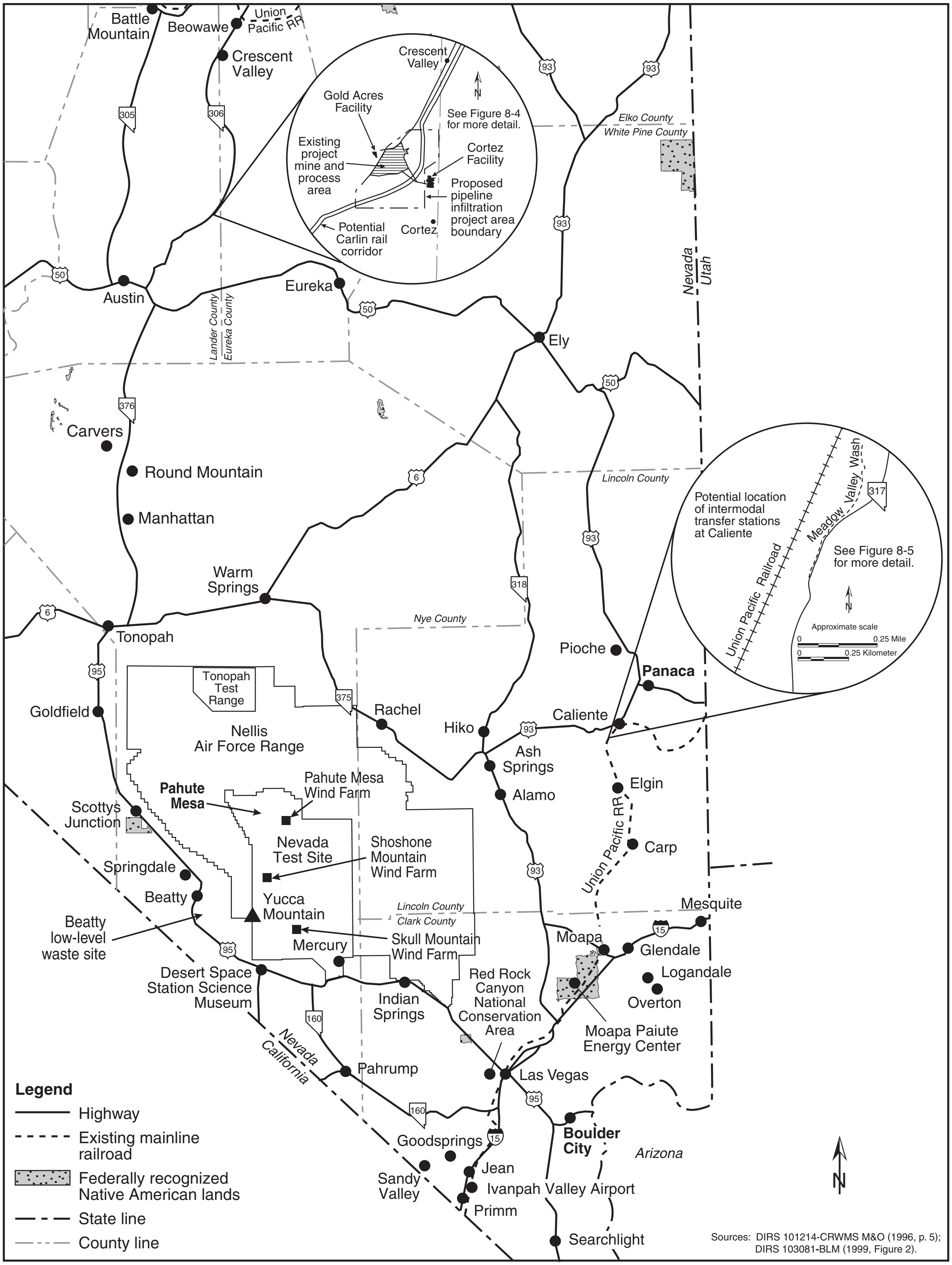

Figure 8-2. Locations of past, present, and reasonably forseeable future actions considered in the cumulative impact analysis.

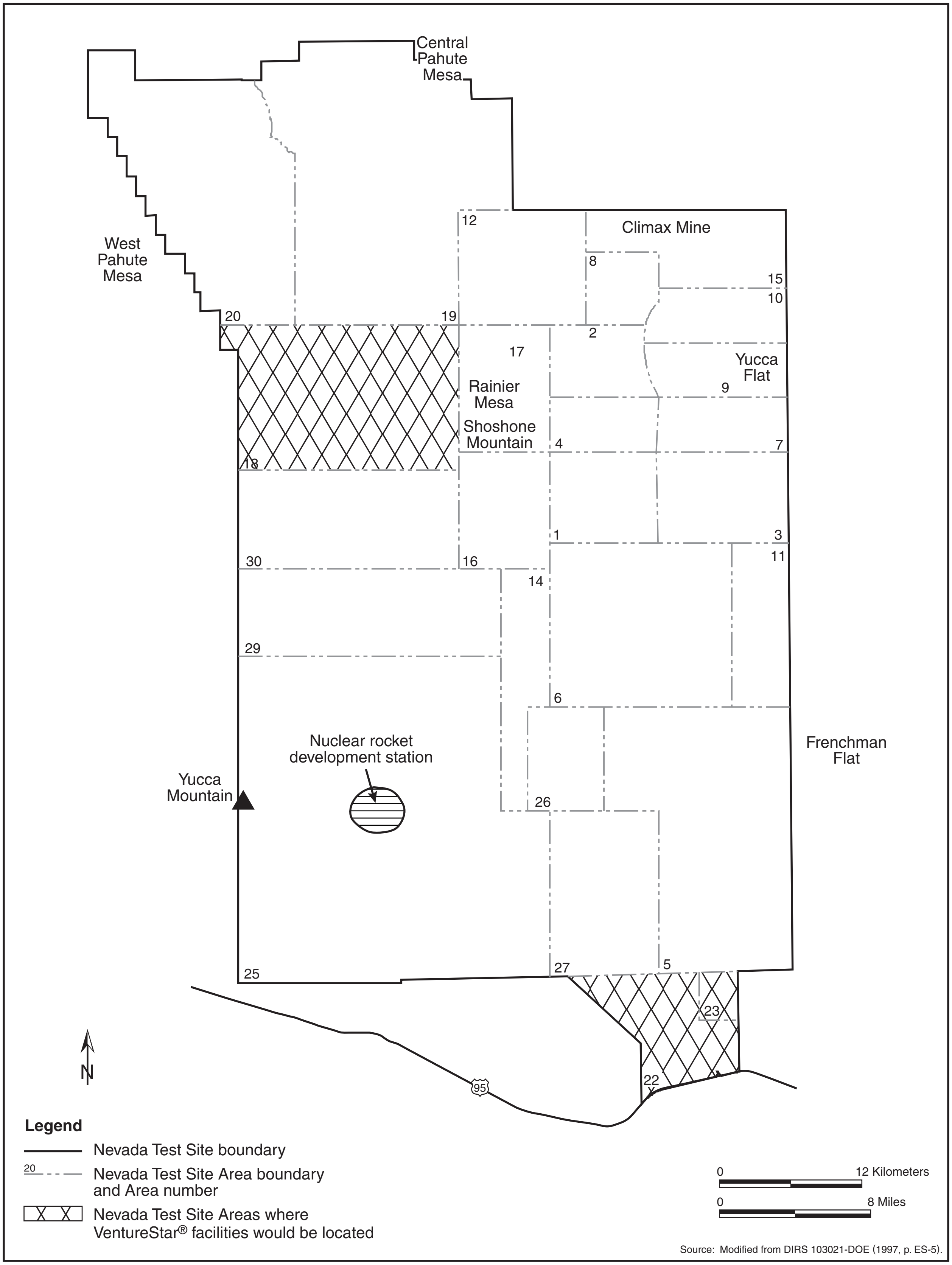

Figure 8-3. Potential locations of proposed cumulative activity associated with VentureStar®/Kistler at the Nevada Test Site.

The Expanded Use Alternative incorporates all the activities and operations from ongoing Nevada Test Site programs and increases some of those programs. Activities of the Office of Defense Programs would expand at both the Nevada Test Site and the Tonopah Test Range, primarily in the areas of stockpile stewardship and management, materials disposition, and nuclear emergency response. As part of the Stockpile Stewardship and Management Program, there are continuing *subcritical* weapons test activities to study aging of weapons components and their reliability after aging. Waste management activities would continue at current levels pending decisions by DOE based on the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DIRS 101816-DOE 1997, all). Based on the preferred alternative in the programmatic EIS, this cumulative impact analysis included the additional low-level and mixed waste that could come to the Nevada Test Site. The Environmental Restoration Program would continue, potentially at an accelerated rate, at the Nevada Test Site and all offsite locations. Under the Work for Others Program, military use of the airspace over the Nevada Test Site and the Tonopah Test Range would increase, as would the use of certain lands on the Nevada Test Site by the military for training, research, and development. Public education activities would include the possible construction of a museum that highlights Nevada Test Site testing activities. The Nevada Test Site Development Corporation is considering the VentureStar® program initiative from the Lockheed Martin Corporation for a launch/recovery system that would link with the Kistler Aerospace Satellite launch and recovery project. The VentureStar® program would require two spaceports, a manufacturing and assembly facility, and a payload processing and administrative complex. These activities could occur in Areas 18, 22, and 23, respectively (Figure 8-3). However, the Kistler aerospace activity is currently on hold (DIRS 152582-Davis 2000, all), and there is not enough information at this time to perform a cumulative impacts analysis for this project.

An analysis of the environmental impacts presented in the Nevada Test Site EIS (DIRS 101811-DOE 1996, all) (including impacts from weapons testing and the VentureStar®/Kistler project) identified the following resources for which impacts could overlap in relation to geography and timing with impacts from the proposed repository: air quality, groundwater, socioeconomics, public health and safety, and transportation. The effects on the Yucca Mountain Repository if a decision were made in the future to resume nuclear weapons testing or from a possible vehicle launch or recovery accident at the proposed VentureStar®/Kistler project are considered in the accident analysis of potential external events in Appendix H.

As discussed above in the section on the Nellis Air Force Range, part of the land previously assigned to the Range, specifically the parcel known as Pahute Mesa, has been transferred to the Nevada Test Site. The use of the land has not changed; this was a transfer of jurisdiction to match actual use with ownership.

A moratorium on the explosive testing of nuclear weapons began in October 1992. As discussed in the Nevada Test Site EIS, however, other testing continues at the Test Site, including dynamic, hydrodynamic, and explosive tests (DIRS 101811-DOE 1996, all). These tests are necessary for the continued assurance of the Nation's nuclear arsenal but do not result in nuclear explosions like those that were common during the Cold War. Therefore, environmental contamination from nuclear weapons testing is largely due to past testing and not to current activities at the Test Site. Although there are potential past and present impacts of the explosive testing of nuclear weapons, the long-lived radionuclides that have been deposited far underground could pose future impacts that are evaluated in Section 8.3. As shown in that section, DOE has made conservative assumptions to ensure the identification of any potential cumulative impacts between the Nevada Test Site and the proposed repository.

In March 2000, DOE published the *Nevada Test Site Development Corporation's Desert Rock Sky Park at the Nevada Test Site Environmental Assessment* (DIRS 155529-DOE 2000, all) and the associated

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Finding of No Significant Impact. This environmental assessment evaluated the potential impacts of issuing a general use permit to the Nevada Test Site Development Corporation to develop, operate, and maintain a commercial/industrial park at the Test Site. The project would permit development of approximately 2 square kilometers (510 acres) of land already designated as a "private/commercial development zone."

In March 2001, DOE published the *Preapproval Draft Environmental Assessment for a Proposed Alternative Energy Generation Facility at the Nevada Test Site* (DIRS 154545-DOE 2001, all). The NTS Development Corporation (NTSDC) and the M&N Wind Power Inc. and Siemens (MNS) have requested authorization (under an easement between DOE and NTSDC and a subeasement between NTSDC and MNS) for the installation of 260 and 436 megawatts of a commercial wind-turbine-generated power system using as many as 545 wind turbine generators on three areas of the Nevada Test Site. The development of this system would allow for land use diversification of the Test Site by including nondefense and private use. The areas consist of the Shoshone Mountain Area, the Pahute Mesa, and Skull Mountain. DOE used these areas comprising 4.9 square kilometers (1,200 acres) for nuclear and conventional explosive testing facilities. The wind generators would be constructed on the ridges in these areas to maximize the effects of wind currents. They would be constructed in three phases and would not conflict with continued Nevada Test Site operations in the valley areas. On July 25, 2001, DOE announced its intention to prepare an EIS based on its analysis contained in the previous environmental assessment. This EIS would consider alternative locations and examine the impacts of the No-Action Alternative.

DOE Waste Management Activities

The Waste Management Programmatic EIS (DIRS 101816-DOE 1997, all) evaluates the environmental impacts of managing five types of radioactive and hazardous wastes generated by past and future nuclear defense and research activities at a variety of DOE sites in the United States. The five waste types are low-level radioactive waste, mixed low-level waste (referred to in this EIS as simply mixed waste), transuranic waste, high-level radioactive waste, and hazardous waste. The Waste Management Programmatic EIS provides information to assist DOE with decisions on the management of, and facilities for, the treatment, storage, and disposal of these radioactive, hazardous, and mixed wastes.

DOE has issued six Records of Decision or revisions to Records of Decision on the Programmatic Waste Management EIS (DIRS 101816-DOE 1997, all). The discussion of these decisions is presented in this section; however, the impacts of actions from these decisions would be related primarily to transportation of materials; these impacts are part of the analysis in Section 8.4. The first Record of Decision (63 *FR* 3629, January 23, 1998) announced the Department's decision to treat and store transuranic waste at each DOE facility except Sandia National Laboratory, which would transfer its transuranic waste to Los Alamos National Laboratory for preparation and storage. This waste would ultimately be disposed of in the Waste Isolation Pilot Plant in Carlsbad, New Mexico.

The fourth Record of Decision announced the Department's decision to make the Nevada Test Site and the Hanford Site available to all DOE sites for disposal of low-level waste and mixed low-level waste. This decision was accompanied by an amendment to the Record of Decision for the Nevada Test Site EIS (65 *FR* 10061, February 25, 2000) to implement the Expanded Use Alternative from that EIS.

On December 29, 2000, the Department announced a revision (65 *FR* 82985) to its decision regarding transuranic waste. Under this decision, the Department would establish at the Waste Isolation Pilot Plant the capability to prepare transuranic waste for disposal. In addition, the above-ground capacity at the Waste Isolation Pilot Plant would be increased by 25 percent.

On July 25, 2001, the Department issued (66 *FR* 38646) a further revision to its previous decision by announcing its decision to transfer about 300 cubic meters of transuranic waste from the Mound facility in Miamisburg, Ohio, to the Savannah River Site for storage, characterization, and repackaging prior to sending it to the Waste Isolation Pilot Plant.

The *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (DIRS 101814-DOE 1997, Chapter 5) identifies potential cumulative transportation impacts from the shipment of transuranic wastes from DOE sites across the United States, including the Nevada Test Site, to the Waste Isolation Pilot Plant in southeastern New Mexico for disposal.

Low-Level Waste Intermodal Transfer Station

DOE prepared a draft environmental assessment (DIRS 103225-DOE 1998, all) on a proposed action to encourage low-level radioactive waste generators and their contractors to use transportation alternatives that would minimize radiological risk, enhance safety, and reduce the cost of waste shipments to the Nevada Test Site. However, DOE determined that there was no decision for it to make relative to transportation of low-level radioactive waste that would require a National Environmental Policy Act analysis, and therefore no longer plans to issue a National Environmental Policy Act document. DOE has published a technical report that provides its low-level radioactive waste generators with a comparative risk analysis of alternative highway routes and intermodal transportation facilities (DIRS 155779-DOE 1999, all).

Road improvements to accommodate legal-weight trucks and the construction of a rail siding or spur on a 0.02-square-kilometer (5-acre) site 1.2 kilometers (0.75 mile) south of Caliente would be needed for the low-level radioactive waste intermodal transfer station. Lifting equipment (crane or forklift) would transfer containers of low-level radioactive waste from railcars to trucks for transport to the Nevada Test Site. Based on a 10-year average estimate of low-level waste volumes and shipments for the expanded use alternative from the Nevada Test Site EIS (DIRS 101811-DOE 1996, pp. 5-110 to 5-112), DOE expects the traffic through the intermodal transfer station to be less than 3 trains per day and about 14 trucks per day (7 outbound from the station and 7 returning from the Nevada Test Site). Intermodal transfer operations would occur only during daytime working hours, with containers dropped off during the night transported to the Nevada Test Site the following morning. A staff of three would be adequate to conduct operations at the station. Trucks would be inspected and decontaminated, as necessary, at the Nevada Test Site before returning to the station (DIRS 103225-DOE 1998, pp. 2-1 to 2-10 unless otherwise noted).

A high-end estimate for the planned trucking operation to support the low-level radioactive waste intermodal transfer station indicates a terminal on about 0.04 to 0.06 square kilometer (10 to 15 acres), a maintenance building 21 by 23 meters (70 by 75 feet), 9 tractors and 27 trailers, and 11 employees. One proposed location would be south and just outside of Caliente. Trucks would not pass through the Town of Caliente to reach the intermodal transfer station site (DIRS 103225-DOE 1998, p. 5-4).

The projections of low-level radioactive waste shipments from current DOE-approved generators to the Nevada Test Site do not extend to 2010 when shipments of spent nuclear fuel and high-level radioactive waste would begin to the proposed Yucca Mountain Repository. However, because it is reasonable to assume that low-level radioactive waste shipments to the Nevada Test Site could continue and occur coincidentally with shipments to the Yucca Mountain Repository, Section 8.4 analyzes the potential for cumulative impacts from the construction and operation of these two intermodal transfer stations as well as a privately owned intermodal transfer station described in the following section.

Timbisha Shoshone Reservation

The Secretary of the Interior issued a draft report to Congress (DIRS 103470-Timbisha Shoshone and DOI 1999, all) describing a plan to establish a discontiguous reservation for people of the Timbisha Shoshone Tribe in portions of the Mojave Desert in eastern California and southwestern Nevada. On

November 1, 2000, the President signed Bill S.2102 (Public Law 106-423) to provide a permanent land base for the Timbisha Shoshone Tribe within its ancestral homeland.

The National Park Service of the U.S. Department of the Interior prepared a Legislative EIS (DIRS 154121-DOI 2000, all), which describes the environmental impacts of this action. The EIS analyzes the potential transfer of almost 32 square kilometers (7,800 acres) in five noncontiguous parcels in portions of the Mojave Desert in eastern California and southwestern Nevada, as follows:

- Approximately 1.3 square kilometers (314 acres) in Furnace Creek, Death Valley National Park, California
- Approximately 4 square kilometers (1,000 acres) in Death Valley Junction, California
- Approximately 11 square kilometers (2,800 acres) in Scottys Junction, Nevada
- Approximately 2.6 square kilometers (640 acres) in Centennial, California
- Approximately 12 square kilometers (3,000 acres) in Lida, Nevada

Of these five parcels, the first three are in whole or in part within the 80-kilometer (50-mile) radius of the proposed repository. In addition to these five parcels, the Law authorizes the Secretary of the Interior to purchase two additional parcels of land with water rights as follows:

- Approximately 0.49 square kilometer (120 acres) at the Indian Rancheria Site, California
- Approximately 9.5 square kilometers (2,340 acres) at Lida Ranch, Nevada

In addition, Public Law 106-423 prescribes Federal water rights for these parcels of land and describes partnerships between the National Park Service and the Timbisha Shoshone Tribe that will provide economic and cultural opportunities for the Tribe while preserving the resources in the area. As described in the Legislative EIS (DIRS 154121-DOI 2000, all), activities on the parcels of land would not differ greatly from their historic uses. Modern housing with the associated infrastructure could be constructed at the Furnace Creek site, but would be limited by law to conserve and protect resources. Commercial development is permitted at several of the sites, but would have to be consistent with existing designations and uses of the land. The future development could cause potential transportation impacts, but the lack of information on specific plans precludes a detailed analysis at this time.

Because of the proximity of some of the parcels to the proposed repository and to some of the transportation corridors, there are potential cumulative impacts between their use and the proposed repository with regard to land use, regional water use, and transportation impacts. Therefore, DOE considered this action in its analysis of cumulative impacts in this chapter. As discussed in Chapter 6, the parcel near Scottys Junction (shown in Figure 8-1), if inhabited, could be affected if a rail corridor was used in the future.

8.1.2.3 Non-Federal and Private Actions

The following paragraphs describe reasonably foreseeable future actions of non-Federal and private agencies or individuals that could result in cumulative impacts. This EIS considers the Cortez Pipeline Gold Deposit projects described below to be private actions even though they require the approval of the Bureau of Land Management.

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Cortez Pipeline Gold Deposit Projects

The Cortez Gold Mine Pipeline Project is near the potential branch rail line in the Carlin Corridor in Nevada (see Chapter 6, Section 6.3.2.2.2). Cortez Gold Mine, Inc., operates the Pipeline Project mine and processing facility; the environmental impacts of the existing mining operation are discussed in the *Cortez Pipeline Gold Deposit: Final Environmental Impact Statement* (DIRS 103078-BLM 1996, all). The Pipeline Infiltration Project (which was approved in March 1999) would expand the Pipeline Project area to add more land for the construction and operation of infiltration ponds to support the existing mine (DIRS 103081-BLM 1999, all). The Bureau of Land Management published the *South Pipeline Project Final Environmental Impact Statement* (DIRS 155530-BLM 2000, all) in which the proposed action was to "develop the South Pipeline ore deposit and construct associated facilities to continue to extract gold from the mined ore within the existing Project Area." Based on an analysis of the general area potentially affected by the Cortez Gold Mine Project, there could be cumulative land-use and ownership impacts with the proposed Carlin rail corridor (see Figure 8-2). The Bureau issued the Record of Decision for the EIS on June 27, 2000 (DIRS 155095-BLM 2000, all). On July 31, 2000, the Western Mining Action Project (representing Great Basin Mine Watch, Western Shoshone Defense Project, and Mineral Policy Center) filed an Appeal and Request for Stay (DIRS 155531-BLM 2001, all); however, the stay request was denied in January 2001.

Apex Bulk Commodities Intermodal Transfer Station

Apex Bulk Commodities is negotiating with BHP Copper of Ely, Nevada, to build an intermodal transfer station at Caliente near the potential intermodal transfer station site for shipping spent nuclear fuel and high-level radioactive waste to the proposed Yucca Mountain Repository. Apex anticipates one diesel truck per hour carrying 40 tons of copper concentrate, 24 hours per day, for 15 years. An improved access road and about 4,200 meters (14,000 feet) of new rail would be constructed. The transfer facility would be housed in a building 90 by 30 meters (300 by 100 feet) designed to retain dust, water, and spills generated during the transfer process. Air emission particulates would be collected in two baghouses. Apex would also need a truck maintenance facility, which would be in a building 30 by 18 meters (100 by 60 feet). An above-ground storage tank for about 45,000 liters (12,000 gallons) of diesel fuel is also planned. Apex estimates 25 new jobs for Caliente and an annual payroll of $800,000 (DIRS 103225-DOE 1998, p. 5-5).

Although a start date for Apex copper concentration intermodal transfer station and truck transportation operations is unknown, Section 8.4 analyzes the potential for cumulative impacts from the construction and operation of that station, assuming these activities would coincide with impacts from the Nevada Test Site low-level radioactive waste intermodal transfer station and the intermodal transfer station for shipments to the proposed Yucca Mountain Repository.

Shared Use of a DOE Branch Rail Line

If DOE built a branch rail line to transport spent nuclear fuel and high-level radioactive waste to the Yucca Mountain Repository, it could share the use of this line with others. A branch rail line in the Carlin corridor could provide transportation service options for mine operators in the central mountain valleys of Nevada and could provide freight service options for southwestern Nevada communities such as Tonopah, Beatty, Goldfield, and Pahrump. A branch rail line in the Caliente corridor could serve those communities plus Warm Springs, along with mine operators in the interior of Nevada. A branch rail line in the Valley Modified or Jean corridors would provide freight service access to farms, industries, and businesses in the Amargosa Valley and Pahrump communities. A Valley Modified branch line would also provide rail service to the Indian Springs community. Any of the potential branch rail lines to the Yucca Mountain site (see Chapter 6, Figure 6-14) would provide rail access to the Nevada Test Site. The shared use of a branch rail line would have positive economic benefits, but could produce cumulative impacts due to increased operations and traffic.

Private Fuel Storage at Skull Valley

In June 2000, the Nuclear Regulatory Commission published the *Draft Environmental Impact Statement for the Construction and Operation of an Independent Spent Fuel Storage Installation on the Reservation of the Skull Valley Band of Goshute Indians and the Related Transportation Facility in Tooele County, Utah* (DIRS 152001-NRC 2000, all). That EIS evaluates the environmental impacts of constructing and operating a facility for the interim storage of commercial spent nuclear fuel.

The storage site would be on the reservation of the Skull Valley Band of Goshute Indians in Skull Valley in Tooele County, Utah. The facility would occupy approximately 3.3 square kilometers (820 acres) and would involve construction of a 52-kilometer (32-mile) rail line on public land administered by the Bureau of Land Management from Skunk Ridge (near Low, Utah) to the reservation.

The facility would be constructed and operated by Private Fuel Storage, LLC, a limited liability company comprised of eight U.S. power utilities.

The storage site would be designed to store up to 40,000 metric tons of heavy metal (MTHM) of commercial spent nuclear fuel, which is sufficient to store all the spent nuclear fuel from the Private Fuel Storage member utilities as well as additional fuel from non-member utilities. The fuel would be stored in above-ground concrete vault structures that would provide structural integrity and radiation shielding. The proposed facility would be licensed by the Nuclear Regulatory Commission to operate for as long as 20 years, at which time the Commission could renew the license.

The facility would be used as an interim storage facility until a geologic repository was available for disposal of the spent nuclear fuel. Therefore, the actions considered in the Nuclear Regulatory Commission EIS could have cumulative impacts with those contemplated in the Yucca Mountain EIS by affecting the transportation routes through which material would arrive at the proposed repository. However, because of the distance of the storage facility from the Yucca Mountain site, DOE does not expect cumulative impacts between the proposed operation of the facility and the Proposed Action for this EIS.

Section 8.4 discusses estimated impacts from transportation of material to the Private Fuel Storage facility.

Owl Creek Energy Project

The Owl Creek Energy Project (DIRS 155595-Stuart and Anderson 1999, all) is a potential interim storage project for commercial spent nuclear fuel that would be developed in the State of Wyoming. The location for the project is near the Town of Shoshoni, Wyoming, and consists of about 11 square kilometers (2,700 acres) of privately owned land with access to rail and nearby roads. A private company is pursuing the project, which would be temporary, with a projected life of 40 years.

The Owl Creek Energy Project would involve the storage of spent nuclear fuel using dry storage techniques in specially designed facilities. However, the project is still in its infancy; no license application has been submitted to the Nuclear Regulatory Commission. Further, the potential impacts of the facility are unknown at present. Therefore, DOE has not attempted to quantify potential impacts at this time, but believes it would be unlikely that the operational impacts would be markedly different from those expected for the Private Fuel Storage Facility in Tooele County, Utah (described above).

Moapa Paiute Energy Center

In March 2001, the Bureau of Indian Affairs issued the *Moapa Paiute Energy Center Draft Environmental Impact Statement* (DIRS 155979-PBS&J 2001, all). Calpine Corporation proposes to construct the Moapa Paiute Energy Center on 0.26 square kilometer (65 acres) of land leased from the Moapa River Paiute Reservation approximately 12 kilometers (45 miles) northeast of Las Vegas. The plant would consist of a nominal 760-megawatt baseload natural-gas-fired, combined-cycle power unit with peak capacity to approximately 1,100 megawatts. The land disturbance would consist of as much as 0.88 square kilometer (218 acres) of reservation land and as much as 0.33 square kilometer (82 acres) of off-reservation lands. Transmission lines would follow an existing Bureau of Land Management utility corridor that passes through the reservation, requiring no change in land use. The lines would pass approximately 19 kilometers (12 miles) to the southwest to the existing Nevada Power Company Harry Allen Substation. The natural gas supply system to the facility would consist of approximately 1,220 meters (4,000 feet) of pipeline and a pumping station. The natural gas line and the pump station would require approximately 0.004 square kilometer (5.5 acres). The Bureau of Land Management would be responsible for rights-of-way for construction, operation, and termination for the facilities in the utility right-of-way on the reservation.

Because the Energy Center would be some distance from the proposed repository, there is minimal potential for direct cumulative impacts with repository operation. Groundwater management practices would minimize depletion of groundwater resources. Air emissions would be minimized, and there would be essentially no potential for overlap of the plumes from the repository and the Energy Center.

Southern Nevada Public Land Management Act

The Southern Nevada Public Land Management Act (Public Law 105-263) authorizes the Bureau of Land Management to sell some public lands in the Las Vegas Valley to promote responsible and orderly development.

The law specifies that money generated by these land sales will remain in Nevada. This money will provide funding for a variety of land management activities emphasizing recreation sites, such as the following:

- Acquisition of environmentally sensitive land in Nevada, with priority given to lands in Clark County
- Capital improvements at the Lake Mead National Recreation Area, the Desert National Wildlife Refuge, the Red Rock Canyon National Conservation Area, and other areas administered by the Bureau of Land Management in Clark County, and the Spring Mountains National Recreation Area (subject to an annual limitation)
- Development of a multispecies habitat conservation plan in Clark County, Nevada
- Development of parks, trails, and natural areas in Clark County

The Act included approximately 110 square kilometers (27,000 acres) of land for sale (Public Law 105-263). As of April 2001, the Bureau of Land Management had conveyed about 17 square kilometers (4,200 acres) to private and commercial entities. In December 2000, the Bureau published its “Round 2 Preliminary Recommendation” in which it recommended the acquisition of more than 23 square kilometers (5,800 acres) of land throughout Nevada that is privately or commercially owned to be distributed among the Bureau, the National Park Service, and the Forest Service (DIRS 155597-BLM 2000, all).

This action has potential land use cumulative impacts because some of the parcels conveyed or acquired by the Bureau of Land Management could be either within the 80-kilometer (50-mile) radius of the proposed repository or near potential transportation corridors, although DOE cannot predict which parcels might be affected or the timing of such conveyances.

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Ivanpah Valley Airport

On October 27, 2000, the President signed the Ivanpah Valley Airport Public Lands Transfer Act (Public Law 106-362) to transfer Federal lands in Ivanpah Valley, Nevada, to Clark County. The land to be transferred, which is part of the Mojave National Preserve, would be used for construction of a general aviation airport at Jean, Nevada.

The passage of the Ivanpah Valley Airport Public Lands Transfer Act does not automatically transfer the lands. Under provisions of the bill, the U.S. Departments of the Interior and Transportation must complete an environmental impact statement before an actual transfer. As described in Chapter 6, the initiation of the Stateline option of the Jean Corridor for a potential branch rail line encroaches upon the land to be transferred. Therefore, this EIS evaluates the potential for cumulative impacts due to the land transfer.

Desert Space Station Science Museum

The Nevada Science and Technology Center is proposing to construct an 8,800-square-meter (95,000-square-foot) museum on 1.8 square kilometers (450 acres) of land in Amargosa Valley at the intersection of U.S. Highway 95 and State Route 373 (DIRS 148148-Williams and Levy 1999, p. 1). The land would be transferred from the Bureau of Land Management to Nye County, which in turn would lease the land to the Nevada Science and Technology Center (DIRS 155478-Dorsey 2001, all). As shown in Figure 8-2, this parcel of land is near the Nevada Test Site and is, thus, within the region of influence for the proposed repository.

Because detailed quantitative impact information is not available, DOE has not included a detailed analysis of this action other than to report the potential land use implications in Section 8.2.1.

8.2 Cumulative Short-Term Impacts in the Proposed Yucca Mountain Repository Region

This section describes short-term cumulative impacts during the construction, operation and monitoring, and closure of the repository in the regions of influence for the resources the repository could affect. DOE has organized the analysis of cumulative impacts by resource area. As necessary, the discussion of each resource area includes cumulative impacts from Inventory Module 1 or 2; from other Federal, non-Federal, and private actions; and from the combination of Inventory Modules 1 and 2 and other Federal, non-Federal, and private actions. Table 8-5 summarizes these impacts. The impacts listed for the Proposed Action in Table 8-5 include the combined effects of the potential repository and transportation activities.

There would be essentially no difference in the design and operation of the repository for Inventory Modules 1 and 2. As described in Appendix A, the radioactive inventory for Greater-Than-Class-C waste and for Special-Performance-Assessment-Required waste is much less than that for spent nuclear fuel and high-level radioactive waste. The subsurface emplacement of the material in Inventory Module 2, in comparison with the inventory for Module 1, would not greatly increase radiological impacts to workers or the public (DIRS 104523-CRWMS M&O 1999, p. 6-44). For the surface facilities, the number of workers and the radiological exposure levels would be the same for Inventory Modules 1 and 2 (DIRS 104508-CRWMS M&O 1999, Tables 6-1, 6-2, 6-4, and 6-5). Therefore, DOE did not perform separate analyses for Modules 1 and 2 to estimate the short-term impacts. This section identifies the short-term impacts as being for Modules 1 and 2, indicating that the impacts for the two modules would not differ greatly.

Table 8-5. Summary of cumulative short-term impacts in the proposed Yucca Mountain Repository region (page 1 of 8).

Resource area	Proposed Action (repository and transportation)	Inventory Module 1 or 2[a]	Other Federal, non-Federal, and private actions	Total cumulative impacts
Land use and ownership	Withdraw about 600 square kilometers (150,000 acres) of land already under Federal control by DOE, U.S. Air Force, and Bureau of Land Management. Public access to about 200 square kilometers (50,000 acres) of BLM public lands would be terminated. About 6.0 square kilometers (1,500 acres) of withdrawn land would be disturbed for the repository under the Proposed Action. As much as 20 square kilometers (4,900 acres) of land would be disturbed along transportation routes in Nevada, a portion of which would be in the Yucca Mountain region and could include the need for rights-of-way agreements or withdrawals.	Land withdrawal impacts would be the same as those for the Proposed Action. As much as 1 square kilometer (250 acres) of additional land would be disturbed, for a total of as much as 7.0 square kilometers (1,730 acres). Land use and ownership impacts from transportation would be the same as for the Proposed Action.	In addition to impacts for the Proposed Action, under current and reasonably foreseeable actions, 10,000 acres of federal land would be transferred for Indian reservations; 65 acres of reservation land would be used for commercial purposes; in excess of 38,000 acres of Federal land would be used for private and commercial purposes. There is the potential for over 5,800 acres of privately owned land to be acquired by the Federal Government. An intermodal transfer station could be constructed for shipping low-level radioactive waste within the Yucca Mountain region.	Withdraw about 600 square kilometers (150,000 acres) of land already under Federal control by DOE, U.S. Air Force, and Bureau of Land Management. Public access to about 200 square kilometers (50,000 acres) of BLM public lands would be terminated. As much as 27 square kilometers (1,100 acres) of withdrawn land would be disturbed for the repository and along transportation route. In addition to impacts for the Proposed Action, under current and reasonably foreseeable actions, 10,000 acres of federal land would be transferred for Indian reservations; 65 acres of reservation land would be used for commercial purposes; in excess of 38,000 acres of Federal land would be used for private and commercial purposes. There is the potential for over 5,800 acres of privately owned land to be acquired by the Federal Government.
Air Quality				
Nonradiological	Criteria pollutant [nitrogen dioxide, sulfur dioxide, carbon monoxide, and particulate matter ($PM_{10,}$ $PM_{2.5}$)] and cristobalite concentrations calculated at the analyzed land withdrawal area boundary would be less than 6 percent of applicable regulatory limits (see Tables 8-6, 8-7, and 8-8). Emissions associated with transportation in the proposed repository region would be low.	Criteria pollutant and cristobalite concentrations calculated at the analyzed land withdrawal area boundary would be less than 7 percent of applicable regulatory limits (see Tables 8-6, 8-7, and 8-8). Emissions associated with transportation in the proposed repository region would be low.	Nevada Test Site: Baseline monitoring shows that criteria pollutants at the Nevada Test Site and in the proposed repository region are well below National Ambient Air Quality Standards and would result in very small cumulative nonradiological air quality impacts. Emissions associated with the transportation of waste, people, and materials for Nevada Test Site activities in the repository region would be low.	Criteria pollutant and cristobalite concentrations calculated at the analyzed land withdrawal area boundary would be small fractions of applicable regulatory limits (generally less than 10 percent). Emissions associated with transportation in the repository region would be low.

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Table 8-5. Summary of cumulative short-term impacts in the proposed Yucca Mountain Repository region (page 2 of 8).

Resource area	Proposed Action (repository and transportation)	Inventory Module 1 or 2[a]	Other Federal, non-Federal, and private actions	Total cumulative impacts
Air Quality (continued)				
Radiological[b]	The maximally exposed individual in the public would receive an estimated annual radiation dose of 1.3 millirem or less (see Tables 8-10, 8-11, 8-12, and 8-13), primarily from naturally occurring radon.	The maximally exposed individual in the public would receive an estimated annual dose of 2.2 millirem or less, primarily from naturally occurring radon.	Nevada Test Site: Activity would continue to contribute extremely small increments to the risk to the general population and should not increase injury or mortality rates. As an example, the maximally exposed individual in the public would receive an estimated annual radiation dose of less than 0.15 millirem from past, present and reasonably foreseeable future activities.	The maximally exposed individual in the public would receive an annual radiation dose of 2.5 millirem or less, which is well below the 10 CFR 63.204 limit of 15 millirem from radioactive material releases from the repository and the Nevada Test Site.
Hydrology				
Surface water	Between 2.8 and 4.5 square kilometers (690 and 1,100 acres) of land would be newly disturbed and resulting impacts would likely be small and limited to the site. Impacts from construction and use of transportation capabilities (heavy-haul and rail) in the site vicinity and region would result in small impacts to surface water. Minor changes to runoff and infiltration rates. Floodplain/wetlands assessment concluded impacts would be small. Additional transportation floodplain/wetlands assessments would be performed in the future as necessary.	Would be similar to impacts from the Proposed Action with an increase of as much as 1 square kilometer (250 acres) in new surface disturbance for a total of as much as 5.5 square kilometers (1,360 acres). Impacts from construction and use of transportation capabilities (heavy-haul and rail) would be small. Minor changes to runoff and infiltration rates. Floodplain/wetlands assessment concluded impacts would be small. Transportation floodplain/wetlands assessments would be performed in the future as necessary.	No other actions were identified with potential cumulative surface-water impacts within the region of influence of repository construction, operation and monitoring, and closure. Transportation impacts would be small.	As much as 5.5 square kilometers (1,360 acres) of land would be newly disturbed and resulting impacts would likely be minor and limited to the site. Impacts from construction and use of transportation capabilities (heavy-haul and rail) in the site vicinity and region would result in small impacts to surface water. Minor changes to runoff and infiltration rates. Floodplain/wetlands assessment concluded impacts would be small. Transportation floodplain/wetlands assessments would be performed in the future as necessary.

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Table 8-5. Summary of cumulative short-term impacts in the proposed Yucca Mountain Repository region (page 3 of 8).

Resource area	Proposed Action (repository and transportation)	Inventory Module 1 or 2[a]	Other Federal, non-Federal, and private actions	Total cumulative impacts
Hydrology (continued)				
Groundwater	Annual water demand would be between 230 and 290 acre-feet (during emplacement), and below the lowest estimate of perennial yield of the western two-thirds of the Jackass Flats basin (580 acre-feet). Water use for the construction of a rail line could be as much as 710 acre-feet from multiple wells and hydrographic areas over 4 years.	Anticipated annual water demand (below Nevada State Engineer's ruling on perennial yield) could be slightly higher (ranging from 240 to 320 acre-feet) than that of the Proposed Action, and the highest demand, which would also occur when emplacement and development activities occurred together, would extend for an additional 14 years. Water use for transportation would be the same as that for the Proposed Action.	Nevada Test Site: Anticipated annual water demand from Nevada Test Site activities would be about 280 acre-feet, which is less than the estimate of perennial yield of the western two-thirds of the Jackass Flats basin (580 acre-feet).	Combining the highest annual water demand of the repository of 320 acre-feet (during emplacement and development activities for the lower-temperature maximum spacing scenario with Modules 1 or 2) with annual water withdrawals from the Nevada Test Site of 280 acre-feet would result in a total of 600 acre-feet, which would slightly exceed the lowest estimate of perennial yield of the western two-thirds of the Jackass Flats basin (580 acre-feet), but would not approach the highest estimate of perennial yield, which is 4,000 acre-feet. There is a potential for drawdown of the water level in nearby wells from water withdrawal. The combined peak annual water use of a repository under other operation options, even with Modules 1 or 2, with Nevada Test Site annual water use would result in a maximum peak cumulative use of about 560 acre-feet per year, which is below the lowest estimate of perennial yield of the western two-thirds of the Jackass Flats basin (580 acre-feet). In addition, up to 710 acre-feet of water over 2.5 years would be used to construct a rail line in Nevada.

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Table 8-5. Summary of cumulative short-term impacts in the proposed Yucca Mountain Repository region (page 4 of 8).

Resource area	Proposed Action (repository and transportation)	Inventory Module 1 or 2[a]	Other Federal, non-Federal, and private actions	Total cumulative impacts
Biological resources and soils	Between 2.8 and 4.5 square kilometers (690 to 1,100 acres) of soil, habitat, and vegetation would be newly disturbed, resulting in lost productivity and animal mortality and displacement. Adverse impacts to the desert tortoise and loss of individuals would occur. Wetland assessment concluded impacts would be small. Impacts from transportation would include the loss of 0 (legal-weight truck) to 20 square kilometers (4,900 acres) (rail) of habitat in Nevada. Impacts to the desert tortoise probably would occur if a rail line were constructed. Additional wetlands assessments would be performed in the future as necessary.	Inclusive of the Proposed Action, a total of as much as 5.5 square kilometers (1,360 acres) of soil, habitat, and vegetation would be disturbed, resulting in lost productivity and animal mortality and displacement. Adverse impacts to the desert tortoise would occur. Wetland assessment concluded impacts would be small. Impacts from transportation would be the same as those under the Proposed Action. Additional wetlands assessments would be performed in the future as necessary.	No other actions were identified with potential cumulative biological resource or soil impacts within the region of influence of repository construction, operation and monitoring, and closure.	As much as 5.5 square kilometers (1,360 acres) of soil, habitat, and vegetation would be newly disturbed, resulting in lost productivity and animal mortality and displacement. Adverse impacts to the desert tortoise and loss of individuals would occur. Impacts to potential jurisdictional wetlands would be very small and minimized. Impacts from transportation would include the loss of 0 (legal-weight truck) to 20 square kilometers (4,900 acres) (rail) of habitat in Nevada, a portion of which would be within the Yucca Mountain vicinity. Impacts to the desert tortoise and wetlands probably would occur if a rail line were constructed. Additional wetlands assessments would be performed in the future as necessary.

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Table 8-5. Summary of cumulative short-term impacts in the proposed Yucca Mountain Repository region (page 5 of 8).

Resource area	Proposed Action (repository and transportation)	Inventory Module 1 or 2[a]	Other Federal, non-Federal, and private actions	Total cumulative impacts
Cultural resources	Repository development would disturb about 2.8 to 4.5 square kilometers (690 to 1,100 acres). Direct and indirect impacts (damage to archaeological and historical sites or illicit collection of artifacts) would be mitigated per applicable regulations. In addition, as much as 20 square kilometers (4,900 acres) would be disturbed along transportation routes in Nevada. Native Americans view all impacts to be adverse and immune to mitigation.	Land disturbance for repository development would increase to a total of as much as 5.5 square kilometers (1,360 acres). Transportation impacts would be the same as those under the Proposed Action. Direct and indirect impacts and mitigations would be similar to the Proposed Action. Native Americans view all impacts to be adverse and immune to mitigation.	No other actions were identified with potential cumulative cultural resource impacts within the region of influence of repository construction, operation and monitoring, and closure. Native Americans view all impacts to be adverse and immune to mitigation.	Repository development would disturb as much as 5.5 square kilometers (1,360 acres). As much as 20 square kilometers (4,900 acres) would be disturbed if a rail line was constructed in Nevada. Direct and indirect impacts (damage to archaeological and historical sites or illicit collection of artifacts) would be mitigated per applicable regulations. Native Americans view all impacts to be adverse and immune to mitigation.
Socioeconomics	Estimated peak direct employment of 3,400 occurring in 2006 would result in less than a 1 percent increase in direct and indirect regional employment. Employment increases would range from less than 1 percent to approximately 5 percent (use of intermodal transfer station or rail line in Lincoln County, Nevada) of total employment by county.	Estimated peak direct employment would be the same as for the Proposed Action.	Nevada Test Site: Any employment increases would occur prior to construction of the repository and no cumulative impacts would be expected.	Estimated peak employment increase of about 3,400 occurring in 2006 would result in less than a 1-percent increase in direct and indirect regional employment (with as much as a 5-percent change in Lincoln County, Nevada if intermodal transfer station or rail line were located there).
Occupational and public health and safety[d]				
Nonradiological health impacts	2 to 3 fatalities[e] during construction, operation and monitoring, and closure. Exposures well below regulatory limits. Also, between 14 and 26 fatalities[e] from commuting, and transportation of material (repository and rail line construction material, as well as spent nuclear fuel and high-level radioactive waste).	4 or less fatalities[e] during construction, operation and monitoring, and closure. Exposures well below regulatory limits. Also, between 19 and 33 fatalities[e] from commuting, and transportation of material (repository and rail line construction material, as well as spent nuclear fuel and high-level radioactive waste).	No other actions were identified with potential cumulative industrial hazard impacts to repository workers.	23 to 37 fatalities[e] during construction, operation and monitoring, and closure (including transportation). Exposures well below regulatory limits.

Table 8-5. Summary of cumulative short-term impacts in the proposed Yucca Mountain Repository region (page 6 of 8).

Resource area	Proposed Action (repository and transportation)	Inventory Module 1 or 2[a]	Other Federal, non-Federal, and private actions	Total cumulative impacts
Occupational and public health and safety (continued)[d]				
Radiological health impacts				
Workers	4 to 7 latent cancer fatalities[e] from repository construction, operation and monitoring, and closure. Up to 3 to 12 latent cancer fatalities[e] to workers from mostly rail and mostly truck, respectively.	5 to 8 latent cancer fatalities[e] from repository construction, operation and monitoring, and closure. Up to 7 to 24 latent cancer fatalities[e] to workers from mostly rail and mostly truck, respectively.	No other actions were identified with potential cumulative radiological health impacts to repository workers.	About 12 to 32 latent cancer fatalities[e] from repository construction, operation and monitoring, and closure (including transportation).
Public	Estimated doses would result in less than 1 latent cancer fatality to the public from repository construction, operation and monitoring, and closure. Up to 1 to 3 latent cancer fatalities[e] would result from transport by mostly rail and mostly truck, respectively.	Estimated doses would result in less than one latent cancer fatality to the public from repository construction, operation and monitoring, and closure. Impacts from transportation would be almost twice those from the Proposed Action.	Nevada Test Site: Estimated doses and associated health effects from the Nevada Test Site would be less than one latent cancer fatality.	About 2 to 5 latent cancer fatalities[e] from repository construction, operation and monitoring, and closure (including transportation); and Nevada Test Site activities.
Accidents	No latent cancer fatalities would be likely from the maximum reasonably foreseeable repository accident scenarios. Between 1 and 5 latent cancer fatalities would result from a maximum reasonably foreseeable transportation accident scenario that has less than 3 chances in 10 million of occurring.	The accident risk (probability of occurrence times consequence) is essentially the same as that for the Proposed Action. Impacts of a maximum reasonably foreseeable transportation accident scenario would be the same as those for the Proposed Action.	No other actions were identified with potential cumulative accident risk impacts.	No latent cancer fatalities would be likely from the maximum reasonably foreseeable repository accident scenarios. Between 1 and 5 latent cancer fatalities would result from a maximum reasonably foreseeable transportation accident scenario that has less than 3 chances in 10 million of occurring.

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Table 8-5. Summary of cumulative short-term impacts in the proposed Yucca Mountain Repository region (page 7 of 8).

Resource area	Proposed Action (repository and transportation)	Inventory Module 1 or 2[a]	Other Federal, non-Federal, and private actions	Total cumulative impacts
Noise	Impacts from construction, operation and monitoring, and closure of a repository would result in low noise impacts. Noise levels would be transient, less than 90 dBA[c]. New intermittent noise source if a rail line was used in Nevada, including in the Yucca Mountain region.	Same as the Proposed Action.	Future development of the Timbisha Shoshone Homeland parcel near Scottys Junction could result in residents or businesses being exposed to up to 90 dB of noise from the transportation route.	Impacts from construction, operation and monitoring, and closure of a repository would result in low noise impacts. Noise levels would be transient, less than 90 dBA[c]. New intermittent noise source if a rail line was used in Nevada, including in the Yucca Mountain.
Aesthetics	Placement of exhaust stacks on top of Yucca Mountain could possibly impact visual resources, since stacks would be visible for some distance. If the stacks were equipped with beacons, the visual effect would be more noticeable at night. Rail line construction would occur if rail was used in Nevada. Possible conflict with visual resource management goals for Jean rail corridor.	Same as the Proposed Action.	Disturbed areas are likely on former federal lands that are used for commercial and private purposes. Acquisition of private lands by the federal government could result in reduced aesthetics impacts and possible return of land to natural state.	Placement of exhaust stacks on top of Yucca Mountain could possibly impact visual resources, since stacks would be visible for some distance. If the stacks were equipped with beacons, the visual effect would be more noticeable at night. Rail line construction would occur if rail was used in Nevada. Possible conflict with visual resource management goals for Jean rail corridor. Disturbed areas are likely on former federal lands that are used for commercial and private purposes. Acquisition of private lands by the federal government could result in reduced aesthetics impacts and possible return of land to natural state.
Utilities, energy, materials, and site services	Peak electric power demand would require an upgrade to the electrical transmission and distribution system. Adverse impacts on energy and material supplies or to site services would be unlikely, including materials needed for transportation capabilities in the Yucca Mountain vicinity.	Peak electric power demand would require upgrade to the electrical transmission and distribution system. Although requirements for electricity, fossil fuels, concrete, steel, and copper would increase, adverse impacts to energy and material supplies or to site services would be unlikely, including materials needed for transportation capabilities in the Yucca Mountain vicinity.	Construction of other energy supply facilities, such as the Moapa Paiute Energy Center or the Alternative Energy Facility at the Nevada Test Site could provide additional electrical capacity for the region.	Peak electric power demand would require upgrade to the electrical transmission and distribution system. (See Chapter 4, Section 4.1.11.) Adverse impacts on energy and material supplies or to site services would be unlikely, including materials needed for transportation capabilities in the Yucca Mountain vicinity.

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Table 8-5. Summary of cumulative short-term impacts in the proposed Yucca Mountain Repository region (page 8 of 8).

Resource area	Proposed Action (repository and transportation)	Inventory Module 1 or 2[a]	Other Federal, non-Federal, and private actions	Total cumulative impacts
Waste management	Disposal of repository-generated low-level waste would require about 4 percent of the reserve capacity of the Nevada Test Site. If nonradioactive, nonhazardous solid waste would be disposed of at the Nevada Test Site, existing landfills would need to be expanded.	Disposal of repository-generated low-level waste would require about 9 percent of the reserve capacity of the Nevada Test Site. If nonradioactive, nonhazardous solid waste would be disposed of at the Nevada Test Site, the larger quantity of this waste would require even further landfill expansion at the Nevada Test Site.	Nevada Test Site: The total low-level radioactive waste disposal capacity of the Nevada Test Site is sufficient and would not be exceeded by the combined actions of repository development and selection of the Nevada Test Site as a regional disposal site for DOE-complex-wide low-level radioactive and mixed wastes.	The Nevada Test Site has sufficient capacity for low-level radioactive waste from all reasonably foreseeable future actions. If nonradioactive, nonhazardous solid waste would be disposed of at the Nevada Test Site, existing landfills would need to be expanded.
Environmental justice	No disproportionately high and adverse impacts to minority or low-income populations would occur for repository or transportation activities. DOE recognizes that Native American people living in the region near Yucca Mountain have concerns about the protection of traditions and the spiritual integrity of the land that extend to the propriety of the Proposed Action, and that implementing the Proposed Action would continue restrictions on access to the proposed site.	No disproportionately high and adverse impacts to minority or low-income populations would occur for repository or transportation activities. DOE recognizes that Native American people living in the region near Yucca Mountain have concerns about the protection of traditions and the spiritual integrity of the land that extend to the propriety of the Proposed Action, and that implementing the Proposed Action would continue restrictions on access to the proposed site.	No other actions were identified with potential cumulative impacts within the region of influence of repository construction, operation and monitoring, and closure that would create environmental justice concerns. DOE recognizes that Native American people living in the region near Yucca Mountain have concerns about the protection of traditions and the spiritual integrity of the land that extend to the propriety of the Proposed Action, and that implementing the Proposed Action would continue restrictions on access to the proposed site.	No disproportionately high and adverse cumulative impacts to minority or low-income populations would occur for repository or transportation activities. DOE recognizes that Native American people living in the region near Yucca Mountain have concerns about the protection of traditions and the spiritual integrity of the land that extend to the propriety of the Proposed Action, and that implementing the Proposed Action would continue restrictions on access to the proposed site.

a. As described in Section 8.1.2.1, there would be essentially no difference in the design and operation of the repository for Inventory Module 1 or 2. Therefore, the analysis considered cumulative impacts from Inventory Module 2 to be the same as those from Inventory Module 1.

b. DOE compared the estimated annual dose to the Preclosure Public Health and Environmental Standard found at 10 CFR 63.204, which is 15 millirem per year to a member of the public.

c. dBA = A-weighted decibels, a common sound measurement. A-weighting accounts for the fact that the human ear responds more effectively to some pitches than to others. Higher pitches receive less weighting than lower ones.

d. Occupational and public health and safety impacts for the Proposed Action and Inventory Module 1 or 2 include both impacts from transportation activities in the repository region of influence as well as impacts estimated to occur nationally from transportation of spent nuclear fuel and high-level radioactive waste.

e. These ranges represent the maximum for each environmental resource area. Because the maximum could occur for different implementing alternatives in the various resource areas, simple addition of these summary level maximums could overstate the impacts due to mixing of incompatible alternatives.

DOE performed quantitative calculations for long-term impacts for both modules (see Section 8.3.1). The conclusion from these quantitative estimates was that the long-term impacts for Modules 1 and 2 would not differ greatly.

In estimating the potential impacts considered in this EIS, DOE consulted various documents, including resource plans, other National Environmental Policy Act documents, and technical documents. If appropriate, DOE has cited these documents in the discussion of each technical discipline.

Based on comments received during scoping and on the Draft EIS, DOE considered the Special Nevada Report from September 1991 (DIRS 153277-SAIC 1991, all) for inclusion as a source of technical information for the EIS. The Special Nevada Report, which was mandated by the Military Lands Withdrawal Act of 1986, contains a description of defense-related activities (as identified in 1991) along with estimates of potential impacts from those activities. However, the cumulative impacts analysis in this chapter considered the agencies that report represents—the Department of the Air Force, Department of the Navy, and Department of the Interior. Evaluations of the cumulative impacts of repository activities and other agency activities included review of a number of documents that are more current than the Special Nevada Report, including National Environmental Policy Act documents prepared by the Federal agencies listed throughout Section 8.1. Therefore, based on these more recent reports, DOE believes this report does not provide additional insight into projections of future impacts and, therefore, did not use it in its analysis of cumulative impacts.

8.2.1 LAND USE AND OWNERSHIP

The ownership, management, and use of the analyzed land withdrawal area described in Chapter 4, Section 4.1.1 for the Proposed Action would not change for Inventory Module 1 or 2. The amount of land required for surface facilities would increase somewhat for Module 1 or 2 because of the larger storage area for excavated rock and additional ventilation shafts for the larger required repository. This would have no substantial cumulative land-use or ownership impact.

To identify and quantify cumulative impacts for land use, DOE used a twofold approach. Actions that occurred within a 50-mile (80-kilometer) radius of the repository were reviewed for potential contributions to land use impacts. Second, actions that could affect transportation corridors were reviewed for their potential land use impacts. This second group of impacts is discussed in Section 8.4.2.1 (see Table 8-4).

Section 8.1 lists several actions that have the potential for land use impacts. DOE reviewed those actions to identify land areas that could be affected and has quantified, where possible, the amount of land that is subject to new uses. DOE identified how the land use would be converted (for example, undisturbed federal land to commercial use) and any restrictions that might affect the length of time the land would be used.

As discussed in Chapter 3, Section 3.1.1.1, the Federal Government manages approximately 240,000 square kilometers of land in Nevada, approximately 190,000 square kilometers of which are managed by BLM and available for public use. The land transfer/usage indicated in Table 8-6 represents approximately 340 square kilometers of additional land that is currently scheduled for removal from public use. In addition approximately 430 square kilometers would require removal from public use as the result of the potential development of a repository and transportation corridor. The total land removed from public use would represent less than 0.5 percent of BLM land and approximately 0.3 percent of the total Federal lands of Nevada. The largest change in land use is associated with the Southern Nevada Public Land Management Act. Although the Bureau of Land Management could convey as much as 110 square kilometers (27,000 acres) to private and commercial use, only about 17 square kilometers (4,200 acres) had been transferred as of April 30, 2001. As stipulated by the Act,

Table 8-6. Potential cumulative land use impacts for activities in or near the region of influence.[a]

Action	Land use conversion[b]	Ownership change	Land use restrictions
Moapa Paiute Energy Center[c]	Powerplant construction/ operation on 0.26 square kilometers of Reservation land.	Moapa Band of Paiute Indians to Calpine Corporation – powerplants footprint. Reservation to BLM for management of new natural gas pipeline	25-year lease with 20-year renewal
Ivanpah Cargo Airport[d]	Recreation and mining to airport and industrial development. Approximately 27 square kilometers, 8.1 square kilometers of which is for airport alone.	BLM to Clark County for public/private development	None
Timbisha Shoshone Reservation[e]	Grazing, recreation, mining, wildlife management to Tribal use (economic development, historic/cultural use, special use). Approximately 40 square kilometers.	NPS, BLM, and private lands to reservation/BIA	None
Cortez Mine[f]	Grazing, recreation, mining to mining 18 square kilometers.	BLM lease to Cortez Gold Mine	10 years
NTS Energy Generation Facility (Wind Farm)[g]	DOE land withdrawn for NTS to commercial use–4.9 square kilometers.	NTS subeasement to MNS through NTSDC	20 year generation period
Southern Nevada Public Land Management Act[h,i]	BLM general use to private/ commercial development and private/commercial land to public land. • Potential of 110 square kilometers to be transferred • 17 square kilometers conveyed as of April 30, 2001 • More than 23 square kilometers recommended by BLM to be acquired	• BLM to private/commercial • Private/commercial to BLM, NFS, NPS	None
Desert Space Station Science Museum[j]	BLM general use to commercial use (1.8 square kilometers).	BLM to Nye County	Land leased from Nye County to Nevada Science and Technology Center
Total land use impacts			
Federal land to Indian Reservations:	40 square kilometers		
Federal land to private and commercial use:	154+ square kilometers		
Private to Federal land:	25+ square kilometers (proposed as of December 2000)		

a. BLM = Bureau of Land Management; NTS = Nevada Test Site; NTSDC = NTS Development Corporation; MNS = M&N Wind Power Inc. and Siemans; NPS = National Park Service; BIA = Bureau of Indian Affairs.
b. To convert square kilometers to acres, multiply by 247.1.
c. Source: DIRS 155979-PBS&J (2001, pp. xi and xiii to xviii).
d. Source: Ivanpah Valley Public Lands Transfer Act (Public Law 106-362, 114 Stat. 1404).
e. Source: DIRS 154121-DOI (2000, Section 2.2).
f. Source: DIRS 155095-BLM (2000, pp. 1 to 13).
g. Source: DIRS 154545-DOE (2001, pp. 3-1 to 3-9).
h. Source: *Southern Nevada Public Land Management Act of 1998* (Public Law 105-263, 112 Stat. 2343).
i. Source: DIRS 155597-BLM (2000, all).
j. Source: DIRS 148148-Williams and Levy (1999, p. 1).

the Bureau has recommended acquiring about 23 square kilometers (5,800 acres) of environmentally sensitive lands throughout the State of Nevada that would be transferred from commercial and private use to general Bureau use.

Several land use conversions could result in commercial or private use of Federal lands. In addition to those lands transferred under the Southern Nevada Public Land Management Act, lands would be leased or transferred for the Ivanpah Cargo Airport, the Moapa Paiute Energy Center, the Cortez Mine, and the Desert Space Station Science Museum. These changes in land use would permit orderly development of public lands.

The projects that would occur on the Nevada Test Site and the Nellis Air Force Range would result in no net change in land use because the lands are already removed from the public use and are designated for development.

Some of the lands that would be transferred to the Timbisha Shoshone Nation could have some associated commercial use; however, this use would be consistent with the designations for the areas, and developments would be restricted to maintain the natural resources of the land.

In addition to the cumulative changes to land use and ownership, DOE considered potential conflicts with plans and policies issued by various government entities in the vicinity of the proposed Yucca Mountain Repository. In particular, DOE reviewed a number of documents issued by or in conjunction with Nye County and communities in Nye County. In general, the local governments have expressed goals that would minimize the conversion of private lands to public use. At this time DOE is not aware of any direct operational conflicts between the proposed repository and Nye County planning efforts because the Department does not foresee a need to expand the withdrawal area or for the conversion of private lands in the vicinity of the repository. Transportation-related issues are discussed in Section 8.4.2.1.

8.2.2 AIR QUALITY

8.2.2.1 Inventory Module 1 or 2 Impacts

This section addresses potential nonradiological and radiological cumulative impacts to air quality from emplacement in a repository at Yucca Mountain of the additional quantities of spent nuclear fuel and high-level radioactive waste above those evaluated for the Proposed Action, Greater-Than-Class-C waste, and Special-Performance-Assessment-Required waste (that is, Inventory Modules 1 and 2). It compares potential nonradiological and radiological cumulative impacts to applicable regulatory limits, including the new U.S. Environmental Protection Agency National Ambient Air Quality Standard for particulate matter with a diameter of less than 2.5 micrometers. Chapter 3, Section 3.1.2.1, discusses the current status of this standard. Sources of nonradiological air pollutants at the proposed repository could include fugitive dust emissions from land disturbances, excavated rock handling, and concrete batch plant operations and emissions from fossil-fuel consumption.

8.2.2.1.1 *Nonradiological Air Quality*

The construction, operation and monitoring, and closure of the proposed Yucca Mountain Repository for Inventory Module 1 or 2 would result in increased releases of criteria pollutants (nitrogen dioxide, sulfur dioxide, carbon monoxide, and particulate matter) and cristobalite as described in the following sections. The types of activities producing these releases would be the same as those described for the Proposed Action (see Chapter 4, Section 4.1.2).

Construction. The repository construction phase for Inventory Module 1 or 2 would produce the same levels of gaseous pollutants and cristobalite but slightly higher air concentrations of particulate matter, as

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listed in Table 8-7. The air concentrations would still be small fractions of the applicable regulatory limits.

Table 8-7. Estimated construction phase concentrations of criteria pollutants and cristobalite (micrograms per cubic meter).[a]

			Proposed Action			
			Maximum concentration[c,d,e]		Percent of regulatory limit[e]	
Pollutant	Averaging time	Regulatory limit[b]	Higher-temperature	Lower-temperature	Higher-temperature	Lower-temperature
Nitrogen dioxide	Annual	100	0.40	0.41 - 0.42	0.41	0.41 - 0.42
Sulfur dioxide	Annual	80	0.10	0.10	0.13	0.13
	24-hour	365	1.3	1.3	0.36	0.36
	3-hour	1,300	8.5	8.6 - 8.7	0.66	0.66 - 0.67
Carbon monoxide[f]	8-hour	10,000	4.2	4.3 - 4.4	0.041	0.042 - 0.043
	1-hour	40,000	29	29 - 30	0.072	0.073 - 0.075
PM_{10} ($PM_{2.5}$)[f]	Annual	50 (15)	0.69	0.74 - 0.94	1.4	1.5 - 1.9
	24-hour	150 (65)	6.5	7.0 - 8.4	4.3	4.7 - 5.6
Cristobalite	Annual[g]	10[g]	0.018	0.017 - 0.018	0.18	0.17 - 0.18
			Inventory Module 1 or 2			
Nitrogen dioxide	Annual	100	0.40	0.41 - 0.42	0.40	0.41 - 0.42
Sulfur dioxide	Annual	80	0.10	0.10	0.13	0.13
	24-hour	365	1.3	1.3	0.36	0.36
	3-hour	1,300	8.5	8.6 - 8.7	0.66	0.66 - 0.67
Carbon monoxide	8-hour	10,000	4.2	4.3 - 4.4	0.041	0.043
	1-hour	40,000	29	29 - 30	0.072	0.073 - 0.075
PM_{10} ($PM_{2.5}$)[f]	Annual	50 (15)	0.81	0.85 - 1.1	1.6	1.7 - 2.1
	24-hour	150 (65)	7.1	7.4 - 8.9	4.7	4.9 - 5.8
Cristobalite	Annual[g]	10[g]	0.018	0.017 - 0.018	0.18	0.17-0.18

a. Source: Appendix G, Section G.1.4.
b. Regulatory limits for criteria pollutants from 40 CFR 50.4 through 50.11 and Nevada Administrative Code 445B.391 (see Chapter 3, Table 3-5).
c. Sum of highest concentrations at the accessible land withdrawal boundary, regardless of direction.
d. Source: Chapter 4, Section 4.1.2 and Appendix G, Section G.1.4.
e. Numbers are rounded to two significant figures; therefore, the percent of regulatory limit might not equal the percent calculated from the numbers listed in the table.
f. Data on $PM_{2.5}$ not being collected at time of analysis. However, overall PM_{10} numbers are well below standard for both.
g. There are no regulatory limits for public exposure to cristobalite, a form of crystalline silica. An Environmental Protection Agency health assessment (DIRS 103243-EPA 1996, all) states that the risk of silicosis is less than 1 percent for a cumulative exposure to 1,000 micrograms per cubic meter-year. Using a 70-year lifetime, an approximate annual average concentration of 10 micrograms per cubic meter was established as a benchmark for comparison.

Operation and Monitoring. Table 8-8 lists estimated air quality impacts from criteria pollutants and cristobalite for Inventory Module 1 or 2. The concentrations in this table are for the period of continuing surface and subsurface development and emplacement activities. During the subsequent monitoring and maintenance activities these concentrations would decrease considerably. All concentrations are comparable to those produced under the Proposed Action. All concentrations would be small fractions of the applicable regulatory limits for Module 1 or 2. Because the development of the emplacement drifts for Module 1 or 2 would take additional time compared to the Proposed Action, these releases of criteria pollutants would occur over a longer period than those from the Proposed Action. In general, the values in Table 8-8 for operation and monitoring are smaller than the values in Table 8-7 for construction because there would be more land surface disturbance during construction.

Closure. Continuing the closure of the repository for either Inventory Module 1 or 2 would produce comparable, but slightly lower, concentrations of gaseous pollutants, particulate matter, and cristobalite than those estimated for the Proposed Action. The concentrations would still be small fractions of the applicable regulatory limits (see Table 8-9). With Inventory Module 1 or 2, the amount of backfill required to close the ramps, main tunnels, and ventilation shafts would be larger than that for the Proposed Action, and the size of the excavated rock pile to reclaim would be larger. However, the

Table 8-8. Estimated operation and monitoring phase concentrations of criteria pollutants and cristobalite (micrograms per cubic meter).[a]

			Proposed Action			
			Maximum concentration[c,d,e]		Percent of regulatory limit[e]	
Pollutant	Averaging time	Regulatory limit[b]	Higher-temperature	Lower-temperature	Higher-temperature	Lower-temperature
Nitrogen dioxide	Annual	100	0.28	0.28 - 0.31	0.28	0.29 - 0.32
Sulfur dioxide	Annual	80	0.089	0.089 - 0.092	0.11	0.11 - 0.12
	24-hour	365	1.2	1.2	0.33	0.34
	3-hour	1,300	7.8	7.9 - 8.0	0.60	0.61 - 0.62
Carbon monoxide	8-hour	10,000	2.7	2.7 - 3.0	0.026	0.027 - 0.029
	1-hour	40,000	19	19 - 21	0.048	0.049 - 0.052
PM_{10} ($PM_{2.5}$)[f]	Annual	50 (15)	0.080	0.10 - 0.19	0.16	0.20 - 0.39
	24-hour	150 (65)	0.97	1.3 - 2.3	0.65	0.87 - 1.6
Cristobalite	Annual[g]	10[g]	0.0093	0.009 - 0.017	0.093	0.091 - 0.17
			Inventory Module 1 or 2			
Nitrogen dioxide	Annual	100	0.28	0.29 - 0.32	0.28	0.29 - 0.32
Sulfur dioxide	Annual	80	0.089	0.090 - 0.093	0.11	0.12
	24-hour	365	1.2	1.2 - 1.3	0.34	0.34
	3-hour	1,300	7.9	7.9 - 8.1	0.60	0.61 - 0.62
Carbon monoxide	8-hour	10,000	2.6	2.7 - 2.9	0.026	0.026 - 0.029
	1-hour	40,000	19	19 - 21	0.047	0.048 - 0.052
PM_{10} ($PM_{2.5}$)[f]	Annual	50 (15)	0.18	0.18 - 0.23	0.37	0.37 - 0.46
	24-hour	150 (65)	2.6	2.6 - 3.0	1.7	1.7 - 2.0
Cristobalite	Annual[g]	10[g]	0.011	0.010 - 0.016	0.11	0.10 - 0.16

a. Source: Appendix G, Section G.1.5.
b. Regulatory limits for criteria pollutants from 40 CFR 50.4 through 50.11, and Nevada Administrative Code 445B.391 (see Chapter 3, Table 3-5).
c. Sum of highest concentrations at accessible land withdrawal boundary, regardless of direction.
d. Source: Chapter 4, Section 4.1.2 and Appendix G, Section G.1.5.
e. Numbers are rounded to two significant figures; therefore, the percent of regulatory limit might not equal the percent calculated from the numbers listed in the table.
f. Data on $PM_{2.5}$ not being collected at time of analysis. However, overall PM_{10} numbers are well below standard for both.
g. There are no regulatory limits for public exposure to cristobalite, a form of crystalline silica. An Environmental Protection Agency health assessment (DIRS 103243-EPA 1996, all) states that the risk of silicosis is less than 1 percent for a cumulative exposure to 1,000 micrograms per cubic meter-year. Using a 70-year lifetime, an approximate annual average concentration of 10 micrograms per cubic meter was established as a benchmark for comparison.

duration of the closure period for Inventory Module 1 or 2 would increase over that of the Proposed Action, resulting in minor changes in the air concentrations between the Proposed Action and Inventory Module 1 or 2.

8.2.2.1.2 *Radiological Air Quality*

Inventory Module 1 or 2 would require more subsurface excavation and a longer closure phase leading to increased radon releases compared to the Proposed Action. The increased quantity of spent nuclear fuel that repository facilities would receive and package would also result in additional releases of krypton-85 from failed spent nuclear fuel cladding but, as for the Proposed Action, naturally occurring radon-222 and its radioactive decay products would still be the dominant dose contributors.

The following paragraphs discuss the estimated radiological air quality impacts in terms of the potential radiation dose to members of the public and workers for the construction, operation and monitoring, and closure phases of Inventory Module 1 or 2. For these estimates, workers exposed through the air pathway would be noninvolved workers.

Construction. Table 8-10 lists estimated doses to members of the public and workers for the construction phase. These values resulting from radon releases during the 5-year construction phase

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Table 8-9. Estimated closure phase concentrations of criteria pollutants and cristobalite (micrograms per cubic meter).[a]

Pollutant	Averaging time	Regulatory limit[b]	Proposed Action: Maximum concentration[c,d,e] Higher-temperature	Maximum concentration Lower-temperature	Percent of regulatory limit[d] Higher-temperature	Percent of regulatory limit Lower-temperature
Nitrogen dioxide	Annual	100	0.54	0.54	0.54	0.54 - 0.55
Sulfur dioxide	Annual	80	0.11	0.11	0.15	0.15
	24-hour	365	1.4	1.4	0.38	0.38
	3-hour	1,300	9.3	9.3	0.71	0.71 - 0.72
Carbon monoxide	8-hour	10,000	4.7	4.7	0.045	0.045 - 0.046
	1-hour	40,000	31	31	0.078	0.078
PM_{10} ($PM_{2.5}$)[f]	Annual	50 (15)	0.38	0.34 - 0.37	0.76	0.67 - 0.73
	24-hour	150 (65)	5.5	5.2 - 5.4	3.6	3.4 - 3.6
Cristobalite	Annual[g]	10[g]	0.012	0.0089 - 0.0095	0.12	0.089 - 0.098
			Inventory Module 1 or 2			
Nitrogen dioxide	Annual	100	0.51	0.48 - 0.49	0.52	0.49
Sulfur dioxide	Annual	80	0.11	0.11	0.14	0.14
	24-hour	365	1.4	1.4	0.38	0.37
	3-hour	1,300	9.1	9.0	0.70	0.69
Carbon monoxide	8-hour	10,000	4.4	4.2 - 4.3	0.043	0.041 - 0.042
	1-hour	40,000	30	28 - 29	0.075	0.071 - 0.072
PM_{10} ($PM_{2.5}$)[f]	Annual	50 (15)	0.40	0.32 - 0.35	0.079	0.65 - 0.69
	24-hour	150 (65)	5.6	5.1 - 5.2	3.7	3.4 - 3.5
Cristobalite	Annual[g]	10[g]	0.013	0.010 - 0.013	0.13	0.10 - 0.13

a. Source: Appendix G, Section G.1.6.
b. Regulatory limits for criteria pollutants from 40 CFR 50.4 through 50.11 and Nevada Administrative Code 445B.391 (see Chapter 3, Table 3-5).
c. Sum of highest concentrations at accessible land withdrawal boundary, regardless of direction.
d. Source: Chapter 4, Section 4.1.2 and Appendix G, Section G.1.6.
e. Numbers are rounded to two significant figures; therefore, the percent of regulatory limit might not equal the percent calculated from the numbers listed in the table.
f. Data on $PM_{2.5}$ not being collected at time of analysis. However, overall PM_{10} numbers are well below standard for both.
g. There are no regulatory limits for public exposure to cristobalite, a form of crystalline silica. An Environmental Protection Agency health assessment (DIRS 103243-EPA 1996, all) states that the risk of silicosis is less than 1 percent for a cumulative exposure to 1,000 micrograms per cubic meter-year. Using a 70-year lifetime, an approximate annual average concentration of 10 micrograms per cubic meter was established as a benchmark for comparison.

would be similar to those for the Proposed Action because the subsurface volume excavated would be about the same.

Operation and Monitoring. The doses from krypton-85 from receipt and packaging activities during operation and monitoring would be very low. Dose to the public would be only a fraction (0.00003 or less) of the dose from naturally occurring radon-222 and its radioactive decay products, as discussed below. Similarly, the dose to Yucca Mountain workers from krypton-85 would be a fraction (0.00001 or less) of the dose to those workers from radon-222. The annual dose from krypton-85 would be the same as that for the Proposed Action, but would occur for 38 years of spent nuclear fuel handling activities rather than 24 years.

Table 8-11 and Table 8-12 list doses to individuals and populations for operation and monitoring, respectively. In all cases, naturally occurring radon-222 would be the dominant contributor to the doses, which would increase because of the larger repository required for Inventory Module 1 or 2. Average annual doses would be higher to members of the public and higher to noninvolved workers during the 38 years of development and emplacement activities when the South Portal would be open and used for exhaust ventilation. The analysis estimated collective doses for public and worker populations for the 100 to 338 years for operation and monitoring, including the 38 years of development and emplacement activities and 62 to 300 years of monitoring and maintenance activities. The dose to the maximally exposed member of the public is for 38 years of operations and 32 years of monitoring (that is, a 70-year

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Table 8-10. Estimated radiation doses to maximally exposed individuals and populations from subsurface radon-222 releases during initial construction period.[a,b,c]

Impact	Higher-temperature Total	Higher-temperature Maximum annual	Lower-temperature Total	Lower-temperature Maximum annual
	Proposed Action			
Dose to public				
Offsite MEI[d] (millirem)	1.7	0.43	1.7 - 2.0	0.43 - 0.53
80-kilometer population[e] (person-rem)	33	8.4	33 - 40	8.4 - 10
Dose to noninvolved (surface) workers				
Maximally exposed noninvolved worker[f] (millirem)	7.5	2.0	7.5 - 9.0	1.9 - 2.3
Yucca Mountain noninvolved worker population[g] (person-rem)	0.41	0.10	0.41 - 0.48	0.10 - 0.13
Nevada Test Site noninvolved worker population[h] (person-rem)	0.0013	0.00032	0.0013 - 0.0015	0.00032 - 0.00039
	Inventory Module 1 or 2			
Dose to public				
Offsite MEI (millirem)	1.7	0.43	2.0	0.52 - 0.53
80-kilometer population (person-rem)	33	8.4	39 - 40	10
Dose to noninvolved (surface) workers				
Maximally exposed noninvolved worker (millirem)	7.5	2.0	8.8 - 9.0	2.3
Yucca Mountain noninvolved worker population (person-rem)	0.41	0.10	0.47 - 0.49	0.12 - 0.13
Nevada Test Site noninvolved worker population (person-rem)	0.0013	0.00032	0.0015	0.00038 - 0.00039

Operating mode columns: Higher-temperature and Lower-temperature.

a. Source: Appendix G, Section G.2.
b. Numbers are rounded to two significant figures.
c. Annual values are for the maximum year during the construction phase.
d. MEI = maximally exposed individual; public MEI location would be at the southern boundary of the land withdrawal area.
e. The population includes about 76,000 individuals within 80 kilometers (50 miles) of the repository (see Chapter 3, Section 3.1.8).
f. Maximally exposed noninvolved worker would be in the South Portal Development Area.
g. Includes noninvolved workers at the North Portal Operations Area and South Portal Development Area.
h. DOE workers at the Nevada Test Site [about 6,600 workers (DIRS 101811-DOE 1996, p. 5-14) 50 kilometers (30 miles) east-southeast near Mercury, Nevada].

Table 8-11. Estimated radiation doses to maximally exposed individuals and populations during operations activities.[a,b,c,d]

Impact	Higher-temperature Total	Higher-temperature Maximum annual	Lower-temperature Total	Lower-temperature Maximum annual
	Proposed Action			
Dose to public				
Offsite MEI[e] (millirem)	12	0.73	17 - 43	1.0 - 1.3
80-kilometer population[f] (person-rem)	230	14	320 - 830	20 - 26
Dose to noninvolved (surface) workers				
Maximally exposed noninvolved worker[g] (millirem)	30	2.0	39 - 42	2.8 - 3.0
Yucca Mountain noninvolved worker population[h] (person-rem)	1.2	0.081	1.8 - 1.9	0.12 - 0.13
Nevada Test Site noninvolved worker population[i] (person-rem)	0.011	0.00063	0.015 - 0.043	0.00090 - 0.0012
	Inventory Module 1 or 2			
Dose to public				
Offsite MEI (millirem)	22	0.94	31 - 66	1.3 - 2.2
80-kilometer population (person-rem)	430	18	600 - 1,300	26 - 42
Dose to noninvolved (surface) workers				
Maximally exposed noninvolved worker (millirem)	45	2.0	62 - 95	2.8 - 4.6
Yucca Mountain noninvolved worker population (person-rem)	1.8	0.081	2.5 - 4.1	0.11 - 0.2
Nevada Test Site noninvolved worker population (person-rem)	0.02	0.00085	0.028 - 0.063	0.0012 - 0.002

Operating mode columns: Higher-temperature and Lower-temperature.

a. Source: Appendix G, Section G.2.
b. Numbers are rounded to two significant figures.
c. For Inventory Module 1 or 2, the operation and monitoring phase would last 100 years for the higher-temperature operating mode and 163 to 338 years for the lower-temperature operating mode.
d. Maximum annual dose occurs during the last year of development, when repository would be largest and South Portal would still be used for exhaust ventilation.
e. MEI = maximally exposed and individual; at the southern boundary of the land withdrawal area.
f. The population includes about 76,000 individuals within 80 kilometers (50 miles) of the repository (see Chapter 3, Section 3.1.8).
g. Maximally exposed noninvolved worker would be in the South Portal Development Area.
h. Includes noninvolved workers at the North Portal Operations Area and South Portal Development Area.
i. DOE workers at the Nevada Test Site [6,600 workers (DIRS 101811-DOE 1996, p. 5-14) 50 kilometers (30 miles) east-southeast near Mercury, Nevada].

Table 8-12. Estimated radiation doses to maximally exposed individuals and populations during monitoring activities.[a,b,c,d]

Impact	Operating mode			
	Higher-temperature		Lower-temperature	
	Total	Maximum annual	Total	Maximum annual
	Proposed Action			
Dose to public				
Offsite MEI[e] (millirem)	29	0.41	30 - 62	0.59 - 0.89
80-kilometer population[f] (person-rem)	600	8	1,500 - 3,500	11 - 17
Dose to noninvolved (surface) workers				
Maximally exposed noninvolved worker[g] (millirem)	0.096	0.0019	0.16 - 0.33	0.0011 - 0.0067
Yucca Mountain noninvolved worker population[h] (person-rem)	0.0091	0.0013	0.0031 - 0.05	0.000034 - 0.0057
Nevada Test Site noninvolved worker population[i] (person-rem)	0.033	0.00044	0.083 - 0.019	0.00021 - 0.00094
	Inventory Module 1 or 2			
Dose to public				
Offsite MEI (millirem)	39	0.62	20 - 100	0.29 - 1.4
80-kilometer population (person-rem)	740	12	2,200 - 5,400	5.6 - 28
Dose to noninvolved (surface) workers				
Maximally exposed noninvolved worker (millirem)	0.22	0.0043	0.33 - 0.54	0.0022 - 0.011
Yucca Mountain noninvolved worker population (person-rem)	0.025	0.0044	0.067 - 0.1	0.000075 - 0.0091
Nevada Test Site noninvolved worker population (person-rem)	0.041	0.00066	0.12 - 0.3	0.00031 - 0.0015

a. Source: Appendix G, Section G.2.
b. Numbers are rounded to two significant figures.
c, For Inventory Module 1 or 2, the operation and monitoring phase would last 100 years for the higher-temperature operating mode and 163 to 338 years for the lower-temperature operating mode.
d. Maximum annual dose occurs during the last year of development, when repository would be largest and South Portal would still be used for exhaust ventilation.
e. MEI = maximally exposed individual; at the southern boundary of the land withdrawal area.
f. The population includes about 76,000 individuals within 80 kilometers (50 miles) of the repository (see Chapter 3, Section 3.1.8).
g. Maximally exposed noninvolved worker would be in the South Portal Development Area.
h. Includes noninvolved workers at the North Portal Operations Area and South Portal Development Area.
i. DOE workers at the Nevada Test Site [6,600 workers (DIRS 101811-DOE 1996, p. 5-14) 50 kilometers (30 miles) east-southeast near Mercury, Nevada].

lifetime). The dose to the maximally exposed noninvolved worker is for 50 years at the South Portal during development, emplacement, and monitoring activities.

Closure. Table 8-13 lists estimated doses to populations and maximally exposed individuals during the closure phase. Radiation doses would increase over those for the Proposed Action not only because of the larger excavated volume but also the longer time required for closure (12 to 23 years) in comparison to 10 to 17 years.

Summary. Based on the analysis of radiological air quality impacts from repository construction, operation and monitoring, and closure for Inventory Module 1 or 2, the estimated maximum annual dose to the maximally exposed individual member of the public would be 0.99 millirem for the lower-temperature operating mode during development and emplacement activities in the operation and monitoring phase. DOE compared the estimated annual dose to the Preclosure Public Health and Environmental Standard found at 10 CFR 63.204, which is 15 millirem per year to a member of the public. The dose would be about 6.6 percent of this standard. The radiation dose is 0.3 percent of the annual 340-millirem natural background dose to individuals in Amargosa Valley. Section 8.2.7 discusses human health impacts to the public that could result from radiation exposures during construction, operation and monitoring, and closure for Inventory Module 1 or 2.

8.2.2.2 Cumulative Impacts from Inventory Module 1 or 2 and Other Federal, Non-Federal, and Private Actions

This section addresses potential nonradiological and radiological cumulative impacts to air quality from activities at the repository for the Proposed Action or Inventory Module 1 or 2 and other Federal,

Table 8-13. Estimated radiation doses to maximally exposed individuals and populations from radon-222 releases during closure phase.[a,b,c]

Impact	Higher-temperature Total	Higher-temperature Maximum annual	Lower-temperature Total	Lower-temperature Maximum annual
	Proposed Action			
Dose to public				
MEI[d] (millirem)	3.0	0.39	4.3 - 9.4	0.57 - 0.87
80-kilometer population[e] (person-rem)	57	7.4	83 - 180	10 - 16
Dose to noninvolved (surface) workers				
Maximally exposed noninvolved (surface) worker[f] (millirem)	0.014	0.0018	0.024 - 0.070	0.0030 - 0.0063
Yucca Mountain noninvolved (surface) worker population[g] (person-rem)	0.0040	0.00052	0.0070 - 0.015	0.00088 - 0.0014
Nevada Test Site noninvolved worker population[h] (person-rem)	0.0031	0.00041	0.0046 - 0.0099	0.00058 - 0.00089
	Inventory Module 1 or 2			
Dose to public				
MEI (millirem)	4.9	0.60	8.5 - 19	0.86 - 1.4
80-kilometer population (person-rem)	95	11	160 - 360	16 - 26
Dose to noninvolved (surface) workers				
Maximally exposed noninvolved (surface) worker (millirem)	0.034	0.0040	0.063 - 0.14	0 - 0.010
Yucca Mountain noninvolved (surface) worker population (person-rem)	0.012	0.0013	0.015 - 0.026	0.0014 - 0.0019
Nevada Test Site noninvolved worker population (person-rem)	0.0052	0.00061	0.0090 - 0.020	0.00088 - 0.00015

a. Source: Appendix G, Section G-2.
b. Numbers are rounded to two significant figures.
c. The closure phase would last 10 to 7 years for the Proposed Action and 12 to 23 years for Inventory Module 1 or 2.
d. MEI = maximally exposed individual; at the southern boundary of the land withdrawal area.
e. The population includes about 76,000 individuals within 80 kilometers (50 miles) of the repository (see Chapter 3, Section 3.1.8).
f. Maximally exposed noninvolved worker would be in the South Portal Development Area.
g. Includes noninvolved workers at the North Portal Operations Area and South Portal Development Area.
h. DOE workers at the Nevada Test Site [6,600 workers (DIRS 101811-DOE 1996, p. 5-14) 50 kilometers (30 miles) east-southeast near Mercury, Nevada].

non-Federal, and private actions that would coincide with repository operations and potentially affect the air quality within the geographic boundaries of repository air quality impacts.

To identify and quantify potential cumulative impacts on air resources from other actions, the Department used a 50-mile (80-kilometer) radius around the proposed repository as the region of influence. However, because of the distances involved and the dispersion afforded by distance and different wind directions, the potential for overlap of plumes from multiple actions would be greatest for those actions that are in close proximity to each other (that is, a few miles). Beyond that, the degree of plume overlap is less certain and indeed may not exist.

8.2.2.2.1 *Nonradiological Air Quality*

Construction, operation and monitoring, and closure of the proposed Yucca Mountain Repository would have very small impacts on regional air quality for the Proposed Action or for Inventory Module 1 or 2. Annual average concentrations of criteria pollutants at the land withdrawal boundary would be 1 percent or less of applicable regulatory limits except for PM_{10}, which the analysis estimated would be as much as 6.5 percent of the regulatory limit at the land withdrawal boundary. This estimate does not consider standard dust suppression activities (such as wetting), so actual concentrations probably would be much lower.

DOE has monitored particulate matter concentrations in the Yucca Mountain region since 1989; gaseous criteria pollutants were monitored from October 1991 through September 1995. Concentrations were well below applicable National Ambient Air Quality Standards (see Chapter 3, Section 3.1.2.1). In 1990, DOE also measured ambient air quality in several Nevada Test Site areas for short-term concentrations of sulfur dioxide, carbon monoxide, and PM_{10} (DIRS 101811-DOE 1996, Volume I, pp. 4-146 and 4-148).

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The measurements were all lower than the applicable short-term (1-hour, 3-hour, 8-hour, and 24-hour) limits.

Pollutant concentrations related to Nevada Test Site activities would be well below ambient air quality standards and would not increase ambient pollutant concentrations above standards in Nye County (DIRS 101811-DOE 1996, Volume I, p. 4-146). Therefore, DOE expects the cumulative impacts from proposed repository and Nevada Test Site operations to be very small.

Other actions discussed in Section 8.1 would be unlikely to have cumulative impacts with the repository because they are sufficiently far away that plumes would have limited potential for overlap. Further, the responsible agencies would take measures for each action to minimize regional air impacts.

Repository activities would have no effect on air quality in the Las Vegas Valley air basin, which is a nonattainment area for carbon monoxide and PM_{10}, because the Las Vegas Valley air basin lies approximately 120 kilometers (75 miles) southeast of the proposed repository site.

8.2.2.2.2 *Radiological Air Quality*

Past activities at the Nevada Test Site are responsible for the seepage of radioactive gases from underground testing areas and slightly increased krypton-85 levels on Pahute Mesa in the northwest corner of the Nevada Test Site (see Figure 8-2). Some radioactivity on the site is attributable to the resuspension of soils contaminated from past aboveground nuclear weapons testing (DIRS 101811-DOE 1996, Volume I, p. 4-149). Current Nevada Test Site defense program activities have not resulted in detectable offsite levels of radioactivity. As discussed in Chapter 3, Section 3.1.8.2, estimated radiation doses to the public during 1999 were 0.12 millirem to the maximally exposed individual [a hypothetical resident of Springdale, Nevada, which is about 14 kilometers (19 miles) north of Beatty (see Figure 8-2)] and 0.38 person-rem to the population within 80 kilometers (50 miles) of Nevada Test Site airborne emission sources (DIRS 146592-Black and Townsend 1998, p. 7-1). The radiation dose estimates from repository construction, operation and monitoring, and closure (see Tables 8-10, 8-11, 8-12, and 8-13) would add to these estimates assuming the exposed individuals and population were the same (they are not). Conservatively adding the 1999 maximally exposed individual dose from the Nevada Test Site to the highest estimated average annual dose to the maximally exposed individual from repository operations (hypothetical individual located at the southern border of the land withdrawal area) (2.2 millirem) resulted in a cumulative dose of 2.3 millirem. DOE compared the estimated annual dose to the Preclosure Public Health and Environmental Standard found at 10 CFR 63.204, which is 15 millirem per year to a member of the public. The dose would be about 15 percent of this standard. This dose would also represent 0.68 percent of the annual 340-millirem natural background radiation dose to individuals in Amargosa Valley. Conservatively adding the 1999 Nevada Test Site and highest estimated annual repository population dose (42 person-rem) results in a cumulative dose of 42 person-rem. No latent cancer fatalities to the population would be expected from this cumulative exposure (see Section 8.2.7).

Chapter 3 discusses potential radiological doses from past weapons testing at the Nevada Test Site. Residents who were present during the periods when such testing (in particular, atmospheric weapons testing from the 1950s to the early 1960s) occurred could have received as much as 5 rem to the thyroid gland from iodine-131 releases. Using a tissue weighting factor of 0.03 as specified in International Commission on Radiological Protection Publication 26 (DIRS 101075-ICRP 1977, all) this equates to an effective dose equivalent of about 150 millirem. Because of the length of time since atmospheric weapons testing ended, essentially all of this dose has already occurred. This dose would apply only to those residents who lived in the region of influence during the period of atmospheric weapons testing. DOE has not added this dose to the maximally exposed individual dose, but has included this information here so long-term residents in the region of influence can evaluate their potential for impacts from past nuclear weapons testing. (DOE has also included this information in the air quality portion of Table 8-60.)

The only other activity identified in the 80-kilometer (50-mile)-radius region of influence that could affect radiological air quality is a low-level radioactive disposal site near Beatty, Nevada, which was officially closed on January 1, 1993. The physical work of a State-approved Stabilization and Closure Plan ended in July 1994. Custodianship of the site has been transferred to the State of Nevada. Monitoring is continuing at the site to ensure that any radioactive material releases to the air continue to be low (DIRS 102171-NSHD 1999, Section on the Bureau of Health Protection Services).

8.2.3 HYDROLOGY

8.2.3.1 Surface Water

Potential impacts to surface waters from the Proposed Action would be relatively minor and limited to the immediate vicinity of land disturbances associated with the action (see Chapter 4, Section 4.1.3.2, and the floodplain/wetlands assessment in Appendix L). Surface-water impacts of primary concern would include the following:

- Introduction and movement of contaminants
- Changes to runoff or infiltration rates
- Alterations of natural drainage

This section addresses these impact areas in a discussion of possible increases or other changes that could occur as a result of the emplacement of Inventory Module 1 or 2. To be cumulative, other Federal, non-Federal, or private action effects would have to occur in the immediate area because of the transient nature of the surface water from the repository (that is, stormwater runoff). No currently identified actions have met this criterion.

Introduction and Movement of Contaminants

For Inventory Module 1 or 2, there would be essentially no change in the potential for soil contamination during the construction, operation and monitoring, and closure phases. There would be no change in the types of contaminants present nor would there be changes in operations that would make spills or releases more likely. Similarly, there would be no change in the threat of flooding to cause contaminant releases beyond that described for the Proposed Action.

Changes to Runoff or Infiltration Rates

Compared to the estimated area of land disturbed under the Proposed Action, Inventory Module 1 or 2 would require the disturbance of additional land for the corresponding repository operating mode (see Table 8-4). A maximum of about 5.5 square kilometers (1,400 acres) of land would be newly disturbed for Module 1 or 2 for the lower-temperature mode if surface aging was included. This increase in disturbed land would still be a relatively small portion of the natural drainage areas and would make little difference in the amount of water that soaked into the ground or reached the intermittently flowing drainage channels. Disturbed areas not covered by structures would slowly return to conditions more similar to those of the surrounding undisturbed ground.

Alterations of Natural Drainage

No additional actions or land disturbances associated with Inventory Module 1 or 2 would involve a potential to alter noteworthy natural drainage channels in the area. The excavated rock pile and its increased size for Module 1 or 2 would be in an area that would obstruct a very small portion of overland drainage. Potential impacts to floodplains would be the same as those described for the Proposed Action (see Chapter 4, Section 4.1.3.3). The construction, operation, and maintenance of a rail line, roadways, and bridges in the Yucca Mountain vicinity could affect the 100- and 500-year floodplains of Fortymile Wash, Busted Butte Wash, Drill Hole Wash, and Midway Valley Wash at Yucca Mountain. The floodplains affected and the extent of activities in the floodplains would depend on which routes DOE selected. Appendix L contains a floodplain/wetlands assessment that describes the actions DOE could take to construct, operate, and maintain a branch rail line or highway route in the Yucca Mountain vicinity.

8.2.3.2 Groundwater

8.2.3.2.1 *Inventory Module 1 or 2 Impacts*

Potential groundwater impacts would be related to the following:

- The potential for a change in infiltration rates that could increase the amount of water in the unsaturated zone and adversely affect the performance of waste containment in the repository, or decrease the amount of recharge to the aquifer
- The potential for contaminants to migrate to the unsaturated or saturated groundwater zones during the active life of the repository
- The potential for water demands associated with the repository to deplete groundwater resources to an extent that could affect downgradient groundwater use or users

Changes to Infiltration and Aquifer Recharge. If DOE emplaced Inventory Module 1 or 2, changes related to infiltration and recharge rates would be limited to three areas: a possible increase in the size of the excavated rock pile, an increase in the number of ventilation shaft operations areas, and an extended scope for subsurface activities. The following paragraphs discuss these items.

Additional land disturbance anticipated during the operation and monitoring phase would be the continued growth of the excavated rock pile. Depending on the repository operating mode, this could involve as much as about 0.5 square kilometer (120 acres) of additional land over that required for the Proposed Action (see Table 8-4). Although the excavated rock pile could have different infiltration rates than undisturbed ground, it probably would not be a recharge location because of the extended depth of unconsolidated material, nor would it be likely to cause a large change in the amount of water that would otherwise reach recharge areas such as drainage channels.

Increased land disturbance would result from the additional ventilation shaft operation areas and the access roads that would be required as the repository footprint size increased to accommodate the Module 1 or 2 inventory. Depending on the repository operating mode, this could involve an additional 0.3 to 0.47 square kilometer (74 to 120 acres) of land disturbance over that required for these elements of the Proposed Action (see Table 8-4). These areas of disturbance would be primarily on steeper terrain, uphill from the portal areas, where unconsolidated material is likely thin and where disturbances could expose fractured bedrock. Infiltration rates could be increased notably in such areas as a result. However, much of the disturbed area would be capped with road material or equipment pads, and the amount of disturbed land would still be small in comparison to the surrounding undisturbed area.

Underground activities and their associated potential to contribute to the deep infiltration of water would be basically the same as those described for the Proposed Action, except emplacement drift construction would take an estimated 36 years to complete with either Inventory Module 1 or 2, compared to 22 years for the Proposed Action (see Table 8-3). As described for the Proposed Action, the quantities of water in the subsurface not removed to the surface by ventilation or pumping and thus available for infiltration

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would be small and primarily limited to the duration of drift development when the largest quantities of water would be used in the subsurface for dust control.

Potential for Contaminant Migration to Groundwater Zones. Neither Inventory Module 1 nor 2 would involve additional actions likely to increase the potential for contaminant releases to the environment. The only possible exception to this could be the extended period of subsurface excavation activities to accommodate the additional inventory. However, this exception would be an extension of activities with minimal potential to involve substantial contaminant releases.

Potential to Deplete Groundwater Resources. Anticipated annual water demand for Inventory Module 1 or 2 would be the same or very similar to that projected for the Proposed Action. Table 8-14 summarizes estimated annual water demands for both the Proposed Action and Inventory Module 1 or 2. The table indicates no notable change in water demand during construction.

Table 8-14. Estimated annual water demand (acre-feet)[a] for the Proposed Action and Inventory Module 1 or 2.

Phase	Duration (years)	Water demand (acre-feet/year)[a] Operating mode: Higher-temperature	Water demand (acre-feet/year)[a] Operating mode: Lower-temperature
	Proposed Action		
Construction	5	160	190 to 210
Operation and monitoring (by activity)			
Emplacement and development activities			
Combined emplacement and development	22	230	250 to 290
Subsequent emplacement or aging only[b]	2 or 28	180	90 to 190
Monitoring activities			
Initial decontamination	3	220	200 to 230
Subsequent monitoring/caretaking	73 to 297	6	3 to 6
Closure	10 to 17	81	70 to 84
	Inventory Module 1 or 2		
Construction	5	160	190 to 210
Operation and monitoring (by activity)			
Emplacement and development activities			
Combined emplacement and development	36	250	240 to 320
Subsequent emplacement only[b]	2 or 15	180	90 to 190
Monitoring activities			
Initial decontamination	3	220	200 to 230
Subsequent monitoring/caretaking	59 to 297	6	4 to 6
Closure	12 to 23	83	73 to 91

a. To convert acre-feet to cubic meters, multiply by 1,233.49.

b. Unless surface aging is involved, the period during which development was complete and only emplacement being conducted would last 2 years. This higher duration listed is applicable only to the lower-temperature repository operating mode that includes surface aging.

Projected annual water demand during emplacement and development activities of the operation and monitoring phase (as listed in Table 8-14) would be very similar, but generally a little higher under Inventory Module 1 or 2. However, the difference in total water demand would be greater when the change in the duration of the annual demand is taken into consideration. That is, this phase of repository activities, which would have the highest annual water demand, is extended from 22 to 36 years with the Module 1 or 2 inventory. On an annual basis, water demand would increase no more than 4 to 10 percent over that for the Proposed Action but, during the entire 36-year period, Inventory Module 1 or 2 would result in an increased water demand by as much as about 80 percent, depending on the repository operating mode.

Projected annual water demand during monitoring activities of the operation and monitoring phase would be basically the same under either the Proposed Action or Inventory Module 1 or 2. In either case, the relatively high demands listed in Table 8-14 would last only about 3 years during surface facility decontamination, after which the annual demand would drop drastically for the remainder of this long-duration activity. The closure phase for Module 1 or 2 shows there would be only a slight increase in projected annual water demand in comparison to the Proposed Action. The fact that the duration of the closure phase would be longer under Module 1 or 2 would increase the difference on a total-phase basis, but the increases would still be minor.

Potential impacts to water resources under Inventory Module 1 or 2 would be very similar to those under the Proposed Action because the annual water demand would change little, and the best understanding of the groundwater resource is that it is replenished on an annual basis as gauged by the perennial yield of the groundwater basin. Under Module 1 or 2, the repository's annual water demand from the western two-thirds of the Jackass Flats basin would remain below the lowest estimated value for its perennial yield of [720,000 cubic meters (580 acre-feet)] (see Chapter 3, Table 3-11). See Chapter 4, Section 4.1.3.3 for more information on regional groundwater usage and demand.

8.2.3.2.2 *Cumulative Impacts from Inventory Module 1 or 2 and Other Federal, Non-Federal, and Private Actions*

Potential impacts to groundwater, as described in Chapter 4, Section 4.1.3.3, and in Section 8.2.3.2.1, for the Proposed Action and Inventory Module 1 or 2 would be small and limited to the immediate vicinity of land disturbances associated with the action. The exceptions to this would be the potential impact from water demands on groundwater resources and potential impacts from contaminants in groundwater. With these exceptions, other Federal, non-Federal, or private action effects would have to occur in the same region of influence to be cumulative with those resulting from the Proposed Action or Inventory Module 1 or 2, and no currently identified actions meet this criterion.

The remainder of this discussion addresses potential impacts to groundwater resources from water demand. Section 8.3 addresses long-term impacts of contaminants in groundwater.

The discussion of impacts to groundwater resources in Chapter 4, Section 4.1.3.3, includes ongoing water demands from Area 25 of the Nevada Test Site. Area 25 is the proposed location of the primary repository surface facilities. It is also the location of wells J-12 and J-13, which would provide water for the Proposed Action and for ongoing Nevada Test Site activities in this area. The estimated water demand for these ongoing activities is 340,000 cubic meters (280 acre-feet) a year (DIRS 103226-DOE 1998, Table 11-2, p. 11-6).

Water demand during emplacement and development activities of the operation and monitoring phase under Inventory Module 1 or 2 combined with the baseline demands from Nevada Test Site activities would exceed the lowest perennial yield estimate under the lower-temperature repository operating modes if certain features were enacted. The highest annual water demand attributed to the lower-temperature operating mode with maximum package spacing, in combination with ongoing Nevada Test Site water demands, would exceed the lowest estimate of perennial yield, but only marginally. The worst-case scenario for repository water demand (maximum spacing and surface aging under the lower-temperature operating mode) added to the Nevada Test Site demand would total about 240,000 cubic meters (600 acre-feet) per year compared to 720,000 cubic meters (580 acre-feet), the lowest estimate of perennial yield for the western two-thirds of Jackass Flats. Besides these exceptions, the combined water demands would be below the lowest estimate of perennial yield. None of the water demand estimates would approach the high estimate of perennial yield for the entire Jackass Flats hydrographic basin, which is 4.9 million cubic meters (4,000 acre-feet) (see Chapter 3, Table 3-11). Potential impacts to groundwater resources from this combined demand would be no different than those described in Chapter 4, Section 4.1.3.3. That is, some decline in the water level would be likely near the production wells, and water elevation decreases at the town of Amargosa Valley would probably be no more than 0.4 to 1.1 meter (1.2 to 3.6 feet) (see Section 4.1.3.3). The reduction in underflow from the Jackass Flats hydrographic area to the Amargosa Desert hydrographic area would be less than the quantity of water actually withdrawn from the upgradient area because there would probably be minor changes in groundwater flow patterns as the water level adjusted to the withdrawals. Groundwater flow models predict the reduction in underflow to the Amargosa Desert would be no higher than 160,000 to 180,000 cubic meters (130 to 150 acre-feet) per year (see Section 4.1.3.3).

The Nevada Test Site EIS (DIRS 101811-DOE 1996, pp. 3-18, 3-19, and 3-34) indicates that the potential construction and operation of a Solar Enterprise Zone facility would represent the only action that would cause water withdrawals on the Test Site to exceed past levels. That EIS estimates that this demand would be greater than the highest estimates of the basin's perennial yield. Therefore, cumulative impacts from the Solar Enterprise Zone facility are likely. DOE is considering several locations for the Solar Enterprise Zone facility, one of which is Area 25. If DOE built this facility in Area 25, it would obtain water from the Jackass Flats hydrologic area, and possibly from other hydrologic areas.

Cumulative demands on the Jackass Flats hydrographic area could have long-term impacts on water availability in the downgradient aquifers beneath the Amargosa Desert. The groundwaters in these areas are hydraulically linked, but the exact nature and extent of that link is still a matter of study and some speculation. However, the amount of water already being withdrawn in the Amargosa Desert [averaging about 17 million cubic meters (14,000 acre-feet) of water per year from 1995 through 1997 (see Chapter 3, Table 3-11)] is much greater than the quantities being considered for withdrawal from Jackass Flats. If water pumpage from Jackass Flats affected water levels in the Amargosa Desert, the impacts would be small in comparison to those caused by local pumping in that area.

A report from the Nye County Nuclear Waste Repository Office (DIRS 103099-Buqo 1999, pp. 39 to 53) provides a perspective of potential cumulative impacts with that County as the center of interest. The Nye County report evaluates impacts to all water resources potentially available in the entire county, whereas this EIS focuses principally on impacts to the Jackass Flats groundwater basin (the source of water that DOE would use for the repository) and the groundwater system that could become contaminated thousands of years in the future. Nye County reports that the potential cumulative impacts would include additive contamination as radionuclides ultimately reached the groundwater, constraints on development of groundwater due to land withdrawal, and reduction of water available for Nye County development because of use by Federal agencies (DIRS 103099-Buqo 1999, pp. 49 to 51).

8.2.4 BIOLOGICAL RESOURCES

Impacts to biological resources from Inventory Module 1 or 2 would be similar to impacts that would occur as a result of the Proposed Action evaluated in Chapter 4, Section 4.1.4. Those impacts would occur primarily as a result of site clearing, placement of material in the excavated rock pile, habitat loss, and the loss of individuals of some animal species during site clearing and from vehicle traffic.

Inventory Module 1 or 2 would require disturbing biological resources in a larger area under each thermal load scenario than would be disturbed under the Proposed Action, primarily because the excavated rock pile would be larger (Table 8-15).

Repository construction and the excavated rock pile to support Inventory Module 1 or 2 would disturb up to 5.5 square kilometers of previously undisturbed land. Disturbances would occur in areas dominated by Mojave mixed scrub and salt desert scrub land cover types. These cover types are widespread in the withdrawal area and in Nevada. This disturbed area is larger than that for the Proposed Action and would

Table 8-15. Area of land cover types in analyzed withdrawal area disturbed by construction and the excavated rock pile (square kilometers).[a,b,c]

Land cover type	Area in Nevada	Area in analyzed withdrawal area[d]	Operating mode: Higher-temperature	Operating mode: Lower- temperature
		Proposed Action		
Blackbrush	9,900	140	0.0	0 - 0.2
Creosote-bursage	15,000	300	0.6	0.6 - 0.7
Mojave mixed scrub	5,700	120	2.2	2.4 - 3.6
Sagebrush	67,000	16	0.0	0
Salt desert scrub	58,000	20	0.0	0
Previously disturbed[e]	NA[f]	4	1.5	1.5
Totals	***NA***	***600***	***4.3***	***4.5 - 6***
		Inventory Module 1 or 2		
Blackbrush	9,900	140	0.0	0 - 0.2
Creosote-bursage	15,000	300	0.6	0.6 - 0.7
Mojave mixed scrub	5,700	120	3.0	3.2 - 4.6
Sagebrush	67,000	16	0.0	0
Salt desert scrub	58,000	20	0.0	0
Previously disturbed[e]	NA	4	1.5	1.5
Totals	***NA***	***600***	***5.1***	***5.4 - 7***

a. Source: Facility diagrams from DIRS 104523-CRWMS M&O (1999, Figures 6.1.7-1, 6.1.7-2, 6.2.7-1, and 6.2.7-2; pp. 6-42, 6-43, 6-84, and 6-85) overlain on the land cover types map; DIRS 104589-CRWMS M&O (1998, p. 9 as adapted) using a Geographic Information System.
b. To convert square kilometers to acres, multiply by 247.1.
c. Totals might differ from sums of values due to rounding.
d. A small area [0.016 square kilometer (4 acres)] of the pinyon-juniper-2 land cover type occurs in the analyzed land withdrawal area, but would not be affected.
e. Estimate of land previously disturbed in support of the proposed repository.
f. NA = not applicable.

affect vegetation on approximately 1 percent of the previously undisturbed land within the land withdrawal area.

Releases of radioactive materials would not adversely affect biological resources. Routine releases would consist of noble gases, primarily krypton-85 and radon-222. These gases would not accumulate in the environment around Yucca Mountain and would result in low doses to plants or animals.

Overall impacts to biological resources from Inventory Module 1 or 2 would be very small. Species at the repository site are generally widespread throughout the Mojave or Great Basin Deserts and repository activities would affect a very small percentage of the available habitat in the region. Changes in the regional population of any species would be undetectable and no species would be threatened with extinction. The removal of vegetation from the small area required for Module 1 or 2 or the local loss of small numbers of individuals of some species due to site clearing and vehicle traffic would not affect regional biodiversity and ecosystem function. The loss of desert tortoise habitat and small numbers of tortoises under Module 1 or 2 would have no impact on recovery efforts for this threatened species.

Activities associated with other Federal, non-Federal, and private actions in the region should not add measurable impacts to the overall impact on biological resources. However, as stated in the Nevada Test Site EIS (DIRS 101811-DOE 1996, p. 6-16), cumulative impacts to the desert tortoises would occur throughout the region, although the intensity of the impacts would vary from location to location. The largest impact to the habitat probably would occur in the Las Vegas Valley region. The Clark County Desert Conservation Plan authorizes the taking of all tortoises on 445 square kilometers (110,000 acres) of non-Federal land in the County, and on 12 square kilometers (3,000 acres) disturbed by Nevada

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Department of Transportation activities in Clark and adjacent counties. The plan also authorizes several recovery units designed to optimize the survival and recovery of this threatened species. Potential land disturbance activities at the Nevada Test Site under the expanded use alternative represent a small amount of available desert tortoise habitat and will not add measurably to the loss of this species (DIRS 101811-DOE 1996, p. 6-16). As discussed in Chapter 4, Section 4.1.4, repository construction activities would involve the loss of an amount of desert tortoise habitat that would be small in comparison to its range. Yucca Mountain is at the northern end of the range of this species. DOE anticipates that small numbers of tortoises would be killed inadvertently by vehicle traffic during the repository construction, operation and monitoring, and closure phases.

8.2.5 CULTURAL RESOURCES

The only identified actions that could result in cumulative cultural resource impact in the Yucca Mountain site vicinity are Inventory Module 1 or 2. The emplacement of either module would require small additional disturbances to land in areas already surveyed during site characterization activities (see Table 8-4). Because repository construction, operation and monitoring, and closure would be Federal actions, DOE would identify and evaluate cultural resources, as required by Section 106 of the National Historic Preservation Act, and would take appropriate measures to avoid or mitigate adverse impacts to such resources. As a consequence, archaeological information gathered from artifact retrieval during land disturbance would contribute additional cultural resources information to the regional data base for understanding past human occupation and use of the land. However, there would be a potential for illicit or incidental vandalism of archaeological or historic sites and artifacts as a result of increased activities in the repository area, which would be extended for Module 1 or 2 (see Table 8-3), and this could contribute to an overall loss of regional cultural resources information.

The Native American view of resource management and preservation is holistic in its definition of cultural resources, incorporating all elements of the natural and physical environment in an interrelated context (DIRS 102043-AIWS 1998, all). The Native American perspective on cultural resources is further discussed in Chapter 3, Section 3.1.6. Potential impacts resulting from the Proposed Action described in Chapter 4, Section 4.1.5, would also apply to Inventory Module 1 or 2.

8.2.6 SOCIOECONOMICS

8.2.6.1 Inventory Modules 1 and 2 Impacts

This section addresses potential socioeconomic impacts associated with Inventory Module 1 or 2 and concludes that impacts for Inventory Module 1 or 2 would be essential the same during construction phase as the Proposed Action, slightly greater during the development and emplacement phases than the Proposed Action, the same during the monitoring phase, and slightly greater than impacts for the Proposed Action during the closure phase. The impacts in all phases for Module 1 or 2 would be small, as are impacts estimated for the Proposed Action (see Chapter 4, Section 4.1.6). DOE analyzed both the higher-temperature operating mode and the lower-temperature operating mode. Table 8-16 summarizes the peak direct employment levels during all phases for the Proposed Action and for the Inventory Modules.

Construction

DOE expects the construction phase to last for 5 years. The construction phase for Inventory Module 1 or 2 would require approximately 1,800 workers in the peak year, the same as the Proposed Action (see Table 8-16). The impacts for Module 1 or 2 would therefore be the same as those for the Proposed Action.

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Table 8-16. Estimated peak direct employment level impacts from repository phases.[a,b]

Phase	Proposed Action: Higher-temperature	Proposed Action: Lower-temperature	Inventory Module 1 or 2: Higher-temperature	Inventory Module 1 or 2: Lower-temperature
Construction	1,800	1,800	1,800	1,800
Operation and Monitoring				
Development, emplacement	1,700	1,800 - 1,900	1,700	1,700 - 2,600
Monitoring[c]	120	40 - 120	140	130 - 140
Closure	960	960	970	1,100 - 1,200

a. Includes approximately 220 currently employed workers.
b. Numbers rounded to two significant places.
c. Excludes approximately 1,100 workers required for decontamination (monitoring period). Number of required workers is approximately the same for both operating modes for Inventory Module 1 or 2.

Operation and Monitoring

For the Proposed Action, DOE expects the repository development to last for 22 years and emplacement to last for 24 years. With Modules 1 or 2, development would last 36 years and emplacement 38 years. If a design with an aging facility were selected, emplacement activities would last 50 years for the Proposed Action or 51 years for Module 1 or 2. Monitoring activities occur concurrently and then extend beyond the emplacement period for up to 300 years. Employment levels for Module 1 or 2 during this phase could require approximately 700 more workers than the estimated worker requirement for the Proposed Action (see Table 8-16). Although the overall duration of the operation phase, including the development, emplacement, and monitoring activities, varies in length depending on the final scenario of the flexible design, the primary difference between Inventory Module 1 or 2 and the Proposed Action is the increased duration of development and emplacement activities (by 14 years).

The annualized impacts during development and emplacement activities for Inventory Module 1 or 2 would be similar to those for the Proposed Action, but these impacts would continue for an additional 14 years. As with the Proposed Action, direct and indirect increases in regional employment, population, Gross Regional Product, real disposal income, and government expenditures would be small, 3 percent or less of the baselines, for affected counties. No substantial socioeconomic impacts would be likely during the operations phase.

Closure

DOE expects the closure phase to last between 12 and 23 years. Although the required staffing level for Inventory Module 1 or 2 would be slightly greater, but similar in impact, to that of the Proposed Action, Inventory Module 1 or 2 would require more time. Closure would last up to 23 years for Inventory Module 1 or 2. However, as with the Proposed Action, because work force demands would be less than the peak year employment demands during the operations or construction phase, impacts to regional employment, population, Gross Regional Product, real disposal income, and government expenditures would be very small. No substantial impact would likely occur during the closure for Inventory Module 1 or 2.

8.2.6.2 Cumulative Impacts from Inventory Module 1 or 2 and Other Federal, Non-Federal, and Private Actions

Reasonably foreseeable future actions at the Nevada Test Site could affect the socioeconomic region of influence (Nye, Clark, and Lincoln Counties). Sections 8.1.1 and 8.1.2 discuss other activities in the region that could have a socioeconomic impact. However, most of these activities have either already occurred or would occur prior to peak employment associated with the proposed repository. Because of the minimal amount of overlap that would occur in the activities, the affected communities would have more time to assimilate any new residents that might relocate to the region. Thus, no substantial impacts would be likely to occur from these activities.

8.2.7 OCCUPATIONAL AND PUBLIC HEALTH AND SAFETY

This section discusses the short-term health and safety impacts to workers and to members of the public (radiological only) associated with construction, operation and monitoring, and closure activities at the Yucca Mountain site for Inventory Module 1 or 2 (Sections 8.2.7.1 through 8.2.7.3). Section 8.2.7.4 provides a summary of these impacts. Appendix F contains the approach and methods used to estimate the health and safety impacts and additional detailed results for Module 1 or 2 health and safety impacts to workers.

With one exception, no other Federal, non-Federal, or private actions were identified with spatially or temporally coincident short-term impacts in the region of influence that would result in cumulative health and safety impacts with those of the proposed Yucca Mountain Repository. Chapter 3 discusses the potential radiological doses from past weapons testing at the Nevada Test Site. While all of the current population was not present at the time of the testing, residents who were present during the time periods when weapons testing (in particular, atmospheric weapons testing from the 1950s to the early 1960s) occurred could have received as much as 5 rem to the thyroid gland from iodine-131 releases. Using a tissue-weighting factor of 0.03 as specified in International Commission on Radiological Protection Publication 26 (DIRS 101075-ICRP 1977, all), this would equate to an effective dose equivalent of about 150 millirem. Because of the length of time since atmospheric weapons testing ceased, essentially all of this dose has already occurred. This dose would apply only to those residents who lived in the region of influence during the time period of atmospheric weapons testing. DOE has not added this dose to the maximally exposed individual dose, but DOE has included this information so that long-term residents in the region of influence can evaluate their potential for impacts from past nuclear weapons testing. (The dose is included in the risk estimates in Table 8-60 for the summary of public health and safety.)

With the increased number of persons living and working in the region, the number of injuries and fatalities from nonrepository-related activities would increase. However, injury and mortality incidence should remain unchanged or decrease, assuming the continued enforcement of occupational and public health and safety regulations.

Regarding the health and safety impact analysis for Inventory Module 1 or 2, the radiological characteristics of the spent nuclear fuel and high-level radioactive waste would be the same as those for the Proposed Action; there just would be more material to emplace. As described in Appendix A, the radioactive inventory (and radiological properties) of the Greater-Than-Class-C waste and Special-Performance-Assessment-Required waste is much less than that for spent nuclear fuel and high-level radioactive waste. Therefore, the subsurface emplacement of the material in Inventory Module 2 would not greatly increase radiological impacts to workers over those estimated for Module 1. For the surface facility evaluation, the number of workers would be the same for Inventory Module 1 or 2 (DIRS 104508-CRWMS M&O 1999, Section 3.3, third paragraph). Therefore, DOE did not perform separate impact analyses for Modules 1 and 2.

The primary changes in the parameters that would affect the magnitude of the worker health and safety impacts between the Proposed Action and Inventory Module 1 or 2 would be the periods required to perform the work and the numbers of workers for the different phases. Appendix F, Table F-43 p. 2 contains a detailed breakdown of the estimates for the involved and noninvolved workforce for the repository phases for Inventory Module 1 or 2 in terms of full-time equivalent worker-years.

For the public, the principal changes in parameters that would affect the magnitude of the health impact estimates would be the length of the various phases and the rate at which air would be exhausted from the repository. The exhaust rate of the subsurface ventilation system would affect both the radon-222 concentrations to which subsurface workers would be exposed and the quantity of radon-222 released to

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the environment. Appendix G, Section G.2.3.1, discusses radon-222 concentrations in the subsurface environment and release rates to the environment from the various project phases.

8.2.7.1 Construction

This section presents estimates of health and safety impacts to repository workers and members of the public for the construction phase. The values are similar to those for the Proposed Action because the length of the construction phase would be the same and activities would be similar.

Industrial Hazards

Table 8-17 lists health and safety hazards to workers common to the workplace. They are based on the health and safety loss statistics listed in Appendix F, Tables F-4 and F-5. For Inventory Module 1 or 2 these impacts would be independent of the operating mode because the number of workers would be the same for both operating modes.

Table 8-17. Summary of industrial hazard health and safety impacts to facility workers during the construction phase.[a]

Worker group	Operating mode: Higher-temperature	Operating mode: Lower-temperature
	Proposed Action	
Involved worker		
Total recordable cases of injury and illness	340	340 - 370
Lost workday cases	160	160 - 180
Fatalities	0.16	0.16 - 0.18
Noninvolved worker		
Total recordable cases of injury and illness	55	55 - 61
Lost workday cases	27	27 - 30
Fatalities	0.048	0.048 - 0.054
All workers		
Total recordable cases of injury and illness	400	400 - 430
Lost workday cases	190	190 - 210
Fatalities	0.21	0.21 - 0.23
	Inventory Module 1 or 2	
Involved worker		
Total recordable cases of injury and illness	340	340 - 370
Lost workday cases	160	160 - 180
Fatalities	0.16	0.16 - 0.18
Noninvolved worker		
Total recordable cases of injury and illness	55	55 - 61
Lost workday cases	27	27 - 30
Fatalities	0.048	0.048 - 0.054
All workers		
Total recordable cases of injury and illness	400	400 - 430
Lost workday cases	190	190 - 210
Fatalities	0.21	0.21 - 0.23

a. Source: Appendix F, Table F-12.

Radiological Health Impacts

This analysis presents radiological health impacts in terms of doses and resultant latent cancer fatalities. Estimated doses were converted to estimates of latent cancer fatality using a dose-to-risk conversion factor of 0.0004 and 0.0005 latent cancer fatality per person-rem for workers and the public, respectively (see Appendix F, Section F.1.1.5).

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Workers. Spent nuclear fuel and high-level radioactive waste would not be present during the construction phase. Potential radiological impacts to surface workers during this phase would be limited to those from releases of naturally occurring radon-222 and its decay products with the subsurface ventilation exhaust (these impacts are presented in Section 8.2, Table 8-10). Subsurface workers would incur exposure from radiation resulting from radionuclides in the walls of the drifts and from inhalation of radon-222 in the subsurface atmosphere. Surface worker exposure would be very small compared to those for subsurface workers. The radiological doses and health impacts for Inventory Module 1 or 2 are listed in Table 8-18. The Module 1 or 2 impacts would be independent of the operating mode because the subsurface workforce would not change.

Table 8-18. Summary of radiological health impacts to workers from all activities during construction phase.[a]

Worker group	Operating mode	
	Higher-temperature	Lower-temperature
	Proposed Action	
Involved worker		
Dose to maximally exposed worker (millirem)	1,300	1,300
Probability of latent cancer fatality	0.00052	0.00052
Collective dose (person-rem)	680	680
Number of latent cancer fatalities	0.27	0.27
Noninvolved worker		
Dose to maximally exposed worker (millirem)	330	330
Probability of latent cancer fatality	0.00013	0.00013
Collective dose (person-rem)	37	37
Number of latent cancer fatalities	0.015	0.015
All workers		
Collective dose (person-rem)	720	720
Number of latent cancer fatalities	0.29	0.29
	Inventory Module 1 or 2	
Involved worker		
Dose to maximally exposed worker (millirem)	1,300	1,300
Probability of latent cancer fatality	0.00052	0.00052
Collective dose (person-rem)	680	680
Number of latent cancer fatalities	0.27	0.27
Noninvolved worker		
Dose to maximally exposed worker (millirem)	330	330
Probability of latent cancer fatality	0.00013	0.00013
Collective dose (person-rem)	37	37
Number of latent cancer fatalities	0.015	0.015
All workers		
Collective dose (person-rem)	720	720
Number of latent cancer fatalities	0.29	0.29

a. Source: Appendix F, Table F-11.

Public. Potential radiological impacts to the public during the construction phase would be limited to those from the release of naturally occurring radon-222 with the exhaust from subsurface ventilation. Table 8-19 presents radiological health impacts for the public surrounding the proposed repository.

8.2.7.2 Operations

This section presents estimates of health and safety impacts to workers and members of the public during the operations period. The primary differences between Inventory Module 1 or 2 and the Proposed Action would be the longer durations for development and emplacement activities. Under Module 1 or 2,

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Table 8-19. Radiological health impacts to the public from the construction phase.[a]

Impact	Operating mode			
	Higher-temperature		Lower-temperature	
	Total	Maximum annual	Total	Annual
	Proposed Action			
Dose to public				
Offsite MEI[b] (millirem)	1.7	0.43	1.7 - 2	0.43 - 0.53
80-kilometer population (person-rem)	33	8.4	33 - 40	8.4 - 10
Offsite MEI probability of latent cancer fatality	8.5×10^{-7}	2.1×10^{-7}	8.5×10^{-7} - 0.000001	2.1×10^{-7} - 2.6×10^{-7}
80-kilometer population number of latent cancer fatalities	0.017	0.0042	0.017 - 0.02	0.0042 - 0.0052
	Inventory Module 1 or 2			
Dose to public				
Offsite MEI (millirem)	1.7	0.43	2	0.52 - 0.53
80-kilometer population (person-rem)	33	8.4	39 - 40	10
Offsite MEI probability of latent cancer fatality	8.5×10^{-7}	2.1×10^{-7}	9.9×10^{-7} - 0.000001	2.6×10^{-7} - 2.6×10^{-7}
80-kilometer population number of latent cancer fatalities	0.017	0.0042	0.019 - 0.02	0.0051 - 0.0052

a. Sources: Chapter 4, Table 4-23; Appendix G, Section G.2.
b. MEI = maximally exposed individual.

it would take DOE 14 more years to complete drift development (36 years total) than for the Proposed Action and 14 more years to complete emplacement (38 years total) than for the Proposed Action.

Industrial Hazards

Table 8-20 lists health and safety impacts to workers from industrial hazards common to the workplace. These impacts would be about 50 to 60 percent greater than those calculated for the Proposed Action.

Radiological Impacts

Workers. Table 8-21 lists radiological doses and health impacts to workers during the operations period for Inventory Module 1 or 2. Appendix F contains additional detail and presents the radiological impacts for surface workers, subsurface workers, and monitoring activities. Radiological impacts to workers for Module 1 or 2 would be about 50 to 60 percent greater than those for the Proposed Action.

Public. Potential radiological impacts to the public from the operations period would result from the release of naturally occurring radon-222 and its decay products with the subsurface exhaust ventilation air and from radioactive gases, principally krypton-85, that could be released from the Waste Handling Building during spent nuclear fuel handling operations.

Table 8-22 lists the total radiological doses and radiological health impacts to the public from releases to the atmosphere of krypton-85 and radon-222 during the operations period. Radon-222 and its decay products would be the dominant dose contributors (greater than 99 percent).

8.2.7.3 Monitoring

This section contains estimates of the health and safety impacts to workers and members of the public for the monitoring period. The length of this period would depend on the operating mode; however, the monitoring phase for Inventory Module 1 or 2 would generally be shorter than the corresponding monitoring phase for the Proposed Action as shown in Table 8-3.

Industrial Hazards

Table 8-23 lists health and safety impacts to workers from hazards common to the workplace. As discussed above, the duration of the monitoring period for the Inventory Modules is shorter than that for the Proposed Action; therefore, the industrial safety impacts would be less for the Inventory Modules than for the Proposed Action.

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Table 8-20. Summary of industrial hazard health and safety impacts to facility workers during operations period.

Worker group	Operating mode: Higher-temperature	Operating mode: Lower-temperature
	Proposed Action	
Involved worker		
Total recordable cases of injury and illness	1,200	1,200 - 1,700
Lost workday cases	590	620 - 840
Fatalities	0.9	0.91 - 1.4
Noninvolved worker		
Total recordable cases of injury and illness	300	310 - 470
Lost workday cases	150	150 - 230
Fatalities	0.31	0.31 - 0.45
All workers		
Total recordable cases of injury and illness	1,500	1,500 - 2,200
Lost workday cases	740	770 - 1,100
Fatalities	1.2	1.2 - 1.9
	Inventory Module 1 or 2	
Involved worker		
Total recordable cases of injury and illness	1,900	1,900 - 2,200
Lost workday cases	970	970 - 1,100
Fatalities	1.4	1.4 - 1.7
Noninvolved worker		
Total recordable cases of injury and illness	470	470 - 560
Lost workday cases	230	230 - 270
Fatalities	0.46	0.46 - 0.54
All workers		
Total recordable cases of injury and illness	2,400	2,400 - 2,800
Lost workday cases	1,200	1,200 - 1,400
Fatalities	1.9	1.9 - 2.2

a. Source: Appendix F, Tables F-22 and F-52.

Radiological Impacts

Workers. Table 8-24 lists radiological doses and health impacts from activities during the monitoring period. During this period the primary source of collective dose to the involved subsurface worker population would be the inhalation dose from radon-222 while the primary source of collective dose to the involved surface worker population would be direct exposure to the waste packages.

Public. Table 8-25 lists the radiological doses and health impacts to the public from activities during the monitoring period. The primary source of these impacts is the release of radon-222 via subsurface ventilation flow.

8.2.7.4 Closure

This section contains estimates of health and safety impacts to workers and members of the public for the closure phase.

Industrial Hazards

Table 8-26 lists health and safety impacts to workers from hazards common to the workplace. The impacts for Inventory Module 1 or 2 would be slightly greater than those for the Proposed Action.

Radiological Impacts

Workers. Table 8-27 lists radiological doses and health impacts to workers during the closure phase. Subsurface workers would be exposed to radon-222 from inhalation of air in the drifts, to external

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Table 8-21. Summary of radiological health impacts to workers from all activities during operations period.[a]

Worker group	Operating mode: Higher-temperature	Operating mode: Lower-temperature
	Proposed Action	
Involved worker		
Dose to maximally exposed worker (millirem)	15,000	15,000 - 30,000
Probability of latent cancer fatality	0.006	0.006 - 0.012
Collective dose (person-rem)	7,500	7,600 - 12,000
Number of latent cancer fatalities	3.0	3.0 - 4.8
Noninvolved worker		
Dose to maximally exposed worker (millirem)	1,500	1,500 - 1,800
Probability of latent cancer fatality	0.0006	0.0006 - 0.00072
Collective dose (person-rem)	150	160 - 170
Number of latent cancer fatalities	0.06	0.064 - 0.068
All workers		
Collective dose (person-rem)	7,700	7,800 - 12,000
Number of latent cancer fatalities	3.1	3.1 - 4.8
	Inventory Module 1 or 2	
Involved worker		
Dose to maximally exposed worker (millirem)	24,000	24,000 - 33,000
Probability of latent cancer fatality	0.0096	0.0096 - 0.013
Collective dose (person-rem)	12,000	12,000 - 15,000
Number of latent cancer fatalities	4.8	4.8 - 6
Noninvolved worker		
Dose to maximally exposed worker (millirem)	2,400	2,400
Probability of latent cancer fatality	0.00096	0.00096
Collective dose (person-rem)	180	180 - 190
Number of latent cancer fatalities	0.072	0.072 - 0.076
All workers		
Collective dose (person-rem)	12,000	12,000 - 15,000
Number of latent cancer fatalities	4.8	4.8 - 6

a. Source: Appendix F, Tables F-23 and F-53.

Table 8-22. Radiological health impacts to the public from the operations period.

Impact	Higher-temperature: Total	Higher-temperature: Maximum annual	Lower-temperature: Total	Lower-temperature: Annual
	Proposed Action			
Dose to public				
Offsite MEI[a] (millirem)	12	0.73	17 - 43	1 - 1.3
80-kilometer population (person-rem)	230	14	320 - 830	20 - 26
Offsite MEI probability of latent cancer fatality	0.000006	3.7×10^{-7}	8.3×10^{-6} - 0.000022	5.2×10^{-7} - 6.7×10^{-7}
80-kilometer population number of latent cancer fatalities	0.12	0.0071	0.16 - 0.42	0.01 - 0.013
	Inventory Module 1 or 2			
Dose to public				
Offsite MEI (millirem)	22	0.94	31 - 66	1.3 - 2.2
80-kilometer population (person-rem)	430	18	600 - 1,300	26 - 42
Offsite MEI probability of latent cancer fatality	0.000011	4.7×10^{-7}	0.000016 - 0.000033	6.7×10^{-7} - 1.1×10^{-6}
80-kilometer population number of latent cancer fatalities	0.22	0.0091	0.3 - 0.64	0.013 - 0.021

a. MEI = maximally exposed individual.

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Table 8-23. Summary of industrial hazard health and safety impacts to facility workers during monitoring period.[a]

Worker group	Operating mode	
	Higher-temperature	Lower-temperature
	Proposed Action	
Involved worker		
Total recordable cases of injury and illness	320	400 - 1,000
Lost workday cases	130	160 - 410
Fatalities	0.31	0.38 - 1
Noninvolved worker		
Total recordable cases of injury and illness	55	65 - 150
Lost workday cases	27	32 - 73
Fatalities	0.049	0.057 - 0.13
All workers		
Total recordable cases of injury and illness	380	470 - 1,200
Lost workday cases	160	190 - 480
Fatalities	0.36	0.44 - 1.1
	Inventory Module 1 or 2	
Involved worker		
Total recordable cases of injury and illness	290	450 - 1,100
Lost workday cases	120	180 - 440
Fatalities	0.28	0.43 - 1.1
Noninvolved worker		
Total recordable cases of injury and illness	51	74 - 160
Lost workday cases	25	36 - 78
Fatalities	0.045	0.065 - 0.14
All workers		
Total recordable cases of injury and illness	340	520 - 1,300
Lost workday cases	150	220 - 520
Fatalities	0.33	0.50 - 1.2

a. Source: Appendix F, Tables F-31 and F-59.

radiation from radionuclides in the rock in the drift walls, and to external radiation emanating from the waste packages.

Public. Potential radiation-related health impacts to the public from closure activities would result from releases of radon-222 in the subsurface ventilation flow. Section 8.2.2.1.2 describes radiation doses to the public for this phase. Table 8-28 lists radiological dose and health impacts for the closure phase. Radiological health impacts to the public for the inventory modules would be greater than those for the Proposed Action largely because of the longer time period for closure activities (see Table 8-3).

8.2.7.5 Summary

This section contains three summary tables:

- A summary of health impacts to workers from industrial hazards common to the workplace for all phases (Table 8-29)
- A summary of radiological doses and health impacts to workers for all phases (Table 8-30)
- A summary of radiological doses and health impacts to the public for all phases (Table 8-31)

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Table 8-24. Summary of radiological health impacts to workers from all activities during monitoring period.[a]

Worker group	Operating mode: Higher-temperature	Operating mode: Lower-temperature
	Proposed Action	
Involved workers		
Dose to maximally exposed worker (millirem)	18,000	18,000
Probability of latent cancer fatality	0.0072	0.0072
Collective dose (person-rem)	1,100	1,500 - 4,300
Number of latent cancer fatalities	0.44	0.6 - 1.7
Noninvolved workers		
Dose to maximally exposed worker (millirem)	1,800	1,800
Probability of latent cancer fatality	0.00072	0.00072
Collective dose (person-rem)	36	46 - 140
Number of latent cancer fatalities	0.014	0.018 - 0.056
All workers		
Collective dose (person-rem)	1,100	1,500 - 4,400
Number of latent cancer fatalities	0.44	0.6 - 1.8
	Inventory Module 1 or 2	
Involved workers		
Dose to maximally exposed worker (millirem)	18,000	18,000
Probability of latent cancer fatality	0.0072	0.0072
Collective dose (person-rem)	990	1,700 - 4,500
Number of latent cancer fatalities	0.4	0.68 - 1.8
Noninvolved workers		
Dose to maximally exposed worker (millirem)	1,800	1,800
Probability of latent cancer fatality	0.00072	0.00072
Collective dose (person-rem)	31	56 - 150
Number of latent cancer fatalities	0.012	0.022 - 0.06
All workers		
Collective dose (person-rem)	1,000	1,800 - 4,700
Number of latent cancer fatalities	0.4	0.72 - 1.9

a. Source: Appendix F, Table F-32 and F-60.

Table 8-25. Radiological health impacts to the public from the monitoring period.

Impact	Higher-temperature: Total	Higher-temperature: Maximum annual	Lower-temperature: Total	Lower-temperature: Annual
	Proposed Action			
Dose to public				
Offsite MEI[a] (millirem)	29	0.41	30 - 62	0.59 - 0.89
80-kilometer population (person-rem)	600	8	1,500 - 3,500	11 - 17
Offsite MEI probability of latent cancer fatality	0.000015	2.1×10^{-7}	0.000015 - 0.000031	3×10^{-7} - 4.4×10^{-7}
80-kilometer population number of latent cancer fatalities	0.3	0.004	0.75 - 1.7	0.0057 - 0.0085
	Inventory Module 1 or 2			
Dose to public				
Offsite MEI (millirem)	39	0.62	20 - 100	0.29 - 1.4
80-kilometer population (person-rem)	740	12	2,200 - 5,400	5.6 - 28
Offsite MEI probability of latent cancer fatality	0.000019	3.1×10^{-7}	0.00001 - 0.00005	1.5×10^{-7} - 7.2×10^{-7}
80-kilometer population number of latent cancer fatalities	0.37	0.006	1.1 - 2.7	0.0028 - 0.014

a. MEI = maximally exposed individual.

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Table 8-26. Summary of industrial hazard health and safety impacts to facility workers during closure phase.[a]

Worker group	Operating mode	
	Higher-temperature	Lower-temperature
	Proposed Action	
Involved worker		
Total recordable cases of injury and illness	320	340 - 420
Lost workday cases	150	160 - 200
Fatalities	0.15	0.16 - 0.2
Noninvolved worker		
Total recordable cases of injury and illness	51	53 - 62
Lost workday cases	25	26 - 30
Fatalities	0.045	0.047 - 0.054
All workers		
Total recordable cases of injury and illness	370	390 - 480
Lost workday cases	180	190 - 230
Fatalities	0.2	0.21 - 0.25
	Inventory Module 1 or 2	
Involved worker		
Total recordable cases of injury and illness	350	400 - 600
Lost workday cases	170	190 - 280
Fatalities	0.17	0.19 - 0.28
Noninvolved worker		
Total recordable cases of injury and illness	54	59 - 82
Lost workday cases	26	29 - 40
Fatalities	0.048	0.052 - 0.072
All workers		
Total recordable cases of injury and illness	400	460 - 680
Lost workday cases	200	220 - 320
Fatalities	0.22	0.24 - 0.35

a. Source: Appendix F, Tables F-38 and F-66.

Industrial Hazards to Workers

Table 8-29 summarizes health and safety impacts to workers from industrial hazards common to the workplace for all phases. The calculated health impacts from industrial hazards common to the workplace would be in the range of 2 to 3 fatalities for Inventory Module 1 or 2. Most of the impacts would come from the operations period. Industrial safety impacts for Module 1 or 2 are about 30 to 40 percent greater than those for the Proposed Action.

Radiological Health

Workers. Table 8-30 summarizes radiological doses and health impacts to workers for the Proposed Action and Inventory Module 1 or 2. It lists these impacts as the likelihood of a latent cancer fatality for the maximally exposed individual worker over a 50-year working career, and as the number of latent cancer fatalities that could occur in the population. The calculated values for latent cancer fatalities for repository workers during the construction, operation and monitoring, and closure phases for Module 1 or 2 are in the range of 6 to 8 fatalities for Module 1 or 2. These are higher than those for the Proposed Action (4 to 7 fatalities) and would be about double those from normal workplace industrial hazards (see Table 8-29).

Most of the total worker radiation dose would be from the receipt and handling of spent nuclear fuel during the operation period. Radiation exposure from inhalation of radon-222 and its decay products by exposure to radiation emanating from the subsurface would also be contributors to the total dose. No other activities in the area were identified that could cause cumulative impacts to repository workers.

Table 8-27. Summary of radiological health impacts to workers from all activities during closure phase.[a]

Worker group	Operating mode: Higher-temperature	Operating mode: Lower-temperature
	Proposed Action	
Involved worker		
Total recordable cases of injury and illness	320	340 - 420
Lost workday cases	150	160 - 200
Fatalities	0.15	0.16 - 0.2
Noninvolved worker		
Total recordable cases of injury and illness	51	53 - 62
Lost workday cases	25	26 - 30
Fatalities	0.045	0.047 - 0.054
All workers		
Total recordable cases of injury and illness	370	390 - 480
Lost workday cases	180	190 - 230
Fatalities	0.2	0.21 - 0.25
	Inventory Module 1 or 2	
Involved worker		
Total recordable cases of injury and illness	350	400 - 600
Lost workday cases	170	190 - 280
Fatalities	0.17	0.19 - 0.28
Noninvolved worker		
Total recordable cases of injury and illness	54	59 - 82
Lost workday cases	26	29 - 40
Fatalities	0.048	0.052 - 0.072
All workers		
Total recordable cases of injury and illness	400	460 - 680
Lost workday cases	200	220 - 320
Fatalities	0.22	0.24 - 0.35

a. Source: Appendix F, Tables F-39 and F-67.

Table 8-28. Radiological health impacts to the public from the closure phase.

Impact	Higher-temperature: Total	Higher-temperature: Maximum annual	Lower-temperature: Total	Lower-temperature: Annual
	Proposed Action			
Dose to public				
Offsite MEI[a] (millirem)	3	0.39	4.3 - 9.4	0.55 - 0.85
80-kilometer population (person-rem)	57	7.4	83 - 180	10 - 16
Offsite MEI probability of latent cancer fatality	1.5×10^{-6}	1.9×10^{-7}	2.2×10^{-6} - 4.7×10^{-6}	2.7×10^{-7} - 4.2×10^{-7}
80-kilometer population number of latent cancer fatalities	0.028	0.0037	0.041 - 0.09	0.0052 - 0.0081
	Inventory Module 1 or 2			
Dose to public				
Offsite MEI (millirem)	4.9	0.57	8.5 - 19	0.83 - 1.4
80-kilometer population (person-rem)	95	11	160 - 360	16 - 26
Offsite MEI probability of latent cancer fatality	2.5×10^{-6}	2.9×10^{-7}	4.2 × 10-6 - 9.5×10^{-6}	4.2×10^{-7} - 6.9×10^{-7}
80-kilometer population number of latent cancer fatalities	0.047	0.0055	0.081 - 0.18	0.008 - 0.013

a. MEI = maximally exposed individual.

Public. Table 8-31 summarizes radiological doses and health impacts to the public during all phases for the Proposed Action and Inventory Module 1 or 2. The radiological doses and health impacts would result from exposure of the public to naturally occurring radon-222 and decay products released from the subsurface facilities in ventilation exhaust air. The calculated likelihood for Module 1 or 2 that the maximally exposed individual would experience a latent cancer fatality is less than 0.00005. The

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Table 8-29. Summary of industrial hazard health and safety impacts to facility workers during all phases.[a]

Worker group	Operating mode	
	Higher-temperature	Lower-temperature[b]
	Proposed Action	
Involved worker		
Total recordable cases of injury and illness	2,200	2,500 - 3,300
Lost workday cases	1,000	1,200 - 1,500
Fatalities	1.5	1.8 - 2.6
Noninvolved worker		
Total recordable cases of injury and illness	470	500 - 720
Lost workday cases	230	250 - 350
Fatalities	0.45	0.48 - 0.68
All workers		
Total recordable cases of injury and illness	2,700	3,000 - 4,000
Lost workday cases	1,200	1,500 - 1,900
Fatalities	2	2.3 - 3.3
	Inventory Module 1 or 2	
Involved worker		
Total recordable cases of injury and illness	2,900	3,400 - 4,000
Lost workday cases	1,400	1,600 - 1,900
Fatalities	2.1	2.4 - 3.1
Noninvolved worker		
Total recordable cases of injury and illness	640	690 - 830
Lost workday cases	310	340 - 410
Fatalities	0.61	0.65 - 0.78
All workers		
Total recordable cases of injury and illness	3,500	4,100 - 4,800
Lost workday cases	1,700	1,900 - 2,300
Fatalities	2.7	3.1 - 3.9

a. Source: Appendix F, Tables F-40 and F-68.

b. These ranges might differ from simple addition of the minimum and maximum values listed for the constituent phases because the values might not correspond between different phases. For example, a scenario that maximizes impacts during construction could result in minimal impacts during operations.

estimated increase in the number of latent cancer fatalities is less than 2 for the exposed population within about 80 kilometers (50 miles) over the period of more than 100 years of repository activities.

For purposes of comparison, the number of latent cancer fatalities calculated from the public for the Yucca Mountain construction, operation and monitoring, and closure phases for Inventory Module 1 or 2 would be less than 0.75. Statistics published by the Centers for Disease Control indicate that during 1998, 24 percent of all deaths in the State of Nevada were attributable to cancer of some type and cause (adapted from DIRS 153066-Murphy 2000, p. 83). Assuming this rate would remain unchanged for the estimated population in 2035 of about 76,000 within 80 kilometers (50 miles) of the Yucca Mountain site, about 18,000 members of this population would be likely to die from cancer-related causes.

As discussed in Section 8.2.2.2.2, the current operations at the Nevada Test Site resulted in a dose to the maximally exposed individual in 1999 of 0.12 millirem. During that same year, the population dose from Nevada Test Site activities was 0.38 person-rem. Conservatively adding the doses from repository activities to Nevada Test Site activities would result in a dose of 2.3 millirem to the maximally exposed individual and 42 person-rem to the population.

As discussed in the introduction to Section 8.2.7, potential radiological doses from past weapons testing at the Nevada Test Site could result in additional impacts to those residents who were present during that

Table 8-30. Summary of radiological health impacts to workers from all activities during all phases.[a]

Worker group	Operating mode: Higher-temperature	Operating mode: Lower-temperature[b]
	Proposed Action	
Involved worker		
Dose to maximally exposed worker (millirem)	18,000	18,000 - 30,000
Probability of latent cancer fatality	0.0072	0.0072 - 0.012
Collective dose (person-rem)	9,800	11,000 - 17,000
Number of latent cancer fatalities	3.9	4.4 - 6.8
Noninvolved worker		
Dose to maximally exposed worker (millirem)	1,800	1,800
Probability of latent cancer fatality	0.00072	0.00072
Collective dose (person-rem)	230	280 - 360
Number of latent cancer fatalities	0.092	0.11 - 0.14
All workers		
Collective dose (person-rem)	10,000	11,000 - 17,000
Number of latent cancer fatalities	4	4.4 - 6.8
	Inventory Module 1 or 2	
Involved worker		
Dose to maximally exposed worker (millirem)	24,000	24,000 - 33,000
Probability of latent cancer fatality	0.0096	0.0096 - 0.013
Collective dose (person-rem)	14,000	16,000 - 20,000
Number of latent cancer fatalities	5.6	6.4 - 8
Noninvolved worker		
Dose to maximally exposed worker (millirem)	2,400	2,400
Probability of latent cancer fatality	0.00096	0.00096
Collective dose (person-rem)	270	330 - 410
Number of latent cancer fatalities	0.11	0.13 - 0.16
All workers		
Collective dose (person-rem)	14,000	16,000 - 20,000
Number of latent cancer fatalities	5.6	6.4 - 8

a. Source: Appendix F, Tables F-41 and F-69.
b. These ranges might differ from simple addition of the minimum and maximum values listed for the constituent phases because the values might not correspond between different phases. For example, a scenario that maximizes impacts during construction could result in minimal impacts during operations.

Table 8-31. Summary of radiological health impacts to the public from all project phases.

Impact	Higher-temperature: Total	Higher-temperature: Maximum annual	Lower-temperature[a]: Total	Lower-temperature[a]: Annual
		Proposed Action		
Dose to public				
Offsite MEI[b] (millirem)	31	0.73	44 - 62	1 - 1.3
80-kilometer population (person-rem)	930	14	1,900 - 3,900	20 - 26
Offsite MEI probability of latent cancer fatality	0.000016	3.7×10^{-7}	0.000022 - 0.000031	5.2×10^{-7} - 6.7×10^{-7}
80-kilometer population number of latent cancer fatalities	0.46	0.0071	0.97 - 2	0.010 - 0.013
		Inventory Module 1 or 2		
Dose to public				
Offsite MEI (millirem)	51	0.94	60 - 110	1.3 - 2.2
80-kilometer population (person-rem)	1,300		3,100 - 6,200	5.6 - 42
Offsite MEI probability of latent cancer fatality	0.000026	4.7×10^{-7}	0.00003 - 0.000057	6.7×10^{-7} - 1.1×10^{-6}
80-kilometer population number of latent cancer fatalities	0.65	0.0091	1.5 - 3.1	0.0028 - 0.021

a. These ranges might differ from simple addition of the minimum and maximum values listed for the constituent phases because the values might not correspond between different phases. For example, a scenario that maximizes impacts during construction could result in minimal impacts during operations.
b. MEI = maximally exposed individual.

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timeframe. If the maximally exposed individual is assumed to have also been present during the entire time period in which weapons testing occurred, the maximally exposed individual dose listed in Table 8-31 could be increased by as much as 150 millirem. (These doses have been included in Table 8-60.)

8.2.8 ACCIDENTS

Disposal in the proposed repository of the additional spent nuclear fuel and high-level radioactive waste along with the Greater-Than-Class-C waste and Special-Performance-Assessment-Required waste in Inventory Module 1 or 2 would result in a very small increase in the estimated risk from accidents described in Chapter 4, Section 4.1.8, for the Proposed Action. The potential hazards and postulated accident scenarios identified and evaluated in Chapter 4, Section 4.1.8, would be the same as those for Module 1 or 2 because there would be no change to the basic repository design or operation. The time required for receipt, packaging, and emplacement of the additional waste would extend from 24 to 38 years, but the probability of an accident scenario (likelihood per year) would be essentially unaffected. The accident scenario consequences evaluated for the Proposed Action would bound those that could occur for Inventory Module 1 or 2 because the spent nuclear fuel and high-level radioactive waste, except the Greater-Than-Class-C waste and the Special-Performance-Assessment-Required waste, would be the same. DOE has not determined the final disposition method for Greater-Than-Class-C and Special-Performance-Assessment-Required waste but, based on the characteristics and expected packaging of these wastes (type and quantity of radionuclides; see Appendix A), the accident scenario consequences calculated in Chapter 4, Section 4.1.8 for spent nuclear fuel and high-level radioactive waste would be bounding. Therefore, substantial cumulative accident impacts would be unlikely for Inventory Module 1 or 2.

The analysis of potential external events in Appendix H considered the potential effects on the Yucca Mountain Repository if there was a decision in the future to resume nuclear weapons testing or from a possible vehicle launch or recovery accident at the proposed VentureStar®/Kistler project. An earlier environmental assessment (DIRS 100136-DOE 1986, all) states that DOE could temporarily suspend underground repository activities during a nuclear weapons test to ensure worker safety. The Department has not decided that such a suspension of work activities at the repository would be necessary at the present time; however, as it finalized the design of the proposed repository, the Department could find it necessary to enact worker safety requirements at the repository site if there was a resumption of nuclear weapons testing. As discussed in Section 8.1.2.2, the Kistler aerospace activity is currently on hold.

In addition, the analysis identified no other Federal, non-Federal, or private action that could affect either the occurrence probability or consequences of the accident scenarios evaluated for the Proposed Action or Inventory Modules.

8.2.9 NOISE

The emplacement of Inventory Module 1 or 2 would have noise levels associated with the construction and operation of the repository similar to those for the Proposed Action. An increase in potential noise impacts from Module 1 or 2 would result only from the increased number of shipments to the site. The expected rate of receipt would be about the same as that for the Proposed Action; therefore, the impact would be an extended period (approximately 14 years) that shipping would continue beyond the Proposed Action.

DOE does not expect other Federal, non-Federal, or private actions in the region to add measurable noise impacts to those of the Proposed Action or Inventory Module 1 or 2 because the other activities are some distance from the proposed repository, and it is unlikely that overall increased noise would result.

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8.2.10 AESTHETICS

There would be no impacts for Inventory Module 1 or 2 beyond those described in Chapter 4, Section 4.1.10, because the profile of the repository facility would not be different as a result of implementation of Modules 1 or 2. One action that could add to cumulative aesthetics impacts of the region would be the construction and operation of a proposed wind farm (DIRS 154545-DOE 2001, all) on the Nevada Test Site. The locations being considered for the proposed wind farm are located within the areas of Pahute Mesa and the Shoshone Mountains. The areas under consideration are higher in elevation than the surrounding environs. With the addition of the wind turbine to maximum heights of approximately 430 feet above-ground surface these wind turbines may be visible from the west (especially from mountain ranges west of the Nevada Test Site).

8.2.11 UTILITIES, ENERGY, MATERIALS, AND SITE SERVICES

This section discusses potential impacts to utilities, energy, materials, and site services from the construction, operation and monitoring, and closure of the repository for Inventory Module 1 or 2. The scope of the analysis includes electricity use, fossil-fuel and oil and lubricant consumption, and consumption of construction materials. Chapter 4, Section 4.1.11, evaluates special services such as emergency medical support, fire protection, and security and law enforcement, which would not change for Inventory Module 1 or 2. The material in this section parallels Section 4.1.11, which addresses impacts from the Proposed Action. DOE has considered the other actions described in Section 8.1 to evaluate the potential for cumulative impacts on utilities, energy, materials, and site services. Most of the actions have limited information on their potential cumulative impacts, or the available information indicates that there could be no cumulative impacts. However, one action that would potentially have a cumulative impact is the Alternative Energy Generation Facility (Wind Farm) on the Nevada Test Site, which would increase electrical generating capacity for the region by approximately 600 megawatts, which represents less than 15 percent of the peak power (4,300 megawatts) distributed by Nevada Power in 2000, as described in Chapter 3, Section 3.1.11.2.

To determine the potential impacts of Inventory Module 1 or 2, DOE evaluated the projected uses of electricity, fuel, oils and lubricants and construction materials for each repository phase and compared them to those for the Proposed Action. The following paragraphs describe these evaluations.

Construction

As in the Proposed Action, the major impact during the construction phase for Inventory Module 1 or 2 would be the estimated demand for electric power. The peak demand for electricity for the Proposed Action would be 25 megawatts during construction (Table 8-32). During the construction required for Module 1 or 2, the peak demand for electricity would be about the same (25 megawatts). The tunnel boring machines would account for more than half of the demand for electricity during the 5-year construction phase, but power would also be required to operate ventilation equipment and to support the construction of surface facilities. As for the Proposed Action, the existing electric transmission and distribution system at the Nevada Test Site could not support this increased demand. DOE is evaluating modifications to the site electrical system, as discussed in Chapter 4, Section 4.1.11.

The use of electricity for the higher-temperature operating mode for Inventory Module 1 or 2 would be about 150,000 megawatt-hours during the construction phase, which is about the same as for the Proposed Action (see Table 8-33). For the lower-temperature operating mode the electricity usage ranges from 190,000 to 210,000 megawatt-hours, which is the same as for the Proposed Action. The similarity in numbers between the Proposed Action and the Inventory Modules is due to the similar length of time for construction activities.

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Table 8-32. Peak electric power demand (megawatts).

Phase	Operating mode	
	Higher-temperature	Lower-temperature
Proposed Action		
Construction	25	25
Operation and monitoring		
Operation	47	40 - 54
Monitoring	8	7.8 - 15
Closure	10	10 - 18
Maximum	47	40 - 54
Inventory Module 1 or 2		
Construction	25	25
Operation and monitoring		
Operation	53	44 - 54
Monitoring	11	11 - 15
Closure	14	10 - 18
Maximum	53	44 - 54

Table 8-33. Electricity use (1,000 megawatt-hours).

Phase	Operating mode	
	Higher-temperature	Lower-temperature
Proposed Action		
Construction	150	190 - 210
Operation and monitoring		
Operation	5,200	5,300 - 9,200
Monitoring	4,800	9,700 - 29,000
Closure	720	790 - 1,300
Totals	***11,000***	***16,000 - 36,000***
Inventory Module 1 or 2		
Construction	150	190 - 200
Operation and monitoring		
Operation	8,200	7,700 - 9,700
Monitoring	6,000	11,000 - 39,000
Closure	1,100	1,300 - 1,600
Totals	***15,000***	***21,000 - 50,000***

The use of liquid fossil fuel during the construction phase would include diesel fuel and fuel oil. The estimated liquid fuel use would be 5.5 to 6 million liters (1.5 to 1.6 million gallons) which would be about the same as for the Proposed Action (see Table 8-34). About 2.6 to 3.5 million liters of oils (primarily hydraulic oil) and lubricants would also be used to support construction as shown in Table 8-35. The usage rate should be well within the regional supply capacity and, therefore, would not result in substantial impacts.

The primary materials needed to support construction would be concrete, steel, and copper. Concrete would be used for liners in the main drifts and ventilation shafts. Concrete also would be used in the construction of the surface facilities. The quantity of concrete required for the surface facilities and initial emplacement drift construction would be about 420,000 to 500,000 cubic meters (550,000 to 650,000 cubic yards). Cement (see Table 8-36) would come from regional suppliers. Sand and gravel needs would be met from materials excavated from the repository or hauled to the repository by local/ regional suppliers. As much as 120,000 metric tons (132,000 tons) of steel for a variety of uses including rebar, piping, vent ducts, and track, and 230 metric tons (250 tons) of copper for electrical cable also would be required. These quantities would not be likely to affect the regional supply capacity.

Table 8-34. Fossil-fuel use (million liters).

Phase	Operating mode	
	Higher-temperature	Lower-temperature
Proposed Action		
Construction	5.5	5.5 - 6.0
Operation and monitoring		
Operation	360	360 - 500
Monitoring	2.3	2.6 - 13
Closure	5.2	5.1 - 6.6
Totals	***370***	***380 - 510***
Inventory Module 1 or 2		
Construction	5.4	5.5 - 6.1
Operation and monitoring		
Operation	550	550 - 600
Monitoring	2.1	7 - 22
Closure	7.4	6.1 - 6.9
Totals	***560***	***570 - 620***

Table 8-35. Oils and lubricants (million liters).

Phase	Operating mode	
	Higher-temperature	Lower-temperature
Proposed Action		
Construction	2.6	3.1 - 3.5
Operation and monitoring		
Operation	8.5	9.8 - 18
Monitoring	9	13 - 53
Closure	1.7	1.8 - 3
Totals	***22***	***33 - 71***
Inventory Module 1 or 2		
Construction	2.6	3.1 - 3.5
Operation and monitoring		
Operation	13	16 - 27
Monitoring	9.9	23 - 110
Closure	3.8	2.9 - 3.2
Totals	***30***	***56 - 140***

Table 8-36. Cement use (1,000 metric tons).

Phase	Operating mode	
	Higher-temperature	Lower-temperature
Proposed Action		
Construction	160	190
Operation and monitoring		
Operation	100	150 - 340
Monitoring	0	0
Closure	1.2	1.2 - 1.9
Totals	***250***	***310 - 530***
Inventory Module 1 or 2		
Construction	160	160 - 190
Operation and monitoring		
Operation	260	290 - 890
Monitoring	0	0
Closure	1.9	1.9 - 2.0
Totals	***420***	***480 - 1,100***

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Operation and Monitoring

The event that would indicate the start of the operation and monitoring phase would be the beginning of emplacement of spent nuclear fuel and high-level radioactive waste. During this phase the construction of emplacement drifts would continue in parallel with emplacement activities at about the same rate as during the construction phase. As a result, the peak electric power demand would increase to between about 44 and 54 megawatts. The maximum value of 54 megawatts would be about the same as that for the Proposed Action. As was the case for the Proposed Action, DOE would have to upgrade or revise the transmission and distribution system on the Nevada Test Site to meet this demand. However, the upgrade or revision for the Proposed Action would accommodate the similar increase for Inventory Module 1 or 2.

The demand for electricity for Inventory Module 1 or 2 would be well within the regional capacity for power generation. Nevada Power Company, for example, plans to maintain a reserve capacity of about 12 percent. For the beginning of the operation and monitoring phase in 2010, Nevada Power projects a net peak load of about 6,000 megawatts and plans a reserve of about 710 megawatts (DIRS 103413-NPC 1997, Figure 4, p. 9). The repository peak demand of 54 megawatts would be less than 1 percent of the Nevada Power Company planned capacity and about 8 percent of planned reserves. The repository would not affect the regional availability of electric power to any extent.

Fossil-fuel use during the operation and monitoring phase would be for onsite vehicles and for heating. It should range between 360 and 500 million liters (100 and 130 million gallons) during repository operations. The corresponding use of oils and lubricants would be between 23 and 130 million liters (6 and 34 million gallons). The annual usage rates for fuels would be highest during the first half of the operation and monitoring phase (emplacement and continued construction of drifts) and would decrease substantially during the monitoring period (see Table 8-34). The projected annual usage rates of liquid petroleum products would be higher than those for the Proposed Action but would still be within the regional supply capacity.

Additional construction materials would be required to support the continued construction of subsurface facilities for Inventory Module 1 or 2. About 660,000 cubic meters (860,000 cubic yards) of concrete would be required for the flexible design, higher-temperature repository operating mode, and 730,000 to 2,300,000 cubic meters (950,000 to 3,000,000 cubic yards) would be required for the lower-temperature repository operating mode (see Table 8-37). Corresponding amounts of cement that would be obtained regionally are shown in Table 8-36.

Table 8-37. Concrete use (1,000 cubic meters).

Phase	Operating mode	
	Higher-temperature	Lower-temperature
Proposed Action		
Construction	420	490 - 500
Operation and monitoring		
Operation	240	350 - 880
Monitoring	0	0
Closure	3	3 - 5
Totals	***670***	***850 - 1,400***
Inventory Module 1 or 2		
Construction	420	430 - 490
Operation and monitoring		
Operation	660	730 - 2,300
Monitoring	0	0
Closure	5	4 - 5
Totals	***1,100***	***1,200 - 2,800***

The requirement for steel would be between 120,000 and 360,000 metric tons (130,000 and 390,000 tons), and for copper it would be about 200 and 1,100 metric tons (220 and 1,200 tons) (see Tables 8-38 and 8-39). These quantities, while above the Proposed Action, would be unlikely to affect the regional supply capacity because the annual usage rate would be only slightly higher than that for the Proposed Action.

Table 8-38. Steel use (1,000 metric tons).

	Operating mode	
Phase	Higher-temperature	Lower-temperature
Proposed Action		
Construction	100	120
Operation and monitoring		
Operation	62	150 - 180
Monitoring	0	0
Closure	0.03	0.04
Totals	***160***	***270 - 300***
Inventory Module 1 or 2		
Construction	100	100 - 120
Operation and monitoring		
Operation	120	190 - 360
Monitoring	0	0
Closure	0.04	0.04 - 0.07
Totals	***230***	***290 - 480***

Table 8-39. Copper use (1,000 metric tons).

	Operating mode	
Phase	Higher-temperature	Lower-temperature
Proposed Action		
Construction	0.20	0.23
Operation and monitoring		
Operation	0.08	0.24 - 0.6
Monitoring	0	0
Closure	0	0
Totals	***0.30***	***0.50 - 0.86***
Inventory Module 1 or 2		
Construction	0.20	0.16 - 0.23
Operation and monitoring		
Operation	0.20	0.3 - 1.1
Monitoring	0	0
Closure	0	0
Totals	***0.4***	***0.46 - 1.3***

Closure

The peak electric power required during the closure phase for Inventory Module 1 or 2 would be only slightly higher than that for the Proposed Action and would be less than 20 megawatts for all operating modes. This would be much less than the peak levels predicted for the earlier phases, so impacts would be small.

Fossil-fuel use would be between 6.1 million and 7.4 million liters (1.6 million and 2.0 million gallons). A small amount of concrete and steel would be used for closure. An estimated maximum of 5,000 cubic meters (6,500 cubic yards) of concrete would be required for any operating mode. Similarly, an estimated maximum 70 metric tons (77 tons) of steel would be required for closure. The fossil-fuel and material quantities required for closure would not be large and would not result in substantial impacts.

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8.2.12 MANAGEMENT OF REPOSITORY-GENERATED WASTE AND HAZARDOUS MATERIALS

8.2.12.1 Inventory Module 1 or 2 Impacts

Activities for the emplacement of Inventory Module 1 or 2 would generate waste totals beyond the quantities estimated for the Proposed Action (see Chapter 4, Section 4.1.12). The generated waste types and the treatment and disposal of each waste type would be the same as those described for the Proposed Action. The quantities of generated waste are primarily affected by the increase in the amount of spent nuclear fuel and waste emplaced and the subsequent longer operations and monitoring and closure phases. (Table 8-3 lists the difference in time sequences.) Table 4-40 presents the waste types and quantities generated from activities during the construction phase. This table applies to both the Proposed Action and the Inventory Modules because the timeframe and actions are the same during this phase. Table 8-40 lists the waste quantities generated for Inventory Modules 1 and 2 for the operation and monitoring phase. Table 8-41 lists the waste quantities generated for Inventory Modules 1 and 2 for the closure phase.

Table 8-40. Estimated operation and monitoring phase waste quantities.[a]

Waste type	Operating mode: Higher-temperature	Operating mode: Lower-temperature
	Inventory Module 1	
Low-level radioactive (cubic meters)a	110,000	110,000 - 230,000
Hazardous (cubic meters)	10,000	9,200 - 16,000
	Inventory Module 2	
Low-level radioactive (cubic meters)	130,000	130,000 - 270,000
Hazardous (cubic meters)	12,000	11,000 - 20,000
	Inventory Module 1 or 2	
Sanitary and industrial solid (cubic meters)	110,000	120,000 - 170,000
Sanitary sewage[b] (million liters)	2,500	3,000 - 3,900
Industrial wastewater (million liters)	1,400	1,400 - 2,200

a. To convert cubic meters to cubic feet, multiply by 35.314.
b. To convert liters to gallons, multiply by 0.26418.

Table 8-41. Estimated closure phase waste quantities.[a]

Waste type	Inventory Module 1 or 2: Higher-temperature	Inventory Module 1 or 2: Lower-temperature
Low-level radioactive (cubic meters)[b]	3,500	3,200 - 7,100
Hazardous (cubic meters)	1,200	1,100 - 1,800
Sanitary and industrial solid (cubic meters)	10,000	14,000 - 18,000
Sanitary sewage (million liters)[c]	180	240 - 410
Industrial wastewater (million liters)	84	110 - 160
Demolition debris (cubic meters)	220,000	220,000 - 440,000

a. To convert cubic meters to cubic feet, multiply by 35.314.
b. Module 1 is 7,000 cubic meters.
c. To convert liters to gallons, multiply by 0.26418.

Sanitary and industrial solid waste, sanitary sewage, and industrial wastewater would be disposed of in facilities at the repository site. These facilities would be designed to accommodate the additional waste from Inventory Module 1 or 2. However, DOE could use existing Nevada Test Site landfills to dispose of nonrecyclable construction and demolition debris and sanitary and industrial solid waste. If Nevada Test Site landfills were used, about 360,000 cubic meters (13 million cubic feet) for the higher-temperature operating mode and 640,000 cubic meters (23 million cubic feet) under the lower-temperature operating mode would be disposed of from construction through closure. Disposal of the Proposed Action waste quantities would require the Nevada Test Site landfills to operate past their projected operating lives and to expand as needed (Chapter 4, Section 4.1.12.2). Disposal of the larger waste quantities under Inventory Module 1 or 2 would require the availability of additional disposal capacity in future landfill expansions.

Impacts from the treatment and disposal of hazardous waste off the site would be the same for the Proposed Action and Inventory Module 1 or 2. At present, commercial facilities are available for hazardous waste treatment and disposal, and DOE expects similar facilities to be available until the closure of the repository. The National Capacity Assessment Report (DIRS 103245-EPA 1996, pp. 32, 33, 36, 46, 47, and 50) indicates that the estimated 20-year (1993 to 2013) available capacity for incineration of solids and liquids at permitted treatment facilities in the western states is about 7 times more than the demand for these services. Moreover, the report indicates that the estimated landfill capacity for hazardous waste disposal is about 50 times the demand. Given the current outlook for the capacity versus demand for hazardous waste treatment and disposal, the treatment and disposal of repository-generated hazardous waste would not present a large cumulative impact.

The Nevada Test Site has an estimated total disposal capacity of 3.7 million cubic meters (130 million cubic feet). The DOE analysis of demand for low-level radioactive waste disposal at the Nevada Test Site through 2070 projects a need for about 1.1 million cubic meters (39 million cubic feet or 30 percent) of the total disposal capacity (DIRS 155856-DOE 2000, Table 4-1). The reserve capacity at the Nevada Test Site is about 2.6 million cubic meters (92 million cubic feet). The disposal of repository-generated waste would require about 5 percent of the reserve capacity for the higher-temperature operating mode and about 5 percent to 9 percent for the lower-temperature operating mode.

Even under the Final Waste Management Programmatic Environmental Impact Statement's (DIRS 101816-DOE 1997, pp. 7-23 and I-39) regional disposal concept, the disposal of repository-generated low-level radioactive waste under the Proposed Action and Inventory Module 1 or 2, cumulatively with other DOE waste generators, would use less than 20 percent of the Nevada Test Site's reserve disposal capacity.

The emplacement of Inventory Module 1 or 2 would require the same types and annual quantities of hazardous materials as the Proposed Action, as described in Chapter 4, Section 4.1.12.3. These materials would be used for the additional years associated with the emplacement of the module inventory. As with the Proposed Action, no cumulative impact would be likely from the procurement and use of hazardous materials at the repository.

8.2.12.2 Cumulative Impacts from Inventory Module 1 or 2 and Other Federal, Non-Federal, and Private Actions

Waste operations at the Nevada Test Site (disposing of Nevada Test Site-generated waste and accepting waste from other sites in accordance with decisions from the Waste Management Programmatic EIS) could present a cumulative impact. Section 8.2.12.1 discusses the impact on Test Site facilities from disposal of repository waste and waste that is already projected to be disposed of at the Test Site.

If Nevada Test Site landfills are used to dispose of nonrecyclable construction and demolition debris and sanitary and industrial waste, the landfills would be required to operate past their projected operating lives and to expand as needed (the degree of expansion would depend on how much waste was disposed of at the repository facilities).

Low-level waste capacity at the Nevada Test Site is sufficient to accommodate the repository-generated waste and the projected volume of 1.1 million cubic meters of waste from the Test Site, although the facility might have to use some of its reserve capacity to meet the combined need.

8.2.13 ENVIRONMENTAL JUSTICE

As discussed in Chapter 4, Section 4.1.13, the environmental justice analysis brings together the results of all resource and feature analyses to determine (1) if an activity would have substantial environmental impacts and (2) if those substantial impacts would have disproportionately high and adverse human health or environmental effects on minority or low-income populations. DOE determined that cumulative impacts from Inventory Module 1 or 2 along with those expected from other Federal, non-Federal, and private actions would not produce cumulative adverse impacts to any surrounding populations, which would include minority and low-income populations. Evaluation of subsistence lifestyles and cultural values has confirmed that these factors would not change the conclusion that the absence of high and adverse impacts for the general population means there would be no disproportionately high and adverse impacts on minority or low-income communities. No substantial impacts were identified; therefore, cumulative impacts from Inventory Module 1 or 2 and other Federal, non-Federal, and private actions would not cause environmental justice concerns.

DOE recognizes that Native American people living in areas near Yucca Mountain have concerns about the protection of traditions and the spiritual integrity of the land that extend to the propriety of the Proposed Action, and that the implementation of the Proposed Action would continue restrictions on access to the site. Chapter 4, Section 4.1.3.4, discusses these views and beliefs.

8.3 Cumulative Long-Term Impacts in the Proposed Yucca Mountain Repository Vicinity

This section describes results from the long-term cumulative impact analysis that DOE conducted for Inventory Modules 1 and 2 (Section 8.3.1) and for past, present, and reasonably foreseeable future actions at the Nevada Test Site, and past actions at the Beatty low-level radioactive waste site (Section 8.3.2).

8.3.1 INVENTORY MODULE 1 OR 2 IMPACTS

The analysis of long-term performance for Inventory Modules 1 and 2 used the same methodology described in Chapter 5 and Appendix I for the Proposed Action to estimate potential human health impacts from radioactive and chemically toxic material releases through waterborne and airborne pathways. Section 8.3.1.1 presents the radioactive and chemically toxic material source terms for Inventory Modules 1 and 2, and Sections 8.3.1.2 and 8.3.1.3 present the results of the analysis for Inventory Modules 1 and 2, respectively.

In addition to long-term human health impacts from radioactive and chemically toxic material releases, the other potential long-term impact identified following repository closure involve biological resources. Though the surface area affected by heat rise would be larger for Inventory Module 1 or 2, the amount of heat per unit area would be constant for a given repository operating mode (lower- or higher-temperature), and, therefore, the small ground surface temperature increase would be the same. Thus, long-term biological effects of Module 1 or 2 from heat generated by waste packages that would potentially raise ground surface temperatures would be the same as those described in Chapter 5, Section 5.9 for the Proposed Action.

8.3.1.1 Radioactive and Chemically Toxic Material Source Terms for Inventory Modules 1 and 2

For calculations of long-term performance impacts, the radioactive material inventory of individual waste packages for commercial spent nuclear fuel, high-level radioactive waste, and DOE spent nuclear fuel under Inventory Modules 1 and 2 would be identical to the radioactive material inventory under the

Proposed Action for the same waste categories. Inventory Module 2 includes an additional waste category for Greater-Than-Class-C and Special-Performance-Assessment-Required wastes. This category includes a different category of waste package with its own radioactive material inventory. This waste was simulated with 601 idealized waste packages. The inventory used for each modeled waste package is an averaged radioactive material inventory of each waste category (commercial spent nuclear fuel, DOE spent nuclear fuel, high-level radioactive waste, and Greater-Than-Class-C and Special-Performance-Assessment-Required wastes). More waste packages would be used for Inventory Modules 1 and 2 than for the Proposed Action to accommodate the expanded inventories. Table 8-42 lists the number of waste packages used in the analysis of long-term performance calculations for the Proposed Action and Modules 1 and 2.

Table 8-42. Number of idealized waste packages used in analysis of long-term performance calculations.[a]

Modeled inventory	Commercial SNF[b]	Codisposal (DOE SNF and HLW[c])	GTCC and SPAR[d]	Total
Proposed Action	7,860	3,910	0	11,770
Inventory Module 1	11,754	4,877	0	16,631
Inventory Module 2	11,754	4,877	601	17,232

a. The idealized waste packages in the simulation (model) are based on the inventory abstraction in Appendix I, Section I.3. While the total inventory is represented by the material in the idealized waste packages, the actual number of waste packages emplaced in the proposed repository would be different.
b. SNF = spent nuclear fuel.
c. HLW = high-level radioactive waste.
d. GTCC = Greater-Than-Class-C; SPAR = Special-Performance-Assessment-Required.

IDEALIZED WASTE PACKAGES

The number of waste packages used in the performance assessment simulations do not exactly match the number of actual waste packages specified in DIRS 150558-CRWMS M&O (2000, Section 6.2).

The TSPA model uses two types of *idealized waste packages* (commercial spent nuclear fuel package and codisposal package), representing the averaged inventory of all the actual waste packages used for a particular waste category.

While the number of idealized waste packages varies from the number of actual waste packages in DIRS 150558-CRWMS M&O (2000, Section 6.2), the total radionuclide inventory represented by all of the idealized waste packages collectively is representative of the total inventory, for the radionuclides analyzed, given in Appendix A of this EIS for the purposes of analysis and long-term performance. *The abstracted inventory is designed to be representative for purposes of analysis of long-term performance and cannot necessarily be used for any other analysis, nor can it be directly compared to any other abstracted inventory used for other analyses in this EIS.*

As listed in Table 8-42, Inventory Module 2 differs from Inventory Module 1 only by the addition of 601 Greater-than-Class-C and Special-Performance-Assessment-Required idealized waste packages. Table 8-43 lists the inventory of the Greater-than-Class-C and Special-Performance-Assessment-Required waste packages under Inventory Module 2.

A screening analysis documented in Appendix I, Section I.6.1, showed that the only chemical materials of concern for the 10,000-year analysis period were those that would be released as the external waste package Alloy-22 layer and the waste package support pallet materials corroded. This is because most waste packages would be intact for more than 10,000 years after closure (the results of the analysis of

Table 8-43. Abstracted inventory (grams) of radionuclides passing the screening analysis in each idealized waste package for Greater-Than-Class-C and Special-Performance-Assessment-Required wastes under Inventory Module 2.[a]

Isotope	Inventory
Actinium-227	0
Americium-241	40
Americium-243	0.00151
Carbon-14	28.9
Cesium-137	771
Iodine-129	0.000705
Nickel-63	0
Neptunium-237	0
Protactinium-231	0
Lead-210	0
Plutnium-238	1.56
Plutonium-239	2,860
Plutonium-240	0.0123
Plutonium-241	0.0207
Plutonium-242	0.00614
Radium-226	0.0504
Radium-228	0
Strontium-90	0.82
Technetium-99	568
Thorium-229	0
Thorium-230	0
Thorium-231	0
Uranium-232	0.00000287
Uranium-233	0.00419
Uranium-234	0
Uranium-235	0
Uranium-236	0

a. The idealized waste packages in the simulation (model) are based on the inventory abstraction in Appendix I, Section I.3. While the total inventory is represented by the material in idealized waste packages, the actual number of waste packages emplaced in the proposed repository would be different.

long-term performance for radionuclides described in Appendix I, Section I.5, show that, at most, only three waste packages would be breached before 10,000 years, due to improper heat treatment, under the Proposed Action). Therefore, accounting for the quantities of materials in the engineered barrier system, but not in the waste packages, and accounting for toxicity to humans, the only chemical materials of concern would be chromium, nickel, molybdenum, and vanadium. The inventories of these chemical materials in the engineered barrier system for the Proposed Action and Inventory Modules 1 and 2 are listed in Table 8-44. These are essentially the only inventories available for mobilization and transport within 10,000 years after closure; the inventories of chemical materials in the waste packages would not begin to degrade until waste package failure. Further information on the inventory of chemical materials of concern is provided in Appendix I, Section I.3.

The only radionuclide that would have a relatively large inventory and a potential for gas transport is carbon-14. Iodine-129 can exist in a gas phase, but it is highly soluble and, therefore, would be likely to dissolve in groundwater rather than migrate as a gas. Radon-222 is a gas, but would decay to a solid isotope before escaping from the repository region (see Appendix I, Section I.7.3). After the carbon-14 escaped from the waste package, it could flow through the fractured and porous rock in the form of carbon dioxide. About 2 percent of the carbon-14 in commercial spent nuclear fuel is in gas in the space (or gap) between the fuel and the cladding around the fuel (DIRS 103446-Oversby 1987, p. 92). There are 1.37 grams of carbon-14 in an abstracted commercial spent nuclear fuel waste package (see Appendix I, Table I-5). This represents 6.11 curies per waste package. Since 2 percent of the total is gaseous, the gaseous inventory consists of 0.122 curie of carbon-14 per commercial spent nuclear fuel waste package. There would be additional carbon-14 activity associated with Inventory Module 2, in relation to Module 1, resulting from neutron irradiation of the core shroud metal. The carbon-14 would be unlikely to be present as gaseous carbon dioxide that could be released to the environment and is therefore not included in Table 8-45.

Table 8-44. Total quantities of waterborne chemicals of concern in the engineered barrier system under the Proposed Action and Inventory Modules 1 and 2 (kilograms).[a,b]

Modeled inventory	Chromium	Molybdenum	Nickel	Vanadium
Proposed Action	23,735,000	17,307,000	60,797,000	377,600
Inventory Module 1	34,695,000	25,301,000	88,879,000	552,000
Inventory Module 2	34,951,000	25,490,000	89,545,000	556,000

a. To convert kilograms to pounds, multiply by 2.2046.
b. See screening analysis in Appendix I, Section I.3.2.

Table 8-45. Total **gaseous** carbon-14 in the repository from commercial spent nuclear fuel for the Proposed Action and Inventory Modules 1 and 2 (curies).

Modeled inventory	Quantity[a]
Proposed Action	959
Inventory Module 1	1,430
Inventory Module 2	1,430

a. Based on 0.122 curies of carbon-14 per commercial spent nuclear fuel waste package.

8.3.1.2 Impacts for Inventory Module 1

The human-health impacts from Inventory Module 1 for radioactive materials and chemically toxic materials are discussed in this section.

8.3.1.2.1 *Waterborne Radioactive Material Impacts*

The DOE used the modeling methods described for the Proposed Action in Chapter 5 (and in greater detail in Appendix I) to calculate the impacts both for an individual and the local population resulting from groundwater releases of radioactive material for 10,000 years and 1 million years following repository closure for Inventory Module 1.

8.3.1.2.1.1 Higher-Temperature Operating Mode. Table 8-46 lists the estimated impacts for an individual for the higher-temperature operating mode under the Proposed Action and Inventory Module 1. The peak annual individual dose for the first 10,000 years shows slightly higher values for the mean and 95th percentile of the Proposed Action than for Module 1. Because Module 1 has a higher inventory, this would seem like an incorrect trend. However, note that in the first 10,000 years releases are dominated by at most about 3 waste package failures due to a manufacturing defect (improper heat treatment). Thus, the release is essentially insensitive to inventory and the differences in Table 8-46 between the Proposed Action and Module 1 are merely the result of slightly different statistical outcomes in the 300 simulations.

Table 8-46. Impacts for an individual from groundwater releases of radionuclides during 10,000 years after repository closure for the higher-temperature repository operating mode under the Proposed Action and Inventory Module 1.

		Mean			95th-percentile		
Modeled inventory	Individual	Peak annual individual dose (millirem)	Time of peak (years)	Probability of a LCF[a]	Peak annual individual dose (millirem)	Time of peak (years)	Probability of a LCF[a]
Proposed Action	At RMEI location[b]	0.00002[c]	4,900	6×10^{-10}	0.0001[d]	4,900	4×10^{-9}
	At 30 kilometers[e]	~0[f]	NC[g]	~0	~0[f]	NC[g]	~0
	At discharge location[h]	~0[f]	NC[g]	~0	~0[f]	NC[g]	~0
Inventory Module 1	At RMEI location[b]	0.00003[c]	4,900	1×10^{-9}	0.002[d]	4,100	6×10^{-9}
	At 30 kilometers[d]	~0[f]	NC[g]	~0	~0[f]	NC[g]	~0
	At discharge location[h]	~0[f]	NC[g]	~0	~0[f]	NC[g]	~0

a. LCF = latent cancer fatality; incremental lifetime (70 years) risk of contracting a fatal cancer, assuming a risk of 0.0005 latent cancer fatality per rem for members of the public (DIRS 101856-NCRP 1993, p. 31).
b. The RMEI location, defined in 40 CFR Part 197, is where the predominant groundwater flow path crosses the boundary of the controlled area and is approximately 18 kilometers (11 miles) downgradient from the repository. The maximum allowable peak of the mean annual individual dose for 10,000 years at this distance is 15 millirem.
c. Based on 300 simulations of total system performance, using random samples of uncertain parameters.
d. Represents a value for which 285 out of the 300 simulations yielded a smaller value.
e. To convert kilometers to miles, multiply by 0.62137.
f. Values would be lower than the small values computed for the RMEI location.
g. NC = not calculated (peak time would be greater than time given for the RMEI location).
h. 60 kilometers (37 miles) at Franklin Lake Playa.

Table 8-47 lists the impacts to the population during the first 10,000 years after repository closure for both the Proposed Action and Inventory Module 1 for the higher-temperature operating mode. These impacts were calculated on the same population basis used for the Proposed Action calculations presented in Chapter 5, that is a population size was based on the projected population numbers for 2035 in Figure 3-25 in Chapter 3. For these calculations, the analysis assumed that no contaminated groundwater

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Table 8-47. Population impacts from groundwater releases of radionuclides during 10,000 years after repository closure for the higher-temperature repository operating mode under the Proposed Action and Inventory Module 1.[a]

Modeled inventory	Case	Mean: Population dose (person-rem)	Mean: Population LCFs[b]	95th-percentile: Population dose (person-rem)	95th-percentile: Population LCFs[b]
Proposed Action	Peak 70-year lifetime	0.006	0.000003	0.04	0.00002
	Integrated over 10,000 years	0.5	0.0002	0.6	0.0003
Inventory Module 1	Peak 70-year lifetime	0.01	0.000005	0.06	0.00003
	Integrated over 10,000 years	0.7	0.0003	0.8	0.0004

a. Based on 300 simulations of total system performance for each location, using random samples of uncertain parameters.
b. LCF = latent cancer fatality; expected number of cancer fatalities for populations, assuming a risk of 0.0005 latent cancer fatality per rem for members of the public (DIRS 101856-NCRP 1993, p. 31).

would reach populations in any regions to the north of Yucca Mountain. Therefore, populations in the sectors north of the due east and due west sectors were not considered to be exposed.

- 47 people would be exposed at the Reasonably Maximally Exposed Individual (RMEI) location [approximately 18 kilometers (11 miles)] downgradient from the repository [includes sectors from 12 to 28 kilometers (7 to 27 miles)].

- 4,200 people would be exposed at about 30 kilometers (19 miles) downgradient from the potential repository [includes sectors from 28 to 44 kilometers (17 to 27 miles)].

- 69,500 people would be exposed at the discharge location, about 60 kilometers (37 miles) downgradient of the potential repository [includes sectors from 44 to 80 kilometers (27 to 50 miles)].

Thus, approximately 74,000 people would be exposed to contaminated groundwater. This stylized population dose analysis assumed that people would continue to live in the locations being used at present. This assumption is consistent with the recommendation made by the National Academy of Sciences (DIRS 100018-National Research Council 1995, all) because it is impossible to make accurate predictions of future lifestyles and residence locations far into the future.

The population impacts would be greater than the impacts for the Proposed Action under the higher-temperature operating mode. For example, the population dose in the 70-year period of maximum impacts would be about 25 percent greater for Module 1 than for the Proposed Action at the mean level and the same 70-year period.

The values in Table 8-47 include a scaling factor for water use. The performance assessment transport model calculated the annual individual dose assuming the radionuclides dissolved in water that flowed through the unsaturated zone of Yucca Mountain would mix in an average of 2.4 million cubic meters (1,940 acre-feet) (DIRS 155950-BSC 2001, p. 13-42) per year in the saturated zone aquifer. This compares to an annual water use in the Amargosa Valley of about 17.1 million cubic meters (13,900 acre-feet) (DIRS 155950-BSC 2001, p. 13-42). The analysis diluted the concentration of the nuclides in the 2.4 million cubic meters of water throughout the 17.1 million cubic meters of water prior to calculating the population dose.

Table 8-48 lists the peak annual individual dose and time of peak for 1 million years after repository closure for both Inventory Module 1 and the Proposed Action for the higher-temperature operating mode. The impacts would follow the same pattern as those for the first 10,000 years after repository closure listed in Table 8-47, with the impacts for Module 1 about 60 percent greater than those for the Proposed Action.

Table 8-48. Impacts to an individual from groundwater releases of radionuclides for 1 million years after repository closure for the higher-temperature repository operating mode under the Proposed Action and Inventory Module 1.

		Mean		95th-Percentile	
Modeled inventory	Individual	Peak annual individual dose (millirem)	Time of peak (years)	Peak annual individual dose (millirem)	Time of peak (years)
Proposed Action	At RMEI location[a]	150[b]	480,000	620[c]	410,000
	At 30 kilometers[d]	100[e]	NC[f]	420[e]	NC[f]
	At discharge location[g]	59[e]	NC[f]	240[e]	NC[f]
Inventory Module 1	At RMEI location[a]	240[b]	480,000	980[c]	480,000
	At 30 kilometers[d]	160[e]	NC[f]	660[e]	NC[f]
	At discharge location[g]	90[e]	NC[f]	450[e]	NC[f]

a. The RMEI location, defined in 40 CFR Part 197, is where the predominant groundwater flow path crosses the boundary of the controlled area and is approximately 18 kilometers (11 miles) downgradient from the repository.
b. Based on 300 simulations of total system performance for each location, using random samples of uncertain parameters.
c. Represents a value for which 285 out of the 300 simulations yielded a smaller value.
d. To convert kilometers to miles, multiply by 0.62137.
e. Estimated using scale factors as described in Chapter 5, Section 5.4.1.
f. NC = not calculated (peak time would be greater than time given for the RMEI location).
g. 60 kilometers (37 miles) at Franklin Lake Playa.

WHY ARE THE MEAN IMPACTS SOMETIMES HIGHER THAN THE 95TH-PERCENTILE IMPACTS?

The *mean* impact is the arithmetic average of the 300 impact results from simulations of total-system performance. The mean is not the same as the 50th-percentile value (the 50th-percentile value is called the *median*) if the distribution is *skewed*.

The performance results reported in this EIS come from highly skewed distributions. In this context, *skewed* indicates that there are a few impact estimates that are much larger than the rest of the impacts. When a large value is added to a group of small values, the large value dominates the calculation of the mean. The simulations reported in this EIS have mean impacts that are occasionally above the 90th-percentile and occasionally above the 95th percentile.

With respect to groundwater protection standards set forth in 40 CFR Part 197.30, both the mean and the 95th percentile estimated levels during the 10,000-year regulatory period are hundreds of thousands of times less than the regulatory limits (see Table 8-49) for both the Proposed Action and Inventory Module 1.

8.3.1.2.1.2 Lower-Temperature Operating Mode. Impacts were not calculated for the lower-temperature operating mode under Inventory Module 1 or 2 because of the lack of differentiation between higher-temperature and lower-temperature operating modes under the Proposed Action (see Chapter 5). Comparison of the mean individual dose history at the RMEI location for the lower- and higher-temperature operating modes is shown in Figure 8-4. For the Proposed Action, the individual dose for the lower-temperature operating mode at a given location would be about the same as that for the higher-temperature operating mode, with the long-term peak slightly greater for the higher-temperature operating mode. Calculations for Inventory Module 1 produce a similar response. Given the similarity of impacts, and that the lower-temperature operating mode impacts are generally bounded by the higher-temperature operating mode impacts, it was deemed unnecessary to perform detailed simulations for the lower-temperature operating mode under Inventory Module 1. The results would be similar to, but less than, those for the higher-temperature operating mode under Inventory Module 1, as reported in Section 8.3.1.2.1.1.

Table 8-49. Comparison of nominal scenario long-term consequences at the RMEI location[a] to groundwater protection standards during 10,000 years following repository closure for the higher-temperature repository operating mode under the Proposed Action and Inventory Module 1.

Modeled inventory	Radionuclide or type of radiation emitted	EPA Limit[b]	Mean peak[c]	95th-percentile peak[d]
Proposed Action	Combined radium-226 and radium-228,[e] picocuries per year	5	1.0 (1×10^{-11})[f]	1.0 (2×10^{-11})
	Gross alpha activity (including radium-226 but excluding radon and uranium),[e] picocuries per year	15	0.4 (2×10^{-8})	0.4 (1×10^{-8})
	Combined beta and photon emitting radionuclides,[g] millirem per year to the whole body or any organ, based on drinking 2 liters of water per day from the representative volume	4	2×10^{-5}	1×10^{-4}
Inventory Module 1	Combined radium-226 and radium-228,[e] picocuries per year	5	1.0 (3×10^{-10})	1.0 (3×10^{-11})
	Gross alpha activity (including radium-226 but excluding radon and uranium),[e] picocuries per year	15	0.4 (3×10^{-8})	0.4 (4×10^{-8})
	Combined beta and photon emitting radionuclides,[g] millirem per year to the whole body or any organ, based on drinking 2 liters of water per day from the representative volume	4	3×10^{-5}	2×10^{-4}

a. The RMEI location, defined in 40 CFR Part 197, is where the predominant groundwater flow path crosses the boundary of the controlled area and is located approximately 18 kilometers (11 miles) downgradient from the repository.
b. Environmental Protection Agency limits set forth in 40 CFR Part 197.30.
c. Based on 300 simulations of total system performance, each using random samples of uncertain parameters.
d. Represents a value for which 285 out of the 300 simulations yielded a smaller value.
e. Includes natural background radiation.
f. Value in parentheses is the incremental increase over background radiation that would be attributable to the potential repository.
g. This represents a bounding (overestimate) of the maximum dose to any organ because the different radionuclides would affect different organs preferentially.

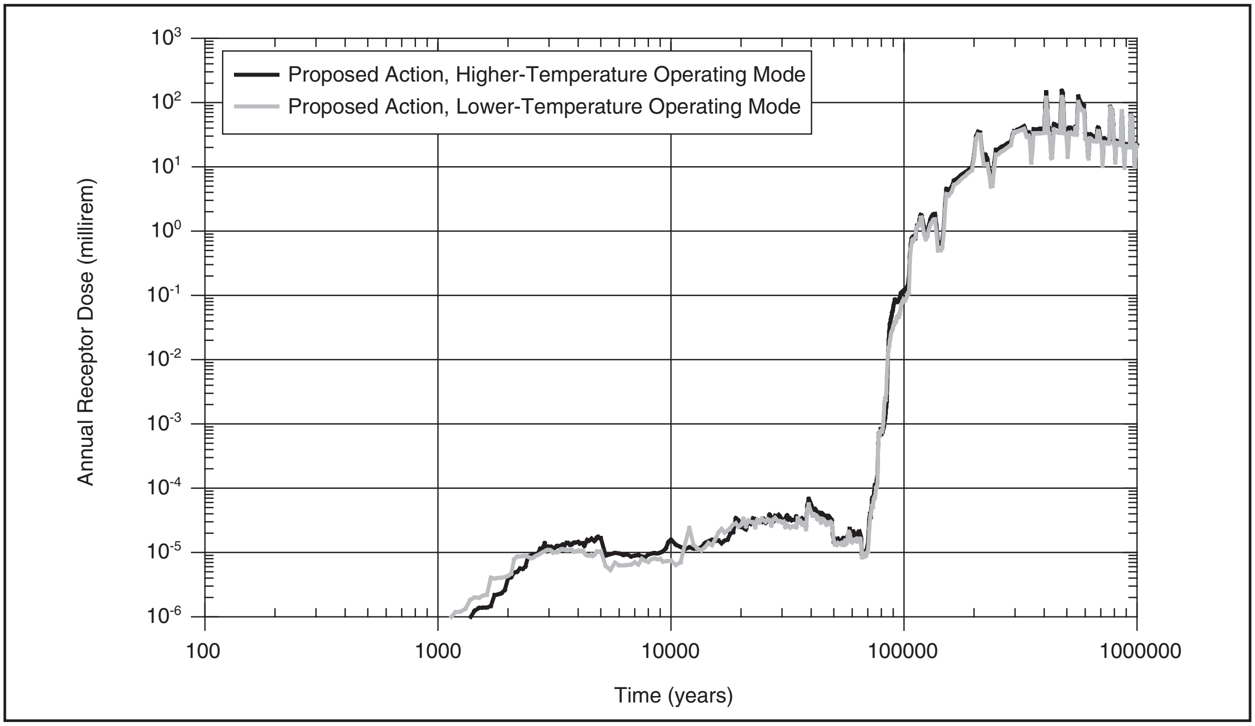

Figure 8-4. Comparison of mean annual individual dose (based on 300 simulations of total system performance, each using random samples of uncertain parameters) at the RMEI location for the higher- and lower-temperature operating modes. (Note use of logarithmic scale for both axes.)

8.3.1.2.2 *Waterborne Chemically Toxic Material Impacts*

A number of nonradioactive materials that DOE would place in the repository are hazardous to human health at high concentrations in water. This section examines the consequences to individuals in the Amargosa Desert from releases of these nonradioactive materials under Inventory Module 1.

The inventory of chemically toxic materials that would be emplaced in the repository under the Proposed Action is identified by element in Appendix I, Section I.3. Based on this inventory, a screening analysis (described in Appendix I, Section I.6.1) identified which of the chemically toxic materials might pose a risk to human health. Only chromium, molybdenum, nickel, and vanadium were identified as potentially posing such a risk, and these elements were further evaluated in a bounding consequence analysis, as described in Appendix I, Section I.6.2. The analysis was performed under the conservative assumption that all chromium dissolves in hexavalent form. The results of the bounding analysis are summarized for both the Proposed Action and Inventory Module 1 in Table 8-50. In some cases a Maximum Containment Level or Maximum Contaminant Level Goal was available for comparison to the calculated concentration. In other cases, only an Oral Reference Dose was available. The Oral Reference Dose can be compared to intake that would result for a 70-kilogram (154-pound) person drinking 2 liters (0.53 gallon) of water per day. More detail on these comparative measures can be found in Chapter 5, Section 5.6, and Appendix I, Section I.6.2.5.

Table 8-50. Peak concentration of waterborne chemical materials released during 10,000 years after closure estimated using bounding calculations for the Proposed Action and Inventory Module.

Modeled inventory	Material	Estimated concentration in well water (milligram per liter)	Maximum Contaminant Level Goal (milligram per liter)	Estimated intake rate for a 70-kilogram person (milligram per kilogram per day)	Oral Reference Dose (milligram per kilogram per day)
Proposed Action	Chromium (VI)	0.01	0.1[a]	0.0004	0.005[b]
	Molybdenum	0.009	NA[c]	0.0003	0.005[d]
	Nickel	0.04	NA	0.001	0.02[e]
	Vanadium	0.0002	NA	0.000006	0.007[f]
Inventory Module 1	Chromium (VI)	0.02	0.1[a]	0.0006	0.005[b]
	Molybdenum	0.01	NA	0.0004	0.005[d]
	Nickel	0.05	NA	0.002	0.02[e]
	Vanadium	0.0003	NA	0.000009	0.007[f]

a. 40 CFR 191.51.
b. DIRS 148224-EPA (1999, all).
c. NA = not available.
d. DIRS 148228-EPA (1999, all).
e. DIRS 148229-EPA (1999, all).
f. DIRS 103705-EPA (1997, all).

Because the bounding concentration of chromium, molybdenum, nickel, and vanadium in well water is calculated to be below the Maximum Contaminant Level Goal or yield intakes well below the Oral Reference Dose for Inventory Module 1, there is no further need to refine the calculation to account for physical processes that would limit mobilization of this material or delay or dilute it during transport in the geosphere.

8.3.1.2.3 *Atmospheric Radioactive Material Impacts*

Using the analysis methods described in Chapter 5, Section 5.5, DOE estimated the impacts of carbon-14 releases to the atmosphere within 10,000 years past closure for Inventory Module 1. As explained in Appendix I, Section I.7.1, the maximum release rate to the ground surface for this period is the same for both Inventory Modules 1 and 2 as for the Proposed Action. Therefore, there would be no incremental atmospheric radioactive material impacts for Inventory Module 1 for the Proposed Action.

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8.3.1.3 INCREMENTAL IMPACTS FOR INVENTORY MODULE 2

DOE addressed the long-term consequences from Inventory Module 2 by analyzing the effects of disposing waste packages containing Greater-Than-Class-C and Special-Performance-Assessment-Required wastes in addition to the material in Inventory Module 1. Table 8-43 lists the average inventory of the additional waste packages containing Greater-Than-Class-C and Special-Performance-Assessment-Required wastes. The following sections discuss these impacts in terms of waterborne radioactive releases, chemically toxic materials waterborne release, and atmospheric radioactive material releases.

8.3.1.3.1 *Waterborne Radioactive Material Impacts*

The addition of Greater-Than-Class-C and Special-Performance-Assessment-Required wastes is the only difference between Inventory Modules 1 and 2. Inventory Module 2 was modeled as an incremental inventory; specifying only the Greater-Than-Class-C and Special-Performance- Assessment-Required waste as the radionuclide inventory. The results of the incremental inventory simulations constitute the additional impacts of Inventory Module 2 over those of Module 1. In addition, they represent the dose attributable solely to the Greater-Than-Class-C and Special- Performance-Assessment-Required waste.

Table 8-51 lists the incremental consequences for an individual from the Greater-Than-Class-C and Special-Performance-Assessment-Required wastes in Inventory Module 2 during 10,000 years and 1 million years following repository closure. Peak impacts from waterborne radioactive materials for Module 2 would be less than 1 percent higher for 1,000,000 years after repository closure. For the first 10,000 years following the repository closure, the Module 2 impact would remain very small (mean annual individual dose of 0.0007 millirem, compared to the Environmental Protection Agency standard of 15 millirem for this period as defined in 40 CFR Part 197).

Table 8-51. Incremental increase (millirem) in mean peak individual annual dose at the RMEI location[a] under Inventory Module 2 over the mean peak individual annual dose under Inventory Module 1 during 10,000 and 1 million years after repository closure.

Postclosure period	Incremental Increase[b]
10,000 years	0.0007
1,000,000 years	0.3

a. The RMEI location, defined in 40 CFR Part 197, is where the predominant groundwater flow path crosses the boundary of the controlled area and is approximately 18 kilometers (11 miles) downgradient from the repository.

b. Based on 300 simulations each for Inventory Modules 1 and 2 using random samples of uncertain parameters.

8.3.1.3.2 *Waterborne Chemically Toxic Material Impacts*

A number of nonradioactive materials that DOE would place in the repository are hazardous to human health at high concentrations in water. This section examines the consequences to individuals in the Amargosa Desert from releases of these nonradioactive materials under Inventory Module 2.

The inventory of chemically toxic materials that would be emplaced in the repository under the Proposed Action is identified by element in Appendix I, Section I.3. Based on this inventory, a screening analysis (described in Appendix I, Section I.6.1.) identified which of the chemically toxic materials could pose a risk to human health. Only chromium, molybdenum, nickel, and vanadium were identified as posing such a risk, and these elements were further evaluated in a bounding consequence analysis, as described in Appendix I, Section I.6.2. The results of the bounding analysis are summarized for both the Proposed Action and Inventory Module 2 in Table 8-52. In some cases a Maximum Contaminant Level Goal was available for comparison to the calculated concentration. In other cases, only an Oral Reference Dose was available. The Oral Reference Dose can be compared to the intake that would result for a 70-kilogram (154-pound) person drinking 2 liters (0.53 gallon) of water per day. More detail on these comparative measures can be found in Chapter 5, Section 5.6, and Appendix I, Section I.6.2.5.

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Table 8-52. Peak concentration of waterborne chemical materials released during 10,000 years after closure estimated using bounding calculations for the Proposed Action and Inventory Module 2.

Modeled inventory	Material	Estimated concentration in well water (milligram per liter[a])	Maximum Contaminant Level Goal (milligram per liter)	Estimated intake rate for a 70-kilogram person (milligram per kilogram per day)	Oral Reference Dose (milligram per kilogram per day)
Proposed Action	Chromium (VI)	0.01	0.1[a]	0.0004	0.005[b]
	Molybdenum	0.009	NA[c]	0.0003	0.005[d]
	Nickel	0.04	NA	0.001	0.02[e]
	Vanadium	0.0002	NA	0.000006	0.007[f]
Inventory Module 2	Chromium (VI)	0.02	0.1	0.0006	0.005[b]
	Molybdenum	0.01	NA	0.0004	0.005[d]
	Nickel	0.06	NA	0.002	0.02[e]
	Vanadium	0.0003	NA	0.00001	0.007[f]

a. 40 CFR 191.51.
b. DIRS 148224-EPA (1999, all).
c. NA = not available.
d. DIRS 148228-EPA (1999, all).
e. DIRS 148229-EPA (1999, all).
f. DIRS 103705-EPA (1997, all).

Because the bounding concentration of chromium, molybdenum, nickel, and vanadium in well water is calculated to be below the Maximum Containment Level Goal or yield intakes well below the Oral Reference Dose for Inventory Module 2, there is no further need to refine the calculation to account for physical processes that would limit mobilization of this material or delay or dilute it during transport in the geosphere.

The incremental (that is, the increase in) consequences for an individual from the Greater-Than-Class-C and Special-Performance-Assessment-Required wastes in Inventory Module 2 over Inventory Module 1 during 10,000 years and 1 million years following repository closure is 4 percent for all four waterborne chemical materials of concern (chromium, molybdenum, nickel, and vanadium).

8.3.1.3.3 *Atmospheric Radioactive Material Impacts*

There would be no incremental impact for airborne carbon-14 releases for Inventory Module 2. None of the additional waste packages would contain a waste form in which carbon-14 would exist in gaseous form (that is, as carbon dioxide). As for the Proposed Action and Inventory Module 1, radon-222 would be released as a gas but would decay to a solid isotope before escaping from the repository region (see Appendix I, Section I.7.3).

8.3.2 CUMULATIVE IMPACTS FROM OTHER FEDERAL, NON-FEDERAL, AND PRIVATE ACTIONS

This section discusses potential cumulative impacts from other Federal, non-Federal, and private actions that could contribute to doses at the locations considered in the performance assessment of the Yucca Mountain Repository. The actions identified with the potential for long-term cumulative impacts are past, present, and reasonably future actions at the Nevada Test Site and past actions at the low-level radioactive waste disposal facility near Beatty, Nevada.

8.3.2.1 Past, Present, and Reasonably Foreseeable Future Actions at the Nevada Test Site

Historically, the primary mission of the Nevada Test Site was to conduct nuclear weapons tests. Nuclear weapons testing and other activities have resulted in radioactive contamination and have the potential for radioactive and nonradioactive contamination of some areas of the Nevada Test Site. These areas and the

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associated contamination and the potential for contamination were evaluated for potential cumulative impacts with postclosure impacts from the proposed Yucca Mountain Repository. This section discusses these Nevada Test Site activities, the locations where these activities occurred, and the potential for cumulative long-term impacts with the repository.

Unless otherwise identified, DOE derived the information in this section from the Nevada Test Site Final EIS (DIRS 101811-DOE 1996, all). The Yucca Mountain site is in the southwestern portion of the Nevada Test Site along its western boundary, as shown in Figure 8-2.

At the Nevada Test Site, seven categories of activities have resulted in radioactive contamination or have the potential to result in radioactive and nonradioactive contamination:

1. *Atmospheric Weapons Testing.* One hundred atmospheric detonations occurred before the signing of the Limited Test Ban Treaty in August 1963. Atmospheric tests included detonations at ground level, from towers or balloons, or from airdrops.

2. *Underground Nuclear Testing.* Approximately 800 underground nuclear tests have occurred at the Nevada Test Site. Chapter 3, Figure 3-2 shows the locations of these tests in relation to Yucca Mountain. They included deep underground tests to study weapons effects, designs, safety, and reliability, and shallow underground tests to study the peaceful application of nuclear devices for cratering.

3. *Safety Tests.* Between 1954 and 1963, 16 above-ground tests studied the vulnerability of weapons designs to possible accident scenarios.

4. *Nuclear Rocket Development Station.* Twenty-six experimental tests of reactors, nuclear engines, ramjets, and nuclear furnaces occurred between 1959 and 1973. Figure 8-3 shows the location of the Nuclear Rocket Development Station.

5. *Shallow Land Radioactive Waste Disposal.* DOE disposed of some radioactive waste generated during testing in shallow cells, pits, and trenches. Because of the significant thickness of alluvial material and high mean annual temperatures and low precipitation under the current climate regime, downward advection of groundwater to the water table is highly unlikely. Therefore, shallow burial continues to be an important waste disposal activity at the Nevada Test Site (DIRS 155159-REECo, 1994, all; DIRS 108774-Tyler et al. 1996, all).

Section 8.3.2.1.3 discusses present and potential future low-level radioactive waste disposal activities.

6. *Crater Disposal.* DOE disposed of contaminated soils and equipment collected during the decontamination of atmospheric testing areas and the consolidation of radioactively contaminated structures, and other bulk wastes, in subsidence craters at Yucca Flat in Area 3. Figure 8-3 shows the location of Area 3 on the Nevada Test Site.

7. *Greater Confinement Disposal.* In 1981, Greater Confinement Disposal began at Area 5 for low-level radioactive wastes not suitable for shallow land disposal. This waste includes some transuranic radionuclides. Figure 8-3 shows the location of Area 5 on the Nevada Test Site.

Table 8-53 lists the approximate inventory for each of these categories. Atmospheric testing, shallow underground testing, safety testing, and nuclear rocket development all resulted in a small (less-than-40-curie) source term, which would not contribute substantially to cumulative impacts. Additionally, the inventories represented by crater disposal and shallow-land disposal were determined to not be important to cumulative impact considerations. Only the deep underground testing and greater confinement

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Table 8-53. Summary of radioactivity on the Nevada Test Site (January 1996).[a]

Source	Area	Environmental media	Major known isotopes or wastes	Depth range	Approximate inventory (curies)
Atmospheric weapons testing	Aboveground nuclear weapon proving area	Surficial soils and test structures	Americium, cesium, cobalt, plutonium, europium, strontium	At land surface	20
Underground testing: shallow underground tests	Underground nuclear testing areas	Soils and alluvium	Americium, cesium, cobalt, europium, plutonium, strontium	Less than 61 meters[b]	1 at land surface; unknown at depth
Underground testing: deep underground tests	Underground nuclear testing areas	Soils, alluvium, and consolidated rock	Tritium, fission, and activation products	Typically less than 640 meters, but might be deeper	130 million[c]
Safety tests	Aboveground experimental areas	Surficial soils	Americium, cesium, cobalt, plutonium, strontium	Less than 0.9 meter	35
Nuclear rocket development area	Nuclear rocket motor, reactor, and furnace testing area	Surficial soils	Cesium, strontium	Less than 3 meters	1
Shallow land disposal	Waste disposal landfills	Soils and alluvium	Dry-packaged low-level and mixed wastes	Less than 9 meters	500,000[d,e]
Crater disposal	Test-induced subsidence crater with sidewalls, cover, and drainage	Soils and alluvium	Bulk contaminated soils and equipment	Less than 30 meters	1,250[d,f]
Greater confinement disposal	Monitored underground waste disposal	Soils and alluvium	Tritium, americium	37 meters	9.3 million[d,g]

a. Source: DIRS 101811-DOE (1996, p. 4-6). This table uses information and terminology from that document and is for information purposes only.
b. To convert meters to feet, multiply by 3.2808.
c. Source: DIRS 157116-Bowen et al. (2001, Table V, p. 21)
d. Inventory at time of disposal (not corrected for decay).
e. Inventory does not include prospective future low-level radioactive and mixed waste disposal (see Section 8.3.2.1.3).
f. Volume of waste considered for inventory was approximately 205,000 cubic meters (7.25 million cubic feet).
g. Volume of waste considered for inventory was approximately 300 cubic meters (10,000 cubic feet).

disposal categories represent substantial inventories that could, when combined with the repository inventory, potentially result in increased cumulative impacts.

8.3.2.1.1 *Underground Nuclear Testing*

The United States began a moratorium on the explosive testing of nuclear weapons in October 1992. As discussed in the Nevada Test Site EIS (DIRS 101811-DOE 1996), however, other weapons testing continues at the Test Site, including dynamic, hydrodynamic, and explosive tests. These tests are necessary for the continued assurance of the nuclear arsenal but do not result in nuclear explosions like those that were common during the Cold War. Environmental contamination is due largely to past weapons testing and not to the current limited activities at the Test Site. Although there are potential past and present impacts of the explosive testing of nuclear weapons, the long-lived radionuclides that such testing deposited far underground could pose future impacts, which this section evaluates.

As of September 23, 1992, the estimated total radionuclide source term for all tests was about 130 million curies (DIRS 157116-Bowen et al. 2001, Table V, p. 21). Because these radionuclides are either in or close to the water table and therefore subject to dissolution and possible transport by groundwater, they are referred to as the hydrologic source term. This source term represents the remaining radioisotopes (as of September 23, 1992) that could be available to the groundwater regime. However, because of the existence of multiple, complex migration pathways and limited characterization data, there is considerable uncertainty concerning the actual hydrologic source term. In recent years, the drilling of new characterization wells and the retrofitting of existing boreholes and wells have provided valuable new data that are now being integrated into the overall database so new evaluations can be made. These studies and planned future studies will help reduce the current levels of uncertainty concerning the quantity of radionuclides available for groundwater transport as well as uncertainty concerning both the mechanisms and consequences of radionuclide transport by groundwater flow at the Nevada Test Site. Testing with subcritical assemblies since 1994 has added quantities of material that are very small compared to the historical testing. Thus, the Department has based its analysis on the much larger inventory from historical testing (DIRS 156758-Crowe 2001, all).

There is recent evidence of plutonium migration from one underground test. Groundwater monitoring results indicate that plutonium has migrated about 1.3 kilometers (0.8 mile), possibly facilitated by the movement of very small and relatively mobile particles called *colloids* in the groundwater (DIRS 103282-Kersting et al. 1999, p. 59). No radioactive contamination attributable to underground tests has been detected in monitoring wells off the Nevada Test Site. DOE is conducting further monitoring and research to study these and other potential radionuclide migration phenomenon.

The above information indicates that groundwater could transport radionuclides from underground nuclear tests at the Nevada Test Site. This transport could result in releases from underground testing at the sites analyzed for releases from the proposed repository. DOE did not make long-term performance assessment calculations for the underground testing inventory with the same rigor as the analyses for the repository, and there is much uncertainty related to the hydrogeologic system. Since issuing the Draft EIS, DOE has continued to evaluate design features and operating modes that would reduce uncertainties in or improve long-term repository performance, including the waste package design, and improve operational safety and efficiency. The result of the design evolution process was the development of the Science and Engineering Report flexible design (DIRS 153849-DOE 2001, all). In addition, DOE has continued technical development of the Total System Performance Assessment since the publication of the Draft EIS, including further site characterization, improvements to the engineered system design, system performance assessment calculations, and quality assurance and validation of results. These efforts have resulted in an updated performance assessment referred to as the Total System Performance Assessment-Site Recommendation (TSPA-Site Recommendation; DIRS 153246-CRWMS M&O 2000). The results of this analysis for long-term impacts from the Yucca Mountain Repository are reported in Chapter 5 of this Final EIS. The TSPA-Site Recommendation evaluated the long-term performance of the Science and Engineering Report flexible design and included the best available information related to contaminant fate and transport. The results for the groundwater impacts from the repository in this analysis are substantially lower than reported in the Draft EIS. However, an update of this simplified scaling analysis used to estimate the potential cumulative impact from underground testing at the Nevada Test Site was not performed for the Final EIS because the principal factors affecting contaminant fate and transport remained essentially unchanged between the TSPA-Viability Assessment and the TSPA-Site Recommendation. DOE considers the estimates of Nevada Test Site groundwater impacts developed using the simplified model conservative and applicable for environmental evaluation. Further, any minor enhancements to these factors incorporated into the TSPA-Site Recommendation would have yielded results for an updated cumulative analysis well within the uncertainty reported for the analysis based on the TSPA-Viability Assessment. Therefore, DOE developed a simplified analysis that uses the TSPA-Viability Assessment (DIRS 101779-DOE 1998, all) repository infiltration and groundwater fate and transport models to scale groundwater impacts that could result from the underground test inventory. The analysis made the following assumptions for this calculation:

- The total 130-million-curie radionuclide inventory from underground testing at the Nevada Test Site would be available for transport. Tritium constitutes about 90 percent of the total underground testing inventory (DIRS 157116-Bowen et al. 2001, Table V, p. 21). However, the short half-life of tritium (about 12.5 years) would mean that radioactive decay would deplete the tritium inventory to insignificant levels in about 200 years, long before any Yucca Mountain releases would occur. Since potential impacts from tritium migration from the Test Site would not overlap repository impacts temporally, they would not be cumulative. Therefore, DOE did not consider them in this analysis.

- The radionuclide inventory available for transport at the repository would be the estimated curie content of the source material that would become wet in the 10,000-year analysis period. The analysis determined this amount by estimating the quantity of source material in the waste packages and cladding that are predicted to fail (*juvenile* and new *failures*) during the analysis period. Assuming that DOE would emplace 10,000 waste packages in the repository, the package failure rates developed in the TSPA-Viability Assessment indicate two waste package failures with 100 percent of contained elements exhibiting failed cladding. Since issuing the Draft EIS, DOE has continued to evaluate design features and operating modes that would reduce uncertainties in or improve long-term repository performance, including the waste package design, and improve operational safety and efficiency. The result of the design evolution process was the development of the Science and Engineering Report flexible design (DIRS 153849-DOE 2001, all). In addition, DOE has continued technical development of the Total System Performance Assessment since publication of the Draft EIS, including further site characterization, improvements to the engineered system design, system performance assessment calculations, and quality assurance and validation of results. These efforts have resulted in an updated performance assessment referred to as the Total System Performance Assessment-Site Recommendation [TSPA-Site Recommendation (DIRS 153246-CRWMS M&O 2000)]. The results of this analysis for long-term impacts from the Yucca Mountain Repository are reported in Chapter 5 of this Final EIS. The TSPA-Site Recommendation evaluated the long-term performance of the updated Science and Engineering Report flexible design and included the best available information related to contaminant fate and transport. The results for the groundwater impacts from the repository in this analysis are substantially lower than reported in the Draft EIS. However, an update of this simplified scaling analysis used to estimate the potential cumulative impact from underground testing at the Nevada Test Site was not performed for the Final EIS because the principal factors affecting contaminant fate and transport remained essentially unchanged between the TSPA-Viability Assessment and the TSPA-Site Recommendation. DOE considers the estimates of Nevada Test Site groundwater impacts developed using the simplified model conservative and applicable for environmental evaluation. Further, any minor enhancements to these factors incorporated into the TSPA-Site Recommendation would have yielded results for an updated cumulative analysis well within the uncertainty reported for the analysis based on the TSPA-Viability Assessment.

- The estimated total inventory for all underground tests at the Nevada Test Site was 130 million curies as of September 23, 1992 (DIRS 157116-Bowen et al. 2001, Table V, p. 21). As discussed above, the contribution to the total inventory from subcritical experiments is very small and is adequately accounted for by analyzing the inventory from historical testing (DIRS 156758-Crowe 2001, all). The Department only evaluated the radionuclides of interest (that is, those that result in 99 percent of

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the impact; technetium-99, iodine-129, and carbon-14) in this inventory (see Section 5.4.1 of the Draft EIS for details.)

- The total underground testing inventory available for transport would migrate through the same locations as those considered in this EIS for dose calculations for releases from the repository. This is very conservative because much of the water migrating from the underground test locations would discharge to locations other than those for releases from the proposed repository. Such locations include Oasis Valley, Ash Meadows, or the Amargosa Desert.

- The radionuclide-specific distribution coefficients, k_d, are assumed to be equal for source materials at the repository and the Nevada Test Site. This assumption recognizes that most of the nonvolatile radionuclide inventory at the Test Site is captured within the glass-like material resulting from the intense heat generated by past underground tests. The analysis assumed that the leachability of this material is not remarkably different than that of ceramic spent nuclear fuel pellets. Concentrations of the contaminants (curies per milliliter) in leachates are directly proportional to the source material (curies per gram) and the radionuclide-specific distribution coefficients.

- All contaminants originating on the Nevada Test Site would flow to the same discharge points as contaminants from Yucca Mountain, as modeled by the TSPA-Viability Assessment, and the peak groundwater concentrations of contaminants from the Test Site would coincide (in time and space) with the peak groundwater concentrations from repository contaminants.

- Concentrations of radionuclides in the groundwater would be diluted by total infiltration through the repository footprint and groundwater recharge for the repository and the Nevada Test Site, respectively.

The absolute potential cumulative Nevada Test Site groundwater impact can be estimated by comparison with the 10,000-year impacts presented in Table 5-4 of the Draft EIS. Based on these tables, the estimated cumulative Test Site impacts for the Proposed Action for the maximally exposed individual would be about 0.007 millirem per year at 20 kilometers. The dose to the RMEI at 18 kilometers, as described in Chapter 5, would be slightly higher. Therefore, the estimated total potential cumulative impact (Yucca Mountain impact plus Nevada Test Site impact) would be essentially (because of the small contribution from the proposed repository) 0.007 millirem per year to the RMEI.

Because of the large uncertainties in the current level of understanding of the hydrogeologic system, DOE has not attempted to model the actual groundwater transport of the Nevada Test Site with this simplified model. However, by assuming that the radionuclide contaminants in the groundwater at the Test Site would be transported in an identical manner to those from the repository and that peak concentrations would occur at precisely the same time, the Department believes that the resulting estimates of cumulative impacts from underground testing activities represent a reasonable upper bound of the actual cumulative impacts.

Uncertainties associated with Nevada Test Site groundwater impacts:

- *Source material concentration* – The concentration of contaminants within the source material is the parameter with the most sensitivity to outcome but also the parameter that the least is known about at the Nevada Test Site. However, the actual Test Site concentrations could be higher than those estimated for this analysis and still have little effect on the outcome. This is because, as the density of the Test Site inventory increases (that is, the radionuclide inventory is assumed to occupy a smaller volume), the quantity of infiltration “seen” by the contaminant would decrease because of the reduced footprint of the source term. Since both of these terms (radionuclide density and water infiltration per unit area) are directly proportional to the calculated groundwater concentration, they

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would tend to offset one another. However, for conservatism, the assumption was made that all of the Test Site source term for radionuclides of interest was concentrated only in the affected soil at Yucca Flat. This assumption could have resulted in an overestimate of the Test Site concentration and potential impacts by as much as two.

- *Travel distances and times* – The conservative assumption was made that the contaminants from Yucca Mountain and the Nevada Test Site would travel along the same pathways (those assumed for Yucca Mountain in the TSPA-Viability Assessment) and at the same time to maximize potential impacts. If more realistic modeling had been performed, the peak contaminate concentrations from Yucca Mountain and the Test Site probably would not coincide and the Test Site contribution to the cumulative impacts would therefore be smaller than those estimated.

- *Solute partition coefficients* – These coefficients as described in the literature are known to vary by orders of magnitude depending on soil and source zone material types. Because the precise nature of the soils at the Nevada Test Site was not considered in the simplified analysis, the actual result could be different. However, these values are not readily available and are impossible to estimate accurately with currently available data.

- *Contaminant mobilization* – To simplify the analysis, the assumption was made that the waste isolated in engineered barrier systems for the Yucca Mountain Repository and the waste dispersed in glass-like material from underground nuclear blasts at the Nevada Test Site will have the same release characteristics. The actual mechanisms for waste mobilization for Test Site underground testing contamination are largely unknown. The actual differences in the mobilization of the contaminants could result in changes (larger or smaller) in the impact estimates, however, due to the relative size of the calculated impacts, coupled with the other conservatisms assumed in this simplified analysis, they are not likely to influence the conclusion.

- *Groundwater flow direction and discharge points* – If realistic modeling was performed, and adequate characterization data to support that modeling was available, then it is extremely unlikely that the modeling would show that all contaminants resulting from underground testing across the Nevada Test Site would migrate to only one discharge point and that point would be the same point of discharge as the releases from the Yucca Mountain Repository. More detailed information on actual groundwater flow would likely serve to reduce the estimated impact of the Test Site inventory.

8.3.2.1.2 *Greater Confinement Disposal*

Waste disposed of at the Nevada Test Site under Greater Confinement Disposal constitutes a radiological source term that is less than 10 percent of the repository radionuclide source term immediately available for groundwater transport when the first waste packages at the Yucca Mountain Repository are assumed to have initially degraded (that is, 2 percent of the total repository radionuclide source term). The waste disposed of by Greater Confinement Disposal was placed in boreholes that are approximately 37 meters (120 feet) deep; the waste itself is no closer than approximately 21 meters (70 feet) to the surface. DOE has reviewed analyses related to the Nevada Test Site and has concluded that there is no credible pathway for long-term releases of materials by resuspension of nonvolatile radionuclides because the material is sufficiently far below the surface. In addition, evapotranspiration exceeds precipitation in this region, which, coupled with the fact that the boreholes are sufficiently above the water table (more than 125 meters), indicates that there is no credible release scenario for Greater Confinement Disposal material to enter the groundwater. Therefore, DOE expects no cumulative impacts from Greater Confinement Disposal activities.

8.3.2.1.3 *Future Nevada Test Site Low-Level Waste Disposal*

The Nevada Test Site is a disposal site for low-level radioactive waste generated by DOE-approved generators. Managed radioactive waste disposal operations began in the early 1960s, and DOE has disposed of low-level, transuranic, mixed, and classified low-level wastes in selected pits, trenches, landfills, and boreholes on the Nevada Test Site. Environmental impacts from the disposal of low-level waste at the Nevada Test Site are discussed in the Nevada Test Site Final EIS (DIRS 101811-DOE 1996, pp. 2-15 to 2-17). The current source term of low-level and mixed wastes in shallow land disposal on the Nevada Test Site does not constitute a substantial inventory in relation to the radionuclide source term immediately available for groundwater transport from the repository when the first waste packages initially degrade (that is, 2 percent of the total repository radionuclide source term). However, shallow burial of low-level radioactive waste continues to be an important waste disposal activity at the Nevada Test Site. Therefore, this section evaluates reasonably foreseeable future activities in this category as a potential cumulative impact.

Waste disposal activities on the Nevada Test Site occur at two specific locations. They are the Area 3 and Area 5 Radioactive Waste Management Sites. The Area 3 Radioactive Waste Management Site is on Yucca Flat and covers an area of approximately 0.2 square kilometer (50 acres). DOE uses conventional landfill techniques to dispose of contaminated debris from the Nevada Test Site Atmospheric Testing Debris Disposal Program and packaged bulk low-level waste from other DOE sites in subsidence craters from underground nuclear tests. The estimated total remaining capacity for low-level waste in the Area 3 site is 1.8 million cubic meters (64 million cubic feet) (DIRS 103224-DOE 1998, Section A.5.2) .

DOE has used the Area 5 Radioactive Waste Management Site since 1961 to dispose of low-level waste and classified low-level waste from Nevada Test Site operations. In 1978, the Test Site began accepting low-level waste generated by other DOE sites. The total area of the Area 5 site is 3 square kilometers (740 acres). The developed portion occupies 0.37 square kilometer (92 acres) in the southeast corner and contains 17 landfill cells (pits and trenches), 13 Greater Confinement Disposal boreholes, and a transuranic waste storage pad. DOE is seeking a Resource Conservation and Recovery Act permit for Pit 3 as a mixed-waste disposal unit. In the future, if the mixed-waste volume warranted it, the Department might consider obtaining a new unit and, hence, a new permitted facility. However, current projected waste volumes do not indicate the need for an additional mixed-waste disposal unit at this time. The estimated total remaining capacity for low-level waste in the Area 5 Radioactive Waste Management Site is 1.2 million cubic meters (42 million cubic feet) (DIRS 103224-DOE 1998, Section A.5.3).

As discussed in Section 8.2.12.1, DOE projects a need for 1.1 million cubic meters of capacity for low-level waste disposal at the Nevada Test Site through 2070 (DIRS 155856-DOE 2000, Table 4-1).

The Final Waste Management Programmatic EIS (DIRS 101816-DOE 1997, Summary) reported volumes of radioactive waste DOE may dispose of at the Nevada Test Site for "current plus 20 years" of waste disposal. The current inventory plus 20 years of additional disposal inventory would total 3,000 cubic meters (106,000 cubic feet) of low-level mixed waste, 1,700 cubic meters (60,000 cubic feet) of low-level waste, and 610 cubic meters (21,500 cubic feet) of transuranic waste (DIRS 101816-DOE 1997, Summary, p. 102). The Nevada Test Site Final EIS (DIRS 101811-DOE 1996, Table 4-1, p. 4-6) estimates the total current inventory already in shallow disposal at the Nevada Test Site to be 500,000 curies at the time of disposal (uncorrected for decay to the present time).

According to the Final Waste Management Programmatic EIS, the only expected groundwater impacts from low-level mixed, low-level radioactive, and transuranic waste disposal at the Nevada Test Site in excess of regulatory limits are for the hazardous chemicals 1,2-dichloroethane, methylene chloride, and benzene, and those only under Regionalized Alternative 3 and the Preferred Alternative in that EIS (DIRS 101816-DOE 1997, p. 11-61). None of these hazardous chemicals would be in the Yucca Mountain

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Repository inventory, so there would be no potential cumulative impacts from those chemicals from the Proposed Action or Inventory Module 1 or 2.

DOE has estimated potential long-term impacts from radioactive material disposed of at the Nevada Test Site. DOE based its calculations of long-term atmospheric releases for the Nevada Test Site on estimates of the inventory at the Test Site that could be accessible by residents around the area. For this calculation, the Department considered three potential sources of radionuclide releases:

- The Area 3 radioactive waste disposal area
- The Area 5 radioactive waste disposal area
- Soil sites around the Nevada Test Site that are contaminated at or near the surface from nuclear weapons testing

Because this material is not near the water table and because evapotranspiration exceeds precipitation in this area, there is no credible release scenario for this material to enter the groundwater. DOE postulated that, over time, weathering at the site could resuspend contaminants in the air and transport them from the contaminated areas to offsite residents. Therefore, DOE performed calculations using current meteorological information for the Nevada Test Site and site-specific resuspension factors to estimate the amount of material that could be released off the site. To ensure conservatism in the estimate, DOE assumed that the three sources listed above were in the same location (even though in reality they are separated by large distances) and that a future resident could be as near as 100 meters (330 feet) from the site. Analyses based on these assumptions are likely to overestimate the true impacts to a future resident because they result in a calculated total emission and radiation dose that is probably higher than if a resident were within 100 meters of a single site.

Based on these conservative assumptions, DOE calculated that the total radiation dose from the three sources could be approximately 7 millirem for each year of exposure during the first 10,000 years, and DOE does not expect that the dose would increase beyond that value for as long as 1,000,000 years. If a resident received this dose as long as 70 years, that person's lifetime dose could be as high as 490 millirem, which could result in an increased risk of fatal cancer of 0.0002.

8.3.2.2 Past Actions and Present Actions at the Beatty Low-Level Radioactive Waste Disposal and Hazardous Waste Treatment Storage and Disposal Facilities

A low-level radioactive waste disposal facility, formerly operated by U.S. Ecology, a subsidiary of American Ecology, is 16 kilometers (10 miles) southeast of Beatty, Nevada, and 180 kilometers (110 miles) northwest of Las Vegas. This site is about 15 kilometers (9.3 miles) west of the proposed Yucca Mountain Repository (see Figure 8-2). The disposal facility, which opened in 1962, covers roughly 0.14 square kilometer (35 acres) of unlined trenches. Acceptance of low-level radioactive waste ended December 31, 1992 (DIRS 101815-DOE 1997, Chapter 4, Table 4-17). The Nevada State Health Division formally accepted permanent custody of the low-level radioactive commercial waste disposal in a letter to American Ecology dated December 30, 1997 (DIRS 148088-AEC 1998, all). An adjacent U.S. Ecology facility remains open for hazardous waste disposal.

From 1962 through 1992, the inventory shipped to the Beatty low-level radioactive waste facility totaled 137,000 cubic meters (4.8 million cubic feet) in volume (DIRS 101815-DOE 1997, Chapter 4, Table 4-17) with radioactivity of about 640,000 curies (DIRS 101815-DOE 1997, Chapter 4, Table 4-18). The radioactivity in this sum was measured by year of shipment (that is, it is not corrected for decay since that time).

The Manifest Information Management System (DIRS 148160-MIMS 1992, all) calculated the total radionuclide inventory the Beatty facility received from 1986 through 1992, which represents 29 percent of the total undecayed inventory at that facility. Even if multiplied by a factor of 3 to 4 to compensate for the period (1962 to 1985) for which the Manifest Information Management System did not provide information, the source term represents a small percentage of the radionuclide source term immediately available for groundwater transport from the repository when the first waste packages initially degrade (that is, 2 percent of the total repository radionuclide source term). Therefore, cumulative long-term impacts from the Beatty Low-Level Radioactive Waste Disposal Facility with the repository would be very small.

The U.S. Ecology Hazardous Waste Treatment, Storage and Disposal Facility is a Resource Conservation and Recovery Act-permitted facility, with engineered barriers and systems and administrative controls that minimize the potential for offsite migration of hazardous constituents.

8.4 Cumulative Transportation Impacts

This section discusses the results of the cumulative impact analysis of transportation. Paralleling the transportation analyses of the Proposed Action in Chapter 6, potential national transportation cumulative impacts from Inventory Module 1 or 2, and past, present, and reasonably foreseeable future actions, are presented in Section 8.4.1. Potential cumulative impacts with construction and operation of the Nevada transportation implementing rail and heavy-haul truck alternatives are included in Section 8.4.2.

The shipment of Inventory Module 1 or 2 to the repository would use the same transportation routes, but would take more shipments and an additional 14 years compared to the Proposed Action. Table 8-2 lists the estimated number of shipments for Modules 1 and 2. Impacts from Module 1 or 2 would be similar because the shipping rate would be the same for spent nuclear fuel and high-level radioactive waste and only about 3 percent more shipments would be made over the 38-year period under Module 2 to transport Greater-Than-Class-C and Special-Performance-Assessment-Required wastes. Because the difference in impacts between Inventory Modules 1 and 2 would be small, the following discussions present the impacts from both modules as being the same.

8.4.1 NATIONAL TRANSPORTATION

This section describes cumulative impacts from national transportation. Section 8.4.1.1 presents potential cumulative impacts from shipping Inventory Module 1 or 2 from commercial nuclear generating sites and DOE facilities to the proposed Yucca Mountain Repository (Section 8.4.1.1). Section 8.4.1.2 presents potential cumulative national transportation impacts for the Proposed Action and Module 1 or 2 when combined with past, present, and reasonably foreseeable future shipments of radioactive material.

8.4.1.1 Inventory Module 1 or 2 Impacts

This section describes the potential cumulative impacts of loading operations at generating sites and incident-free radiological impacts, vehicle emission impacts, and accident impacts associated with transportation activities for Inventory Module 1 or 2. Cumulative impact results are provided for the mostly legal-weight truck and mostly rail scenarios which are described in Chapter 6. The section also describes potential cumulative impacts from transportation of other materials, personnel, and repository-generated waste for Modules 1 or 2. Appendix J contains additional detailed analysis results.

Loading operations would be extended for an additional 14 years to load the greater quantities of spent nuclear fuel and high-level radioactive waste under Inventory Module 1 or 2. The impacts of routine loading operations described for the Proposed Action in Chapter 6, Section 6.2.2, would increase for Module 1 or 2 due to the additional inventory. Therefore, the increase in dose to the public would be about 42 person-rem based on 0.001 person-rem per metric ton of heavy metal and 42,000 additional MTHM (46,000 tons) (DIRS 104731-DOE 1986, Volume 2, p. E.6) for Modules 1 and 2. This dose could result in an additional 0.02 cancer fatality in the exposed population. Table 8-54 lists estimated radiological and industrial hazard impacts to involved workers for the routine loading operations under Module 1 or 2. The Proposed Action impacts are listed for comparison.

Table 8-54. Radiological and industrial hazard impacts to involved workers from loading operations.[a,b]

Impact	Proposed Action[b]		Inventory Module 1 or 2	
	Mostly legal-weight truck scenario	Mostly rail scenario	Mostly legal-weight truck scenario	Mostly rail scenario
Radiological				
Maximally exposed individual				
Dose (rem)[c]	12	12	12	12
Probability of latent cancer fatalities	0.005	0.005	0.005	0.005
Involved worker population				
Dose (person-rem)	15,000	4,200	32,000	8,400
Number of latent cancer fatalities	6.0	1.7	13	3.4
Industrial hazards				
Total recordable cases[d]	380	130	770	260
Lost workday cases[e]	200	70	400	130
Fatalities[f]	0.88	0.3	1.8	0.6

a. Includes all involved workers at all facilities and does not vary by operating mode.
b. Source: Chapter 6, Section 6.2.
c. Assumes 500 millirem per year to radiation workers. The average individual exposure was assumed to be 24 years for both the Proposed Action and Inventory Module 1 or 2 since 24 years is a conservatively long time to assume an individual would be involved in loading operations.
d. Total recordable cases based on a loss incidence rate of 0.084.
e. Lost workday cases based on a loss incidence rate of 0.046.
f. Fatalities based on a loss incidence rate of 0.000218.

Because noninvolved workers would not have tasks that involved radioactive exposure, there would be no or very small radiological impacts to noninvolved workers. For the reasons identified in Chapter 6, Section 6.2.2.2, industrial hazard impacts to noninvolved workers would be about 25 percent of the impacts to the individual worker shown in Table 8-54.

The impacts of loading accident scenarios under Inventory Module 1 or 2 would be the same as those described for the Proposed Action in Chapter 6, Section 6.2.4.1. The same type of single accident event and its impacts are applicable to shipments under the Proposed Action or Module 1 or 2. As summarized in Chapter 6, Section 6.2.4.1, the analysis results indicate that there would be no or very small potential radiological consequences from loading accident scenarios involving spent nuclear fuel or high-level radioactive waste. These consequences would bound the consequences from similar accidents involving Greater-Than-Class-C or Special-Performance-Assessment-Required waste because of the lower available radionuclide inventory (see Appendix A).

Table 8-55 lists radiological impacts to involved workers and the public and vehicle emission impacts from incident-free transportation for the mostly legal-weight truck and mostly rail scenarios. The analysis of impacts for the mostly legal-weight truck scenario assumed that shipments would use commercial motor carriers for highway transportation and general freight commercial services for rail transportation for the naval spent fuel shipments that cannot be transported by legal-weight trucks. The mostly rail analysis accounts for legal-weight truck shipments that would occur for the commercial nuclear generator sites that do not currently have the capacity to handle or load rail casks. In addition, for the mostly rail analysis, DOE assumed that it would use either a branch rail line or heavy-haul trucks in conjunction with an intermodal transfer station in Nevada to transport the large rail casks to and from the

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Table 8-55. Radiological and vehicle emission impacts from incident-free national transportation.

Category	Proposed Action[a,b]		Inventory Module 1 or 2[c]	
	Mostly legal-weight truck scenario[d]	Mostly rail scenario[e]	Mostly legal-weight truck scenario[d]	Mostly rail scenario[e]
Involved worker				
Collective dose (person-rem)	14,000	3,700 - 4,600	28,000	7,100 - 8,800
Estimated number of latent cancer fatalities	5.6	1.5 - 1.9	11.2	2.8 - 3.5
Public				
Collective dose (person-rem)	5,000	1,200 - 1,600	9,700	2,200 - 3,100
Estimated number of latent cancer fatalities	2.5	0.6 - 0.82	5.0	1.1 - 1.6
Estimated vehicle emission-related fatalities	0.95	0.5 - 0.8	1.9	0.9 - 1.4

a. Source: Chapter 6, Section 6.2.3.
b. Impacts are totals for shipments over 24 years.
c. Impacts are totals for shipments over 38 years.
d. Includes rail shipments of naval spent nuclear fuel to Nevada, and intermodal transfer station and heavy-haul truck operations for this fuel in Nevada.
e. Includes legal-weight truck shipments from commercial nuclear generator sites that do not have the capacity to handle or load rail casks, and the rail and heavy-haul truck implementing alternatives for Nevada described in Chapter 6.

repository. The range provided in the table for the mostly rail scenario addresses the different possible rail and heavy-haul truck implementing alternatives described in Chapter 6. The lower end of the range reflects use of a branch rail line in Nevada and the upper end of the range reflects use of heavy-haul trucks in Nevada. The involved worker impacts in Table 8-55 include estimated radiological exposures of truck and rail transportation crews and security escorts for legal-weight truck and rail shipments; the public doses account for the public along the route, the public sharing the route, and the public during stops. The Inventory Module 1 or 2 impacts would exceed those of the Proposed Action due to the additional number of shipments.

DOE does not expect radiological impacts for maximally exposed individuals to change from the Proposed Action due to the conservative assumptions used in the analysis of the Proposed Action (see Chapter 6, Section 6.2.3). The assumptions for estimating radiological dose include the use of the maximum allowed dose rate and conservative estimates of exposure distance and time. For example, the U.S. Department of Transportation maximum allowable dose rate of 10 millirem per hour at a distance of 2 meters (6.6 feet) [40 CFR 173.44(b)] was used for estimating exposure to individuals. In addition, the conservative assumptions for exposure distance and time for workers (that is, crew members, inspectors, railyard crew member) and the public (that is, resident along route, person in a traffic jam, person at a service station, resident near a rail stop) for the Proposed Action are unlikely to be exceeded for Inventory Module 1 or 2 (see Chapter 6, Section 6.2.3).

Table 8-56 lists the radiological accident risk and traffic fatalities for transportation by mostly legal-weight truck and mostly rail for Inventory Module 1 or 2. The radiological accident risk measures the total impact of transportation accidents over the entire shipping campaign (24 years for the Proposed Action and 38 years for Module 1 or 2). The consequences from a maximum reasonably foreseeable accident scenario would be identical to those discussed for the Proposed Action (see Chapter 6, Sections 6.2.4.2.1 and 6.2.4.2.2) because the parameters and conditions for the hypothetical accident event involving spent nuclear fuel or high-level radioactive waste would be the same for a shipment under the Proposed Action or Module 1 or 2. In addition, the hypothetical accident would be bounding for accident scenarios involving Greater-Than-Class-C and Special-Performance-Assessment-Required wastes.

As summarized in Chapter 6, Section 6.1.3, and further described in Appendix J, in addition to the transportation of spent nuclear fuel and high-level radioactive waste to the repository, other materials

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Table 8-56. Accident risk for mostly legal-weight truck and mostly rail scenarios.

Category	Proposed Action[a]		Inventory Module 1 or 2	
	Mostly legal-weight truck scenario	Mostly rail scenario	Mostly legal-weight truck scenario	Mostly rail scenario
Radiological accident risk				
Collective dose risk (person-rem)	0.46	0.8 - 1.0	0.87	1.3 - 1.6
Estimated number of latent cancer fatalities	0.00023	0.00041 - 0.00050	0.00043	0.00066 - 0.00080
Traffic accident fatalities	4.9	2.3 - 3.1	8.7	4.2 - 5.9

a. Source: Chapter 6, Section 6.2.4.2.

would require transportation to and from the proposed repository. These materials would include construction materials, consumables, repository components (disposal containers, drip shields, etc.), office and laboratory supplies, mail, and laboratory samples. Required transportation would also include personnel commuting to the Yucca Mountain site and the shipment of repository-generated wastes offsite for treatment, storage, or disposal.

The implementation of Inventory Module 1 or 2 would increase this transportation as a result of the additional required subsurface development and the longer time required for repository development, emplacement, and closure. However, even with the increased transportation of other material, personnel, and repository-generated wastes for Module 1 or 2, DOE would expect these transportation impacts to be small contributors to the total transportation impacts on a local, state, and national level with no large cumulative impacts based on the analysis of the Proposed Action in Section 6.1.3. The annual air quality impacts for Inventory Module 1 or 2 would be the same as those conservatively estimated in Section 6.1.3 and, therefore, no cumulative air quality impacts would be expected in the Las Vegas airshed, which is in nonattainment for carbon monoxide. Table 8-57 summarizes fatalities from transporting other materials, personnel, and repository-generated waste. The estimated fatalities assume truck shipments in Nevada which would have higher potential impacts than shipments by rail. The Proposed Action impacts are listed in the table for comparison.

Table 8-57. Impacts from transportation of materials, consumables, personnel, and waste.[a,b]

Category	Proposed Action		Inventory Module 1 or 2	
	Kilometers traveled[c]	Fatalities	Kilometers traveled (Module 1/Module 2)	Fatalities (Module l/Module 2)
Materials (including repository components)	130,000,000 - 270,000,000	4.1 - 7.8	170,000,000 - 310,000,000	5.6 - 9.8
Personnel	480,000,000 - 800,000,000	5.4 - 9.2	640,000,000 - 930,000,000	7.3 - 11
Repository-generated waste				
Hazardous	57,000 - 71,000	0.001 - 0.002	110,000 - 170,000	0.002 - 0.003
Low-level radioactive	230,000 - 320,000	0.004 - 0.006	430,000 - 1,000,000	0.008 - 0.02
Nonhazardous solid	5,600,000 - 10,400,000	0.1 - 0.2	7,000,000 - 9,500,000	0.13 - 0.18
Totals	***610,000,000 - 1,100,000,000***	***9.6 - 17***	***820,000,000 - 1,300,000,000***	***13 - 20***

a. Totals might differ from sums of values due to rounding.
b. Source: Appendix J, Section J.3.6.
c. To convert kilometers to miles, multiply by 0.62137.

8.4.1.2 Cumulative Impacts from the Proposed Action, Inventory Module 1 or 2, and Other Federal, Non-Federal, and Private Actions

The overall assessment of cumulative national transportation impacts for past, present, and reasonably foreseeable future actions concentrated on the cumulative impacts of offsite transportation, which would yield potential radiation doses to a greater portion of the general population than onsite transportation and would result in fatalities from traffic accidents. The collective dose to workers and to the general population was used to quantify overall cumulative radiological transportation impacts. This measure

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was chosen because it could be related directly to latent cancer fatalities using a cancer risk coefficient and because of the difficulty in identifying a maximally exposed individual for shipments throughout the United States from 1943 through 2047. Operations at the Hanford Site and the Oak Ridge Reservation began in 1943, and 2047 is when the EIS analysis assumed that radioactive material shipments to the repository for Inventory Module 1 or 2 would end. The source of this cumulative transportation impacts analysis is the Yucca Mountain EIS Environmental Baseline File on transportation (DIRS 104800-CRWMS M&O 1999, Section 7.0), with the exception of impacts from the Proposed Action and Module 1 or 2, which are from Table 8-55.

The cumulative impacts of the transportation of radioactive material would consist of impacts from:

- Historic DOE shipments of radioactive material associated with the Nevada Test Site, the Idaho National Engineering and Environmental Laboratory, the Savannah River Site, the Hanford Site, the Oak Ridge Reservation, and naval spent nuclear fuel and test specimens

- Reasonably foreseeable actions that include the transportation of radioactive material identified in DOE Environmental Policy Act analyses; for example, the Nevada Test Site Environmental Impact Statement (DIRS 101811-DOE 1996, all), the Department of Energy Spent Nuclear Fuel Management Environmental Impact Statement (DIRS 101802-DOE 1995, all; DIRS 101812-DOE 1996, all), and the Final Department of Energy Waste Management Environmental Impact Statement (DIRS 101816-DOE 1997, all) (see Table 8-58). In some cases, transportation impacts included impacts that may have been double counted. For example, the transportation impacts from shipping 40,000 MTHM of spent nuclear fuel to a potential Private Fuel Storage Facility in Tooele County, Utah (DIRS 152001-NRC 2000, all) were included in Table 8-58, but the transportation impacts from the Proposed Action were not decreased to account for this 40,000 MTHM. Table 8-58 also includes reasonably foreseeable projects that include limited transportation of radioactive material (for example, shipment of submarine reactor components from the Puget Sound Naval Shipyard to the Hanford Site for burial, and shipments of uranium billets and low-specific-activity nitric acid from the Hanford Site to the United Kingdom). In addition, for reasonably foreseeable future actions where a preferred alternative was not identified or a Record of Decision has not been issued, the analysis used the alternative estimated to result in the largest transportation impacts. While this is not an exhaustive list of the projects that could include limited transportation of radioactive material, it indicates that the transportation impacts associated with such projects are low in comparison to major projects or general transportation.

- General radioactive materials transportation that is not related to a particular action; for example, shipments of radiopharmaceuticals to nuclear medicine laboratories and shipments of commercial low-level radioactive waste to commercial disposal facilities

- Shipments of spent nuclear fuel, high-level radioactive waste, Greater-Than-Class-C waste, and Special-Performance-Assessment-Required waste under the Proposed Action or Inventory Module 1 or 2

Table 8-58 summarizes the worker and general population doses from the transport of radioactive material. The estimated total cumulative transportation-related collective worker doses from the mostly legal-weight truck shipments (past, present, and reasonably foreseeable actions) with the Proposed Action would be about 360,000 person-rem (140 latent cancer fatalities), and with Inventory Module 1 or 2 about 410,000 person-rem (160 latent cancer fatalities). The estimated total general population doses for the mostly legal-weight truck shipments would be about 320,000 person-rem (160 latent cancer fatalities) with the Proposed Action, and about 350,000 person-rem (180 latent cancer fatalities) with Module 1 or 2. Most of the dose for workers and the general population would be due to general transportation of radioactive material. The estimated total cumulative number (workers plus population) of latent cancer fatalities with the Proposed Action would be about 300, and about 340 with Module 1 or 2. To place

Table 8-58. Cumulative transportation-related radiological doses, latent cancer fatalities, and traffic fatalities.[a]

Category	Worker dose (person-rem)	General population dose (person-rem)	Traffic fatalities
Historical DOE shipments (DIRS 101811-DOE 1996, all)	330	230	NL[b]
Reasonably foreseeable actions			
Private Fuel Storage Facility (DIRS 152001-NRC 2000, all)	29	190	0.78
Sodium-Bonded Spent Nuclear Fuel (DIRS 157167-DOE 2000, all)	0.0044	0.032	0.0001
Idaho High-Level Waste and Facilities (DIRS 155100-DOE 1999, all)	530	2,900	0.1
Surplus Plutonium Disposition (DIRS 118979-DOE 1999, all)	60	67	0.053
Sandia National Laboratories Site-Wide EIS (DIRS 157155-DOE 1999, all)	94	590	1.3
Depleted Uranium Hexafluoride (DIRS 152493-DOE 1999, all)	--[c]	750	4
Tritium Production in a Commercial Light Water Reactor (DIRS 157166-DOE 1999, all)	16	80	0.06
Parallex Project (DIRS 157153-DOE 1999, all)	0.00001	0.00007	0.00005
Los Alamos National Laboratory Site-Wide EIS (DIRS 157154-DOE 1999, all)	580	310	8
Plutonium Residues at Rocky Flats (DIRS 155932-DOE 1998, all)	2.1	1.3	0.0078
Import of Russian Plutonium-238 (DIRS 157156-DOE 1993, all)	1.8	4.4	0.0036
Nevada Test Site expanded use (DIRS 101811-DOE 1996, all)	--	150[d]	8
Spent nuclear fuel management (DIRS 101802-DOE 1995, all; DIRS 101812-DOE 1996, all)	360	810	0.77
Waste Management PEIS (DIRS 101816-DOE 1997, all)[e]	16,000	20,000	36
Waste Isolation Pilot Plant (DIRS 101814-DOE 1997, all)	790	5,900	5
Molybdenum-99 production (DIRS 101813-DOE 1996, all)	240	520	0.1
Tritium supply and recycling (DIRS 103208-DOE 1995, all)	--	--	0.029
Surplus HEU disposition (DIRS 103216-DOE 1996, all)	400	520	1.1
Storage and Disposition of Fissile Materials (DIRS 103215-DOE 1996, all)	--	2,400[d]	5.5
Stockpile Stewardship (DIRS 103217-DOE 1996, all)	--	38[d]	0.064
Pantex (DIRS 103218-DOE 1996, all)	250[f]	490[d]	0.006
West Valley (DIRS 101729-DOE 1996, all)	1,400	12,000	3.6
S3G and D1G prototype reactor plant disposal (DIRS 103221-DOE 1997, all)	2.9	2.2	0.010
S1C prototype reactor plant disposal (DIRS 103219-DOE 1996, all)	6.7	1.9	0.0037
Container system for Naval spent nuclear fuel (DIRS 101941-USN 1996, all)	11	15	0.045
Cruiser and submarine reactor plant disposal (DIRS 103479-USN 1996, all)	5.8	5.8	0.00095
Submarine reactor compartment disposal (DIRS 103477-USN 1984, all)	--	0.053	NL
Uranium billets (DIRS 103189-DOE 1992, all)	0.50	0.014	0.00056
Nitric acid (DIRS 103212-DOE 1995, all)	0.43	3.1	NL
General radioactive material transportation			
1943 to 2033	310,000	260,000	19
1943 to 2047	330,000	290,000	22
Subtotal of non-repository-related transportation impacts			
1943 to 2033	**330,000**	**310,000**	**94**
1943 to 2047	**350,000**	**340,000**	**97**
Proposed Action			
Mostly legal-weight truck	29,000	5,000	4.5
Mostly rail	7,900 - 8,800	1,200 - 1,600	2.3 - 3.1
Module 1 or 2[g]			
Mostly legal-weight truck	60,000	9,700	8.7
Mostly rail	16,000 - 17,000	2,200 - 3,100	4.2 - 5.9
Total collective dose (total latent cancer fatalities)[h] *and total traffic fatalities*			
Proposed Action			
Mostly legal-weight truck	360,000 (140)	320,000 (160)	98
Mostly rail	340,000 (140)	310,000 (160)	97
Module 1 or 2[g]			
Mostly legal-weight truck	410,000 (160)	350,000 (180)	110
Mostly rail	370,000 (150)	340,000 (170)	100

a. Sources: DIRS 104800-CRWMS M&O (1999, Section 7) except for the Proposed Action and Inventory Module 1 or 2, which are from Table 8-54. All references in this table refer to the original source of information cited in DIRS 104800-CRWMS M&O (1999, Section 7).
b. NL = not listed.
c. -- = reported or included with the general population dose.
d. Includes worker and general population doses.
e. Includes mixed low-level waste and low-level waste; transuranic waste included in DIRS 101814-DOE (1997, Volume 1).
f. Includes all highly enriched uranium shipped to Y-12.
g. The transportation-related radiological collective doses for Inventory Module 1 or 2 include the doses from the Proposed Action (see the definition of Modules 1 and 2 in Section 8.1.2.1).
h. The conversion factors for worker and general population dose to latent cancer fatalities are 0.0004 and 0.0005 latent cancer fatality per person-rem, respectively (DIRS 101856-NCRP 1993, p. 31) occurred in the United States. Therefore, the number of vehicular accident fatalities was used to quantify the cumulative impacts of transportation accidents.

these numbers in perspective, there were 541,532 deaths in the United States during 1998 due to cancer, although the number for any given year understandably fluctuates (DIRS 153066-Murphy 2000, p. 83). This section presents an estimate of latent cancer fatalities slightly greater than 300 over a period of about 100 years (that is, an average of about 3 latent cancer fatalities per year). This value would be indistinguishable from the natural fluctuations in the death rate from cancer.

For transportation accidents involving radioactive material, the dominant risk is due to accidents that are not related to the cargo (traffic or vehicular accidents). Typically, the radiological accident risk (latent cancer fatalities) from transportation accidents is less than 1 percent of the vehicular accident risk (see Table 8-56). In addition, no acute radiological fatalities due to transportation accidents have ever occurred in the United States. Therefore, the number of vehicular accident fatalities was used to quantify the cumulative impacts of transportation accidents.

From 1943 through 2033 an estimated 4 million people would be killed in motor vehicle accidents and 180,000 people would be killed by railroad accidents. From 1943 through 2047, an estimated 4.4 million people would be killed in motor vehicle accidents and 200,000 people would be killed in railroad accidents. Based on the estimated number of traffic fatalities for the reasonably foreseeable actions and for the Proposed Action and Inventory Module 1 or 2 listed in Table 8-58, the transport of radioactive material would contribute about 110 fatalities to these totals.

8.4.2 NEVADA TRANSPORTATION

This section analyzes potential cumulative impacts that Inventory Module 1 or 2 and past, present, and other reasonably foreseeable future Federal, non-Federal, and private actions could have on the construction and operation of a branch rail line or the construction and operation of an intermodal transfer station and associated highway upgrades for heavy-haul trucks in the State of Nevada. The analysis included potential cumulative impacts in the vicinity of the five potential branch rail line corridors, the three potential intermodal transfer station locations, and the five associated potential highway routes for heavy-haul trucks.

With respect to potential cumulative impacts from Inventory Module 1 or 2, there would be no cumulative construction impacts because the need for a new branch rail line or new intermodal transfer station and associated highway upgrades for heavy-haul trucks would not change; that is, whatever DOE would build for the Proposed Action would also serve Module 1 or 2. In addition, because the planned annual shipment rate of spent nuclear fuel and high-level radioactive waste to the Yucca Mountain Repository would be about the same for Module 1 or 2 and the Proposed Action, the only cumulative operations impacts would result because of the extra 14 years of shipping time required for Module 1 or 2. With this basis, the operation and maintenance of a branch rail line or an intermodal transfer station and associated highway route for heavy-haul trucks were analyzed for potential cumulative impacts from Module 1 or 2.

Land-use and ownership impacts identified in Chapter 6 (Section 6.3) would be avoided or otherwise resolved to implement the Proposed Action. However, additional conflicts associated with continued use of the affected land areas could occur due to shipping operations being excluded 14 years beyond that analyzed in the Proposed Action. DOE expects no cumulative impacts from the extended 14 years of operation for Inventory Module 1 or 2 to air quality; hydrology (surface water and groundwater); biological resources and soils; cultural resources; socioeconomics; noise; aesthetics; and utilities, energy, and materials, the impacts of which were assessed on a per shipment, weekly, or annual basis (see Chapter 6, Section 6.3).

Cumulative impacts from Inventory Module 1 or 2 to occupational and public health and safety are included in the occupational and public health and safety impacts of national transportation in

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Section 8.4.1. The operation of an intermodal transfer station for more years under Module 1 or 2 would affect waste management impacts. Because of the additional years of operation, more waste of the same types would be generated than for the Proposed Action. However, the small waste quantities generated for Module 1 or 2 would have a minimal impact to the receiving treatment and disposal facilities. Because there would be no large cumulative impacts for any of the resource areas from Module 1 or 2, disproportionately high and adverse cumulative impacts to minority or low-income populations or to Native Americans would be unlikely.

Other than Inventory Module 1 or 2, one other Federal action and several private actions could have the potential for cumulative impacts with the construction and operation of a new branch rail line or intermodal transfer station and associated highway route for heavy-haul trucks.

One private action that could lead to cumulative impacts with the Carlin rail corridor implementing alternative is by Cortez Gold Mine, Inc., which has an existing Pipeline Project mining operation and processing facility (DIRS 103078-BLM 1996, all), a proposed Pipeline Infiltration Project (DIRS 103081-BLM 1999, all), and a possible Pipeline Southeast Expansion Project (DIRS 103078-BLM 1996, p. 5-7) in the Crescent Valley area of Nevada through which the Carlin branch rail line would pass (see Section 8.1.2.3 and Figure 8-5). Because the Carlin corridor would pass through the general area of these projects, there could be cumulative land-use and ownership impacts that would require mitigation.

The analysis for the Carlin rail corridor represents the maximum impact; other rail corridor implementing alternatives would have smaller impacts. Cumulative impacts for the mostly legal-weight truck scenario would also have smaller impacts.

Another private action that could result in cumulative impacts would be shared use of a branch rail line that DOE constructed and operated to transport spent nuclear fuel and high-level radioactive waste to the Yucca Mountain Repository by others (for example, mine operators, private freight shippers) because of the increased rail traffic. Because predicting the increase in rail traffic is not possible at this time, this analysis cannot estimate the cumulative impacts. There could be some added impacts to all the resource areas beyond those evaluated for the Proposed Action in Chapter 6, but there could also be benefits from the improved economic potential for resource development in interior areas of Nevada as well as greater economic development potential for nearby communities. DOE would have to consider these impacts in any decision it made to allow shared use of the branch rail line.

One Federal action and one private action could lead to cumulative impacts with the construction and operation of the Caliente intermodal transfer station. DOE has specified the Caliente site as one of four possible locations for the construction and operation of an intermodal transfer station for the shipment of low-level radioactive waste to the Nevada Test Site (DIRS 103225-DOE 1998, pp. 2-4 to 2-12). In addition, a commercial venture planned by Apex Bulk Commodities for the Caliente site would construct an intermodal transfer station for the transport of copper concentrate. Figure 8-6 shows a possible layout plan for these intermodal transfer stations at Caliente. Section 8.1 provides more information on the potential DOE and Apex intermodal transfer stations. The following sections describe the potential cumulative impact analysis at the Caliente site from the construction and operation of an intermodal transfer station to support the proposed Yucca Mountain Repository, coupled with an intermodal transfer station for shipment of low-level radioactive waste to the Nevada Test Site and an intermodal transfer station proposed by Apex Bulk Commodities.

8.4.2.1 Land Use and Ownership

Chapter 6, Section 6.1.2.1, discusses reasonably foreseeable actions along the rail corridors and heavy-haul truck routes as they would apply to the Proposed Action. The differences in Module 1 and Module 2 in comparison to the Proposed Action are discussed below.

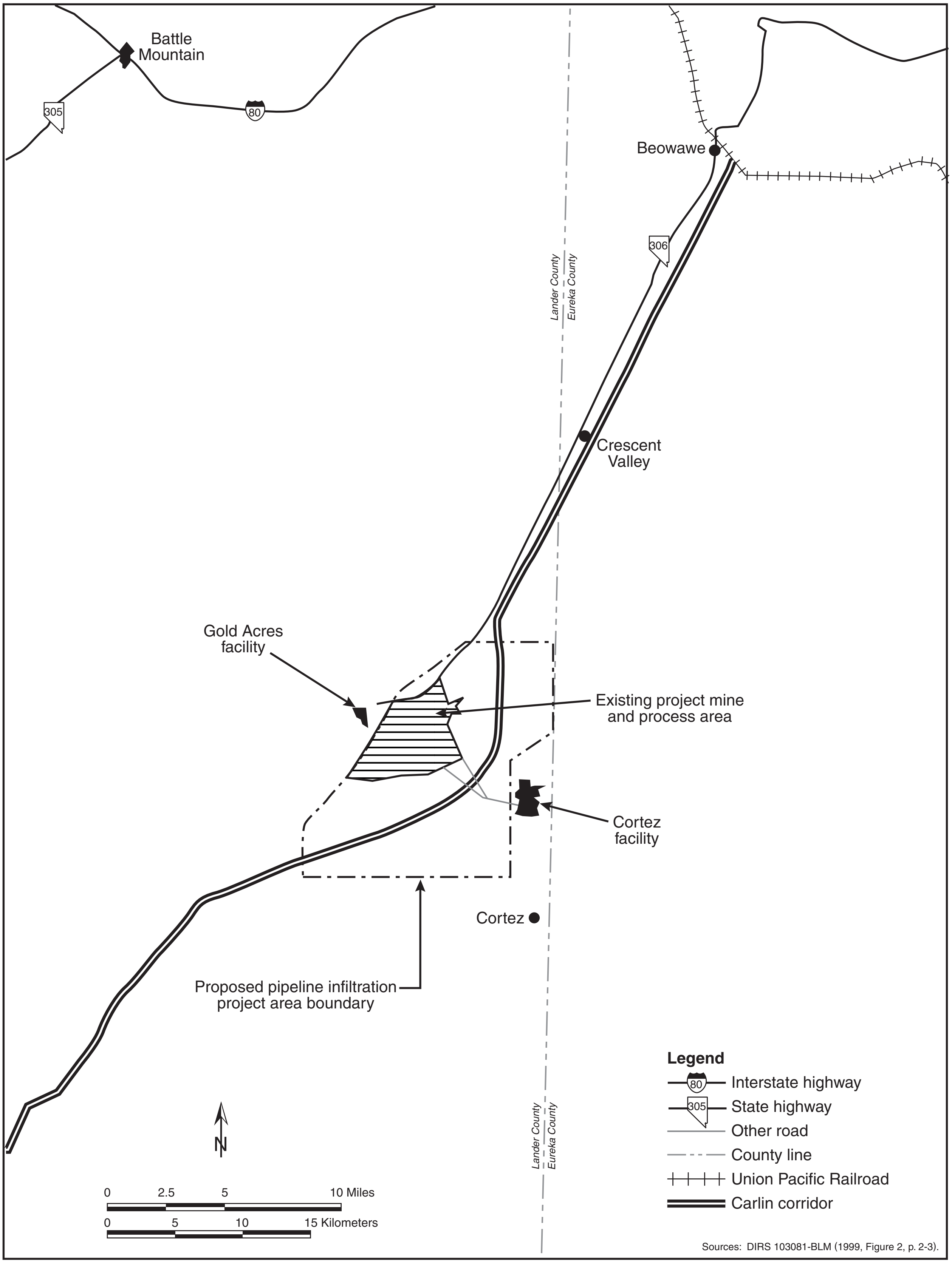

Figure 8-5. Cortez Gold Mine existing pipeline project and proposed pipeline infiltration project.

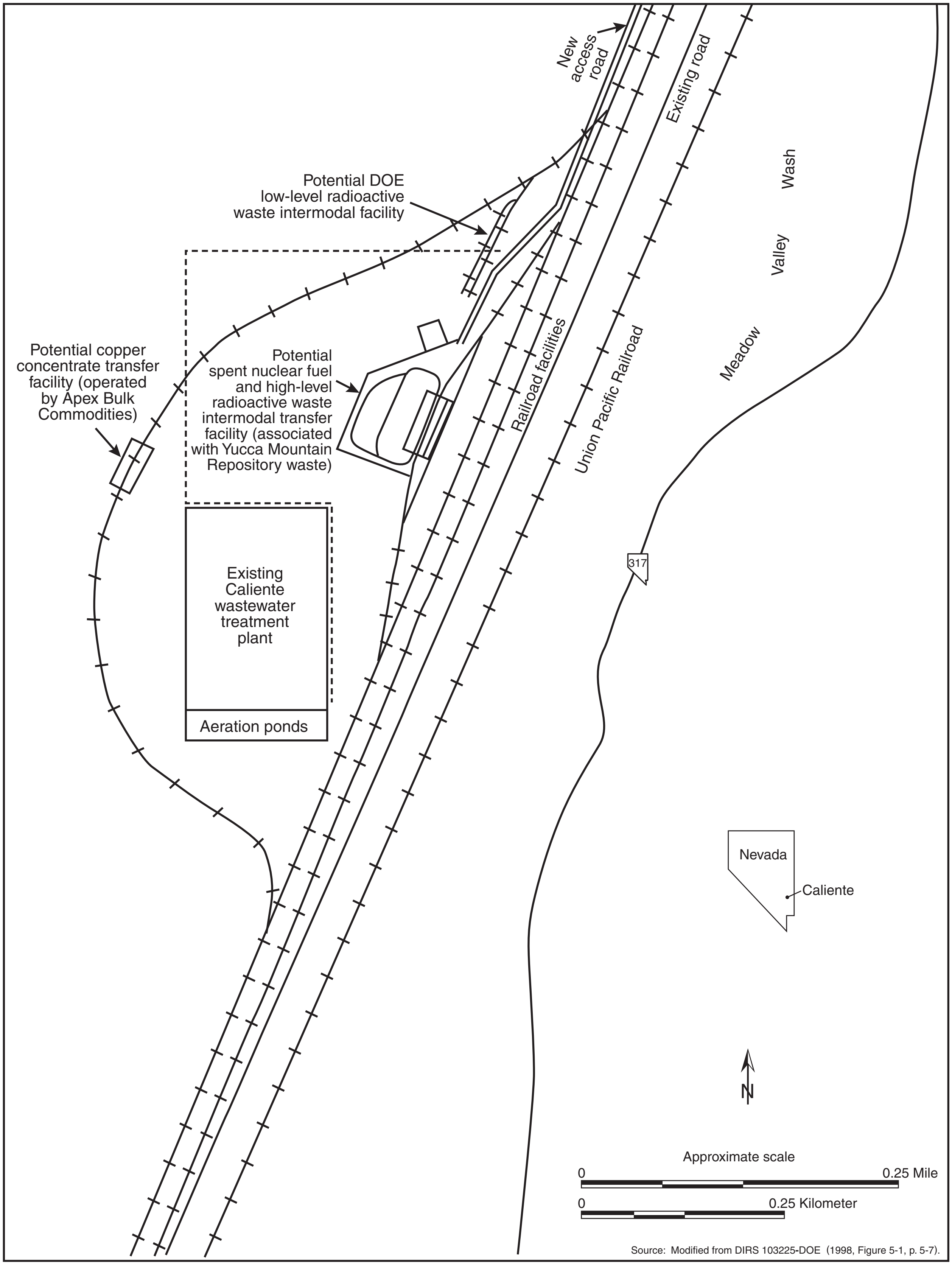

Figure 8-6. Potential locations of intermodal transfer stations at Caliente.

As discussed in Chapter 6, Section 6.3.2.1 there are currently 20 new electric generating plants proposed for the State of Nevada. Of these, 13 are proposed for Clark County in southern Nevada. Currently, plant details are not readily available for a detailed evaluation. However, should these plants be constructed, the rights-of-way necessary for transmission lines and/or natural gas supply lines will most likely be constructed on Bureau of Land Management lands. This would increase the amount of public lands in Nevada that would not be available to other users. Actual impacts associated with the rights-of-way, especially to the candidate rail corridors, would be similar to existing rights-of-way discussed in Section 6.3.2.1.

Section 6.3 of Chapter 6 and Section J.3.1.1 of Appendix J also discuss potential land use and ownership conflicts along candidate rail corridors that could result from the Proposed Action. These include potential conflicts with land areas on the Nellis Air Force Range, Timbisha Shoshone trust land parcel near Scottys Junction, Nevada, planned Ivanpah Valley regional airport, and wilderness study areas. If DOE decided to construct and operate a branch rail line in a rail corridor, it would avoid or mitigate any associated land use and ownership conflicts to implement the Proposed Action. However, additional conflicts associated with continued use of affected land areas could occur due to shipping operations being extended for 14 years beyond that of the Proposed Action.

The land required for the DOE low-level radioactive waste and Apex intermodal transfer stations would add to the approximately 0.21 square kilometer (50 acres) of property that would be required for the intermodal transfer station that would support the proposed Yucca Mountain Repository. The rail spur and facility for the low-level radioactive waste intermodal transfer station would disturb approximately 0.02 square kilometer (5 acres) of land. The Apex transfer facility would be in a building about 90 by 30 meters (300 by 100 feet). In addition, Apex would have a truck maintenance facility in a building about 30 by 18 meters (100 by 60 feet) that it could share with the low-level radioactive waste intermodal facility. The incremental impacts resulting from the changes in land use associated with the three intermodal transfer stations would not result in a substantial cumulative impact.

In addition to the cumulative changes in land use and ownership, DOE considered potential conflicts with plans and policies issued by various government entities along the alternative transportation corridors. In particular, DOE reviewed the Las Vegas 2020 Master Plan (DIRS 157274-City of Las Vegas 2001, all) and various other planning documents, including master plans for the Cities of Caliente (DIRS 157312-Sweetwater and Anderson 1992, all) and Alamo (DIRS 157275-Intertech and Sweetwater 1990, all), and the Lander County Revised Policy for Federally Administered Lands (DIRS 157310-Lander County 1999, all). The Las Vegas Master Plan provides broad policy direction for future land use decisions and related aspects in the City of Las Vegas through 2020. While the Alamo plan deals primarily with zoning issues, the Caliente plan discusses actions for dealing with potential population growth generated by the construction and operation of a repository at Yucca Mountain. The Caliente document generally expresses a need to annex lands that are contiguous to and south of the City in Meadow Valley Wash. The Caliente Intermodal Transfer Facility would be in Meadow Valley Wash (see Chapter 6, Figure 6-17). In general, local government policy indicates a goal of minimizing the conversion of private lands for public use. The transportation corridors and routes described in the EIS, particularly the rail corridors, were developed to minimize impacts to private lands. Section 6.3.2 discusses the amount of private land encountered along the rail corridors and a minimum-to-maximum range for each corridor, including variations and options. However, definitive information is not available on specific tracts of land that could be required for a specific transportation mode or route. Once DOE selected a transportation mode and a specific transportation corridor, more definitive information could be developed on potential conflicts with land uses and various agency plans and policies and, ultimately, the mitigation measures that could be needed to resolve conflicts and impacts on a given area.

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8.4.2.2 Air Quality

Air quality cumulative impacts during construction of three intermodal transfer stations—one for intermodal transfers of casks containing spent nuclear fuel and high-level radioactive waste, one for intermodal transfers of low-level radioactive waste shipments to the Nevada Test Site, and one for intermodal transfers of Apex copper concentrate—would not be expected to occur since construction activities would likely occur at different times. The area in which the construction would occur is in attainment of the National Ambient Air Quality Standards and is outside of the Las Vegas Valley particulate matter (PM_{10}) and carbon monoxide nonattainment areas. Even if construction for all three intermodal transfer stations occurred concurrently, administrative controls would be implemented to prevent an adverse impact from collective emissions and dust-generating activities.

Emissions from all sources would be less than applicable standards for repository activities. Emissions would also be below established standards for a mostly legal-weight truck transportation scenario. For a mostly rail scenario, criteria pollutants would be emitted during earthmoving operations for branch rail line or intermodal transfer station and highway upgrade construction projects. Cumulative impacts would be greatest for activities occurring in the Las Vegas air basin, which is currently in nonattainment for particulate matter (PM_{10}) and carbon monoxide. For rail implementing alternatives, emissions into the Las Vegas air basin would exceed emission standards only for construction of a Valley Modified branch rail line. Emission standards could be exceeded by up to 90 percent for PM_{10} and up to 60 percent for carbon monoxide. Emissions from upgrading highways for a Caliente/Las Vegas heavy-haul truck route could also exceed standards for the Las Vegas air basin. PM_{10} emissions could slightly exceed the standard and carbon monoxide emissions could exceed the standard by 10 percent. All other activities would not cause emissions that exceeded emission standards.

During operations, there would be approximately one or two repository rail shipments and as many as 11 associated heavy-haul trucks a week, an average of about three trains and seven trucks a day for DOE low-level radioactive waste shipments, and one truck an hour for the Apex copper concentrate transport. At present, an average of one train an hour and light highway traffic travels through Caliente. The incremental increase in air pollutants from rail and highway traffic resulting from the three actions would cause slight, temporary increases in pollutants, but would not exceed Federal standards (Chapter 6, Section 6.3.2; DIRS 103225-DOE 1998, pp. 4-13, 5-4, and 5-8). Criteria pollutants released during routine operations of the intermodal transfer stations would include nitrogen dioxide, sulfur dioxide, carbon monoxide, and particulate matter. DOE expects these emissions would also be well within Federal standards.

8.4.2.3 Hydrology

Surface Water

Mitigation measures used during the construction of the intermodal transfer stations would minimize surface-water impacts. Floodplain impacts probably would occur if DOE selected the Caliente intermodal transfer station (see Appendix L). If that location was selected, DOE would conduct a detailed floodplain/wetland assessment and integrate good construction practices to minimize impacts. Construction probably would involve some permanent drainage alterations. Runoff rates would differ from natural or existing terrain but, given the relatively small size of the area, there would be little effect on overall runoff quantities for the area (Chapter 6, Section 6.3.3.1; DIRS 103225-DOE 1998, pp. 4-13 and 5-8). DOE expects very small impacts to surface waters during the construction and operation of the stations.

Groundwater

Construction activities for the intermodal transfer stations would disturb and loosen the ground for some time, which could result in higher infiltration rates. However, these activities and their resultant short-term impacts probably would occur at different times for the three stations. The relatively small sizes of the three facilities would minimize changes in groundwater infiltration rates during operations. Potential sources of contamination would include one to three diesel fuel tanks for the standby generators and heavy equipment for all three stations. The small overall water demand could be met by installing wells or by existing water distribution systems. In addition, the operation of the Apex copper concentrate and DOE low-level radioactive waste intermodal transfer station would only overlap with the beginning years of spent nuclear fuel and high-level radioactive waste shipment to the proposed Yucca Mountain Repository.

8.4.2.4 Biological Resources and Soils

The proposed locations of the intermodal transfer stations are in an irrigated pasture area that is partly wetland. However, because the area was modified as pasture and the native habitat has been degraded, cumulative impacts to biological resources would be low. Construction activities could lead to soil erosion. Water would be applied to suppress dust and compact soil. The operation of the stations would have small cumulative impacts on soils. Erosion damage control would be performed as necessary throughout the operational periods.

8.4.2.5 Cultural Resources

Cumulative impacts could occur to archaeological, historic, and traditional Native American cultural sites from the construction of the intermodal transfer stations. Cultural resource surveys of a portion of the Meadow Wash Area have identified two archaeological sites in the vicinity of the proposed Caliente DOE low-level radioactive waste intermodal site (DIRS 103225-DOE 1998, p. 4-13). Neither site falls within the proposed intermodal transfer station areas. However, Native American consultants have identified these archaeological sites as having significant cultural values for present-day Native American tribes, and construction and operation of the intermodal transfer station at this location could create a cumulative impact to these cultural values. DOE would perform ethnographic studies and archaeological surveys during the engineering design phases and before construction to identify these impacts and address their mitigation.

Impacts to cultural resources could occur along each of the candidate rail corridors where site file and literature searches have indicated a potential for archaeological, historic, and traditional cultural properties (see Chapter 3, Section 3.2.2.1.5). Some impacts to these resources could be cumulative, such the intersection of the National Historic Pony Express Trail by variations of the Carlin Corridor or the construction and operation of a branch rail line in Crescent Valley along the Carlin Corridor, where Native Americans believe that operations at the Cortez Mine have already had an impact on a Native American cemetery. After determining the mode of transportation and the preferred routing, DOE would undertake archaeological field studies and ethnographic evaluations of the corridor to identify further potential impacts and possible mitigative actions to reduce the effects of those impacts.

Some impacts associated with the use of existing highways could be cumulative, depending on the route selected. For example, Native American consultants have identified several places or areas along some of the highways that have cultural significance to regional tribes (see Chapter 3, Section 3.2.2.2.5). Heavy-haul truck traffic could have a cumulative adverse effect on the Goldfield National Register Historic District, although the potential for specific impacts to buildings in the historic district has yet to be fully evaluated. As with other potential components of the Nevada transportation scenario, DOE would complete additional archaeological, historical and ethnographic studies during the engineering design phase to identify and evaluate these types of potential impacts.

8.4.2.6 Socioeconomics

Employment levels for operation of the repository, Apex, and DOE low-level radioactive waste intermodal transfer stations would be 66, 25, and 14 employees, respectively (Chapter 6 and Section 8.1.2.2). Employment associated with the repository and low-level radioactive waste intermodal transfer stations includes operations personnel and truck drivers. Concurrent operations for all three stations would occur over a portion of the entire 24- or 38-year shipping period for the Proposed Action or Inventory Module 1 or 2, respectively. Employment levels would increase gradually to the maximum values listed above and then decrease gradually toward the end of emplacement activities for repository-related workers. Impacts to employment, population, personal income, Gross Regional Product, and state and local government expenditures during station operations would be small for Lincoln County (Chapter 6, Section 6.3.2.2; DIRS 103225-DOE 1998, pp. 4-14 and 5-9).

The truck traffic in the Caliente area would be increased from the three intermodal transfer stations. The small increase would have a very small impact on U.S. Highway 93, which would be used when entering and leaving the intermodal transfer station access road. U.S. 93 is currently characterized as having light traffic. The period of concurrent truck traffic from the three intermodal transfer stations would also occur only over a portion of the 24- or 38-year shipping duration for the Proposed Action or Inventory Module 1 or 2, respectively.

8.4.2.7 Occupational and Public Health and Safety

The incremental impacts resulting from an increase in radiological risk associated with the intermodal transfer stations for the repository and low-level radioactive waste shipments at Caliente would not result in a substantial cumulative impact. The estimated total collective worker dose from the entire DOE low-level radioactive waste intermodal shipping campaign, including transportation impacts, would be about 4.21 person-rem (DIRS 103225-DOE 1998, p. 4-10). This dose, added to the total repository intermodal transfer station and rail and heavy-haul truck shipments worker dose of about 2,200 to 3,300 person-rem for the Caliente intermodal transfer station for Inventory Module 1 or 2 (Appendix J, Table J-59) would be an increase of less than 1 percent. The population dose associated with low-level radioactive waste shipments by truck from the Caliente intermodal transfer station would be 7.55 person-rem for the entire shipping campaign (DIRS 103225-DOE 1998, Table C-11, p. C-23). This dose, added to the dose from shipments in Nevada that use heavy-haul trucks of about 600 person-rem over 38 years, would increase the population dose and associated health effects by less than 1 percent.

In addition to incremental impacts resulting from increases in radiological risk, there would be increments in nonradiological impacts of transportation in Nevada that are not included in the national impacts of transporting spent nuclear fuel and high-level radioactive waste to a Yucca Mountain Repository. These increases would arise from 14 additional years of operating a branch rail line or of maintaining highways for use by heavy-haul trucks and operating an intermodal transfer station. The increments in nonradiological impacts for operation of a branch rail line would include increased traffic fatalities from worker commuting and the transportation of spent nuclear fuel and high-level radioactive waste, as well as repository materials. The increases would range from 0.45 to 1.1 fatalities (see Tables 6-78, 6-79, 6-85, 6-86, 6-93, 6-94, J-61, J-62, and J-63).

8.4.2.8 Noise

There would be an increase in noise levels at Caliente from any of the three candidate intermodal transfer station sites and the associated train switching operations and truck traffic. Noise levels would increase during daytime and night hours for rail activities and during daytime hours for truck shipment activities associated with the repository heavy-haul trucks and the DOE low-level radioactive waste trucks. Apex truck shipments would occur once an hour, 24 hours a day. Noise associated with railcar shipments would occur as the railcars were uncoupled from trains and transferred in and out of the stations, which could occur during the day or night. Elevated noise levels would occur during loading and unloading operations and briefly as trucks passed on the highway. Trucks would not travel through Caliente for shipments to either Yucca Mountain or the Nevada Test Site. Overall, the elevation of noise levels associated with rail and truck activity near a level that would cause concern would be unlikely. In addition, due to the location of the intermodal transfer stations in an uninhabited canyon area, noise impacts from rail and truck loading and unloading would be low. Cumulative effects would also be limited because operations at the DOE low-level radioactive waste and Apex intermodal transfer stations would overlap only a portion of the shipping campaign associated with the proposed repository.

Future development of the Timbisha Shoshone Trust Lands parcel near Scottys Junction could result in additional impacts. Residences and commercial ventures located near the transportation corridor on this parcel (the Bonnie Claire variation of the Caliente and Carlin rail corridors) could encounter noise levels that would not exceed 90 dB at 15 meters (49 feet) from the route.

8.4.2.9 Aesthetics

Chapter 6, Section 6.1.2.9 discusses direct impacts from the candidate rail corridors and heavy-haul truck routes. Section 6.3.2 discusses indirect visual impacts as they could affect land use along the rail corridors.

The alteration of the landscape immediately surrounding the Bureau of Land Management Class II lands [within about 8 kilometers (5 miles) of the Kershaw-Ryan State Park] could exceed the Class II objective. In addition, the Wilson Pass Option in the Jean Corridor passes through Class II lands [55 kilometers (34 miles)] in the vicinity of Wilson Pass in the Spring Mountains. Class II designation by the Bureau of Land Management could require retention of the existing character of the landscape. However, the area proposed for the Caliente intermodal transfer station has been classified as Class III, which would require partial retention of the existing character of the landscape. The intermodal facilities would not greatly alter the landscape more than the current passing trains and sewage treatment operations. The Class II lands of the Wilson Pass Option would require retention of the existing character of the landscape. Public exposure would be limited due to obstruction by natural vegetation. Therefore, visual impacts would be very small (DIRS 103225-DOE 1998, pp. 4-12 and 5-8).

8.4.2.10 Utilities, Energy, and Materials

Electric power lines with adequate capacity are available near the site. Electric power, water supply, and sewage disposal facilities are currently provided to the sewage treatment facility near the proposed location of the intermodal transfer stations (DIRS 103225-DOE 1998, p. 4-12). Therefore, cumulative impacts to utilities would be small. The quantities of concrete, asphalt, and steel needed to build the intermodal facilities (associated mostly with the repository intermodal transfer station) would be unlikely to affect the regional supply system.

8.4.2.11 Management of Intermodal Transfer Station-Generated Waste and Hazardous Materials

The expected quantities of sanitary waste, small amounts of hazardous waste, and low-level radioactive waste associated with radiological surveys would be unlikely to have large impacts to landfill, treatment, and disposal facilities available for use by this site. Therefore, cumulative impacts for waste management would be small. Only limited quantities of hazardous materials would be needed for station operations, and DOE does not expect these needs to affect the regional supply system (DIRS 103225-DOE 1998, pp. 4-12, 4-13, and 5-8).

8.4.2.12 Environmental Justice

Because there would be no large cumulative impacts to human health and safety from the construction or operation of the intermodal transfer stations, there would be no disproportionately high and adverse impacts to minority and low-income populations. The absence of large cumulative environmental impacts for the general population means that there would be no disproportionately high and adverse environmental impacts for the minority or low-income communities. An evaluation of subsistence lifestyles and cultural values confirms these general conclusions. The foregoing conclusions and evaluations and the commitment by DOE to ensure minimal impacts to cultural resources show that construction and operation of the intermodal transfer stations would not be expected to cause or contribute to disproportionately high and adverse impacts to Native Americans (DIRS 103225-DOE 1998; pp. 4-14 and 5-9).

8.5 Cumulative Manufacturing Impacts

This section describes potential cumulative environmental impacts from the manufacturing of the repository components required to emplace Inventory Module 1 or 2 in the proposed Yucca Mountain Repository. No adverse cumulative impacts from other Federal, non-Federal, or private actions have been identified because no actions have been identified that, when combined with the Proposed Action or Inventory Module 1 or 2, would exceed the capacity of existing manufacturing facilities.

The overall approach and analytical methods and the baseline data used for the evaluation of cumulative manufacturing impacts for Inventory Module 1 or 2 were the same as those discussed in Chapter 4, Section 4.1.15 for the Proposed Action. The evaluation focused on ways in which the manufacturing of the repository components could affect environmental resources at a representative manufacturing site and potential impacts to material sources and supplies.

Table 8-59 lists the total number of repository components required for the Proposed Action and Inventory Modules 1 and 2. As listed, the total number would increase by approximately 30 to 50 percent for Modules 1 and 2 in comparison to the Proposed Action depending on the operating mode and packaging scenario. The highest total number of repository components would be for Module 2, assuming the lower-temperature operating mode using derated waste packages, and this was the number used in the cumulative impact analysis.

Based on the total number of components that would be required over a 38-year period for Inventory Module 1 or 2, the annual manufacturing rate would remain the same as that for the Proposed Action.

Based on the number of drip shields required over a 12-year period for Inventory Module 1 or 2, the annual manufacturing rate would increase about 30 percent over that for the Proposed Action 10-year drip shield manufacturing period.

Thus, the annual Module 1 or 2 impacts for air quality, socioeconomics, material use, and waste generation would be as much as 30 percent higher than those for drip shield manufacturing discussed in Chapter 4, Section 4.1.15 for the Proposed Action, and these impacts would continue for 12 years rather than the 10 years for the Proposed Action. The total number of worker injuries and illness or fatalities would increase in proportion to the increase in components manufactured. The potential number of injuries and illnesses over the entire 50-year period for Module 1 or 2 would be from 930 to 1,300 and the estimated number of fatalities would be 0.44 to 0.63 (that is, no expected fatalities), depending on the operating mode and packaging scenario. As for the Proposed Action, there would be few or no impacts on other resources because existing manufacturing facilities would meet the projected manufacturing needs and new construction would not be necessary and environmental justice impacts (that is, disproportionately high and adverse impacts to minority or low-income populations) would be unlikely.

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Table 8-59. Number of offsite-manufactured components required for the Proposed Action and Inventory Modules 1 and 2.

		Operating mode/packaging scenario								
		Proposed Action			Module 1			Module 2		
		UC	C	UC/C[a]	UC	C	UC/C[a]	UC	C	UC/C[a]
Component	Description	HT		LT	HT		LT	HT		LT
Disposal containers	Containers for disposal of SNF[a] and HLW[a]	11,300	11,300	11,300 - 16,900	16,650	16,650	16,650 - 25,350	17,250	17,250	17,250 - 26,000
Rail shipping casks or overpacks	Storage and shipment of SNF and HLW	0	120	0 - 120	0	152	0 - 197	0	157	0 - 202
Legal-weight truck shipping casks	Storage and shipment of uncanistered fuel	120	8	8 - 120	227	13	13 - 227	241	13	13 - 241
Drip shields	Titanium cover for a waste package	10,500	10,500	11,300 - 15,900	15,600	15,600	16,650 - 23,400	16,300	16,300	17,250 - 24,700
Emplacement pallet	Support for emplaced waste package	11,300	11,300	11,300 - 16,900	16,650	16,650	16,650 - 25,350	17,250	17,250	17,250 - 26,000
Solar panels[b]	Photovoltaic solar panels–commercial units	27,000	27,000	27,000	27,000	27,000	27,000	27,000	27,000	27,000
Dry storage cask shells[c]	Metal shell structure of storage vault for aging	0	0	0 - 4,000	0	0	0 - 4,000	0	0	0 - 4,000

a. UC = uncanistered packaging scenario; C = canistered; HT = higher-temperature operating mode; LT = lower-temperature operating mode; SNF = spent nuclear fuel; HLW = high-level radioactive waste.
b. Number of panels in use at any one time.
c. Necessary only if DOE used surface aging as part of a lower-temperature operating mode.

8.6 Summary of Cumulative Impacts

As shown throughout Chapter 8, DOE has examined many actions in the region to determine the potential for cumulative impacts. These impacts could arise from a variety of sources, including other activities in the area and reasonably foreseeable activities.

Table 8-60 summarizes cumulative impacts from all origins. Where qualitative descriptions are more meaningful, these have been included in lieu of quantitative values, although the quantitative values might be provided in this chapter. In other cases, the quantitative values have been provided to give a better representation of the potential impacts.

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Table 8-60. Summary of cumulative impacts presented in Chapter 8 (page 1 of 2).

Discipline area	Cumulative impact
Land use and ownership	About 600 square kilometers (150,000 acres) of land would be withdrawn for the repository, but land is already under Federal control. Other actions in the area would cause additional withdrawals, but some land would also be returned under the Southern Nevada Public Land Management Act. Overall, total land withdrawal analyzed in this EIS is less than 0.5 percent of total Federal lands in Nevada.
Air quality	*Nonradiological:* Emissions from all sources would be less than applicable standards for repository activities. Emissions would also be below established standards for a mostly legal-weight truck transportation scenario. For a mostly rail scenario, criteria pollutants would be emitted during earthmoving operations for branch rail line or intermodal transfer station and highway upgrade construction projects. Cumulative impacts would be greatest for activities occurring in the Las Vegas air basin, which is currently in nonattainment for particulate matter (PM_{10}) and carbon monoxide. For rail implementing alternatives, emissions into the Las Vegas air basin would exceed emission standards only for construction of a Valley Modified branch rail line. Emission standards could be exceeded by up to 90 percent for PM_{10} and up to 60 percent for carbon monoxide. Emissions from upgrading highways for a Caliente/Las Vegas heavy-haul truck route could also exceed standards for the Las Vegas air basin. PM_{10} emissions could slightly exceed the standard and carbon monoxide could exceed the standard by 10 percent. All other activities would not cause emissions that exceeded emission standards.
	Radiological: Short-term air emissions from nearby facilities would result in a dose to the maximally exposed individual of no greater than 2.5 millirem per year. Emissions from past nuclear weapons testing could have resulted in a dose of 150 millirem over the lifetime of those individuals exposed during atmospheric weapons testing. Long-term atmospheric releases from the Nevada Test Site and Beatty Low-Level Waste Facility are not expected to result in a dose greater than 0.007 millirem per year in the future.
Hydrology	*Surface Water:* Cumulative impacts on surface water quality are not expected because of the transient nature of the surface water bodies around the repository. Minor changes to runoff and infiltration rates could occur. Construction of access routes at the repository site could have minor and localized effects on several washes at Yucca Mountain. Elsewhere in Nevada, routes being considered for the movement of waste to Yucca Mountain would pass through or near floodplains and wetlands and would be assessed in more detail once a route is selected.
	Groundwater: Groundwater demands from the repository are below the perennial yield of the western two-thirds of the Jackass Flats basin. When combined with Nevada Test Site activities, the annual water withdrawal (600 acre-feet) could exceed the lowest estimate of perennial yield but would not exceed highest estimate of perennial yield. No short-term impacts to groundwater quality are expected. Long-term impacts to groundwater could be as high as 0.007 millirem per year under the conservative assumption that impacts from the Nevada Test Site and the repository overlap spatially and chronologically.
Biological resources and soils	Disturbance of desert tortoise habitat would occur. Wildlife would be displaced as a result of repository and transportation activities that used additional land in the region. Little or no loss of wetland habitat is expected. No expected impacts to any species.
Cultural resources	Adverse impacts to cultural resources are not expected. Potential for encountering cultural resources exists along transportation corridors. DOE would use practices to avoid or mitigate adverse impacts in these areas.
Socioeconomics	As many as 3,400 direct jobs during peak employment year from repository activities. Intermodal transfer station or rail line in Lincoln County could change employment estimates by 5 percent.

Table 8-60. Summary of cumulative impacts presented in Chapter 8 (page 2 of 2).

Discipline area	Cumulative impact
Occupational and public health and safety	*Nonradiological:* Repository activities, including transportation, could result in up to 37 fatalities[a] from construction to closure of the repository.
	Radiological: Radiation exposure could result in up to 32 latent cancer fatalities[a] to workers. Short-term radiation exposure to the public could result in up to 5 latent cancer fatalities[a] in the population. Short-term radiation exposure to the maximally exposed individual could cause an increased cancer risk of about 1.2×10^{-6}. Emissions from past nuclear weapons testing could have caused an increased risk of about 7.5×10^{-5} for affected individuals. Long-term releases from the repository and other actions in the area could cause an increased risk of fatal cancer in the future of 0.000006 over the lifetime of an exposed individual.
Noise	Noise levels would be transient and would not be expected to cause adverse impacts for repository operation. Future development of the Timbisha Shoshone Trust Lands near Scottys Junction could result in residents of that parcel being subjected to transient noise from a candidate rail corridor through the parcel.
Aesthetics	Placement of exhaust stacks on top of Yucca Mountain could impact visual resources because stacks would be visible from some distance. If the stacks were equipped with beacons, the visual effect would be more noticeable at night. Disturbed areas would be likely on former Federal lands that are used for commercial and private purposes. Acquisition of private lands by the Federal Government could result in reduced aesthetics impacts and possible return of land to natural state.
Utilities, energy, materials, and site services	Peak electrical power demand would require upgrade to electrical transmission and distribution system. Other site systems and nearby suppliers of materials would be sufficient to meet repository and transportation needs. Construction of electrical generating facilities in the region surrounding the repository would increase the electrical generating capacity for the area.
Waste management	If nonradioactive, nonhazardous solid waste was disposed of at the Nevada Test Site, existing landfills would need to be expanded. Other waste types could be disposed of at nearby facilities without exceeding capacities of those facilities.
Environmental justice	No disproportionately high and adverse cumulative impacts to minority or low-income populations would occur for repository, transportation, or other activities. DOE recognizes that Native American people living in the region near Yucca Mountain have concerns about the protection of traditions and the spiritual integrity of the land that extend to the propriety of the proposed repository, and that implementing the Proposed Action would continue restrictions on access to the proposed site.

a. These values represent the maximum for each environmental resource area. Because the maximum could occur for different implementing alternatives in the various resource areas, simple addition of these maximums could overstate the impacts due to mixing of incompatible alternatives.

REFERENCES

Note: In an effort to ensure consistency among Yucca Mountain Project documents, DOE has altered the format of the references and some of the citations in the text in this Final EIS from those in the Draft EIS. The following list contains notes where applicable for references cited differently in the Draft EIS.

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9

Management Actions To Mitigate Potential Adverse Environmental Impacts

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9. MANAGEMENT ACTIONS TO MITIGATE POTENTIAL ADVERSE ENVIRONMENTAL IMPACTS

This chapter describes management actions that the U.S. Department of Energy (DOE or the Department) is considering to reduce or mitigate adverse impacts to the environment that could occur if the Department implemented the Proposed Action to construct, operate and monitor, and eventually close a geologic repository for the disposal of spent nuclear fuel and high-level radioactive waste at Yucca Mountain. In keeping with previous chapters in this environmental impact statement (EIS), this chapter contains separate discussions for the mitigation of repository impacts and the mitigation of impacts from transportation activities. Mitigation includes activities that (1) avoid the impact altogether by not taking a certain action or parts of an action; (2) minimize impacts by limiting the degree or magnitude of the action and its implementation; (3) repair, rehabilitate, or restore the affected environment; (4) reduce or eliminate impacts over time by preservation or maintenance operations during the life of the action; or (5) compensate for the impact by replacing or substituting resources or environments.

This chapter also describes mitigations in environmental resource areas where DOE has identified adverse impacts and analysis has indicated that mitigation has the potential to reduce those impacts. This chapter does not discuss mitigations for environmental resource areas for which analyses have not identified a potential for impacts.

Changes in repository design have resulted in modifications to some planned or potential mitigation measures identified in the Draft EIS. In addition, DOE has identified some new mitigation measures.

Apart from the impact findings and mitigations discussed in this EIS, Section 116(c) of the Nuclear Waste Policy Act, as amended (NWPA) states that "the Secretary shall provide financial and technical assistance to (an affected unit of local government or the State of Nevada)… to mitigate the impact on such (an affected unit of local government or the State of Nevada) of the development of (a) repository and the characterization of (the Yucca Mountain) site." Such assistance can be given to mitigate likely "economic, social, public health and safety, and environmental impacts." Within that broad framework, neither Section 116 nor any other provision of the NWPA limits the impacts that are subject to assistance under Section 116 to the environmental impacts considered in this EIS.

The fact that the EIS analysis has determined that the implementation of the Proposed Action would not cause substantial socioeconomic impacts to communities in Nevada or to the State of Nevada does not prevent local governments or the State government from receiving assistance to address economic, social, public health, or environmental impacts under Section 116(c).

The Section 116 impact assistance review process and the Yucca Mountain Repository EIS process are distinct from one another, and the implementation of one would not depend on the implementation of the other. The provision of assistance under Section 116 would not necessarily be limited either by the impacts identified in this EIS or by its findings on such impacts. Any decision to provide assistance under Section 116 will be based on an evaluation of a report submitted by an affected unit of local government or the State of Nevada pursuant to Section 116 to document likely economic, social, public health and safety, and environmental impacts.

9.1 Types of Management Actions

The design, construction, operation and monitoring, and closure planning for the proposed repository incorporate physical features, procedures, and safeguards to reduce environmental consequences. Some of these features, procedures, and safeguards are the result of DOE determinations based on site characterization activities and the ongoing evaluation of planning and design for the proposed repository.

To complement the measures already incorporated, DOE is considering a range of additional mitigation measures aimed at reducing consequences of the proposed repository project. The repository and transportation mitigation analyses in this chapter discuss impact reduction measures that DOE expects to implement as well as other mitigations DOE is considering.

9.1.1 DOE-DETERMINED IMPACT REDUCTION FEATURES, PROCEDURES, AND SAFEGUARDS

DOE has studied the Yucca Mountain site, vicinity, and regions of influence for more than a decade and has accumulated considerable knowledge. The Department has identified many improvements in its project design and plan to reduce potential impacts. The Proposed Action includes commitments to reduce impacts that DOE has made as a result of its site characterization studies and the ongoing evaluation of repository planning and design. DOE would undertake these measures if the Secretary of Energy recommended the site for development and authorization was provided to proceed with the Proposed Action. This chapter identifies these commitments in appropriate areas.

9.1.2 MITIGATION MEASURES UNDER CONSIDERATION FOR INCLUSION IN PROJECT PLAN AND DESIGN

DOE has conducted extensive site characterization studies, and continues to evaluate whether to commit to additional mitigation measures in the event the site is designated and the Nuclear Regulatory Commission grants a license for the repository project. DOE is considering these additional measures to reduce the potential effects of the repository project. This chapter identifies measures under consideration in appropriate subject areas.

9.1.3 ONGOING STUDIES THAT COULD INFLUENCE MITIGATION MEASURES IN THE PROJECT PLAN AND DESIGN

Accelerator Transmutation of Waste technology has been under consideration for many years as a process for the treatment of nuclear waste. This technology would involve the use of a chemical separation process, a linear accelerator, and a subcritical nuclear assembly. The chemical process would separate transuranic and certain long-lived radioisotopes from the spent nuclear fuel. The linear accelerator and subcritical nuclear assembly would change the transuranic and long-lived radioisotopes into short-lived radioisotopes and stable (nonradioactive) elements.

The National Research Council studied Accelerator Transmutation of Waste and other technologies for use in the treatment of spent nuclear fuel (DIRS 103403-National Research Council 1996, all). The study concluded that:

- The use of separation and transmutation to treat spent nuclear fuel is technically feasible.
- Treatment would cost many tens of billions of dollars and require many decades to implement.
- While other technologies would be based on considerable experience, Accelerator Transmutation of Waste technology would require extensive development before DOE could realistically assess its technical feasibility.
- No separation and transmutation technology offers sufficient promise to abandon current spent nuclear fuel management programs or delay the opening of the first nuclear waste repository.
- Even with a successful separation and transmutation program, a monitored geologic repository would still be necessary because the process would be unlikely to provide perfect transmutation, in which

case there would be residual materials requiring long-term isolation from human populations and concentrations of human activity.

- Separation and transmutation technology might delay or eliminate the need for a second repository, but there are legislative and less expensive technical ways to increase the capacity of the first repository by an equivalent amount.

In the Fiscal Year 1999 Energy and Water Appropriation Act, Congress directed DOE to conduct an Accelerator Transmutation of Waste study and to prepare a plan for the development of this technology in Fiscal Year 1999. In October 1999, DOE submitted to Congress *A Roadmap for Developing Accelerator Transmutation of Waste (ATW) Technology* (DIRS 110625-DOE 1999, all). Key elements of the report include:

- The identification of technical issues requiring resolution
- The delineation of a 6-year science-based program to begin addressing resolution of technical issues
- If technical issues are resolved, a research and development plan for construction of a demonstration facility to become operational in 2035
- If research and development are successful, a production plan for transmutation of 79,000 metric tons (87,000 tons) of civilian waste over 90 years
- A listing of possible collaborative efforts with other countries
- The identification of institutional challenges of an Accelerator Transmutation of Waste program
- A discussion of possible benefits to other programs
- An estimate of the life-cycle costs for transmutation and processing of the currently projected inventory of civilian spent nuclear fuel

The report conclusions include the following:

- The implementation of Accelerator Transmutation of Waste technology will require years of additional research.
- The implementation of Accelerator Transmutation of Waste technology would require a significant investment in research and development funding.
- Accelerator Transmutation of Waste is technically feasible, but it would require billions of dollars and many decades to fully construct and operate a transmutation facility, and it would not eliminate the need for a repository.
- Complex institutional and public acceptance issues regarding the technology would have to be resolved.

A successful Accelerator Transmutation of Waste program would last approximately 117 years and would cost at least $281 billion dollars. Such a program could reduce the radioactivity of commercial waste by a factor of 10 to 100.

Since the October 1999 publication of the Accelerator Transmutation of Waste Roadmap, DOE's transmutation research and development program has undergone significant changes. It is currently managed as an Advanced Accelerator Applications program, with the goal of evaluating the technical feasibility of nuclear waste transmutation using a broader technology base than was covered by the earlier Roadmap. A general description of the modified program was presented in *The Advanced Accelerator Applications Program Plan* on March 30, 2001 (DIRS 156711-DOE 2001, all).

Among other aspects of the program, the plan discusses the proposed design and operation of an Accelerator Driven Test Facility as part of a research and development program that would evaluate combinations of critical and subcritical transmutation systems. These have the potential for utilizing the strengths of each transmutation technology in combination, the effectiveness of which is expected to be greater than either taken separately. A revised roadmap describing the program's new directions is currently being prepared.

The elimination or reduction of certain radionuclides in the disposal inventory could add flexibility to the design of the repository and reduce uncertainties about its performance. DOE will incorporate information from any future studies in its decisions during the preparation of a Mitigation Action Plan for this EIS and during the repository licensing process, if those became necessary.

9.1.4 MITIGATION ACTION PLAN

To minimize potential impacts from the Proposed Action (if the repository site was designated), DOE is evaluating the preparation of a Mitigation Action Plan containing specific commitments for mitigating adverse environmental impacts associated with the Proposed Action. The plan would describe specific actions DOE would take to implement mitigation commitments and would reflect available information about the course of action. DOE could revise this Plan as more specific and detailed information became available.

The Mitigation Action Plan would incorporate all practicable measures to avoid or minimize adverse environmental and human health impacts that could result from the implementation of the Proposed Action. The Plan would contain:

1. An introduction describing the basis, function, and organization of the Plan
2. A summary of the impacts to be mitigated
3. A statement of mitigation goals, objectives, and performance standards
4. A description of specific mitigation actions
5. A description of the Mitigation Action Plan monitoring and reporting system that DOE would implement to ensure that elements of the Plan were met

Precise mitigation measures cannot be identified at present. For example, transportation route selection decisions would affect the potential for impacts to areas of importance to Native Americans, to local communities, or to the general environment; repository or transportation corridor construction activities could reveal new cultural resource sites. DOE would consult with Native American tribes and local governments in developing the Mitigation Action Plan. If activities associated with the Proposed Action could affect specific sacred or ceremonial areas or resources or other areas of importance, DOE could develop procedures for controlled access as long as project integrity was not compromised.

DOE would prepare the Mitigation Action Plan in compliance with applicable regulations. The Plan would accompany any License Application to the Nuclear Regulatory Commission.

9.1.5 MONITORING

DOE would conduct the following monitoring activities during all phases of the project to ensure the implementation of the Proposed Action as described and to ensure mitigation of impacts:

- Continue the performance confirmation program which consists of tests, experiments, and analyses, during all phases of the repository project to evaluate the accuracy and adequacy of the information it used to determine with reasonable assurance that the repository would meet the performance objective for the period after permanent closure.

- Monitor groundwater quality, air emissions, and the repository workplace to ensure project worker safety and other aspects of project interaction with the natural and human environment during the construction, operation and monitoring, and closure phases of the project.

- Conduct cultural resources monitoring activities as appropriate before and during surface disturbance activities to identify and assess the potential for impacts to previously unidentified archaeological resources.

- Conduct monitoring and reporting activities to ensure the implementation and effectiveness of mitigation measures and to ensure in general the accomplishment of the elements of the Mitigation Action Plan.

- Monitor material emplaced in the repository starting with the first emplacement of waste packages and continuing through closure.

- After the completion of emplacement, continue to monitor and inspect waste packages and continue performance confirmation activities.

- After sealing the repository openings, conduct postclosure monitoring to ensure acceptable repository performance. Details of this program would be defined during processing of the license amendment for repository closure rather than now to take advantage of appropriate technology, including technology that might not be currently available.

9.2 Yucca Mountain Repository

This section discusses mitigation measures DOE has determined it would implement, or has identified for consideration, to reduce potential impacts from the construction, operation and monitoring, and eventual closure of the proposed repository.

9.2.1 LAND USE

The Yucca Mountain site is remote and is partly withdrawn for specific Federal uses. The permanent withdrawal of land for the repository would prevent public use of the withdrawn lands for other purposes.

Land Use Measures Under the Proposed Action

- Reclaim lands disturbed during the construction process and not required for permanent use by the repository and surface support facilities.

9.2.2 AIR QUALITY

Construction and operation activities such as vehicle movement, clearing, grading, rock pile maintenance, and excavating could generate substantial quantities of fugitive dust. Standard mitigation measures could reduce dust emissions from fugitive dust-generating activities at the Yucca Mountain site. Other dust-generating sources such as operation of the concrete batch plant and backfill preparation facilities would be comparatively small contributors. DOE expects concentrations of other criteria pollutants to be less than 1 percent of regulatory limits (see Chapter 4, Section 4.1.2). Activities that would generate other criteria pollutants include the operation of internal combustion engines in construction equipment, boiler operation, and similar devices, along with limited emissions of radionuclides.

Air Quality Measures Under the Proposed Action

- Reduce fugitive dust emissions using standard dust control measures routinely applied during construction projects including, for example, routine watering of unpaved surfaces; wet suppression for material storage, handling, and transfer operations; and wind fences to control windblown dust. The efficiency of these controls tends to vary depending on site characteristics, but it ranges from a 60- to 80-percent reduction in fugitive dust emissions (DIRS 103676-Cowherd, Muleski, and Kinsey 1988, p. 5-22).

- Reduce maximum fugitive dust concentrations with working controls such as scheduling construction operations to minimize concurrent generation by activities that were near each other (for example, conducting adjacent clearing and grading activities at different times).

- High-efficiency particulate air filters and modern facility design to minimize the potential for airborne contamination.

9.2.3 HYDROLOGY

This section describes potential mitigation measures for surface water and groundwater.

9.2.3.1 Surface Water

Potential impacts to surface water from the construction, operation and monitoring, and eventual closure of the proposed repository would fall into the following categories: (1) introduction of contaminants, (2) alteration of drainage either by changing infiltration and runoff rates or channel courses, and (3) flood hazards. Changes in infiltration and runoff rates could alter flow rates in channels, cause ponding, and increase erosion. DOE expects such impacts to be minimal (see Chapter 4, Section 4.1.3). Nevertheless, the mitigation of impacts could produce such benefits as erosion control and pollution prevention.

Flash floods could spread contamination from accidental spills. Design and operational controls could mitigate the potential for contamination of surface water from accidental releases of radiological or hazardous constituents. DOE's intent would be to respond rapidly with appropriate cleanup actions.

Surface-Water Measures Under the Proposed Action

- Minimize disturbance of surface areas and vegetation, thereby minimizing changes in surface-water flow and soil porosity that would change infiltration and runoff rates.

- Mitigate flood hazards by designing facilities to withstand or accommodate a 100-year flood, and by designing facilities that would manage radiological materials to withstand the calculated probable maximum flood.

- Minimize physical changes to drainage channels by building bridges or culverts where roadways would intersect areas of intermittent water flow. Use erosion and runoff control features such as proper placement of pipe, grading, and use of rip-rap at these intersections to enhance the effectiveness of the bridges or culverts.

- Maintain natural contours to the maximum extent feasible, stabilize slopes, and avoid unnecessary offroad vehicle travel to minimize erosion.

- In and near floodplains, follow reclamation guidelines (DIRS 102188-YMP 1995, all) for site clearance, topsoil salvage, erosion and runoff control, recontouring, revegetation, siting of roads, construction practices, and site maintenance.

- Implement best management practices, including training employees in the handling, storage, distribution, and use of hazardous materials, to provide practical prevention and control of potential contamination sources.

- Conduct fueling operations and store hazardous materials and other chemicals in bermed areas away from floodplains to decrease the probability of an inadvertent spill reaching the floodplains.

- Provide rapid response cleanup and remediation capability, techniques, procedures, and training for potential spills.

- Use sediment-trapping devices such as hay or straw bales, fabric fences, and devices to control water flow and discharge to trap sediments moved by runoff.

Surface-Water Measures Under Consideration

- Use physical controls such as secondary containment for fuel storage tanks to reduce the potential for releases to mingle with stormwater runoff.

9.2.3.2 Groundwater

Impacts to groundwater from the proposed repository could include introduction of contaminants and alteration of infiltration and runoff rates that could change the rate of recharge to the aquifer. Design and operational actions to reduce such impacts for the active life of the repository and the alteration of infiltration and runoff rates would be identical to those described above for surface-water impacts.

The purpose of proposing a monitored geologic repository is to provide a natural setting that, with engineered repository and waste package barriers, would provide long-term confinement and isolation of spent nuclear fuel and high-level radioactive waste. Two aspects of groundwater analysis—(1) the ability of the repository and the engineered barriers to keep waste packages isolated from groundwater over time, and (2) the extent to which groundwater could become contaminated with radionuclides from breached waste packages and transport radionuclides to places where human exposure could occur—are central elements in determining the potential for a proposed repository to succeed.

DOE's detailed study of the Yucca Mountain site has resulted in the inclusion of many engineered barrier elements to complement the site's natural characteristics to keep unsaturated zone groundwater from reaching and transporting radionuclides and, thereby, to reduce the long-term potential for impacts. The following summarizes the engineered barrier elements that would contribute to a reduction of the long-term potential for impacts from radionuclides isolated in a Yucca Mountain Repository.

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Groundwater Measures Under the Proposed Action

- The Yucca Mountain site has several characteristics (as described in Chapter 3) that indicate a high potential for reducing possible long-term impacts from the disposal of spent nuclear fuel and high-level radioactive waste, including:
  - The Yucca Mountain vicinity is isolated from concentrations of human population and human activity and is likely to remain so.
  - The climate is arid and conducive to evapotranspiration, resulting in a relatively small volume of water that has the capability to move as groundwater within the unsaturated zone of the mountain.
  - The groundwater table is substantially below the level at which DOE would locate a repository, providing additional separation from materials emplaced in waste packages.
  - The sparsely populated hydrogeologic basin into which groundwater from Yucca Mountain flows is closed, providing a barrier to a general spread of radionuclides in the event waste packages were breached and radionuclides reached groundwater.
- Use performance confirmation measures to detect any departure from expected capability of the repository in confining and isolating waste.
- Recycle water collected in subsurface areas for use in dust suppression and other activities, to minimize water consumption.
- Implement measures to minimize the potential for water used during operations to interfere with waste isolation in the repository.
- Minimize surface disturbance, thereby minimizing changes in surface-water flow and soil porosity that could change infiltration and runoff rates.
- Use corrosion-resistant waste packages and other engineered barriers, such as drip shields, to prevent water intrusion.
- Monitor to detect and define unanticipated spills, releases, or similar events.
- Evaluate scenarios to minimize the potential for different heat levels to have a direct effect on corrosion rates and the integrity of containers, as well as on the hydrology, geochemistry, and stability of the drifts. High levels could indirectly affect general groundwater flow and the transport of radionuclides.
- Use stainless-steel-lined concrete basins that include leak detection systems, pool cleanup equipment, and transfer equipment capable of moving waste in the event of a leak, and that are designed to seismic standards to minimize the potential for leaks in fuel transfer and holding pools located inside surface facilities.
- Use drip shields to deflect water migrating downward through the unsaturated zone to waste emplacement areas.

9.2.4 BIOLOGICAL RESOURCES AND SOILS

Potential impacts to biological resources and soils from repository construction, operation and monitoring, and closure could result from land clearing, vehicle movement, materials placement, trenching and excavation, and accidents. This section discusses the potential mitigation of impacts that could affect the desert tortoise and biological resources and soils in general.

9.2.4.1 Desert Tortoise

The desert tortoise is the only Federally protected species that resides on the site of the proposed repository (see Chapter 3, biology sections). Activities that could cause impacts to desert tortoises include site clearing, vehicle traffic, pond management, and taking of habitat. Since 1990, DOE has been conducting site characterization activities in accordance with Fish and Wildlife Service biological opinions on the potential for impacts to desert tortoises (DIRS 104618-Buchanan 1997, pp. 1 and 2). During these activities, five desert tortoises are known to have been killed by site characterization activities, all by vehicle traffic. A recent report (DIRS 103194-CRWMS M&O 1998, p. 9) indicates that 27 of 28 tortoise relocations were successful and that two nest relocations were also successful. The one unsuccessful relocation involved a tortoise that returned to the area of disturbance and became one of those killed by traffic.

DOE submitted to the U.S. Fish and Wildlife Service a biological assessment of the effects of construction, operation and monitoring, and closure of a geologic repository at Yucca Mountain. The U.S. Fish and Wildlife Service has produced a Final Biological Opinion on the effects of construction, operation and monitoring, and closure of a geologic repository at Yucca Mountain (see Appendix O). The Final Biological Opinion establishes conditions for repository construction, operation and monitoring, and eventual closure as well as for the remaining site activities prior to repository construction (if the site was approved). The Final Biological Opinion does not evaluate effects that could occur to the desert tortoise from the construction of transportation infrastructure and transportation of materials.

In its Final Biological Opinion, the U.S. Fish and Wildlife Service lists five reasonable and prudent measures to minimize impacts to the desert tortoise, and then lists 18 terms and conditions with which DOE must comply to implement the five measures. The Final Biological Opinion states reporting requirements upon the location of an injured or dead desert tortoise and conservation recommendations to minimize or avoid adverse effects on listed species or critical habitat. If the repository was authorized, DOE would observe and implement all terms and conditions, reporting requirements, and conservation recommendations that the U.S. Fish and Wildlife Service has established in its Final Biological Opinion to protect the desert tortoise. DOE expects to observe and implement all terms and conditions, reporting requirements, and conservation recommendations in any future biological opinions regarding the effects of transportation or other project activities on the desert tortoise or other listed species.

As discussed in Chapter 4, the proposed repository location is at the extreme northern edge of the range of the desert tortoise, and the population of tortoises at that location is small in relation to other portions of its range. No part of the repository location has been declared critical habitat for the desert tortoise.

Desert Tortoise Measures under the Proposed Action

DOE adopts all impact reduction measures and all terms and conditions established by the U.S. Fish and Wildlife Service to protect the desert tortoise.

The following text summarizes the five reasonable and prudent measures established in the U.S. Fish and Wildlife Service's Final Biological Opinion (see Appendix O), and identifies the terms and conditions that the Biological Opinion has set forth to implement each reasonable and prudent measure:

1. Minimize take of desert tortoises due to project-related activities and operation of heavy equipment

- A qualified biologist would conduct clearance surveys for tortoises before vegetation removal or soil disturbance of more than 0.02 square kilometer (5 acres) or when records indicated that tortoises could occur in the area to be disturbed. Project activity would be moved if there was an adjacent area free of tortoises on which the activity could be conducted. If no suitable site was available, the biologist would determine the site having the smallest impact on tortoises and their habitat.

- The biologist would conduct 100 percent coverage clearance surveys the day before or the day of surface-disturbing activity, during the tortoise activity season, and within 7 days before surface-disturbing activity during hibernation. If tortoises or eggs were found, they would be moved pursuant to U.S. Fish and Wildlife Service guidelines. Burrows would be conspicuously flagged and avoided by at least 9 meters (30 feet).

- Unavoidable burrows would be inspected. If unoccupied, burrows would be collapsed to prevent tortoise entry. If tortoises or eggs were present, they would be excavated by hand and moved.

- If removed from a burrow, a tortoise would be placed in the shade of a shrub or an existing, similar, unoccupied burrow. A tortoise moved when in hibernation, estivation, or brumination (dormant states due to heat or cold) would be placed in an adequate unoccupied or constructed burrow.

- Project activities that could endanger a tortoise would cease if a tortoise was found on a project site and would not resume until after the tortoise moved or was moved out of danger by the biologist.

- A desert tortoise biologist or environmental monitor would be at the site during all phases of construction to ensure compliance with the Biological Opinion and to protect tortoises from harm. The environmental monitor would be responsible for: (1) enforcing the litter-control program; (2) ensuring that tortoise-proof fences were maintained; (3) ensuring that tortoise habitat disturbance was restricted to authorized areas; (4) ensuring storage of all equipment and materials within construction zones or previously disturbed areas; (5) ensuring that all vehicles used existing graded or paved roads or stayed within construction zones; (6) ensuring inspection of open trenches and other excavations; (7) ensuring that speed limits were observed; and (8) ensuring compliance with all terms and conditions of the Biological Opinion. Environmental monitors would not be authorized to handle tortoises.

- Vehicles would not be driven off existing roads in nonemergency situations unless authorized by DOE. Vehicle paths would be cleared of tortoises pursuant to terms of the Biological Opinion.

- Vehicles would be driven at speeds within posted limits on existing roads, and would not exceed 40 kilometers (25 miles) per hour on unposted roads.

- DOE would continue to present a tortoise education program to all employees on the project site and would address specific issues identified in the Biological Opinion. The education program would include definition of “take” and specification, actions that must be avoided, procedures for handling tortoises found on roads, and identification of personnel authorized to handle or otherwise capture and relocate tortoises.

- Marking or telemetry of tortoises would not be allowed.

2. Minimize entrapment of tortoises in open trenches.

    - During tortoise active season, all open trenches with slopes steeper than 0.3 meter (1 foot) rise per 0.9 meter (3 feet) of length would be fenced off, covered, or constructed with escape ramps if they were not immediately backfilled.

    - Open trenches would be inspected for entrapped animals immediately prior to backfilling.

    - If a tortoise was discovered in a trench, all activities associated with the trench would cease until a qualified biologist had removed the tortoise.

3. Minimize predation on tortoises by ravens drawn to the project area.

    - DOE would implement a litter control program that would include the use of covered, raven-proof trash receptacles; disposal of edible trash in trash receptacles after each workday; and disposal of trash in a sanitary landfill. Materials placed in a landfill would be covered often enough to prevent ravens and other predators from feeding in the area.

4. Minimize destruction of tortoise habitat due to project activities

    - DOE would revegetate areas no longer required by the project in accordance with existing procedures and pursuant to site-specific rehabilitation plans prepared in accordance with the Biological Opinion.

5. Ensure compliance with reasonable and prudent measures, terms and conditions, reporting requirements, and reinitiation requirements in the Biological Opinion.

    - DOE personnel would have to acquire appropriate State permits from the Nevada Division of Wildlife prior to handling a desert tortoise, carcass, or egg.

    - DOE would designate a field representative (who could also serve as the environmental monitor), who would be responsible for overseeing compliance with protective stipulations and for coordinating compliance with the terms and conditions of the Biological Opinion, and who would have authority to halt construction equipment activities that could be in violation of the protective stipulations.

    - DOE would keep an up-to-date log of all actions related to the consultation, including acreage affected, habitat rehabilitation actions completed, number of desert tortoises taken and by what means (injured, killed, captured and displaced, or found in trenches or pits). The information would be provided to the U.S. Fish and Wildlife Service Las Vegas Office in the form of an annual report on February 28 of each year during which activities addressed by the Biological Opinion occurred.

9.2.4.2 General Biological Resources and Soils

Impacts to biological resources at the Yucca Mountain site could include habitat fragmentation, loss of individual members of different species, and encroachment of noxious weeds.

Potential soil impacts or concerns related to the proposed repository can be categorized as (1) increased soil erosion rates, (2) slow recovery rate of disturbed soils in the Yucca Mountain environment, and (3) introduction of contaminants. Erosion could result in the loss of the thin topsoil from the disturbed areas, which could affect long-term recovery, be a threat to structures in the region, and result in increased depositions downhill.

General Biological Resources and Soils Measures Under the Proposed Action

- Use the measures described in Section 9.2.2 to control erosion, dust, and particulate matter and therefore to lessen the consequences for biological resources and soils from repository construction, operation and monitoring, and closure.
- Use dust suppression measures such as application of water or environmentally sensitive methods to minimize wind and other erosion and aid recovery on disturbed areas.
- Conduct preconstruction surveys in floodplains to ensure that work would not affect important biological resources and to determine the reclamation potential of sites.
- Consider measures to relocate or avoid sensitive species in floodplains.
- If construction could threaten important biological resources in floodplains, and modification or relocation of the roads and rail line would not be reasonable, develop additional mitigation.

General Biological Resources and Soils Measures Under Consideration

- Align and locate facilities, roadways, cleared areas, laydown areas, and similar construction activities to minimize fragmentation of habitat potentially affected by the proposed project.
- Mitigate potential soil erosion by minimizing areas of surface disturbance and using engineering practices to stabilize disturbed areas. These practices could include such measures as stormwater runoff control through the use of holding ponds, baffles, and other devices and the compacting of disturbed ground, relocated soil, or excavated material in places outside desert tortoise habitat.
- Mitigate the introduction of contaminants to soils, using methods similar to those described for surface-water impacts (see Section 9.2.3.1).
- To aid recovery, strip and stockpile topsoil from disturbed areas (excavated rock pile, etc.). When the disturbed areas are no longer needed, spread the topsoil over the areas and reseed the soil to improve the success of vegetation reestablishment and prevent encroachment of invasive species.
- Provide escape ramps from ponds and basins.

9.2.5 CULTURAL RESOURCES

Land clearing, excavation, and construction activities have the potential to disturb or cause the relocation of cultural artifacts. The operation of industrial facilities can degrade the value of traditional sites or uses. In addition, human activity in project areas causes concern that members of the workforce could affect cultural resource sites, especially those at buried locations or with artifacts.

Actions that DOE would take to mitigate adverse impacts to cultural resources at Yucca Mountain include those required by law or regulation and those that DOE determined the project would include to reduce such impacts. In some cases, precise mitigation measures cannot be identified due to the limited nature of the data (for example, construction activities could reveal previously unidentified sites). To address these cases, programmatic mitigation measures that comply with historic preservation laws and regulations are in place to ensure that DOE would implement appropriate measures following the identification and evaluation of important cultural resources.

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The *Programmatic Agreement Between the United States Department of Energy and the Advisory Council on Historic Preservation for the Nuclear Waste Deep Geologic Repository Program, Yucca Mountain, Nevada* (DIRS 104558-DOE 1988, all) contains the requirements and general procedures for the mitigation of adverse effects at important archaeological and historic sites in the Yucca Mountain region during site characterization. DOE would work to review and update that agreement to establish requirements and procedures for mitigation of any adverse effects at important archaeological and historic sites during construction, operation and monitoring, and closure of the proposed repository in the event the repository was authorized.

The *Research Design and Data Recovery Plan for the Yucca Mountain Project* (DIRS 103196-DOE 1990, all) outlines more detailed approaches and procedures for implementing the mitigation of impacts to archaeological sites. Along with other topics, that document provides specific guidelines for determining the rationale, methods, analytical requirements, and logistics for archaeological mitigation measures at Yucca Mountain. In addition, the Department would consult with affected Native American tribes and organizations to ensure that repository activities avoided or minimized adverse impacts to resources or places that are important to American Indians.

Cultural Resources Measures Under the Proposed Action

- Ensure that onsite employees complete cultural resource sensitivity and protection training to reduce the potential for intentional or accidental harm to sites or artifacts. The training could include descriptions of the importance of different cultural resource types, procedures to follow if resources were encountered in the field, and employment-related and legal penalties for not following the requirements.

- Continue to use the Yucca Mountain Project Native American Interaction Program, which has been in existence since 1985, to promote a government-to-government relationship with Native American tribes and concentrate on the continued protection of important cultural resources. A considerable part of this effort could continue to be directed at protecting these resources and mitigating adverse effects to the fullest extent possible. Historically, as part of this program, members of Native American tribes have made recommendations to DOE about potential adverse effects, mitigation procedures that involve required consultation with tribal governments, and direct involvement of Native Americans in proposed project activities that could affect cultural resources or values (DIRS 102043-AIWS 1998, pp. 1-1, 2-3, and B-1 *et seq.*). Examples of suggested mitigations include incorporating the assistance of Native American people, continued protection of archaeological sites, funding Native American studies on impacts to natural resources and impacts from transportation (DIRS 102043-AIWS 1998, pp. 4-8 to 4-12).

- Conduct preconstruction surveys to ensure that work would not affect important archaeological resources and to determine the research potential of sites.

- If construction could threaten important archaeological resources, and modification or relocation of roads or rail lines would not be reasonable, develop additional mitigation measures.

9.2.6 OCCUPATIONAL HEALTH AND PUBLIC SAFETY

There would be a potential for repository workers to be exposed to radiation during the operation and monitoring and closure phases of repository activities or to be injured or killed as a result of hazards present in the industrial workplace (Chapter 4, Sections 4.1.7 and 4.1.8; Chapter 8, Section 8.2.7).

Erionite and cristobalite are hazardous materials that occur naturally in the Yucca Mountain subsurface. Erionite occurs in strata at varying depths below the planned level of the repository. DOE is mapping these strata as part of a general approach that emphasizes avoidance of erionite. If erionite was encountered during drilling, DOE would shut down the affected portion of its operation until it could put proper controls in place.

Cristobalite, which occurs generally in the subsurface rock structure, could be released during excavation operations or in fugitive dust from the excavated rock pile. There would be a potential for cristobalite to be an inhalation hazard to workers. Implementing specific health and safety plans to prevent worker exposure would minimize risks. Chapter 4, Section 4.1.7, discusses erionite and cristobalite.

After closure, there would be potential for human intrusion that could result in release of radioactive materials.

Occupational and Public Health and Safety Measures Under the Proposed Action

- Avoid erionite-bearing strata where practicable during repository construction and drift development.
- If drilling encountered erionite, close operations in potentially affected areas until proper controls were in place.
- Use high-efficiency particulate air filters or similar controls if drilling occurred in an area where there is potential for encountering erionite.
- Design repository construction procedures to reduce the risk of worker inhalation of cristobalite or erionite.
- Specify features of ventilation systems and other underground equipment to ensure the elimination of opportunities for occupational exposure to health and safety hazards.
- Use ventilation, planned transfer of cristobalite from work areas, and scrubbing of in-place dust to minimize exposure. Use monitoring devices and respirators as appropriate.
- Use ventilation to keep radon levels low in subsurface areas. Use higher ventilation rates and shorter air travel paths to reduce worker exposure to radon.
- Unload, handle, and package spent nuclear fuel and high-level radioactive waste remotely in hot cells or under water.
- Provide appropriate shielding during operations and during shipping and handling of packages when personnel would be present and could be exposed.
- Minimize to the extent practicable the amount of time workers would spend in the subsurface environment.
- Design task procedures to reduce the potential for accidents.
- Implement health and safety procedures and administrative controls to minimize risks to construction and operations workers.
- Design task procedures to reduce the potential for accidents that could lead to radioactivity releases in the workplace environment.

9.2.7 AESTHETICS

Construction, operation and monitoring, and closure of the proposed repository would require the lighting of certain areas of the repository at night. While the repository site is remote, and there are existing sources of nighttime light in the region, nighttime darkness is a valued component of the solitude experience sought by many individuals. Nighttime darkness enhances astronomy and stargazing activities and is one of the important scenic resources of Death Valley National Park.

Aesthetics Measures Under the Proposed Action

- Use exterior lighting only where needed to accomplish facility tasks.
- Limit the height of exterior lighting units, focusing more light on the ground surface and reducing the effects of night lighting on surrounding areas. This limitation would enable the use of reduced wattage output lamps, but could require the use of additional lighting units to obtain the same amount of ground coverage.
- Use shielded or directional lighting to limit the effects of the lighting to areas where it is needed.

Aesthetics Measures Under Consideration

- Orient ventilation system stacks and support structures and use re-contouring and natural vegetation to reduce facility visibility.

9.2.8 UTILITIES, ENERGY, AND MATERIALS

A monitored repository at Yucca Mountain would require a range of utility services, energy to power a variety of activities, and a number of diverse materials. DOE intends to promote efficiency in the use of utilities, energy, and materials.

Utility, Energy, and Materials Measures Under the Proposed Action

- Implement procedures and equipment that would minimize the use of utility services, energy, and materials.

9.2.9 MANAGEMENT OF REPOSITORY-GENERATED WASTE AND HAZARDOUS MATERIALS

As part of the repository design, DOE would institute a waste minimization program similar to the waste minimization and pollution prevention awareness plan successfully implemented during site characterization activities to minimize quantities of generated waste and to prevent pollution (DIRS 103203-YMP 1997, all). In addition, DOE would consider innovations to augment the existing program. The Department could keep the size of the Restricted (for radiological control) Area as small as possible, and it could implement programs to ensure that construction and operation activities used, as practicable, smaller quantities of products such as solvents and cleaners. The design of the proposed repository would incorporate pollution prevention measures and would provide cradle-to-grave waste management, as DOE provided during site characterization.

Waste and Hazardous Materials Measures Under the Proposed Action

- Recycle wastewater to reduce the amount of water needed for repository facilities and the amount of wastewater that could require disposal (DIRS 100248-CRWMS M&O 1997, p. 14).
- Use practical, state-of-the-art decontamination techniques such as pelletized solid carbon dioxide blasting that would reduce waste generation in comparison with other techniques (DIRS 100248-CRWMS M&O 1997, pp. 9-13 and 9-14).

- Institute preventive maintenance and inventory management programs to minimize waste from breakdowns and overstocking (DIRS 104508-CRWMS M&O 1999, p. 55).

- Whenever practicable, recycle nonradioactive materials such as paper, plastic, glass, nonferrous metals, steel, fluorescent bulbs, shipping containers, oils, and lubricants rather than dispose of them (DIRS 104508-CRWMS M&O 1999, pp. 62 and 70). Encourage the reuse of materials and the use of recycled materials.

- Avoid use of hazardous materials where feasible.

Waste and Hazardous Materials Measures Under Consideration

- When protective of the environment and cost effective, recycle dual-purpose canisters.

- Recycle solar panels if cost-effective and environmentally sound recycling options are available.

9.2.10 LONG-TERM REPOSITORY PERFORMANCE

DOE proposes a repository at Yucca Mountain to provide for permanent disposal of spent nuclear fuel and high-level radioactive waste. DOE's proposal includes a natural geologic setting that, with engineered repository and waste package barriers, would provide long-term isolation of spent nuclear fuel and high-level radioactive waste. In its design process, DOE is considering many features and approaches to contain and isolate the materials it proposes to place in the repository.

DOE's detailed study of the Yucca Mountain site and vicinity has resulted in the evaluation of three categories of potential measures: Barriers to limit the release and transport of radionuclides, measures to control heat and moisture in the confined environment of the repository, and measures to improve operational efficiency or safety. Each of these measures has the potential to complement the site's natural characteristics. These measures are conceptual in nature. The following sections summarize design features that could contribute to a reduction of the long-term potential for impacts from radionuclides isolated in a Yucca Mountain Repository. Long-term performance measures are discussed in more detail in Appendix E.

Long-Term Performance Measures Under the Proposed Action

DOE has designed an engineered barrier system that would complement the geologic and hydrologic properties of Yucca Mountain to isolate radionuclides in spent nuclear fuel and high-level radioactive waste from accessible portions of the environment. Design features that are part of the Proposed Action are presented below. The repository flexible design described in Chapter 2 of this EIS can be operated in a range of operating modes, from higher- to lower-temperature. Measures that are unique to only one operating mode are so noted.

- Use two-layer waste packages designed to remain intact for thousands of years (at a minimum), with layers that would fail only from different mechanisms and at different rates.

- Encapsulate spent nuclear fuel (normally in zirconium-alloy cladding) and immobilize high-level radioactive waste (normally in borosilicate glass or ceramic matrices) in the waste packages.

- Use nickel-chromium alloy (Alloy-22) emplacement pallets to hold waste packages off the floors of emplacement drifts.

- Use heat generated from the decay of radioactive material to heat the surrounding rock to drive water and gas away from the emplaced waste packages (higher-temperature operating mode).

- Use drip shields to provide a partial barrier to divert infiltrating water away from waste packages in an emplacement drift.

- Ground support options – Placing an engineered system into repository drifts to ensure drift stability before closure could both enhance safety during emplacement and potential retrieval and improve long-term repository performance by reducing or delaying damage to canisters from rockfall (damaged areas are locations for enhanced corrosion even if the canister is not breached by the rockfall).

- Increase the spacing between waste packages or drifts, or reduce the size of waste packages and maintain spacing to potentially reduce uncertainties regarding elevated temperature of the host rock and reduce waste package material corrosion rates (lower-temperature operating mode).

- Waste package spacing and drift spacing – Emplacing waste packages nearly end-to-end [that is, with a 0.1-meter (0.3-foot)-gap] with no consideration of individual waste package characteristics would provide a more intense and uniform heat source along the length of emplacement, requiring an increase in emplacement drift spacing and, potentially, continuous ventilation of emplacement drifts, but also would keep emplacement drifts hot and dry for a longer period, decrease the amount of water that could contact waste packages, and reduce the number of emplacement drifts needed for waste emplacement (higher-temperature operating mode).

- Use preemplacement aging and blending of spent nuclear fuel and high-level radioactive waste to provide thermal performance benefits. Aging would reduce the total thermal energy that the repository must accommodate, and blending would reduce the variability in the distribution of the thermal energy in the repository drifts. Potential benefits would be improved rock stability and retardation of waste package degradation (lower-temperature operating mode).

- Continuous preclosure ventilation – Continuous ventilation in the emplacement drifts before repository closure would reduce rock wall and air temperatures and remove moisture to reduce corrosion rates and increase the stability of the ground support system.

- Timing of repository closure – Extending the period before final closure, together with a maintenance program to accommodate an extended long-term repository service life and ground support components designed and maintained for a service life of up to 300 years, would allow for reduction of waste package heat output after closure, extended monitoring before closure, and an extended retrieval period for the waste (lower-temperature operating mode).

Long-Term Performance Measures Under Consideration

The design features listed below are being considered, though some are not currently under active consideration. These features are organized by their design purpose, either to limit release and transport of radionuclides, control heat and moisture in the repository environment, or support operational considerations.

Barriers to Limit Release and Transport of Radionuclides. The most direct method to provide the long-term isolation of contaminants is to use structures and techniques that have the potential to inhibit directly the release of contaminants from waste packages or to reduce the likelihood of the transport of released contaminants from the repository. DOE is considering a range of barrier measures that could enhance resistance to corrosion, delay or reduce water transport, retard radionuclide movement and release rates, and reduce the potential for damage to canisters. The Department will continue to evaluate the potential benefits and consequences of these measures together with their compatibility with overall repository system design.

- Ceramic coatings on the exterior of the waste package – Could increase waste package life and repository waste isolation performance by reducing corrosion of the waste package surface and delaying the release of radionuclides.

- Diffusive barrier under waste packages – Loose, dry, granular material placed in the space between each waste package and the bottom of the emplacement drift to form a restrictive barrier to seepage, potentially slowing fluid and radionuclide movement to the natural environment.

- Getter under waste package – Placing a fine-grained material [either phosphate rock (apatite) or iron oxide (hematite, geothite, etc.] with an affinity for sorption of radionuclides in the recess below waste packages prior to waste emplacement could improve long-term waste isolation through retardation of radionuclide movement from the repository drifts.

- Canistered assemblies and waste-specific disposal containers – Placing spent fuel assemblies in canisters at the Waste Handling Building before inserting them into waste packages could provide an additional barrier and further limit mobilization of radionuclides if the waste package was breached.

- Additives and fillers – Placing materials (for example, oxides of iron and aluminum) into waste packages (in addition to those normally required for the basket material) to fill the basket and waste form void spaces could improve both the long-term repository performance (by retarding of release of radionuclides to the groundwater) and the long-term *criticality control*.

Measures to Control Heat and Moisture in the Repository Environment. Long-term influence over heat and moisture in the repository environment could increase the ability of the waste packages to isolate waste. DOE has evaluated measures that have the potential to control temperature and humidity levels in the repository to reduce corrosion rates, increase structural and support system stability, and increase the capability to retain released radionuclides in the repository. The Department will continue to examine the potential for enhancements in repository performance offered by these measures, other consequences of implementing them, and their compatibility with overall repository system design. DOE is considering the items listed below:

- Tailored waste package spatial distribution – Tailoring spatial distribution of the waste packages within the repository block according to waste package heat production, or the tendency of radionuclides in different packages to travel, resulting in a more uniform temperature across the repository. This would improve the performance of waste packages by delaying and reducing contact of water and/or increasing sorption of released radionuclides by zeolites in the unsaturated zone, thereby potentially improving repository waste isolation performance.

- Continuous postclosure ventilation design – Continuous ventilation of the emplacement drifts during the postclosure period could increase removal of moisture from air around the waste packages for a period of time (though moisture would eventually reestablish itself), and it could improve performance by retarding waste package corrosion.

- Drift diameter – A smaller diameter drift would be more stable (less rockfall potential), could reduce seepage into the drifts, and could reduce the need for ground support systems, while a larger diameter drift would allow for other modes of emplacement, such as horizontal or vertical borehole emplacement.

- *Near-field* rock treatment during construction – Filling cracks in a portion of the rock above each emplacement drift with grout to reduce or retard water seepage into the drifts after closure of the repository.

- Surface modification (alluvium) – Covering the surface of Yucca Mountain above the repository footprint with alluvium (soil) could decrease the net infiltration of precipitation water into the repository.

- Surface modification (drainage) – Removing the thin alluvium layer over the footprint of the repository would promote rapid runoff of surface water, potentially reducing infiltration from the top and improving long-term isolation of the waste.

Repository Designs to Support Operational Considerations. Including elements in the design that would enhance the repository's operational capabilities could improve access to waste packages after their emplacement, increase access for conducting performance confirmation, inspection, and maintenance activities, ease any effort to augment the repository system with later-developed materials or processes, and facilitate retrieval of waste packages if retrieval became necessary. DOE is considering measures that could provide additional shielding for personnel, increase usable space in drifts, increase opportunities for monitoring, and reduce the potential for moisture to contact waste packages. The Department will continue to assess the potential for design modifications to assist operational activities within the context of overall repository system design. DOE is considering the following potential design modification measures:

- Rod consolidation – Rod consolidation would involve bringing fuel rods into close contact with one another, allowing the capacity of waste packages to be increased and/or the size of waste packages to be reduced, potentially reducing the size or number of waste packages and, if consolidation were accomplished at the reactor sites, possibly reducing waste transportation shipments.

- Waste package self shielding – Adding a shielding material on the outside of waste packages would reduce the radiation in the drifts to levels such that personnel access would be possible.

- Repository horizon – A two-level repository would increase repository capacity without moving out of the characterized area. It would increase thermal load to reduce the amount of water that could come in contact with waste packages; add flexibility in emplacing waste packages on the lower level, which could be shielded from moisture infiltration by the upper level; and potentially facilitate retrieval due to the ability to operate two independent retrieval operations at the same time.

9.3 Transportation

This section discusses mitigation measures DOE is required to implement, has determined to implement, or has identified for consideration, to reduce potential impacts from the national transportation of spent nuclear fuel and high-level radioactive waste. These measures address impacts from the possible construction of a branch rail line or an intermodal transfer station in Nevada; construction of other transportation routes; upgrading of existing Nevada highways to accommodate heavy-haul vehicles; transportation of spent nuclear fuel and high-level radioactive waste from existing storage sites to the proposed repository; and fabrication of casks and canisters.

9.3.1 LAND USE

Mitigation measures could address three types of potential land-use impacts resulting from the construction and operation of a rail line or an intermodal transfer station: (1) impacts to publicly used lands such as grazing allotments, (2) direct and indirect land loss, and (3) displacement of capital improvements. Mitigation would not necessarily be associated with the potential selection of a route for heavy-haul trucks, which would follow existing rights-of-way and would require little additional land disturbance.

Land Use Measures Under the Proposed Action

- Ensure that construction activities were consistent with best management practices, by:

  – Ensuring that the location selection and final route alignment for a branch rail line or location selection for an intermodal transfer station, in consultation with parties controlling the surrounding lands, consider (1) the minimum impacts to private lands, capital improvements, floodplains or wetlands, areas containing cultural resources, or other environmentally sensitive areas, and (2) indirect loss of land or loss of use of land (the division of property or limitation of access) such as the use of grazing allotments.

  – Minimizing the size and number of easements.

  – During the rail construction phase, locating construction camps and staging areas along the rail line in consultation with parties controlling the surrounding lands.

  – Reclaiming disturbed areas outside the permanent right-of-way as soon as practicable after completion of construction.

Land Use Measures Under Consideration

- For grazed lands (lands grazed on by cattle), provide access across routes via underpasses, revegetate disturbed land, and aid in water provision (if access to water sources by herds is impeded).

- Coordinate DOE transportation schedules with U.S. Air Force training schedules to ensure that transportation of spent nuclear fuel and high-level radioactive waste through Air Force-controlled lands to a Yucca Mountain Repository would not result in safety-related restrictions being imposed on Air Force training activities.

- Implement additional rail realignments where feasible to avoid safety-imposed restrictions on U.S. Air Force use of lands the Air Force controls and uses for training purposes.

- If DOE selected the Bonnie Claire Alternate to the Caliente or Carlin rail corridor as part of its transportation route to Yucca Mountain, evaluate the potential for realignment of this alternate to reduce or eliminate the taking of land from the Timbisha Shoshone Trust Lands.

- Initiate no construction that would cross any presently designated wilderness study area unless that study area had been released from interim status by the State Director of the Bureau of Land Management as nonsuitable for wilderness or Congress has acted to remove the Wilderness Study Area designation.

9.3.2 AIR QUALITY

If DOE selected the Valley Modified rail corridor, mitigation measures could be needed to reduce fugitive dust emissions from rail line construction and carbon monoxide emissions from operations in the Las Vegas Valley nonattainment area. As described in Chapter 6, Section 6.3.2.2.5, fugitive dust emissions during the construction phase could be above the General Conformity Rule minimal levels for particulates. Vehicles used to transport workers and trains used to transport materials would generate criteria pollutants. States could place requirements for control of emissions of volatile organic compounds and nitrous oxide on facilities that manufacture containers and casks.

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Air Quality Measures Under Consideration

- Employ two construction crews at half pace from opposite ends if the Valley Modified rail line was selected. Because only approximately 50 percent of the corridor length is in the Las Vegas Valley air basin, emission rates would be reduced to levels at or below General Conformity thresholds.

- Use buses to transport workers, reducing nitrogen oxide and hydrocarbon emissions.

- Reduce fugitive dust emissions using standard dust control measures routinely applied during construction projects including, for example, routine watering of unpaved surfaces; wet suppression for material storage, handling, and transfer operations; and wind fences to control windblown dust. The efficiency of these controls tends to vary depending on site characteristics, but it ranges from a 60- to 80-percent reduction in fugitive dust emissions (DIRS 103676-Cowherd, Muleski, and Kinsey 1988, p. 5-22).

- Reduce maximum fugitive dust concentrations with working controls such as scheduling construction operations to minimize concurrent generation by activities that were near each other (for example, conducting adjacent clearing and grading activities at different times).

9.3.3 HYDROLOGY

This section describes potential mitigation actions for both surface water and groundwater.

9.3.3.1 Surface Water

Three categories of potential impacts to surface water from the construction and operation of a Nevada transportation route are (1) the introduction of contaminants, (2) the alteration of drainage patterns or runoff rates, and (3) flood hazards. The spread of contamination by surface water could result in adverse impacts to plants and animals or to human health in the immediate area. It could also result in the recharge of contaminated water to groundwater. DOE’s intent is to respond rapidly to such spills with appropriate cleanup actions.

Surface-Water Measures Under the Proposed Action

- Minimize disturbance of surface areas and vegetation, thereby minimizing changes in surface-water flow and soil porosity that would change infiltration and runoff rates.

- Mitigate flood hazards by designing facilities to withstand or accommodate a 100-year flood.

- Minimize the potential for contamination spread or other physical impacts to surface water by avoiding spills in unconfined areas and areas subject to flash floods, where practicable, and by locating the alignment of a branch rail line or heavy-haul road to avoid floodplains and surface waters, including wetlands, springs, and riparian areas, when possible, and to minimize any potential impacts to these features.

- Maintain natural contours to the maximum extent feasible, stabilize slopes, and avoid unnecessary offroad vehicle travel to minimize erosion.

- Minimize physical changes to drainage channels by building bridges or culverts where roadways would intersect areas of intermittent water flow. Use erosion control features such as proper placement of pipe, revegetation, and use of erosion control at these intersections where practicable to enhance the effectiveness of the bridges or culverts.

- Use physical controls such as secondary containment for fuel storage tanks to reduce the potential for releases to mingle with stormwater runoff.
- In and near floodplains, follow reclamation guidelines (DIRS 102188-YMP 1995, all) for site clearance, topsoil salvage, erosion and runoff control, recontouring, revegetation, siting of roads, construction practices, and site maintenance.
- Implement best management practices including training employees in the handling, storage, distribution, and use of hazardous materials to provide practical prevention and control of potential contamination sources.
- Conduct fueling operations and store hazardous materials and other chemicals in bermed areas away from floodplains to decrease the probability of an inadvertent spill reaching the floodplains.
- Provide rapid response cleanup and remediation capability, techniques, procedures, and training for potential spills.

Surface-Water Measures Under Consideration

- Designate bermed or contained sites outside areas subject to flash flooding for fueling and chemical handling to minimize the potential for contamination spreading if spills occurred.

9.3.3.2 Groundwater

Potential transportation-related impacts to groundwater would be most likely to occur from construction activities associated with a potential Nevada transportation route and could include introduction of contaminants and alteration of infiltration and runoff rates that could change the rate of recharge to the aquifer. Design and operational actions to reduce impacts would be identical to those described above for surface-water impacts.

Groundwater Measures Under the Proposed Action

- Implement best management practices, such as training employees in the handling, storage, distribution, and use of hazardous materials, to provide practical prevention and control of potential contamination sources.
- Minimize surface disturbance, thereby minimizing changes in surface-water flow and soil porosity that could change infiltration and runoff rates.

Groundwater Measures Under Consideration

- Place construction wells only in undesignated basins. (A Designated Groundwater Basin is one in which the quantity of appropriated water approaches or exceeds the perennial yield as *determined* by the Nevada State Engineer.)
- Employ water-use minimization and recycling techniques to reduce water consumption.

9.3.4 BIOLOGICAL RESOURCES AND SOILS

9.3.4.1 Desert Tortoise

The desert tortoise is a Federally protected species that resides at or along the candidate rail corridors, intermodal transfer station locations, and routes for legal-weight and heavy-haul trucks in Nevada (see Chapter 6, Sections 6.3.1, 6.3.2.1, and 6.3.3.1). Activities that could cause impacts to desert tortoises include site clearing, vehicle traffic, pond management, and taking of habitat.

DOE has been conducting site characterization activities in accordance with Fish and Wildlife Service biological opinions on the potential for impacts to desert tortoises (DIRS 104618-Buchanan 1997, pages 1 and 2). During these activities, five desert tortoises are known to have been killed by site characterization activities, all by vehicle traffic. A recent report (DIRS 103194-CRWMS M&O 1998, page 9) indicates that 27 of 28 individual tortoise relocations were successful and that two nest relocations were also successful. The one unsuccessful relocation involved a tortoise that returned to the area of disturbance and became one of the five killed by traffic.

If the proposed project proceeded, the U.S. Fish and Wildlife Service would establish measures, terms, and conditions for transportation activities that DOE would have to observe to protect the desert tortoise. DOE would implement terms and conditions established in any future biological opinions regarding the effects of repository-related transportation activities on the desert tortoise. As discussed in Chapter 6, areas that would be affected by transportation activities are at the extreme northern edge of the range of the desert tortoise, and the population of tortoises in these areas is low in relation to other portions of its range. No part of any of the candidate transportation routes has been declared critical habitat for the desert tortoise.

The final biological opinion on site characterization (DIRS 104618-Buchanan 1997, pp. 19 to 25) identified the following actions as requirements that DOE would need to implement to minimize impacts on desert tortoises. The U.S. Fish and Wildlife Service could establish similar conditions as prerequisites for transportation activities associated with the proposed project.

- Alignment and final siting of facilities, construction roadways, cleared areas, laydown areas, and similar elements of construction activity could avoid sensitive areas, lessen the likelihood of entrapment of tortoises, and minimize the fragmentation of known desert tortoise habitat.
- Measures to control erosion, dust, and particulate matter would lessen consequences of repository construction, operation and monitoring, and closure for desert tortoises. Similarly, approaches to minimize soil compaction and crushing of vegetation would lessen consequences for desert tortoises.
- Clearance surveys for desert tortoises before vegetation removal or soil disturbances of more than about 2 hectares (5 acres).
- Removal of tortoises or tortoise eggs found in areas to be disturbed, and tortoises in immediate danger along roads or near ongoing activities to safe nearby locations, with project activity ceasing until removal occurred.
- Prohibitions against driving vehicles off existing roads in nonemergency situations unless authorized. All workers at Yucca Mountain would participate in a required tortoise education program.
- A litter-control program that would include the use of covered, raven-proof trash receptacles, disposal of edible trash in trash receptacles following the end of each workday, and disposal of trash in a designated sanitary landfill.
- Revegetation of project areas no longer required.
- Construction and maintenance of tortoise-proof fencing to lessen the potential for endangerment to desert tortoises from project-related activities.
- Placement of escape ramps in trenches and inspection of trenches before filling.

Desert Tortoise Measures Under the Proposed Action

If a consultation process resulted from a determination that construction or operation of a transportation corridor associated with the proposed repository could affect threatened or endangered species or their habitat, DOE will adopt all reasonable and prudent measures to protect the desert tortoise or other species that could be stated in future biological opinions on transportation corridors.

The following text discusses potential transportation-related measures DOE has identified for the protection of the desert tortoise based on determinations the U.S. Fish and Wildlife Service made for site characterization.

- Align and locate facilities, roadways, and cleared areas and place appropriate signs to lessen the likelihood of trapping tortoises and to minimize habitat fragmentation.
- Minimize soil compaction and vegetation crushing.
- Move desert tortoises or desert tortoise eggs from areas to be disturbed, from roadways, and from proximity to ongoing activities to safe nearby locations; stop project activity until completion of these actions.
- Require authorization for nonemergency offroad vehicle travel.
- Ensure that all workers on the Yucca Mountain Project participate in a tortoise education program.
- Establish a litter-control program that would include the use of covered, raven-proof trash receptacles, disposal of edible trash in trash receptacles at the end of each workday, and disposal of trash in a designated sanitary landfill located away from desert tortoise habitat in order to avoid attracting potential predators.
- Revegetate project areas no longer required for the Proposed Action.
- Post road signs to remind drivers of the presence of desert tortoises and other animals, and enforce speed limits.
- Construct and maintain tortoise-proof fencing around actively used construction and operation sites to lessen the potential for danger from project-related activities.
- Provide escape ramps from trenches; inspect trenches before filling them.

9.3.4.2 General Biological Resources and Soils

Certain herds of migratory animals could be substantially affected if they were prevented from moving between ranges used at different times of the year. Some of the transportation routes under consideration cross game management areas and wild horse and wild burro management areas. Some routes cross areas traversed by herds of antelope, mule deer, elk, and mountain sheep. Fencing would not be likely to affect the movement of mule deer and elk. Fencing could impede the movements of antelope, mountain sheep, wild horses, and wild burros, effectively dividing management areas for these species.

General Biological Resources and Soils Measures Under the Proposed Action

- Use the measures described in Section 9.2.2 to control erosion, dust, and particulate matter and therefore to lessen the consequences for biological resources and soils from transportation activities.

- Use dust suppression measures on disturbed areas to minimize erosion and aid recovery by reducing wind erosion and supporting compaction.

- Conduct preconstruction surveys in floodplains to ensure that work would not affect important biological resources and to determine the reclamation potential of sites.

- Consider measures to relocate sensitive species in floodplains.

- If construction could threaten important biological resources in floodplains, and modification or relocation of the roads and rail line would not be reasonable, develop additional mitigation.

General Biological Resources and Soils Measures Under Consideration

- Mitigate the introduction of contaminants to soils, using methods similar to those described for surface-water impacts (see Section 9.3.3.1).

- Conduct surveys of areas along the transportation corridor selected for construction to locate areas that are potential habitats for sensitive or State-protected species before the beginning of construction activities. Avoid springs, wetlands, waters of the United States, and riparian areas where practicable.

- Reduce habitat fragmentation and barriers to animal movement by considering the needs and movement patterns of mobile species (for example, wild horses) in the design and construction of rail lines, routes, and fencing. Seek input from wildlife agencies and organizations.

- If the construction and operation of a transportation route in Nevada could not avoid springs and wetlands, minimize the amount of disturbance (to the maximum extent possible) by carefully timing construction activities; minimizing corridor widths; locating laydown, excavated rock pile, and fueling areas away from sensitive areas where practicable; and conducting any wetlands replacement activities in accordance with plans approved by the U.S. Army Corps of Engineers.

- Align and locate facilities, roadways, cleared areas, laydown areas, and similar construction activities to minimize fragmentation of habitat potentially affected by the proposed project.

- Mitigate potential soil erosion by minimizing areas of surface disturbance and using engineering practices to stabilize disturbed areas. These practices could include such measures as stormwater runoff control through the use of holding ponds, baffles, and other devices and the compacting of disturbed ground, relocated soil, or excavated material in places outside desert tortoise habitat.

- To aid recovery, strip and stockpile topsoil from disturbed areas. When the disturbed areas were no longer needed, spread the topsoil over the areas and reseed the soil using local seed sources to improve the success of vegetation reestablishment and prevent encroachment of non-native invasive species.

9.3.5 CULTURAL RESOURCES

Land clearing, excavation, and construction activities have the potential to disturb or cause the relocation of cultural artifacts. The operation of industrial facilities can degrade the value of traditional sites or uses. In addition, human activity in project areas causes concern that members of the workforce could affect cultural resource sites, especially those at buried locations or with artifacts.

Actions that DOE would take to mitigate adverse impacts to cultural resources along transportation routes include those required by law or regulation and those built into the project to reduce such impacts. In some cases, DOE cannot identify precise mitigation measures due to the limited nature of the data (for example, construction activities could reveal previously unidentified sites). To address these cases, DOE has programmatic mitigation measures that comply with historic preservation laws and regulations in place to ensure that it would implement appropriate actions after the identification and evaluation of important cultural resources.

Cultural Resources Measures Under the Proposed Action

- Ensure that onsite employees complete cultural resource sensitivity and protection training to reduce the potential for intentional or accidental harm to sites or artifacts. The training could include descriptions of the importance of different cultural resource types, procedures to follow if resources were encountered in the field, and employment-related and legal penalties for not following the requirements.

- Continue to use the Yucca Mountain Project Native American Interaction Program, which has been in existence since 1985, to promote a government-to-government relationship with Native American tribes and concentrate on the continued protection of important cultural resources. A considerable part of this effort could continue to be directed at protecting these resources and mitigating adverse effects to the fullest extent possible. Historically, as part of this program, members of Native American tribes have made recommendations to DOE about potential adverse effects, mitigation procedures that involve required consultation with tribal governments, and direct involvement of Native Americans in proposed project activities that could affect cultural resources or values (DIRS 102043-AIWS 1998, p. 2-19). AIWS (DIRS 102043-1998, p. 4-1) suggested mitigations such as setting aside important cultural and ceremonial areas, and assisting in revegetation and reclamation activities.

- Conduct preconstruction surveys to ensure that work would not affect important archaeological resources and to determine the research potential of sites.

- If construction could threaten important archaeological resources, and modification or relocation of the roads and rail line would not be reasonable, develop additional mitigation measures.

9.3.6 OCCUPATIONAL AND PUBLIC HEALTH AND SAFETY

Over time, traffic accidents involving vehicles associated with the proposed repository would occur. The analysis indicated that fatalities and injuries from traffic accidents (nonradiological events) probably would constitute the largest impact to public health associated with the project. (See the Occupational and Public Safety and Health sections in Chapters 4 and 6.)

During the transportation of spent nuclear fuel and high-level radioactive waste, drivers and escort personnel would be routinely exposed to radiation and would receive radiological doses from this exposure. Workers and members of the public could receive doses from exposures resulting from an accident that released radionuclides.

Apart from impact findings and mitigations discussed in the EIS, Section 180(c) of the NWPA allows DOE to provide technical assistance and funds to states for training local government and Native American tribal public safety officials through whose jurisdictions DOE could plan to transport spent nuclear fuel or high-level radioactive waste. The training would cover procedures for safe routine transportation and for emergency response situations.

Occupational and Public Health and Safety Measures Under the Proposed Action

- Design task procedures to reduce the potential for accidents that could lead to radioactivity releases in the workplace environment.

Occupational and Public Health and Safety Measures Under Consideration

- Establish contract requirements to minimize worker exposure to ionizing radiation.
- Promote alternative transportation such as buses for workers to reduce automobile accidents.
- Implement a radiation protection plan for drivers and escort personnel.
- Implement accident reduction measures such as the Commercial Vehicle Safety Alliance procedures.

9.3.7 NOISE AND VIBRATION

Noise and vibration impacts could occur along a transportation corridor, depending on the scenario. Native Americans have expressed concern about noise associated with the transportation corridors and the movement of spent nuclear fuel and high-level radioactive waste to the proposed repository (DIRS 102043-AIWS 1998, p. 2-16). Impacts could result from the construction and operation of the facilities associated with transportation. There is concern that transportation activities could disrupt ceremonies that address Native American concerns for ecological health and the solitude needed for healing or prayer. Other communities could be subject to adverse noise and vibration levels, depending on the selected route and the potential to reduce such consequences. DOE expects the potential for adverse impacts from noise and vibration to be low.

Noise and Vibration Control Measures Under Consideration

- Avoid areas with sensitive receptors.
- Avoid Native American ceremonial sites.
- Consider noise and vibration intensity, time and distance, and noise canceling or interference factors when planning construction activities and facilities.
- If the transportation corridor passes through areas close to sensitive human receptors (schools, institutions, etc.), plan for noise abatement walls to reduce noise levels at specific locations.
- If the transportation corridor passes through areas close to structures and facilities that are sensitive to vibration (historic structures), plan for vibration abatement measures such as control of speed at specific locations.
- Install equipment that meets decibel limitations (see Chapter 6).
- Schedule vehicle travel through communities during daylight hours.
- Ensure that the receipt and transfer of material from railcars to heavy-haul trucks at an intermodal transfer station occurred during daylight hours.
- Impose speed limits on train or truck operations to reduce the intensity of noise and vibration in areas where there are sensitive receptors.

9.3.8 AESTHETICS

Construction along transportation routes and at facilities such as intermodal transfer stations and overnight stopping areas could reduce the quality of views in key locations. The operation of intermodal transfer stations and overnight stopping areas would require the lighting of these areas at night.

Aesthetics Measures Under the Proposed Action

- Remove or shape construction spoil piles to reflect existing contours. Keep the height of spoil piles that could not be removed or contoured to a minimum.

- Reclaim borrow areas using native vegetation.
- Plant native seedlings and other vegetation to help screen or reduce texture and color contrasts from key observation locations.
- Conduct an active misting and spraying program during construction to minimize the effects of fugitive dust.
- Reduce effects from outdoor night lighting used for intermodal transfer stations and overnight stopping areas by using measures similar to those discussed for lighting equipment above in Section 9.2.7.

9.3.9 MANAGEMENT OF WASTE AND HAZARDOUS MATERIALS

The manufacture of casks and containers could produce liquid and solid waste streams that would require disposal.

Waste and Hazardous Materials Measures Under the Proposed Action

- Design construction to include use of materials, such as depleted uranium, that could otherwise require disposal as wastes.
- Recycle lubricating and cutting oils.
- Recycle solid waste components where practicable.
- Employ ion exchange and filtration or similar methods to treat water used for ultrasonic weld testing for reuse in the manufacturing process.

REFERENCES

Note: In an effort to ensure consistency among Yucca Mountain Project documents, DOE has altered the format of the references and some of the citations in the text in this Final EIS from those in the Draft EIS. The following list contains notes where applicable for references cited differently in the Draft EIS.

102043	AIWS 1998	AIWS (American Indian Writers Subgroup) 1998. *American Indian Perspectives on the Yucca Mountain Site Characterization Project and the Repository Environmental Impact Statement.* Las Vegas, Nevada: Consolidated Group of Tribes and Organizations. ACC: MOL.19980420.0041.
104618	Buchanan 1997	Buchanan, C.C. 1997. "Final Biological Opinion for Reinitiation of Formal Consultation for Yucca Mountain Site Characterization Studies." Letter from C.C. Buchanan (Department of the Interior) to W. Dixon (DOE/YMSCO), July 23, 1997, File No. 1-5-96-F-307R. ACC: MOL.19980302.0368.
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103403	National Research Council 1996	National Research Council 1996. *Nuclear Wastes, Technologies for Separations and Transmutation.* Washington, D.C.: National Academy Press. TIC: 226607.
102188	YMP 1995	YMP (Yucca Mountain Site Characterization Project) 1995. *Reclamation Implementation Plan.* YMP/91-14, Rev. 1. Las Vegas, Nevada: Yucca Mountain Site Characterization Office. ACC: MOL.19970109.0256. In the Draft EIS, this reference was cited as DOE 1995g in Chapter 12.

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10

Unavoidable Adverse Impacts; Short-Term Uses and Long-Term Productivity; and Irreversible or Irretrievable Commitment of Resources

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10. UNAVOIDABLE ADVERSE IMPACTS; SHORT-TERM USES AND LONG-TERM PRODUCTIVITY; AND IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

This chapter discusses adverse impacts that would remain after the application of mitigation measures (see Chapter 9). It analyzes the relationship between short-term uses of the human environment and the maintenance and enhancement of long-term productivity, and it identifies irreversible or irretrievable commitments of resources. The chapter presents information drawn from the analysis of the Proposed Action. It summarizes and consolidates information from the impact and mitigation analyses in Chapters 4, 5, 6, and 9, and provides references to earlier chapters for readers who require more detailed information.

The chapter discusses only resource areas for which preceding analyses have identified some potential for unavoidable adverse impacts. Nevertheless, the discussions in Sections 10.1, 10.2, and 10.3 reflect an examination of all of the resource areas analyzed in this EIS.

The construction, operation and monitoring, and eventual closure of the proposed Yucca Mountain Repository and the associated transportation of spent nuclear fuel and high-level radioactive waste would have the potential to produce some environmental impacts that the U.S. Department of Energy (DOE) could not mitigate. Similarly, some aspects of the Proposed Action could affect the long-term productivity of the environment or would require the permanent use of some resources.

10.1 Unavoidable Adverse Impacts

This section summarizes potential impacts associated with the proposed repository and transportation actions that would be unavoidable and adverse and that would remain after DOE implemented mitigation measures, which are discussed in Chapter 9. Some aspects and activities discussed in Section 10.1 are analyzed from different perspectives in Sections 10.2 and 10.3.

10.1.1 YUCCA MOUNTAIN REPOSITORY

This section summarizes unavoidable adverse impacts associated with the construction, operation and monitoring, closure, and long-term performance of the proposed repository.

10.1.1.1 Land Use

To develop the proposed Yucca Mountain Repository, DOE would need to obtain permanent control of land surrounding the Yucca Mountain site. DOE could obtain permanent control over the land only if Congress completed a land withdrawal action. A Congressional withdrawal would include lands already withdrawn for the Nevada Test Site and Nellis Air Force Range as well as lands under the control of the Bureau of Land Management and not currently withdrawn.

In general, the permanent withdrawal of land for the repository would prevent human use of the withdrawn lands for other purposes. Nevada Test Site activities would continue on a noninterference basis unless the Congressional land withdrawal specifically precluded them. DOE would remove mining and mineral claims from public use as they expired. Because the Yucca Mountain site has a low present resource value, is remote, and is partly withdrawn, the resultant impact would be small.

The disposal of spent nuclear fuel and high-level radioactive waste would permanently affect the availability of the subsurface area of the Yucca Mountain site and surface portions posted as off limits.

The Chapter 4 land-use discussion includes the availability of the land and the consequences of withdrawal.

10.1.1.2 Air Quality

Construction, operation and monitoring, and closure of a repository at Yucca Mountain would produce small impacts to regional air quality. Radiological impacts could occur from the release of radionuclides. The principal radionuclides released from the subsurface would be naturally occurring radon-222 and its decay products in ventilation exhaust air. There are no applicable regulatory limits for radon releases from Yucca Mountain facilities. Other impacts would come from criteria pollutants and materials such as cristobalite and erionite. Exposures of maximally exposed individuals to radionuclides and criteria pollutants would be a small fraction of applicable regulatory limits. If offsite manufacturing occurred in nonattainment areas, the manufacturing processes could detract from the ability of local governments to meet air quality goals.

10.1.1.3 Hydrology

Construction activities would temporarily restrict and minimally alter natural surface-water drainage channels. Facilities and roadways would be designed to withstand at least a 100-year flood. Therefore, after construction was complete, only flow from infrequent more-intense floods would affect those facilities and roadways. Ground-disturbing activities and the surface facilities that DOE would build would alter surface-water infiltration and runoff rates in localized areas. Given the relatively small size of the affected land in comparison to the total drainage area, drainage channels and washes would experience little difference in impacts as a result of the disturbances. DOE estimates that overall consequences from the construction of roadways and facilities would be minimal.

The proposed repository construction and operation would unavoidably involve crossing washes designated as floodplains in the vicinity of Yucca Mountain, but effects on these washes would be small.

There would be withdrawals of groundwater during construction, operations and monitoring, and closure, but they would not exceed estimates of perennial yield. Chapter 4, Section 4.1.3, provides details on the effects of repository construction, operation and monitoring, and closure on hydrology.

Analysts estimate that the placement of drip shields would prevent dripping water from reaching the waste packages for more than 10,000 years (DIRS 154659-BSC 2001, Figure 4.2.5.1, p. 4F-39. Therefore, with the potential exception of a very small number of waste packages (0 to 3) that could fail due to manufacturing defects, there would be no breaches of waste packages before 10,000 years.

If water entered a waste package, it would have to penetrate the metal cladding of the spent nuclear fuel to reach the waste. For approximately 99 percent of the commercial spent nuclear fuel, the cladding is highly corrosion-resistant metal designed to withstand the extreme temperature and radiation environment in the core of an operating nuclear reactor. Current models indicate that it would take thousands of years to corrode cladding sufficiently to allow water to reach the waste and begin to dissolve the radionuclides.

During the thousands of years required for water to reach the waste, the radioactivity of most radionuclides would decay to virtually zero. Remaining radionuclides would have to dissolve in the water to pass from a waste package. Few of the remaining radionuclides could dissolve at a meaningful rate. Thus, only long-lived water-soluble radionuclides could get out of a waste package. Long-lived water-soluble radionuclides that migrated from the waste packages would then have to move down through about 300 meters (about 1,000 feet) of rock to the groundwater and then travel about 18 kilometers (11 miles) to reach a point where they could be taken up in a well and consumed or used to irrigate crops (see Chapter 5, Sections 5.3 and 5.4).

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As the long-lived water-soluble radionuclides began to move down through the rock, some would stick (or adsorb) to the minerals in the rock and be delayed in reaching the water table. After reaching the water table, radionuclides would disperse to some extent in the larger volume of groundwater beneath Yucca Mountain, and the concentrations would be diluted. Eventually, groundwater with varying concentrations of different radionuclides could reach locations in the hydrologic (groundwater) region of influence where the water could be consumed.

Of the approximately 200 different radioactive isotopes present in spent nuclear fuel and high-level radioactive waste, 26 are present in sufficient quantities and are sufficiently long-lived, soluble, mobile, and hazardous to contribute meaningfully to calculated radiation exposures.

10.1.1.4 Biological Resources and Soils

Unavoidable adverse impacts to biological resources would include the loss of small pieces of habitat totaling less than 6 square kilometers (2.5 square miles or 1,500 acres). The pieces that would be disturbed are habitat for terrestrial plant and animal species that are widespread throughout the region and typical of the Mojave and Great Basin Deserts. The death or displacement of individuals of some animal species as a result of site clearing and vehicle traffic would be unavoidable; however, changes in the regional population of any species would be undetectable.

No Federally endangered species are found on the site. The only Federally threatened species on the site is the desert tortoise (see Chapter 4, Section 4.1.4). Approximately 6 square kilometers (2.5 square miles or 1,500 acres) of desert tortoise habitat would be lost. This habitat is at the northern end of the range of the desert tortoise and is not designated critical habitat for the tortoise. The quantity of habitat that could be lost would be minimal in comparison to the range of the desert tortoise.

The U.S. Fish and Wildlife Service has issued a Biological Opinion (see Appendix O) stating reasonable and prudent measures and conditions that DOE would have to observe to protect the desert tortoise if the Proposed Action was implemented. DOE would adhere to all terms stated in the Biological Opinion, but, as the opinion acknowledges, individual tortoises could be killed inadvertently during site clearing, by vehicle traffic, or by predation from ravens. Preconstruction surveys, relocation of affected individuals, and adherence to conditions stated in the Biological Opinion would minimize, but not prevent, such deaths. Chapter 4, Section 4.1.4, discusses in detail the potential for loss of habitat or the deaths of individual members of this species. Chapter 9 (Sections 9.2.4.1 and 9.3.4.1) discusses mitigation measures to reduce potential impacts to the desert tortoise, including measures to locate facilities and roadways to avoid sensitive areas and measures to protect tortoises from construction impacts.

10.1.1.5 Cultural Resources

In the view of Native Americans, the implementation of the Proposed Action would further degrade the environmental setting. Even after closure and reclamation, the presence of the repository would, from the perspective of Native Americans, represent an irreversible impact to traditional lands.

NATIVE AMERICAN VIEW

A Native American view of facility and transportation route development, especially in remote areas such as Yucca Mountain and its surroundings, as expressed in the *American Indian Perspectives on the Yucca Mountain Site Characterization Project and the Repository Environmental Impact Statement* (DIRS 102043-AIWS 1998, pages 2-20 and 3-1), is that development of such facilities and routes inherently degrades the entire environment. This view is based on the concept that the earth, its waters, the air, and the sky are a whole and have a sacred integrity in their natural form. Chapter 4, Section 4.1.13, of this EIS presents an environmental justice discussion of this Native American perspective.

Some unavoidable adverse impacts could occur to archaeological sites and other cultural resources, although no such sites or culturally important artifacts have been found at the site of the proposed repository. There could be a loss of archaeological information due to illicit artifact collection. In addition, excavation activities could cause a loss of archaeological information. Similarly, the location of a solar power generating facility on the repository site, could affect archaeological sites. Chapter 3, Section 3.1.6, discusses the program DOE has in place to address and mitigate cultural resource impacts and issues during site characterization. DOE anticipates this program would continue through repository closure.

10.1.1.6 Socioeconomics

The construction, operation and monitoring, and closure of a repository at Yucca Mountain would result in increased employment and population, which would place increased demands on housing and public services, including schools. Nonetheless, these demands would be small in comparison to total employment, population, real disposable income, gross regional product, and public expenditures in the region of influence.

10.1.1.7 Occupational and Public Health and Safety

There would be a potential for injuries to or fatalities of workers from facility construction, including accidents and inhalation of cristobalite and erionite. Cristobalite and erionite are naturally occurring hazardous materials in the rock of Yucca Mountain. Engineering controls and training and safety programs would reduce but not eliminate the potential for injuries or fatalities to workers.

Short-term impacts during the operation and monitoring phase would present a potential for injuries or fatalities to workers from industrial accidents and exposure to radioactive materials. Engineering controls and training and safety programs would reduce but not eliminate the potential. There would also be a potential for injuries and fatalities during closure. The occupational and public health and safety discussion in Chapter 4 (Sections 4.1.7 and 4.1.8) provides details on the potential for worker injuries and fatalities. The potential for injury or death to members of the public from exposure to radioactive materials or industrial activity would be extremely small.

While there would be a potential for radioactive contamination of groundwater during the 10,000-year analysis period from materials stored at the proposed repository, there would be only a small potential for such contamination to produce long-term adverse health impacts in the surrounding region during this period, even when the potential for changing climate and seismic events is considered. Potential long-term impacts to human health from the repository in the far future would be dominated by impacts from radioactive materials dissolved or suspended in water pathways. The dose to the reasonably maximally exposed individual would depend on the distance from the repository and the uses made of the land and waters.

At the compliance point defined in Chapter 5 [36 degrees, 40 minutes, 13.6661 seconds North latitude in the predominant direction of groundwater flow (40 CFR Part 197)], the highest 95th percentile annual dose to the reasonably maximally exposed individual for the 10,000-year analysis period would be 0.0001 millirem. The highest chance of a latent cancer fatality to this hypothetical individual would be 4 in 1 billion (see Chapter 5, Section 5.4.2.1). A latent cancer fatality is a cancer fatality that could occur after and as a result of exposure to radionuclides from the repository and that would be in addition to cancer fatalities occurring from all other causes.

Expected doses and consequences to the population from exposure to radionuclides transported by groundwater from the repository were forecast for the 10,000-year analysis period. The 95th-percentile population dose over the 10,000-year period could be 0.04 person-rem over an assumed 70-year lifetime.

The estimated 95th-percentile number of latent cancer fatalities in the population during any 70-year lifetime would be 0.00002. Over the 10,000-year analysis period, the estimated number of latent cancer fatalities would be 0.0003 (see Chapter 5, Section 5.4.2.1). These consequences would be small.

DOE estimates that most waste packages would remain intact longer than 10,000 years. Current model simulations forecast that some packages would last more than 1 million years. The highest 95th-percentile peak annual dose to a hypothetical reasonably maximally exposed individual could be 620 millirem approximately 410,000 years in the future. The highest mean peak annual dose rate to a reasonably maximally exposed individual at 18 kilometers (11 miles) could be 150 millirem per year approximately 480,000 years in the future (see Chapter 5, Section 5.4.2.1). In the unlikely event of an igneous disruption of the repository, the probability-weighted peak mean annual dose resulting to an individual would be approximately 0.1 millirem.

As determined by a bounding analysis (see Appendix I, Section I.6), there would also be a potential that chromium releases could produce estimated peak concentrations during the first 10,000 years of 0.01 milligram per liter at 18 kilometers (11 miles). This value is approximately one-tenth of the Maximum Contaminant Level Goal in drinking water.

10.1.1.8 Utilities, Energy, and Materials

The construction, operation and monitoring, and closure of a repository at Yucca Mountain would result in irreversible commitments of energy (mostly electricity and petroleum products) and materials (mostly cement, steel, and copper). These commitments would not be large enough to affect national or regional supplies.

10.1.2 NATIONAL TRANSPORTATION ACTIONS

10.1.2.1 Air Quality

To determine if pollutants of concern from national transportation by truck and rail would degrade air quality in nonattainment areas outside Nevada, DOE reviewed traffic volumes in nonattainment areas (see Chapter 6, Section 6.2). From this review DOE determined that the number of shipments to Yucca Mountain would be very small in relation to normal traffic volumes in the nonattainment areas studied, and that, therefore, impacts to air quality in these areas from repository-related shipments would be very small.

10.1.2.2 Occupational and Public Health and Safety

Certain adverse impacts to workers and the public from the transportation of spent nuclear fuel and high-level radioactive waste would be unavoidable. The loading and transportation of these materials would have the potential to affect workers and the public through industrial accidents, exposure to radiation and vehicle emissions, and through traffic accidents. This EIS evaluates two transportation scenarios—one in which DOE would transport the materials mostly by legal-weight truck and the other in which it would transport the materials mostly by rail. DOE estimates that the transportation of spent nuclear fuel and high-level radioactive waste nationally, including in Nevada, in the mostly legal-weight truck scenario could cause as many as 21 fatalities among workers and the public over the 24 years of the Proposed Action. These fatalities would include fatalities in industrial accidents, traffic fatalities, latent cancer fatalities caused by exposure to radiation, and health effect fatalities caused by exposure to vehicle emissions. DOE estimates that transportation mostly by rail could cause between 8 and 14 fatalities among workers and the public, including fatalities from upgrading and maintaining highways and constructing an intermodal transfer facility or constructing a branch rail line in Nevada as well as fatalities from operations over 24 years. These fatalities would also result from industrial accidents, vehicle crashes, radiation exposure, and exposure to vehicle emissions.

10.1.3 NEVADA TRANSPORTATION ACTIONS

This section summarizes unavoidable adverse impacts associated with the transportation of spent nuclear fuel and high-level radioactive waste and with the construction and operation of transportation facilities and routes in Nevada. Chapter 6 (Sections 6.1.2 and 6.3) provides more detailed discussions.

10.1.3.1 Land Use

Constructing and operating a new branch rail line would result in unavoidable changes to present land uses and control of the lands affected directly. The range of potentially affected uses includes grazing, wildlife habitat and management areas, mining, wilderness, Native American tribal uses, recreation, utility corridors, lands leased for oil and gas development, and military lands. Present uses of adjoining lands could also be affected to some extent. Each of the five corridors for a branch rail line encompasses a range of different land uses and surface features. If the choice was to construct a new branch rail line, the selection of a specific corridor would determine the land actually taken and the extent of impacts to land uses along that corridor. Land disturbed for a specific corridor implementing alternative could vary from 5.1 to 19.2 square kilometers (1,300 to 4,700 acres). Most land along the corridors under consideration is government administered or controlled. The Valley Modified Corridor crosses two Wilderness Study Areas. The Steiner Creek Alternate for the Carlin Corridor passes close to or encroaches on the Simpson Park Wilderness Study Area, depending on alignment. The Bonnie Claire Alternate for the Carlin and Caliente Corridors crosses lands of the Timbisha Shoshone Tribe near Scottys Junction, Nevada. The Caliente Corridor crosses a portion of the South Reveille Wilderness Study Area. The Caliente Corridor and the Caliente-Chalk Mountain Corridor pass through or encroach on the Weepa Springs Wilderness Study Area, depending on alignment.

Routes for heavy-haul or legal-weight trucks would follow existing highways and could require establishing and using access roads to obtain construction materials and additional land disturbance for road widening. Building and operating an intermodal transfer station would result in unavoidable changes of land use and ownership. The land for an intermodal transfer station could be public or private. Actual land uses lost would depend on the site and route selected. DOE expects that the total land disturbance for any implementing alternative for the construction of an intermodal transfer station and upgrades to existing highways could be as much as 3.5 square kilometers (about 860 acres). For heavy-haul truck routes originating at Caliente, an additional 0.04 square kilometer (10 acres) could be required for a midroute stop. A further 0.04 square kilometer could be required for the construction of a highway segment near Beatty, Nevada.

In some instances transportation facilities could remain in place to serve other purposes after DOE had ended use. Similarly, affected land could revert to other uses after the end of transportation activities and the removal of facilities.

10.1.3.2 Air Quality

The potential construction of the Valley Modified Alternate branch rail line or upgrades to roads to accommodate heavy-haul trucks in the Las Vegas Valley air basin, which is in nonattainment with Environmental Protection Agency standards for emissions of PM_{10} and carbon monoxide, could affect the ability of local governments to meet air quality goals.

The operation of a branch rail line or an intermodal transfer station and associated heavy-haul truck routes would lead to releases of pollutants, but these would be below thresholds of concern.

Legal-weight truck shipments through the Las Vegas Valley air basin would also emit pollutants. However, the number of legal-weight truck shipments would be less than 1 percent of all truck traffic in the area and would not contribute discernibly to sources of air pollution.

10.1.3.3 Hydrology

The construction of a branch rail line or the upgrading of roads to accommodate heavy-haul transportation in Nevada would involve the unavoidable adverse impact of altering natural surface-water drainage patterns. Any of the Nevada transportation corridors would cross a number of natural drainage channels. Upgrade activities for a route to be used by heavy-haul trucks would involve the extension of existing drainage control structures as necessary to support the road upgrades. In this case, there would be minor changes to drainage channels already altered to some extent by the original road construction. The construction of a branch rail line would require alterations to many natural drainage areas along the line. Bridges and culverts would be used as necessary to cross streams, creeks, or, most predominantly, washes of any size. These structures would be built to accommodate a 100-year flow in the channels; the resulting drainage alteration would be confined to relatively small areas. Construction could alter small drainage channels or washes more because the railway design could call for the collection of some channels to a single culvert. At the end of the period during which DOE would transport spent nuclear fuel and high-level radioactive waste to the repository, the Department could remove facilities built for transportation and land recovery could begin, or it could use the facilities for other purposes. Appendix L contains a floodplain/wetlands assessment that presents a comparison of what is known about the floodplains, springs, and riparian areas along the five alternative rail routes and at the three alternative intermodal transfer station sites with their five associated heavy-haul truck routes.

In addition, the construction of a branch rail line or upgrades to a route for heavy-haul trucks would involve the withdrawal and use of water from groundwater resources. In many areas that a branch rail line would cross, other uses or commitments of groundwater resources approach or exceed the perennial yield of the underlying groundwater basins. The Nevada State Engineer has identified these areas as Designated Groundwater Basins, which the State watches for potential groundwater depletion. DOE would apply for State water appropriations for withdrawal of groundwater from any wells it developed to construct a branch rail line or would acquire water from appropriated sources and ship the water to its construction sites.

10.1.3.4 Biological Resources and Soils

Unavoidable adverse impacts to biological resources from transportation in Nevada could occur as a result of habitat loss and the deaths of small numbers of individuals of species along transportation routes. Habitat loss would be associated with the construction of either a new rail line or an intermodal transfer station and upgrades to existing highways. This loss would occur in widely distributed land cover types, and would include the loss of a small amount of desert tortoise habitat and the deaths of a small number of tortoises. The deaths of individual members of a species as a result of construction activities or from vehicle traffic would be unlikely to produce detectable changes in the regional population of a species.

Transportation route construction or upgrades would subject disturbed soils to increased erosion for at least some of the construction phase. The recovery of these disturbed areas to predisturbance conditions would occur with the passage of time. Transportation facilities such as a branch rail line could be used for nonrepository-related purposes, potentially extending their useful life beyond the period needed for the Proposed Action. The removal of transportation facilities after the end of their useful life would assist habitat recovery.

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Disturbance of habitat could lend to intrusion of invasive species. These species would compete with native species and could become dominant in areas adjacent to the routes. In addition, they could increase the risk of fire in areas adjacent to the routes.

10.1.3.5 Cultural Resources

Some unavoidable impacts could occur to archaeological sites and other resources as a result of the construction of a rail line or the upgrade of a highway to heavy-haul capability. The potential for impacts to specific resources cannot be identified before final surveys and actual construction. An agreement now in effect between DOE and the Advisory Council on Historic Preservation for repository site characterization could serve as a model for an agreement to protect archaeological sites and other resources along transportation corridors. In addition, a number of statutes provide protective frameworks (see Chapter 11). Nevertheless, there would be a potential for grading and other construction activities to degrade, cause the removal of, or alter the setting of archaeological sites or other cultural resources. Although mitigated to some extent by worker education programs, there could be some loss of archaeological information due to the illicit collection of artifacts. In addition, excavation activities could cause loss of archaeological information.

10.1.3.6 Socioeconomics

The construction of a branch rail line in Nevada or of an intermodal transfer station and upgrades to associated highways for heavy-haul trucks would result in the irreversible use of economic resources. In addition, economic activity spawned by construction and subsequent operations would affect the availability and cost of resources used for other purposes in Nevada. Increased employment and population would place increased demands on housing and public services, including schools. Nonetheless, overall socioeconomic impacts in the region of influence would be small in comparison to total employment, population, real disposable income, Gross Regional Product, and public expenditures.

10.1.3.7 Occupational and Public Health and Safety

Certain adverse impacts to workers and the public from the construction and operation of the rail and heavy-haul implementing alternatives would be unavoidable. Table 10-1 presents potential health and safety impacts to workers and the public (fatalities) during construction and operations for each implementing alternative.

Table 10-1. Unavoidable adverse impacts from rail and heavy-haul truck implementing alternatives.[a]

	Construction (worker and public fatalities)	Operations (worker and public fatalities)
Rail		
Caliente	1.6	1.5
Carlin	1.4	1.6
Caliente-Chalk Mountain	1.0	1.4
Jean	0.89	1.3
Valley Modified	0.5	1.1
Heavy-haul truck[b]		
Caliente	1.8	4.5
Caliente/Chalk Mountain	0.74	3.8
Caliente/Las Vegas	1.3	4.3
Apex/Dry Lake	0.6	3.0
Sloan/Jean	0.6	3.1

a. Source: Chapter 6, Sections 6.3.2.2 and 6.3.3.2.
b. Includes intermodal transfer station impacts.

The transportation of spent nuclear fuel and high-level radioactive waste would have the potential to affect workers and the public in Nevada through exposure to radiation and vehicle emissions and through traffic accidents. This EIS evaluates two transportation scenarios—one in which DOE would transport the materials mostly by legal-weight truck and the other in which it would transport the materials mostly by rail to Nevada and then to the repository by either heavy-haul truck or a branch rail line. DOE estimates that the transportation of spent nuclear fuel and high-level radioactive waste in the mostly legal-weight truck scenario could cause approximately 1.4 fatalities among workers and the public in Nevada as a result of exposure to radiation, vehicle emissions, and accidents over the course of 24 years. Over the same period, DOE estimates that transportation using a branch rail line in Nevada could cause up to 3.1 fatalities among workers and the public, while use of heavy-haul trucks in Nevada could result in up to 6.3 worker and public fatalities.

10.1.3.8 Aesthetics

The construction of a branch rail line in the Jean Corridor (Wilson Pass Option) would lead to a change to the aesthetic resource value of lands along the western slopes of the Spring Mountains, which the Bureau of Land Management classifies as a Class II visual resource. The construction of an intermodal transfer station near Caliente, Nevada, could affect the aesthetic value of lands in the entrance portion of the Kershaw-Ryan State Park until the station was removed.

10.1.3.9 Noise and Vibration

The long-term use of a branch rail line in any of the five rail corridors in Nevada would lead to an increase in ambient noise from periodically passing trains in areas of the State that are currently mostly uninhabited. This could affect solitude which the American Indian Writers Subgroup identified as essential for meditation and prayer. In addition, it could degrade the recreation values of the areas for individuals who seek primitive outdoor experiences. Noise from trains could be noticeable as new noise in residential areas near a potential branch rail line.

For Nevada transportation implementing alternatives that would use heavy-haul trucks, the noise from the trucks and the operation of an intermodal transfer station would be only slightly discernable above the noise of normal traffic and nearby industrial or railroad noise.

10.1.3.10 Utilities, Energy, and Materials

The construction of a branch rail line or upgrades to highways for use by heavy-haul trucks and construction of an intermodal transfer station would result in irreversible commitments of energy (mostly petroleum products) and materials (steel, concrete, and rock). These commitments would not be large enough to affect national or regional supplies.

10.1.3.11 Waste Management

The construction and operation of any of the 10 Nevada heavy-haul truck or rail implementing alternatives would generate small amounts of construction debris, sanitary solid waste, sanitary sewage, and hazardous waste. This waste would be managed by recycling, placement in permitted landfills, reuse or, in the case of sanitary sewage, onsite treatment and disposal. Waste would be managed in accordance with applicable requirements to minimize the possibility of adverse impacts to the environment. A small amount of low-level radioactive waste could be generated at an intermodal transfer station under the heavy-haul truck implementing alternative and would be disposed of in accordance with applicable regulations. The quantities of waste to be disposed of would not affect the availability of waste disposal resources for other users.

DOE would use excavated soil and rock from the construction of a branch rail line and the State of Nevada would use material from existing borrow areas and roadway excavations (highway upgrades) for fill to the extent feasible. However, some previously undisturbed areas could be covered with excavated soil and rock. To place and stabilize these materials, DOE would use approved practices that would minimize affected land areas and reduce potential impacts to biological resources and surface-water resources.

10.2 Relationship Between Short-Term Uses and Long-Term Productivity

The Proposed Action could require short-term uses of the environment that would affect long-term environmental productivity. This section describes possible consequences to long-term productivity from those short-term environmental uses.

The EIS analysis identified two distinct periods for the evaluation of the use of the environment by the Proposed Action:

- A period of 115 to 341 years for surface activities consisting of construction, operation and monitoring, and closure of the proposed repository. DOE activities during this period would include construction of facilities, receipt and emplacement of spent nuclear fuel and high-level radioactive waste, recovery of recyclable materials, ventilation of subsurface emplacement areas, decontamination, closure of surface and subsurface facilities, reclamation of land, and long-term monitoring. Sections 10.1.1.1 through 10.1.1.6 describe the unavoidable impacts that could occur during this period. This period would be the only time during which DOE would actively use the affected lands and the only time during which activities would involve the surface of the land used for the repository.

- The balance of a 10,000-year period would be for the evaluation of consequences from the disposal of spent nuclear fuel and high-level radioactive waste.

In general, transportation and disposal activities associated with the proposed repository would benefit long-term productivity by removing spent nuclear fuel and high-level radioactive waste from 72 commercial and 5 DOE sites around the country. In addition, removing these materials from existing sites would also free people and resources committed—now and in the future—to monitoring and safeguarding these materials for other potentially more productive activities. Removal could create conditions that would enable the initiation of other productive uses at the commercial and DOE sites. Finally, disposing of spent nuclear fuel and high-level radioactive waste in the proposed repository would provide a long-term global benefit by isolating the materials from concentrations of human population and human activity, thereby reducing the potential for sabotage.

10.2.1 YUCCA MOUNTAIN REPOSITORY

This section summarizes the relationship between short-term uses of land and resources and long-term land and resource productivity for the construction, operation and monitoring, closure, and long-term performance of the proposed repository. The terms “short-term” and “long-term” commonly used in National Environmental Policy Act analyses do not have a consistent duration in this section. For the analysis of impacts associated with repository activities, *short-term* refers to the time from the start of construction to the end of relevant surface and subsurface human activity, which DOE anticipates to range from 115 to 341 years. *Long-term* refers to the time between the end of relevant surface and subsurface human activity and the time when environmental resources have recovered from the potential for impacts and are again productive, or a maximum of 10,000 years. For transportation, *short-term* refers to the time of construction or actual transportation, as appropriate. *Long-term* refers to the time from the end of the short-term period to the time of environmental recovery. *Productivity* refers to the ability of an element of the environment to generate crops, provide habitat, or otherwise serve as a medium for the creation of value.

10.2.1.1 Land Use

From the start of construction through the 10,000-year period, the construction, operation and monitoring, and closure of the proposed repository would deny other users the use of the Yucca Mountain vicinity for other purposes. Chapter 4, Section 4.1.1, discusses the long-term uses of land. Conversely, a repository at Yucca Mountain would enable consideration of other uses for the sites where spent nuclear fuel and high-level radioactive waste are being stored and the land buffering those sites. Many present storage sites are in locations that would permit a wider range of alternative uses than does Yucca Mountain.

10.2.1.2 Hydrology

The proposed repository would be in a terminal basin that is hydrologically isolated and separated from other bodies of surface and subsurface water; that is, once water enters the basin it can leave only by evapotranspiration. As explained in Section 10.1.1.3, there would be a potential for materials disposed of at the proposed Yucca Mountain Repository to reach groundwater at some time between several thousand years and several hundred thousand years. If such contamination reached groundwater in the accessible environment, and if the groundwater contamination exceeded applicable regulatory requirements, there could be an attendant loss of productivity for the affected groundwater and for surface waters in the basin that the groundwater supplied. Conversely, the disposal of spent nuclear fuel and high-level radioactive waste at Yucca Mountain would free a wide range of major and minor water bodies throughout the United States from the potential threat of radioactive contamination from the materials at the present storage sites.

10.2.1.3 Biological Resources and Soils

Short-term uses that could cause impacts to biological resources and soils would be associated with the construction, operation and monitoring, and closure of the repository; those activities could lead to long-term productivity loss in disturbed areas. This loss would be limited to less than 6.0 square kilometers (1,500 acres) of widely distributed habitats adjacent to existing disturbed areas. Biological resources would be affected directly by land disturbances. The overall impact to populations of species would be limited because the area disturbed and the number of individual animals lost would be small in relation to the regional availability.

Long-term productivity loss for soils would be limited to areas affected by land disturbances. These areas would be revegetated after the completion of closure activities. Revegetation would be accomplished through the reclamation of disturbed sites using surface soils stockpiled during construction, reseeding, and similar activities that would enhance recovery. Chapter 4, Section 4.1.4, contains more detail on productivity losses and reclamation. The disposal of spent nuclear fuel and high-level radioactive waste at Yucca Mountain would remove these materials from proximity to biota near the present storage sites across the United States.

10.2.1.4 Occupational and Public Health and Safety

A repository at Yucca Mountain would be likely to have a positive effect on the nationwide general occupational and public health because of the cessation of doses to workers at the present storage sites and because the spent nuclear fuel and high-level radioactive waste would be substantially more isolated from concentrations of people and from pathways to concentrations of people.

10.2.2 TRANSPORTATION ACTIONS

The construction of a rail line or an intermodal transfer station and improvements to existing highways, all short-term uses, could lead to a long-term loss of productivity in disturbed areas along the routes. In the context of transportation, *long-term* refers to the period of environmental recovery after the end of the construction period or the active use of a transportation route for repository purposes. A route could be used for repository purposes from 10 to approximately 30 years.

The land cover types along any route are widely distributed in the region. A loss of vegetation from a disturbed area along a route would have little effect on the regional productivity of plants and animals.

Productivity loss for soils would be limited to areas affected by land clearing and construction. These areas would not be available for revegetation and habitat for some time. Disturbed areas would recover, however, and eventually would return to predisturbance conditions, although the process of recovery would be slow in the arid environment. Chapter 6 contains more data on transportation.

The construction of a rail line, if the line were also used for nonrepository uses, could result in productivity benefits for Nevada by increasing transportation opportunities, lowering transportation costs, reducing accidents, and lowering nitrogen oxides, carbon monoxide, and other gaseous criteria pollutant emissions by diverting transportation from highway to rail.

The major long-term consequence of transporting spent nuclear fuel and high-level radioactive waste to the repository would be the permanent consolidation of these materials in an isolated location away from concentrations of people and without exposure pathways to concentrations of people.

10.3 Irreversible or Irretrievable Commitment of Resources

The Proposed Action would involve the irreversible or irretrievable commitment of land, energy, and materials. The commitment of a resource is irreversible if its primary or secondary impacts limit future options for the resource. An irretrievable commitment refers to the use or consumption of resources that are neither renewable nor recoverable for later use by future generations. Construction, operation and monitoring, and eventual closure of a repository at Yucca Mountain would result in a permanent commitment of land, groundwater, surface, subsurface, mineral, biological, soil, and air resources; materials such as steel and concrete; and consume energy in forms such as gasoline, diesel fuel, and electricity. Water use would support construction, operation and monitoring, and closure actions, and options for using groundwater could become limited if there was contamination from radionuclides. There would be an irreversible and irretrievable commitment of associated natural resource services such as uses of land and habitat productivity.

10.3.1 YUCCA MOUNTAIN REPOSITORY

The construction, operation and monitoring, closure, and long-term performance of the Yucca Mountain Repository would result in the permanent commitment of the surface and subsurface of Yucca Mountain and the permanent withdrawal of lands from public use. Because of the remote location of Yucca Mountain, the lack of present uses of the land, the terminal and isolated nature of the water basin, and the limited amounts of materials and energy required for the repository in comparison to the supply capability of the regional and national economies, the irreversible and irretrievable commitments of resources for repository-related activities would be small.

Mitigation approaches that would involve the excavation of archaeological sites to prevent degradation by construction activities would destroy the contexts of those sites and reduce the finite number of such resources in the region. DOE expects that its activities at the proposed repository would affect no more than a minimal number of such sites. The Department would use state-of-the-art mitigation techniques on the Yucca Mountain Project.

Electric power, fossil fuels, and construction materials would be irreversibly committed to the project. Most of the steel used for the surface facilities would be recyclable and, therefore, not an irreversible or irretrievable commitment. Some copper and steel in the ramps and access mains to subsurface facilities would be recyclable, while some in the emplacement drifts would be irreversibly and irretrievably lost. Some steel, such as rebar, would be difficult to recycle. The quantity of resources consumed would be small in comparison to their national consumption or their availability to consumers in southern Nevada. These quantities are described in Chapter 4. To the extent that there is value in spent nuclear fuel or high-level radioactive waste, that value would be committed to the repository.

Aggregate would be crushed as required and mixed in concrete for the cast-in-place and precast concrete structures and liners that would be used in the repository. The amount of sand and aggregate could range from 1.2 million to 2.54 million metric tons (1.3 to 2.8 million tons). If Yucca Mountain tuff was used as the aggregate component of the subsurface concrete, the amount crushed and used as aggregate would be less than 15 percent of the total excavated from the drifts (see Chapter 4, Section 4.1.11).

Repository closure would make the energy content of uranium and plutonium in spent nuclear fuel unavailable for use by future generations.

10.3.2 TRANSPORTATION ACTIONS

The construction of a rail line or an intermodal transfer station would result in an irretrievable but not irreversible commitment of resources. Many resources could be retrieved at a later date through such actions as removing roadbeds, revegetating land, and recycling materials. Land uses would change along the selected transportation corridor during repository construction, operation and monitoring, and closure, thereby limiting or eliminating other land uses for that period. At the end of that period, however, land along the corridor could revert to public or private ownership.

Mitigation approaches involving the recovery of archaeological resources before construction activities degraded the sites would reduce the finite number of such resources in the Yucca Mountain region and destroy the context of sites. DOE would use state-of-the-art mitigation techniques during the construction of a rail corridor or an intermodal transfer station or the modification of roadways to accommodate heavy-haul trucks. Heavy-haul construction would be likely to generate only minimal impacts to cultural resources because construction would largely involve modifications to existing roads.

DOE would use about 500 to 700 million liters (132 to 185 million gallons) of fossil fuel from the nationwide supply system to transport spent nuclear fuel and high-level radioactive waste to the repository. The analysis in Chapter 6 (Sections 6.1.2.10, 6.3, 6.3.2.1, 6.3.2.2, 6.3.3.1, and 6.3.3.2), evaluates fuel use for the different transportation scenarios. The amount used would be a very small fraction of a percent of the Nation’s supply over the period of fuel use.

The manufacture of casks and containers would require commitment of aluminum, chromium, copper, depleted uranium, lead, molybdenum, nickel, and steel. The required amounts of these materials, expressed as percentages of U.S. production, would be low with the exception of nickel, which would require approximately 8.2 percent of annual U.S. production.

REFERENCES

102043	AIWS 1998	AIWS (American Indian Writers Subgroup) 1998. *American Indian Perspectives on the Yucca Mountain Site Characterization Project and the Repository Environmental Impact Statement.* Las Vegas, Nevada: Consolidated Group of Tribes and Organizations. ACC: MOL.19980420.0041.
154659	BSC 2001	BSC (Bechtel SAIC Company) 2001. *FY01 Supplemental Science and Performance Analyses, Volume 2: Performance Analyses.* TDR-MGR-PA-000001 REV 00. Las Vegas, Nevada: Bechtel SAIC Company. ACC: MOL.20010724.0110.

11

Statutory and Other Applicable Requirements

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11. STATUTORY AND OTHER APPLICABLE REQUIREMENTS

The U.S. Department of Energy (DOE or the Department) has conducted site characterization activities in accordance with requirements of applicable laws and regulations and a range of permits and approvals that regulate the various aspects of the activities. The Department has successfully met environmental protection standards for its site characterization activities by developing a comprehensive approach to environmental compliance that ensures adherence to Federal and state requirements. It has implemented specific environmental compliance programs for pollution prevention, protection of cultural resources, and protection of threatened or endangered species. In its future actions involving Yucca Mountain, DOE will continue to comply with applicable Federal and state environmental requirements and with the conditions of the permits and approvals that might be required to conduct its activities, and will continue its involvement with tribal governments in accordance with Executive Orders, laws, and customs, and as based on relationships established by treaties.

This chapter identifies major requirements that could be applicable to the Proposed Action, which is to construct, operate and monitor, and eventually close a geologic repository for the disposal of spent nuclear fuel and high-level radioactive waste at Yucca Mountain. Section 11.1 lists statutory and regulatory provisions that set requirements potentially applicable to siting a monitored geologic repository. Section 11.2 summarizes statutes and regulations that set environmental protection requirements that could apply to a repository at Yucca Mountain. Section 11.3 contains a list of DOE Orders that could apply to activities related to the proposed repository. Section 11.4 contains a list of potentially applicable requirements compiled by the DOE Office of Civilian Radioactive Waste Management.

Table 11-1 lists potential new permits, licenses, and approvals that DOE could need for construction, operation, and closure of the Yucca Mountain Repository.

11.1 Statutes and Regulations Establishing or Affecting Authority To Propose, License, and Develop a Monitored Geologic Repository

Nuclear Waste Policy Act of 1982, as amended (42 U.S.C. 10101-10270)

The Nuclear Waste Policy Act, as amended in 1987 (NWPA), directs DOE to characterize and evaluate the suitability of only Yucca Mountain in southern Nevada as a potential site for a geologic repository for the disposal of spent nuclear fuel and high-level radioactive waste. After considering the suitability of the site and other information, the Secretary may then recommend approval of the site to the President. Further, the NWPA states that an environmental impact statement (EIS) must accompany any recommendation that the President approve the site for a repository. If the President recommends the Yucca Mountain Site to Congress and the designation takes effect, the NWPA provides that the Secretary of Energy must submit an application for construction authorization to the U.S. Nuclear Regulatory Commission not later than 90 days after the date on which the site designation is effective.

The NWPA directs the U.S. Environmental Protection Agency to promulgate generally applicable standards for protection of the environment from offsite releases from radioactive material in repositories. In addition, it requires the Nuclear Regulatory Commission to consider and approve or disapprove an application (if DOE submits one) for authorization to construct a repository for these materials based on Commission standards, which are to be consistent with the Environmental Protection Agency standards. In 1983, the Nuclear Regulatory Commission promulgated licensing requirements (10 CFR Part 60) that contain general criteria governing the issuance of a construction authorization and license for a geologic repository. These requirements would allow DOE to develop a repository for the receipt and disposal of spent nuclear fuel and high-level radioactive waste and would establish conditions under which DOE could receive and possess source, special nuclear, and byproduct material at a geologic repository. The

Table 11-1. Permits, licenses, and approvals needed for a monitored geologic repository.

Activity	Regulatory action	Statute or regulation	Agency(ies)
1. Disposal of spent nuclear fuel and high-level radioactive waste	Final public health and environmental protection standards	40 CFR[a] Part 197	Environmental Protection Agency
2. Repository construction, operation, and closure	Construction authorization, license to operate and monitor, and license for closure	10 CFR Part 63	Nuclear Regulatory Commission
3. Site suitability	Criteria and methodology for determining suitability of Yucca Mountain Site	10 CFR Part 963	Department of Energy
4. Repository construction, operation, and closure	Withdrawal of Land from Public Use	Future Congressional Bill needed to authorize withdrawal, 43 CFR Part 2300	Congress, Bureau of Land Management
5. Air emissions	Approvals for New Sources of Toxic Air Pollutants	40 CFR Parts 61 and 63	Environmental Protection Agency
		NAC[b] 445B.287 *et seq.*	Nevada Division of Environmental Protection
6. Air emissions	Air Quality Operating Permit	NAC 445B.287 *et seq.*	Nevada Division of Environmental Protection
7. Air emissions	National Emission Standards for Hazardous Air Pollutants Subpart H (Radionuclides)	40 CFR Part 61	Environmental Protection Agency
		10 CFR Part 20	Nuclear Regulatory Commission
	National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	Environmental Protection Agency
8. Certification of facilities	Certification of Air and Water Pollution Control Facilities	40 CFR Part 20	Environmental Protection Agency
9. Drinking water	Water System Operating Permit	NAC 445A.070 *et seq.*	Nevada Health Division
10. Effluents	Stormwater Discharge	40 CFR Part 122	Environmental Protection Agency
		NAC 445A.070 *et seq.*	Nevada Division of Water Planning
11. Effluents	National Pollutant Discharge Elimination System	40 CFR Part 122	Environmental Protection Agency
	State Water Pollution Control Permit	NAC Chapter 445A	Nevada Division of Water Planning, Nevada Division of Environmental Protection
12. Excavation; facility construction	Cultural Resource Review Clearance, Section 106 Agreement	36 CFR Part 800	Advisory Council on Historic Preservation, State Historic Preservation Officer
13. Excavation; facility construction	Permit to Proceed (Objects of Antiquity)	36 CFR Part 296 43 CFR Parts 3 and 7	Department of the Interior
14. Excavation; facility construction	Permit for Excavation or Removal of Archaeological Resources	16 U.S.C.[c] 470 *et seq.*	Department of the Interior, affected Native American Tribes
15. Facility construction	Free-Use Permit	43 CFR Part 3620	Bureau of Land Management, Forest Service
16. Facility construction	Permit for the discharge of dredged or fill materials to Waters of the United States	Clean Water Act, Section 404	U.S. Army Corps of Engineers
17. Transportation to Facility	Right-of-way reservations	43 CFR 2800	Bureau of Land Management
18. Facility construction and operation	Endangered Species Consultation	50 CFR 402.6	Fish and Wildlife Service
19. Materials storage	Hazardous Materials Storage Permit	NAC Chapters 459 and 477	Nevada State Fire Marshal

a. CFR = Code of Federal Regulations.
b. NAC = Nevada Administrative Code.
c. U.S.C. = United States Code.

requirements in 10 CFR Part 60 do not apply to any nonrepository activities licensed under other parts of Title 10 of the Code of Federal Regulations.

Congress originally passed the Nuclear Waste Policy Act in 1982. The 1982 legislation directed the Secretary of Energy to recommend potential sites to the President for possible characterization as geologic repositories, and it directed the President to select sites for characterization. The Nuclear Waste Policy Act also required the Secretary of Energy to issue general guidelines for use in recommending potential geologic repository sites for detailed site characterization. DOE issued those guidelines in 1984 (10 CFR Part 960) and applied them when it nominated five sites as suitable for characterization and recommended characterization of three of the sites.

DOE decided to include in the general guidelines a process for evaluating the data obtained from site characterization activities to be used in determining whether a site should be recommended for the development of a geologic repository. In 1996, DOE proposed to clarify and focus its 10 CFR Part 960 guidelines (to be codified at 10 CFR Part 963), but never issued those guidelines as final. In 1999, DOE proposed further revisions to the draft 10 CFR Part 963 guidelines (64 *FR* 67054). DOE has since finalized these changes and 10 CFR Part 963 has been promulgated (66 *FR* 57297). In the Site Recommendation, if any, DOE will consider these finalized guidelines.

Section 116(c) of the NWPA establishes a procedure by which DOE can consider and, if appropriate, address a broad array of considerations. The State of Nevada or an affected unit of local government can describe impacts that are likely to result from site characterization in a report and submit it to the Secretary of Energy. Section 116 of the NWPA allows DOE to consider these impacts as a basis for DOE providing technical or financial assistance. In contrast to the National Environmental Policy Act process, a Section 116(c) determination of impact assistance is not tied to an extensive body of past precedent or regulatory interpretations. DOE has broad discretion under Section 116(c) to consider impacts that the State of Nevada or an affected unit of local government might identify.

Energy Policy Act of 1992 (42 U.S.C. 10101 *et seq.*)

In the NWPA, Congress directed the Environmental Protection Agency to establish standards to protect the general environment from offsite releases from radioactive materials in repositories. The NWPA also directed the Nuclear Regulatory Commission to issue technical requirements and criteria that it will apply in approving or disapproving any applications regarding repositories. In 1992, Congress passed the Energy Policy Act, modifying the rulemaking authorities of the Environmental Protection Agency and the Nuclear Regulatory Commission with respect to the proposed repository at Yucca Mountain. Section 801(a) of the Energy Policy Act directed the Environmental Protection Agency to (1) retain the National Academy of Sciences to make findings and recommendations on reasonable public health and safety standards for Yucca Mountain, and (2) establish Yucca Mountain-specific standards based on and consistent with the National Academy of Science's findings and recommendations. Section 801(b) of the Energy Policy Act directs the Nuclear Regulatory Commission to modify its technical requirements and criteria for geologic repositories to be consistent with the site-specific Yucca Mountain standard (40 CFR Part 197) established by the Environmental Protection Agency. Section 801(c) of the Energy Policy Act requires that DOE continue its oversight of the Yucca Mountain site after closure to prevent: (1) Unreasonable risk of breaching the repository's barriers, and (2) Increasing the exposure of individual members of the public to radiation beyond allowable limits. The National Academy of Sciences issued its findings and recommendations in a 1995 report (DIRS 100018-National Research Council 1995, all).

Environmental Radiation Protection Standards for Yucca Mountain, Nevada (40 CFR Part 197)

In response to the Energy Policy Act of 1992, the Environmental Protection Agency has established Yucca Mountain-specific environmental standards for radioactive material stored at or disposed of in the Yucca Mountain site and for disposing of radioactive material in a Yucca Mountain repository (40 CFR

Part 197; see Table 11-1, item 1). The Environmental Protection Agency provisions set public health and environmental radiation protection standards.

As part of its evaluation of the potential for public health and environmental impacts, DOE measured the short-term and long-term performance of the repository system by comparing the volume and dispersion of analyzed releases against the 40 CFR Part 197 requirements as the Nuclear Regulatory Commission has adopted those requirements. Table 11-2 provides information on the 40 CFR Part 197 standards.

The disposal standards also include limits on radionuclides and types of radiation that releases from the repository could cause in groundwater during the 10,000-year period. The standards further require DOE to calculate the peak dose to the reasonably maximally exposed individual that would occur beyond 10,000 years but within the period of geologic stability and to include the results in this EIS.

Disposal of High-Level Radioactive Wastes in a Proposed Geologic Repository at Yucca Mountain (10 CFR Part 63)

The U.S. Nuclear Regulatory Commission has established licensing regulations for disposal of spent nuclear fuel and high-level radioactive waste in the proposed geologic repository at Yucca Mountain, Nevada (10 CFR Part 63; see Table 11-1, item 2). The regulations establish site-specific technical requirements and criteria governing construction, operations and monitoring, closure, and long-term performance of the repository. If DOE submits appropriate applications, the Commission must use the requirements and criteria in 10 CFR Part 63 to determine whether to authorize the Department to construct a repository at Yucca Mountain, to license DOE to receive and possess spent nuclear fuel and high-level radioactive waste at such a repository, and to authorize DOE to close and decommission such a repository. To gain approval of a licensing application, the DOE repository design for Yucca Mountain must meet Nuclear Regulatory Commission requirements, including requirements for demonstrating compliance with the Environmental Protection Agency standards set forth at 40 CFR Part 197.

Title 10 CFR Part 63 includes the specification of overall performance objectives to protect the public health and safety during preclosure and postclosure phases of the repository. The technical criteria require that DOE demonstrate compliance with these overall performance objectives through an integrated safety analysis of preclosure operations, and through a performance assessment for long-term, postclosure performance. The criteria also address requirements for natural and engineered barriers, licensing procedures, public participation criteria, records and reporting, monitoring and testing programs, performance confirmation, quality assurance, personnel training and certification, and emergency planning. The criteria apply specifically and exclusively to the proposed repository at Yucca Mountain.

Yucca Mountain Site Suitability Guidelines (10 CFR Part 963)

The U.S. Department of Energy has set forth guidelines at 10 CFR Part 963 (see Table 11-1, item 3) to establish methods and criteria for determining the suitability of the Yucca Mountain site for the location and development of a geologic repository. The suitability determination is necessary to complete DOE's site characterization program activities required under section 113(b) of the Nuclear Waste Policy Act.

The guidelines focus on the criteria and methodology to be used for evaluating relevant geological and other related aspects of the Yucca Mountain site in assessing site suitability. The criteria and methodology are consistent with the latest scientific and analytical techniques and with the Nuclear Regulatory Commission's requirements set forth at 10 CFR Part 63 and the Environmental Protection Agency's standards established at 40 CFR Part 197. The guidelines consider the preclosure and postclosure periods, and are specific to Yucca Mountain.

Table 11-2. Title 40 CFR Part 197, Public Health and Environmental Protection Standards.

Component	Storage regulations	Disposal regulations
Individual Protection Standard[a]	150 microsieverts (15 millirem)[b]	150 microsieverts (15 millirem)[b]
Human Intrusion Standard	N/A[c]	150 microsieverts (15 millirem)[b]
Groundwater Protection Standard	N/A	• For combined radium-226 and radium-228, 5 picocuries per liter, including background radiation • For gross alpha activity (including radium-226 but excluding radon and uranium), 15 picocuries per liter, including background radiation • For combined beta- and photon-emitting radionuclides, 40 microsieverts (4 millirem) per year to the whole body or any organ, based on drinking 2 liters of water per day from the representative volume, not including background radiation
Applicable period	Construction, operation and monitoring, closure until repository is sealed	10,000 years after repository is sealed
Standards apply to	All members of the public	Reasonably maximally exposed individual[d]
Location where compliance is assessed	Anywhere in the general environment	The location where projected concentrations would be highest and that is no closer to the repository than the edge of the controlled area
Geographic scope of standards	Everywhere other than the Yucca Mountain site, the Nellis Air Force Range, and the Nevada Test Site	Everywhere outside the surface and subsurface of the controlled area[e]

a. EIS Appendix F includes a primer on potential human health effects from exposure to radionuclides.
b. Annual committed effective dose equivalent, a combination of the dose an individual could absorb during a full year and any subsequent dose over a defined period of time from radionuclides remaining within the individual as a result of the dose absorbed during the year.
c. N/A = not applicable.
d. Represents a person who resides in the accessible environment above the highest concentration of radionuclides in the plume of contamination. The reasonably maximally exposed individual approach is based on providing a sufficient level of protection to this individual so that all other persons, who would be less exposed, would also be protected.
e. The location where projected concentrations would be highest, no closer to the repository than the edge of the controlled area. The controlled area would be 300 square kilometers (120 square miles) maximum surface and subsurface area that extends in the predominant direction of groundwater flow no farther south than 36 degrees, 40 minutes, 13.6661 seconds North latitude (the present southwest corner of the Nevada Test Site), and no more than 5 kilometers (3 miles) from the repository footprint in any other direction. The controlled area would be the area restricted long term for the repository as identified by passive institutional controls DOE would implement at closure.

National Environmental Policy Act of 1969, as Amended (42 U.S.C. 4321 *et seq.*)

DOE has prepared this EIS in accordance with the provisions of the National Environmental Policy Act as implemented by Council on Environmental Quality regulations (40 CFR Parts 1500 through 1508) and DOE National Environmental Policy Act regulations (10 CFR Part 1021), and in conformance with the NWPA.

Atomic Energy Act of 1954, as Amended (42 U.S.C. 2011 *et seq.*)

The Atomic Energy Act, as amended, provides fundamental jurisdictional authority to DOE and the Nuclear Regulatory Commission over governmental and commercial use of nuclear materials. The Atomic Energy Act ensures proper management, production, possession, and use of radioactive materials. In accordance with the Atomic Energy Act, DOE has established a system of requirements that it has issued as DOE Orders.

The Atomic Energy Act gives the Nuclear Regulatory Commission specific authority to regulate the possession, transfer, storage, and disposal of nuclear materials, as well as aspects of transportation packaging design requirements for radioactive materials, including testing for packaging certification. Commission regulations applicable to the transportation of radioactive materials (10 CFR Parts 71 and 73) require that shipping casks meet specified performance criteria under both normal transport and hypothetical accident conditions.

Under the Atomic Energy Act of 1954, as amended, the Environmental Protection Agency has the authority to develop generally applicable standards for protection of the general environment from radioactive material.

Federal Land Policy and Management Act of 1976 (43 U.S.C. 1701 *et seq.*)

The Federal Land Policy and Management Act governs the use of Federal lands administered by the Bureau of Land Management, which is an agency of the U.S. Department of the Interior. Access to and use of public lands administered by the Bureau are primarily governed by the regulations regarding the establishment of rights-of-way (43 CFR Part 2800; see Table 11-1, item 17) and withdrawals of public domain land from public use (43 CFR Part 2300; see Table 11-1, item 4), as described below in this section.

Some implementing alternative branch rail lines, routes for heavy-haul trucks, and intermodal transfer station locations that could be involved in transportation of spent nuclear fuel and high-level radioactive waste to Yucca Mountain would cross or occupy land administered by the Bureau of Land Management and would require right-of-way reservations (see Table 11-1, item 17). DOE has obtained right-of-way reservations from the Bureau of Land Management and a concurrence from the U.S. Air Force for access to the Yucca Mountain vicinity for characterization activities.

To develop a monitored geologic repository at Yucca Mountain, DOE would need to obtain control of Bureau of Land Management, Air Force, and DOE lands in western Nevada. Land withdrawal is the method by which the Federal Government gives exclusive control of land it owns to a particular agency for a particular purpose. Nuclear Regulatory Commission licensing conditions for a repository include a requirement that DOE either own or have permanent control of lands for which it is seeking a repository license, and that lands used for a repository be free and clear of all encumbrances, if significant, such as (1) rights arising under the general mining laws, (2) easements or rights-of-way, and (3) all other rights arising under lease, rights of entry, deed, patent, mortgage, appropriation, prescription, or otherwise.

The Federal Land Policy and Management Act, by which the Government accomplishes most Federal land withdrawals, contains a detailed procedure for application, review, and study by the Bureau of Land Management, and decisions by the Secretary of the Interior on withdrawal and on the terms and conditions of withdrawal. Withdrawals accomplished through the Federal Land Policy and Management Act remain valid for no more than 20 years and, therefore, do not appear to meet the permanency of control required by the Nuclear Regulatory Commission.

Only Congress has the power to withdraw Federal lands permanently for the exclusive purposes of specific agencies. Through legislative action, Congress can authorize and direct a permanent withdrawal of lands such as those proposed for the Yucca Mountain Repository. In addition, Congress would determine any conditions associated with the land withdrawal. In the absence of specific direction to

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another Federal agency the Bureau of Land Management would ordinarily administer details of a Congressional withdrawal, following the provisions of 43 CFR Part 2300.

Executive Order 11514, *National Environmental Policy Act, Protection and Enhancement of Environmental Quality*

Executive Order 11514 directs Federal agencies to monitor and control their activities continually to protect and enhance the quality of the environment. The Order also requires the development of procedures both to ensure the fullest practicable provision of timely public information and understanding of Federal plans and programs with potential environmental impacts, and to obtain the views of interested parties. DOE has promulgated regulations (10 CFR Part 1021, *National Environmental Policy Act Implementing Procedures*) and has issued a DOE Order (451.1A, *National Environmental Policy Act Compliance Program*) to ensure compliance with this Executive Order.

11.2 Statutes, Regulations, and Orders Regarding Environmental Protection Requirements

11.2.1 AIR QUALITY

Clean Air Act, as amended (42 U.S.C. 7401 *et seq.*)

The Clean Air Act is intended to "protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population." Section 118 of the Act requires Federal agencies such as DOE, with jurisdiction over any property or facility that might result in the discharge of air pollutants, to comply with "all Federal, state, interstate, and local requirements" related to the control and abatement of air pollution.

The Clean Air Act requires the Environmental Protection Agency to establish National Ambient Air Quality Standards to protect public health, with an adequate margin of safety, from any known or anticipated adverse effects of a regulated pollutant (42 U.S.C. 7409). It also requires the establishment of national standards of performance for new or modified stationary sources of atmospheric pollutants (42 U.S.C. 7411) and the evaluation of specific emission increases to prevent a significant deterioration in air quality (42 U.S.C. 7470). Air emission standards are established at 40 CFR Parts 50 through 99. The Clean Air Act specifically regulates emissions of hazardous air pollutants, including radionuclides, through the National Emission Standards for Hazardous Air Pollutants Program at 40 CFR Parts 61 and 63 (see Table 11-1, items 5 and 7).

Nevada Revised Statutes: Air Emission Controls, Chapter 445B

These statutes and regulations in the Nevada Administrative Code implement State and Federal Clean Air Act provisions, identify the requirements for permits for each air pollution source (unless it is specifically exempted), and identify ongoing monitoring requirements. In accordance with the Clean Air Act, DOE could have to obtain an Operating Permit from the Nevada Division of Environmental Protection for the control of gaseous, liquid, and particulate emissions associated with the construction and operation of a repository at Yucca Mountain (see Table 11-1, item 6). To ensure that its site characterization activities comply with applicable Clean Air Act and State provisions, DOE has obtained an operating permit for surface disturbances and point source emissions.

11.2.2 WATER QUALITY

Safe Drinking Water Act, as amended [42 U.S.C. 300(f) *et seq.*]

The primary objective of the Safe Drinking Water Act is to protect the quality of public water supplies, including any drinking water system at the proposed repository. This law grants the Environmental Protection Agency the authority to protect the quality of public drinking water supplies by establishing national primary drinking water regulations. In accordance with the Safe Drinking Water Act, the

Environmental Protection Agency has delegated authority for enforcement of drinking water standards to the states. Regulations (40 CFR Parts 123, 141, 145, 147, and 149) specify maximum contaminant levels, including those for radioactivity, in public water systems, which are generally defined as systems that serve at least 15 service connections or regularly serve at least 25 year-round residents.

In 1978, the Environmental Protection Agency approved the Nevada program for enforcing drinking water standards. The Nevada Health Division is responsible for enforcement of these standards. The proposed repository would include a drinking water system that obtained water from a source off the repository site, and DOE would operate the system in accordance with Nevada Health Division permitting requirements, if applicable (see Table 11-1, items 9, 10, 11, and 16).

Clean Water Act of 1977 (33 U.S.C. 1251 *et seq.*)

The purpose of the Clean Water Act, which amended the Federal Water Pollution Control Act, is to "restore and maintain the chemical, physical, and biological integrity of the Nation's water." The State of Nevada has been delegated the authority to implement and enforce most programs in the State under the Clean Water Act; exceptions include those addressed by Section 404, which is administered by the U.S. Army Corps of Engineers, as described below in this section.

The Clean Water Act prohibits the "discharge of toxic pollutants in toxic amounts" to navigable waters of the United States. Section 313 of the Act generally requires all departments and agencies of the Federal Government engaged in any activity that might result in a discharge or runoff of pollutants to surface waters to comply with Federal, state, interstate, and local requirements. Under the Clean Water Act, states generally set water quality standards, and the Environmental Protection Agency and states regulate and issue permits for point-source discharges as part of the National Pollutant Discharge Elimination System permitting program. The Environmental Protection Agency regulations for this program are codified at 40 CFR Part 122, and Nevada rules for this program are codified at Nevada Administrative Code Chapter 445A. If the construction or operation of a Yucca Mountain Project facility or associated transportation route in Nevada would result in point-source discharges, DOE could need to obtain a National Pollutant Discharge Elimination System permit from the State of Nevada Division of Environmental Protection (see Table 11-1, item 10).

Sections 401 and 405 of the Water Quality Act of 1987 added Section 402(p) to the Clean Water Act. Section 402(p) requires the Environmental Protection Agency to establish regulations for the Agency or individual states to issue permits for stormwater discharges associated with industrial activity, including construction activities that could disturb 5 or more acres (40 CFR Part 122). Nevada rules for this program are codified at Nevada Administrative Code Chapter 445A. The Agency has promulgated regulations implementing a separate stormwater permit application process.

Section 404 of the Clean Water Act gives the U.S. Army Corps of Engineers permitting authority over activities that discharge dredge or fill material into waters of the United States. DOE could need to obtain a permit from the Corps for activities associated with a repository at Yucca Mountain if those activities would discharge dredge or fill into any such waters. If the construction or modification of rail lines or highways to the repository included dredge or fill activities or other actions that would discharge dredge or fill into waters of the United States, those activities would also require Section 404 permits. DOE has obtained a Section 404 permit for site characterization-related construction activities it might conduct in Coyote Wash or its tributaries or in Fortymile Wash.

Nevada Revised Statutes: Water Controls, Chapter 445A

These statutes classify the waters of the State, establish standards for the quality of all waters in the State, and specify permitting and notification provisions for stormwater discharges and for other discharges to waters of the State in accordance with provisions of the Federal Clean Water Act. These statutes and regulations in the Nevada Administrative Code also (1) set drinking water standards, specifications for certification, and conditions for issuance of variances and exemptions, (2) set standards and requirements for the construction of wells and other water supply systems, (3) establish the different classes of wells and aquifer exemptions, and (4) establish requirements for well operation and monitoring, plugging, and abandonment activities. Regardless of whether these provisions are applicable, DOE has obtained an Underground Injection Control Permit and a Public Water System Permit for site characterization activities at Yucca Mountain. The Underground Injection Control Permit covers tracers, pump tests, and similar activities. The Public Water System Permit establishes the terms for the provision of potable water.

The Department would install and operate the drinking water system planned for the proposed repository in accordance with Nevada Health Division standards, if applicable, and would obtain a Water System Operating Permit from the Nevada Health Division (see Table 11-1, item 9), if needed. DOE could also need to obtain a General Permit for Storm Water Discharge from the Nevada Division of Water Resources to construct and operate a repository at Yucca Mountain (see Table 11-1, item 10). Any point-source discharges to waters of the State that occurred in the course of Yucca Mountain Project activities could require a National Pollutant Discharge Elimination System permit issued under these provisions. DOE has obtained a general discharge permit from the State for effluent discharges to the ground surface during site characterization.

Nevada Revised Statutes: Adjudication of Vested Water Rights; Appropriation of Public Waters, Chapter 533; Underground Water and Wells, Chapter 534

These statutes and accompanying regulations in the Nevada Administrative Code establish permitting procedures for appropriating public waters of the State, including underground waters, for beneficial use.

DOE has obtained temporary permits for the use of underground water from several wells during site characterization.

It is the policy of the United States Government to apply for water in accordance with state laws. In 1997, DOE applied for an appropriation of water to fulfill the purpose of the NWPA, for the proposed repository in accordance with the provisions of Chapters 533 and 534 of the Nevada Revised Statutes. The Nevada State Engineer denied the DOE water appropriation applications, and DOE appealed the denial in court. The denial is being litigated. On October 15, 2001, the United States Court of Appeals for the Ninth Circuit set the matter for trial in the U.S. District Court for the State of Nevada (No. 00-17330, D.C. No. CV-00-268-RLH).

Chapter 534 of the Nevada Revised Code establishes requirements applicable to drilling, construction, and plugging of wells for extraction of underground water.

Executive Order 11988, *Floodplain Management*

This Order directs Federal agencies to establish procedures to ensure that any Federal action undertaken in a floodplain considers the potential effects of flood hazards and floodplain management and avoids floodplain impacts to the extent practicable. For its site characterization activities, DOE conducted a floodplain assessment (see Appendix L) in accordance with this Order (DIRS 103189-DOE 1992, all) and DOE implementing regulations (10 CFR Part 1022).

Compliance With Floodplain/Wetlands Environmental Review Requirements (10 CFR Part 1022)

Federal regulations (10 CFR Part 1022) establish policy and procedures for implementing Executive Order 11988, *Floodplain Management*, and for discharging DOE responsibilities regarding the consideration of floodplain/wetlands factors in DOE planning and decisionmaking. These regulations also establish DOE procedures for identifying proposed actions located in floodplains, providing opportunity for early public review of such proposed actions, preparing floodplain assessments, and issuing statements of findings for actions in a floodplain. The rules apply to all DOE proposed floodplain actions.

If DOE determines that an action it proposes would take place wholly or partly in a floodplain, it is required to prepare a notice of floodplain involvement and a floodplain assessment containing a project description, a discussion of floodplain effects, alternatives, and mitigations. For a proposed floodplain action for which a National Environmental Policy Act document such as an environmental impact statement or an environmental assessment is required, DOE is to include the floodplain assessment in the document. For floodplain actions for which DOE does not have to prepare such a document, the Department is to issue a separate document as the floodplain assessment. After the conclusion of public comment, DOE is to reevaluate the practicability of alternatives and of mitigation measures, considering all substantive comments.

If it finds that no practicable alternative to locating in the floodplain is available, DOE must design or modify its action to minimize potential harm to and within the floodplain. For actions in a floodplain, DOE must publish a statement of findings of three pages or less containing a brief description of the proposed action, a location map, an explanation indicating the reason for locating the action in the floodplain, a list of alternatives considered, a statement indicating whether the action conforms to applicable State or local floodplain protection standards, and a brief description of steps DOE will take to minimize potential harm to or within the floodplain. For floodplain actions that require the preparation of an EIS, the Final EIS can incorporate the statement of findings. Before implementing a proposed floodplain action, DOE must endeavor to allow at least 15 days of public review of the statement of findings.

Appendix L contains a statement of findings on the potential for repository construction and operation to affect floodplains. Appendix L also contains a floodplain/wetlands assessment that examines the effects of proposed repository construction and operation and potential construction of a rail line or intermodal transfer station. The assessment includes discussion of:

1. Floodplains near Yucca Mountain (Fortymile Wash, Busted Butte Wash, Drillhole Wash, and Midway Valley Wash); there are no delineated wetlands at Yucca Mountain.

2. What is known about floodplains and areas that might have wetlands (for example, springs and riparian areas) along potential rail corridors in Nevada and at intermodal transfer station locations associated with heavy-haul truck routes. If DOE selected rail as the mode of spent nuclear fuel and high-level radioactive waste transport in Nevada, it would select one of the rail corridors, and would prepare a more detailed floodplains/wetlands assessment of the selected corridor. If DOE selected heavy-haul truck as the mode of transport for spent nuclear fuel and high-level radioactive waste in Nevada, it would select one of five heavy-haul truck routes and one of three intermodal transfer stations, and would prepare a more detailed floodplain/wetlands assessment of the selected heavy-haul truck route and the associated intermodal transfer station.

11.2.3 HAZARDOUS MATERIALS PACKAGING, TRANSPORTATION, AND STORAGE

Roles of U.S. Department of Transportation and Nuclear Regulatory Commission in Regulating the Transportation of Radioactive Materials

The U.S. Department of Transportation and Nuclear Regulatory Commission share primary responsibility for regulating safe transportation of radioactive materials in the United States. The Department of Transportation has responsibility to develop and implement transportation safety standards for hazardous materials, including radioactive materials. In Title 49 of the Code of Federal Regulations, the Department of Transportation has established standards and requirements for packaging, transporting, and handling radioactive materials for all modes of transportation, including standards for labeling, shipping papers, placarding, loading and unloading, allowable radioactive levels, and limits for contamination of packages and vehicles, among other requirements. The regulations also specify safety requirements for vehicles and transportation operations, training for personnel who perform handling and transportation of hazardous materials, and liability insurance requirements for carriers.

The Nuclear Regulatory Commission regulates the packaging- and transportation-related operations of its licensees, including commercial shippers of radioactive materials. It sets design and performance standards for packaging (shipping casks) that carry materials with higher levels of radioactivity. The Department of Transportation, by agreement with the Nuclear Regulatory Commission, accepts the Commission standards of 10 CFR Part 71 for packaging. The Nuclear Regulatory Commission also establishes safeguards and security regulations to minimize the possibility of theft, diversion, or attack on shipments of radioactive materials (10 CFR Part 73). Title 10 of the Code of Federal Regulations details these requirements. As required by the NWPA (Section 180), carriers would make all shipments to Yucca Mountain in Nuclear Regulatory Commission-certified packages and in accordance with Commission regulations on advance notification of state and local governments. Appendix M contains a detailed discussion of regulatory responsibilities for transportation activities.

Hazardous Materials Transportation Act (49 U.S.C. 1801)

The Hazardous Materials Transportation Act gives the U.S. Department of Transportation authority to regulate the transport of hazardous materials, including radioactive materials such as those that would be transported to the proposed Yucca Mountain Repository from 72 commercial and 5 DOE sites. Department of Transportation regulations (49 CFR Parts 171 through 180) would require the identification of hazardous materials during transportation to a repository at Yucca Mountain, set forth rules for the selection of routes that carriers must use when transporting such materials, and provide guidance to states in designating preferred routes.

Emergency Planning and Community Right-to-Know Act of 1986 (42 U.S.C. 1001 *et seq.*)

Under Subtitle A of the Emergency Planning and Community Right-to-Know Act (also known as "SARA Title III"), Federal facilities, including a repository at Yucca Mountain, must provide information on hazardous and toxic chemicals to state emergency response commissions, local emergency planning committees, and the Environmental Protection Agency. The goal of providing this information is to ensure that emergency plans are sufficient to respond to unplanned releases of hazardous substances. The required information includes inventories of specific chemicals used or stored and descriptions of releases that occur from sites. This law, implemented at 40 CFR Parts 302 through 372, requires agencies to provide material safety data sheet reports, emergency and *hazardous chemical* inventory reports, and toxic chemical release reports to appropriate local, state, and Federal agencies. DOE has been complying with the provisions of the Emergency Planning and Community Right-to-Know Act and with regulations for maintaining and using inventories of chemicals for site characterization activities. If the proposed repository received a license, DOE would continue to comply with such provisions, as applicable, in storing and using chemicals for project activities.

Nevada Revised Statutes: Hazardous Materials, Chapter 459

A Nevada Hazardous Materials Storage Permit could be required to store hazardous materials in quantities greater than those specified in the Uniform Fire Code. To receive such a permit, if sought, DOE would submit an application to the Nevada State Fire Marshal (Nevada Revised Statutes, Chapter 477) that describes its plans for the storage of hazardous materials in excess of specified quantities (see Table 11-1, item 19). If permit renewal was sought each year, DOE would have to submit an annual report to the State Fire Marshal that complied with the reporting requirements of the Federal Emergency Planning and Community-Right-to-Know Act, Sections 302, 311, and 312. Regardless of whether these provisions are applicable, DOE has obtained a permit from the State Fire Marshal for the storage of flammable materials during site characterization activities.

Nuclear Regulatory Commission Radioactive Materials Packaging and Transportation Regulations (10 CFR Parts 71 and 73)

Under 10 CFR Part 71, the Nuclear Regulatory Commission regulates the packaging and transport of spent nuclear fuel for its licensees, which include commercial shippers of radioactive material and the DOE Office of Civilian Radioactive Waste Management. In addition, under an agreement with the U.S. Department of Transportation, the Commission sets the standards for packages containing Type B quantities of radioactive materials, including high-level radioactive waste and spent nuclear fuel. Type B packages are designed and built to retain their radioactive contents in both normal and accident conditions.

The demonstration of compliance with these requirements applies a combination of simple calculational methods, computer modeling techniques, and physical testing to the design features of the package. An applicant presents the results of the analyses and tests to the Nuclear Regulatory Commission in a Safety Analysis Report for Packaging, which the Commission, after review, approves by issuing a Certificate of Compliance. This certificate would be required for the use of a package (cask) to ship spent nuclear fuel or high-level radioactive waste to the repository.

The regulations at 10 CFR Part 73 govern safeguards and physical security during the transit of shipments of spent nuclear fuel. These regulations specify requirements for vehicles, carrier personnel, communications, notification of state governors, escorts, and route planning for such shipments.

Department of Transportation Hazardous Materials Packaging and Transportation Regulations (49 CFR Subchapter C – Hazardous Materials Regulations, Parts 171 Through 180)

The Department of Transportation regulates the shipments of hazardous materials, including spent nuclear fuel and high-level radioactive waste, in interstate and intrastate commerce by land, air, and navigable water. As outlined in a 1979 Memorandum of Understanding with the Nuclear Regulatory Commission (44 *FR* 38690, July 2, 1979), the Department of Transportation specifically regulates carriers of spent nuclear fuel and the conditions of transport, such as routing, handling and storage, and vehicle and driver requirements. It also regulates the labeling, classification, and marking of transportation packages for radioactive materials.

Department of Transportation regulations include requirements for carriers, drivers, vehicles, routing, packaging, labeling, marking, placarding of vehicles, shipping papers, training, and emergency response. The requirements specify the maximum dose rate associated with radioactive material shipments and the maximum allowable levels of radioactive surface contamination on packages and vehicles.

The public highway routing regulations of the Department of Transportation are prescribed in 49 CFR Part 397. The objectives of the regulations are to reduce the impacts of transporting highway route-controlled quantities of radioactive materials to establish consistent and uniform requirements for route selection, and to identify the role of state and local governments in the routing. The requirements at 49 CFR 173.403(l) contain a complete definition of *Highway Route-Controlled Quantities of Radioactive Material*.

Shipping casks transported by legal-weight trucks typically would contain about 300,000 curies of radionuclides, and rail casks typically would contain larger quantities. These regulations attempt to reduce potential hazards by requiring the use of routes that avoid populous areas and minimize travel times. At present, the Department of Transportation does not regulate the routing of rail shipments of radioactive materials. Department of Transportation regulations also include requirements to protect the health and safety of transportation workers.

11.2.4 CONTROL OF POLLUTION

Pollution Prevention Act of 1990 (42 U.S.C. 13101 *et seq.*)
The Pollution Prevention Act of 1990 establishes a national policy for waste management and pollution control that focuses first on source reduction, then on environmentally safe recycling, treatment, and disposal. DOE requires each of its sites to establish specific goals to reduce the generation of waste. If the Department built and operated a repository at the Yucca Mountain site, it would implement an appropriate pollution prevention plan. DOE has implemented a pollution prevention plan for site characterization activities. DOE would update this plan to include construction, operation and monitoring, and closure activities if the repository received a license.

Comprehensive Environmental Response, Compensation, and Liability Act, as amended (42 U.S.C. 9601 *et seq.*)
The Comprehensive Environmental Response, Compensation, and Liability Act, as amended by the Superfund Amendments and Reauthorization Act, authorizes the Environmental Protection Agency to require responsible site owners, operators, arrangers, and transporters to clean up releases of hazardous substances, including certain radioactive substances. Under this Act, the Environmental Protection Agency would have the authority to regulate hazardous substances, including certain radioactive materials, at the Yucca Mountain Repository in the event of a release or a "substantial threat of a release" of those materials from the repository. Releases greater than reportable quantities would be reported to the National Response Center.

Standards for Protection Against Radiation (10 CFR Part 20)
The purpose of 10 CFR Part 20 is to provide standards and procedures for protection against radiation. Provisions of 10 CFR Part 20 address repository occupational dose limits, public dose limits, survey and monitoring procedures, exposure control in restricted areas, respiratory protection and controls, precautionary procedures, and related topics.

Low-Level Radioactive Waste Policy Amendments Act of 1985 (P.L. 99-240)
Under the Low-Level Radioactive Waste Policy Amendments Act of 1985 (P.L. 99-240), DOE is responsible for disposal of any low-level waste generated by operations at the proposed Yucca Mountain Repository. Such waste would be considered DOE-owned and -generated waste.

On February 25, 2000, DOE issued a Record of Decision (65 *FR* 10061) to establish regional low-level waste disposal at the Hanford Site and Nevada Test Site that would be available to all DOE sites. DOE would ensure that Yucca Mountain is an approved generator in accordance with the requirements of Nevada Test Site waste acceptance criteria prior to disposal of any low-level radioactive waste at the Test Site generated from Yucca Mountain Repository operations.

Resource Conservation and Recovery Act, as amended (42 U.S.C. 6901 *et seq.*)
The treatment, storage, and disposal of hazardous and nonhazardous waste is regulated in accordance with the provisions of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act and the Hazardous and Solid Waste Amendments of 1984, and applicable state laws.

Environmental Protection Agency regulations implementing the hazardous waste portions of the Resource Conservation and Recovery Act define hazardous wastes and specify requirements for their transportation, handling, treatment, storage, and disposal (40 CFR Parts 260 through 272). In addition, under current Civilian Radioactive Waste system requirements, DOE could not accept hazardous waste for disposal at Yucca Mountain. Before shipping to Yucca Mountain, DOE would treat materials that contained hazardous components to eliminate the hazardous waste characteristics. Before shipping materials containing hazardous components listed under Subpart D of Part 261 or applicable state requirements, DOE would process any necessary delisting petitions with the appropriate regulatory authorities. If the activities at Yucca Mountain generated hazardous or mixed waste, the Department would not dispose of such waste on the site and would not treat such waste in a manner that required Resource Conservation and Recovery Act permitting, and would not store such waste on the site for more than 90 days. DOE does not expect to need a Resource Conservation and Recovery Act permit for its activities at the proposed repository.

Noise Control Act of 1972, as amended (42 U.S.C. 4901 *et seq.*)

Section 4 of the Noise Control Act directs Federal agencies to carry out programs in their jurisdictions "to the fullest extent within their authority" and in a manner that furthers a national policy of promoting an environment free from noise that jeopardizes health and welfare. This law provides requirements related to noise that would be generated by construction, operation, or closure activities associated with the Proposed Action at Yucca Mountain.

Nevada Revised Statutes: Sanitation, Chapter 444

These statutes and regulations in the Nevada Administrative Code establish the standards, permits, and requirements for septic tanks and other sewage disposal systems for single-family dwellings, communities, and commercial buildings. The construction and operation of a sanitary sewage collection system at Yucca Mountain could require the State of Nevada to approve DOE designs and to issue a permit. In connection with site characterization activities, DOE operates a septic system that the State has permitted under these provisions.

These statutes and regulations also set forth the definitions, methods of disposal, special requirements for solid waste collection and transportation standards, and classification of landfills. Onsite disposal of solid waste from a repository at Yucca Mountain could require that DOE obtain an appropriate permit for these activities.

In compliance with the Resource Conservation and Recovery Act, the Environmental Protection Agency has authorized the State of Nevada to regulate the management and disposal of solid, hazardous, and mixed wastes in the State. The Nevada Division of Environmental Protection or an equivalent solid waste management authority would regulate the onsite disposal of nonhazardous solid wastes generated by activities associated with the proposed repository. DOE would manage such waste in accordance with applicable laws and regulations.

Nevada Administrative Code Chapter 444 contains regulations that provide for fees, variances, and permits, and has adopted Environmental Protection Agency regulations (40 CFR Parts 2, 124, and 260 through 270) as part of the code. The regulations could affect any hazardous or mixed waste generated, treated, or stored onsite by activities associated with a proposed repository at Yucca Mountain. DOE would ship any generated hazardous or mixed wastes off the site within 90 days for treatment, storage, and disposal.

Executive Order 12088, *Federal Compliance with Pollution Control Standards*

Executive Order 12088, as amended by Executive Order 12580, *Superfund Implementation Control Standards*, generally directs Federal agencies to comply with applicable administrative and procedural pollution control standards established by, but not limited to, the Clean Air Act, the Noise Control Act, the Clean Water Act, the Safe Drinking Water Act, the Toxic Substances Control Act, and the Resource Conservation and Recovery Act. Compliance with these orders, as applicable, would be required for a range of DOE activities associated with a proposed repository at Yucca Mountain.

Executive Order 12856, *Right to Know Laws and Pollution Prevention Requirements*

This Order directs Federal agencies to reduce and report toxic chemicals entering any waste stream; improve emergency planning, response, and accident notification; and encourage the use of clean technologies and testing of innovative prevention technologies. In addition, the Order states that Federal agencies are persons for purposes of the Emergency Planning and Community Right-to-Know Act (SARA Title III), which requires agencies to meet the requirements of the Act. Compliance with these orders, as applicable, would be required for a range of DOE activities associated with a proposed repository at Yucca Mountain.

11.2.5 CULTURAL RESOURCES

National Historic Preservation Act, as amended (16 U.S.C. 470 *et seq.*)

The National Historic Preservation Act provides for the placement of sites with significant national historic value on the *National Register of Historic Places*. It requires no permits or certifications. DOE would evaluate activities associated with a repository at Yucca Mountain to determine if they would affect historic resources. If required after this evaluation, the Department would consult with the Advisory Council on Historic Preservation and the Nevada State Historic Preservation Officer. Such consultations generally result in the development of an agreement that includes stipulations to be followed to minimize or mitigate potential adverse impacts to a historic resource (see Table 11-1, item 12).

DOE has entered into a programmatic agreement with the Advisory Council on Historic Preservation for implementation of the National Historic Preservation Act for site characterization activities. This agreement requires DOE to consult and interact with Native Americans during site characterization. In compliance with the agreement provisions, Native American representatives from the Southern Paiute, Western Shoshone, and Owens Valley Paiute and Shoshone Tribes have reviewed Yucca Mountain activities on the site twice each year. These reviews have been followed by discussions between Native American representatives and DOE personnel, submittal of comments by the Native American representatives, and responses to the comments by DOE.

Archaeological Resources Protection Act, as amended (16 U.S.C. 470aa *et seq.*)

The Archaeological Resources Protection Act requires a permit for excavation or removal of archaeological resources from publicly held or Native American lands (see Table 11-1, item 14). Excavations must further archaeological knowledge in the public interest, and the resources removed are to remain the property of the United States. If a resource is found on land owned by a Native American tribe, the tribe must give its consent before a permit is issued, and the permit must contain terms or conditions requested by the tribe. Requirements of the Archaeological Resources Protection Act would apply to any Yucca Mountain Project excavation activities that resulted in identification of archaeological resources.

American Indian Religious Freedom Act of 1978 (42 U.S.C. 1996)

The American Indian Religious Freedom Act reaffirms Native American religious freedom under the First Amendment and establishes policy to protect and preserve the inherent and constitutional right of Native Americans to believe, express, and exercise their traditional religions. This law ensures the protection of sacred locations and access of Native Americans to those sacred locations and traditional resources that are integral to the practice of their religions. Further, it establishes requirements that would apply to Native American sacred locations, traditional resources, or traditional religious practices potentially affected by the construction and operation of a repository at Yucca Mountain.

Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. 3001)

The Native American Graves Protection and Repatriation Act directs the Secretary of the Interior to guide the repatriation of Federal archaeological collections and collections that are culturally affiliated with Native American tribes and held by museums that receive Federal funding. Major actions to be taken under this law include (1) the establishment of a review committee with monitoring and policymaking responsibilities, (2) the development of regulations for repatriation, including procedures for identifying lineal descent or cultural affiliation needed for claims, (3) the oversight of museum programs designed to meet the inventory requirements and deadlines of this law, and (4) the development of procedures to handle unexpected discoveries of graves or grave goods during activities on Federal or tribal land. The provisions of the Act would be invoked if any excavations associated with a repository at Yucca Mountain led to unexpected discoveries of Native American graves or grave artifacts. DOE and the Southern Paiute, Western Shoshone, and Owens Valley Paiute and Shoshone Tribes have entered an agreement to address the potential applicability of the Native American Graves Protection and Repatriation Act to artifacts collected during site characterization activities at Yucca Mountain.

Antiquities Act (16 U.S.C. 431 *et seq.*)
The Antiquities Act protects historic and prehistoric ruins, monuments, and objects of antiquity (including paleontological resources) on lands owned or controlled by the Federal Government. If historic or prehistoric ruins or objects were found during the construction or operation of facilities associated with a repository at Yucca Mountain, DOE would have to determine if adverse effects to these ruins or objects would occur. If adverse effects would occur, the Secretary of the Interior would have to grant permission to proceed with the activity (36 CFR Part 296 and 43 CFR Parts 3 and 7) (see Table 11-1, item 13).

Executive Order 13007, *Indian Sacred Sites*
This Order directs Federal agencies, to the extent permitted by law and not inconsistent with agency missions, to avoid adverse effects to sacred sites and to provide access to those sites to Native Americans for religious practices. The Order directs agencies to plan projects to provide protection of and access to sacred sites to the extent compatible with the project.

Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments*
This Order directs Federal agencies to establish regular and meaningful consultation and collaboration with tribal governments in the development of Federal policies that have tribal implications, to strengthen United States government-to-government relationships with Indian tribes, and to reduce the imposition of unfunded mandates on tribal governments.

11.2.6 ENVIRONMENTAL JUSTICE

Executive Order 12898, *Environmental Justice*
This Order directs Federal agencies, to the extent practicable, to make the achievement of environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations in the United States and its territories and possessions. The order provides that the Federal agency responsibilities it establishes are to apply equally to Native American programs.

11.2.7 ECOLOGY AND HABITAT

Endangered Species Act, as amended (16 U.S.C. 1531 *et seq.*)
The Endangered Species Act provides a program for the conservation of threatened and endangered species and the ecosystems on which those species rely. If a proposed action could affect threatened or endangered species or their habitat, the Federal agency must assess the potential impacts and develop measures to minimize those impacts. The agency then must consult formally with the Fish and Wildlife Service (part of the U.S. Department of the Interior) and the National Marine Fisheries Service (part of the Department of Commerce), as required under Section 7 of the Act. The outcome of this consultation would be a biological opinion by the Fish and Wildlife Service or the National Marine Fisheries Service that stated whether the proposed action would jeopardize the continued existence of the species under consideration. If there is a non-jeopardy opinion, but some individuals are killed incidentally as a result of the proposed action, the Services can determine that such losses are not prohibited as long as measures

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outlined by the Services are followed. Regulations implementing the Endangered Species Act are codified at 50 CFR Parts 15 and 402.

There are no known endangered species on the Yucca Mountain site. The desert tortoise is the only threatened species found on the site. The Fish and Wildlife Service previously issued a biological opinion stating that site characterization activities at Yucca Mountain would not jeopardize the continued existence of the desert tortoise (DIRS 104618-Buchanan 1997, p. 16).

The U.S. Fish and Wildlife Service has issued a Biological Opinion (50 CFR 402.6; see Table 11-1, item 18) establishing reasonable and prudent meaures and terms and conditions to ensure that constructing, operating and monitoring, and eventually closing a repository at Yucca Mountain would not jeopardize the continued existence of the desert tortoise (see Appendix O). If the repository was approved, DOE would comply with all provisions of the Biological Opinion, including the reasonable and prudent measures and their implementing terms and conditions. DOE would fulfill the requirements of the Endangered Species Act, as appropriate, with regard to transportation impacts before making a final determination on a transportation route.

Fish and Wildlife Coordination Act, as amended (16 U.S.C. 661, 48 Stat. 401)

The Fish and Wildlife Coordination Act promotes more effectual planning and cooperation between Federal, state, public, and private agencies for the conservation and rehabilitation of the Nation's fish and wildlife and authorizes the Department of the Interior to provide assistance.

Migratory Bird Treaty Act, as amended (16 U.S.C. 703 *et seq.*)

The purpose of the Migratory Bird Treaty Act is to protect birds that have common migration patterns between the United States and Canada, Mexico, Japan, and Russia. It regulates the take and harvest of migratory birds. The Fish and Wildlife Service will review this EIS to determine whether the activities analyzed would comply with the requirements of the Migratory Bird Treaty Act. Studies indicate that no requirements of this Act are applicable to the Yucca Mountain Project.

Bald and Golden Eagle Protection Act, as amended (16 U.S.C. 668-668d)

The Bald and Golden Eagle Protection Act makes it unlawful to take, pursue, molest, or disturb bald (American) and golden eagles, their nests, or their eggs anywhere in the United States (Section 668, 668c). The Department of the Interior regulates activities that might adversely affect bald and golden eagles. The Fish and Wildlife Service will review this EIS to determine whether the activities analyzed in this EIS would comply with the Bald and Golden Eagle Protection Act. DOE has established a program to ensure compliance with this law during site characterization activities.

National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd)

The National Wildlife Refuge System Administration Act provides guidelines for the administration and management of lands in the system, including "wildlife refuges, areas for the protection and conservation of fish and wildlife that are threatened with extinction, wildlife ranges, game ranges, wildlife management areas, or waterfowl production areas." If use of lands for transportation corridors and facilities such as a rail line or intermodal transfer station associated with a repository at Yucca Mountain could affect lands in the system, DOE would consult with the Fish and Wildlife Service. Regulations implementing the Act are codified at 50 CFR Parts 25 and 27 through 29. The Fish and Wildlife Service will review this EIS to determine if the Proposed Action would comply with the Act. It is DOE policy to place transportation corridors and facilities to avoid existing wildlife refuges.

Nevada Revised Statutes: Protection and Preservation of Timbered Lands, Trees, and Flora, Chapter 527

These provisions broadly protect the indigenous flora of the State of Nevada. If the State determines that a species or subspecies of native flora is threatened with extinction, that species or subspecies is to be placed on the State list of fully protected species. In general, no member of the species or subspecies may be taken or destroyed unless an authorized State official issues a special permit. Activities associated with a repository at Yucca Mountain arguably could affect such species and could require special permits.

Nevada Revised Statutes: Hunting, Fishing, and Trapping; Miscellaneous Protective Measures, Chapter 503; Nevada Administrative Code, Chapter 503: Sections 010-104, General Provisions

These provisions specify procedures for the classification and protection of wildlife. If the State determines that an animal species is threatened with extinction, the species is to be placed on the State list of fully protected species. In general, no member of the species may be taken or destroyed unless the Nevada Division of Wildlife issues a special permit. Activities associated with a repository at Yucca Mountain arguably could affect such species and could require special permits. Regardless of whether these provisions are applicable, DOE has obtained a permit for site characterization activities from the State of Nevada.

Executive Order 11990, *Protection of Wetlands*

This order directs Federal agencies to avoid new construction in wetlands unless there is no practicable alternative and unless the proposed action includes all practicable measures to minimize harm to wetlands that might result from such use. DOE requirements for compliance with wetlands activity review procedures are codified at 10 CFR Part 1022.

Executive Order 13112, *Invasive Species*

This order directs Federal agencies to act to prevent the introduction of or to monitor and control invasive (non-native) species, to provide for restoration of native species, to conduct research, to promote educational activities, and to exercise care in taking actions that could promote the introduction or spread of invasive species. If a repository were constructed at Yucca Mountain, DOE would comply with provisions of this Executive Order as part of construction, operation and monitoring, and closure activities.

Executive Order 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*

This Order requires Federal agencies to avoid or minimize the negative impacts of their actions on migratory birds, and to take active steps to protect birds and their habitats. The Order directs each Federal agency taking actions having or likely to have a negative impact on migratory bird populations to work with the U.S. Fish and Wildlife Service to develop an agreement to conserve those birds. The Order directs agencies to avoid or minimize impacts to migratory bird populations, take reasonable steps that include restoring and enhancing habitat, prevent or abate pollution affecting birds, and incorporate migratory bird conservation into agency planning processes whenever possible. The Order also requires environmental analyses of Federal actions to evaluate effects of those actions on migratory birds, to control the spread and establishment in the wild of exotic animals and plants that could harm migratory birds and their habitats, and either to provide advance notice of actions that could result in the take of migratory birds or to report annually to the U.S. Fish and Wildlife Service on the numbers of each species taken during the conduct of agency actions. If a repository was constructed at Yucca Mountain, DOE would comply with provisions of this Executive Order as part of construction, operation and monitoring, and closure activities.

11.2.8 USE OF LAND AND WATER BODIES

Coastal Zone Management Act (16 U.S.C. 1451 *et seq.*)

The purpose of the Coastal Zone Management Act is to preserve, protect, develop, restore, and enhance the resources of the Nation's coastal zone. Resources include wetlands, floodplains, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife and their habitat. This law provides for (1) management to minimize the loss of life and property caused by improper development and by the destruction of natural protective features such as beaches, dunes, wetlands, and barrier islands, and (2) improvement, safeguarding, and restoration of the quality of coastal waters, and for protection of existing uses of those waters. The Coastal Zone Management Act requires priority consideration to coastal-dependent uses and orderly processes for siting major facilities related to national defense, energy, fisheries development, recreation, ports and transportation, and the location of new commercial and industrial developments in or adjacent to areas where such development already exists.

The operation of a repository at Yucca Mountain could require the use of barges for transportation of spent nuclear fuel along portions of routes from some storage facilities. In addition, rail corridors, roads, and bridges from some storage facilities could require repair or enhancement before they could support shipment of spent nuclear fuel. DOE would ensure that its activities are consistent with state-specific coastal zone management plans promulgated in accordance with this Act, if applicable. The regulations promulgated under the Act are codified at 15 CFR Part 930.

Rivers and Harbors Act (33 U.S.C. 401 *et seq.*)

The transportation of spent nuclear fuel and high-level radioactive waste could require the construction or modification of road or rail bridges that span navigable waters. The Rivers and Harbors Act prevents the alteration or modification of the course, location, condition, or capacity of any channel of any navigable water of the United States without a permit from the U.S. Army Corps of Engineers. If DOE assumed responsibility for such construction or modifications, it would need to obtain a permit from the U.S. Army Corps of Engineers. Regulations implementing this Act are codified at 33 CFR Part 323.

National Forest Organic Administrative Act (16 U.S.C. 521)

The National Forest Organic Administrative Act establishes the functions and responsibilities of the Forest Service, an agency of the U.S. Department of Agriculture. The Forest Service would be requested to approve the construction of rail lines and roads in Nevada that would be associated with the operation of a repository at Yucca Mountain and that could cross land administered by the Service (16 U.S.C. 1600, 1611 to 1614).

National Forest Management Act of 1976

The National Forest Management Act establishes decision planning and management practices for forests. This law could affect any proposed construction of rail lines or roads associated with the construction or operation of a repository at Yucca Mountain that could cross National Forest lands.

Materials Act of 1947 (30 U.S.C. 601-603)

The Materials Act authorizes land management agencies, such as the Bureau of Land Management and the Forest Service, to make common varieties of sand, stone, and gravel from public lands available to Federal and state agencies under a Free Use Permit (see Table 11-1, item 15). Regulations implementing the Materials Act are codified at 43 CFR Part 3620. DOE has received three free use permits from the Bureau of Land Management to obtain gravel for site characterization activities in a manner compliant with the Materials Act.

Taylor Grazing Act (43 U.S.C. 315-316)

The Taylor Grazing Act establishes the processes by which the Bureau of Land Management grants and administers grazing rights. If a decision is made to construct and operate a repository, a new rail line, or a new road on a Bureau of Land Management grazing allotment, DOE would have to acquire a right-of-way grant across the allotment or a withdrawal of the allotment. Regulations implementing the Taylor Grazing Act are codified at 43 CFR Part 4100.

Farmland Protection Policy Act (7 U.S.C. 4201 *et seq.*)
The Farmland Protection Policy Act seeks to minimize the extent to which Federal programs contribute to the unnecessary and irreversible conversion of farmlands to nonagricultural uses. Compliance with this law requires concurrence from the Natural Resources Conservation Service of the U.S. Department of Agriculture that proposed activities would not affect farmlands. DOE has completed a consultation with the Natural Resources Conservation Service that determined that a repository at Yucca Mountain would not affect prime or unique farmlands. This EIS assesses the potential construction of a rail line, new roads, or an intermodal transfer station in Nevada to determine if that construction could affect such lands. Regulations implementing the Farmland Protection Policy Act are codified at 7 CFR Part 658.

11.3 Department of Energy Orders

Under the authority of the Atomic Energy Act, DOE is responsible for establishing a comprehensive health, safety, and environmental program for its activities and facilities. The Department has established a framework for managing its facilities through the promulgation of regulations and the issuance of DOE Orders. In general, DOE Orders set forth policies, programs, and procedures for implementing policies. Many DOE Orders contain specific requirements in the areas of radiation protection, nuclear safety and safeguards, and security of nuclear material. Table 11-3 lists DOE Orders potentially relevant to the Civilian Radioactive Waste Management Program.

The Nuclear Regulatory Commission is authorized to license the proposed Yucca Mountain repository. Some DOE Orders overlap or duplicate Nuclear Regulatory Commission repository licensing regulations in whole or in part. Recognizing this, the Department issued DOE HQ Order 250.1, *Civilian Radioactive Waste Management Facilities – Exemption from Departmental Directives.* This Order exempts geologic repository design, construction, operation, and decommissioning from compliance with the provisions of DOE Orders that overlap or duplicate Commission requirements related to radiation protection, nuclear safety (including quality assurance), and safeguard and security of nuclear material. The exemption would apply only to portions of a repository project for which DOE sought a Nuclear Regulatory Commission license. DOE Orders would continue to establish requirements for other activities associated with a repository that fall outside the scope of this exemption, for example in the area of computer security (Order 1360.28).

Through DOE Order 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees,* the Department has prescribed the Occupational Safety and Health Act standards that contractors are to meet in their work at government-owned, contractor-operated facilities.

A monitored geologic repository at Yucca Mountain would be a nonreactor nuclear facility. DOE Orders 5480.21, *Unreviewed Safety Questions,* 5480.22, *Technical Safety Requirements,* and 5480.23, *Nuclear Safety Analysis Reports,* ordinarily apply to nonreactor nuclear facilities. Because DOE Order 250.1 gives precedence to Nuclear Regulatory Commission rules, DOE Orders 5480.21, 5480.22, and 5480.23, for example, probably would not apply to the repository.

11.4 Potentially Applicable Federal Regulations

Sections 11.2.1 through 11.2.8 and Section 11.3 identify major laws, regulations, and DOE Orders potentially applicable to the construction, operation and monitoring, and closure of a monitored geologic repository. Table 11-4 lists other potentially applicable regulations and orders.

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Table 11-3. DOE Orders potentially relevant to the Civilian Radioactive Waste Management Program (page 1 of 2).

Order	Subject	Description
151.1	Comprehensive Emergency Management System	Establishes requirements for emergency planning, preparedness, response, recovery, and readiness assurance activities and describes the approach for effectively integrating these activities under a comprehensive, all-emergency concept.
231.1	Environment, Safety and Health Reporting	Establishes the requirements and procedures for reporting information with environmental protection, safety, or health protection significance for DOE operations.
232.1	Occurrence Reporting and Processing of Operations Information	Establishes the requirements for reporting and processing occurrences related to safety, health, security, property, operations, and the environment, up to and including emergencies.
250.1	Civilian Radioactive Waste Management Facilities – Exemption from Departmental Directives	Establishes the relationship between DOE directives and Nuclear Regulatory Commission regulations for the Yucca Mountain Project.
420.1A	Facility Safety	Establishes facility safety requirements related to nuclear safety design, criticality safety, fire protection, and natural phenomena hazards mitigation.
425.1	Facility Startup and Restart	Establishes procedures to be followed when a facility is taken from a nonoperational to an operational state.
430.1	Life Cycle Asset Management	Establishes procedures to be followed in all phases of the management of DOE facilities.
435.1	Radioactive Waste Management	Establishes policies and guidelines by which DOE manages radioactive waste, waste byproducts, and radioactively contaminated surplus facilities.
440.1A	Worker Protection Management for DOE Federal and Contractor Employees	Establishes a comprehensive worker protection program that ensures that DOE and its contractor employees have an effective worker protection program that will reduce or prevent injuries, illnesses, and accidental losses by providing DOE, Federal, and contractor workers with a safe and healthful workplace.
451.1B	National Environmental Policy Act Compliance Program	Establishes DOE internal requirements and responsibilities for implementing the National Environmental Policy Act of 1969, as amended, the Council on Environmental Quality regulations implementing the procedural provisions of the Act (40 CFR Part 1500 *et seq.*), and the DOE procedures that implement it (10 CFR Part 1021).
460.1A	Packaging and Transportation Safety	Establishes requirements and assigns responsibilities for the safe transport of hazardous materials, hazardous substances, hazardous wastes, and radioactive materials.
462.1	Departmental Materials Transportation and Packaging Management	Establishes supplemental policies and requirements for materials transportation and packaging operations.
1300.2A	Department of Energy Technical Standards Program	Establishes policy, assigns responsibility, and provides requirements for development and application of technical standards in DOE facilities, programs, and projects; provides for participation in non-Government standards bodies and for establishment of a DOE Technical Standards Program; and assigns responsibility for the management of the program.

Table 11-3. DOE Orders potentially relevant to the Civilian Radioactive Waste Management Program (page 2 of 2).

Order	Subject	Description
1360.2B	Unclassified Computer Security Program	Establishes requirements, policies, responsibilities, and procedures for developing, implementing, and sustaining a DOE unclassified computer security program.
3790.1B	Federal Employee Occupational Safety and Health Program	Establishes requirements and procedures to ensure that occupational safety and health standards prescribed pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, and the DOE Organization Act of 1977 provide occupational safety and health protection for DOE contractor employees in Government-owned contractor-operated facilities.
5400.1	General Environmental Protection Program	Establishes environmental protection program requirements, authorities, and responsibilities for DOE operations to ensure compliance with applicable Federal, state, and local environmental protection laws and regulations and with internal DOE policies.
5400.5	Radiation Protection of the Public and the Environment	Establishes standards and requirements for operation of DOE and DOE contractors with respect to protection of members of the public and the environment against undue risk from radiation.
5480.19	Conduct of Operations Requirements for DOE Facilities	Provides requirements and guidelines for DOE elements to use in developing directives, plans, and procedures related to the conduct of operations at DOE facilities.
5484.1	Environmental Protection, Safety, and Health Protection Information Reporting Requirements	Establishes the requirements and procedures for the investigation of occurrences having environmental protection, safety, or health protection significance, and for efficient environmental monitoring of DOE operations.
5610.14	Transportation Safeguards System Program Operations	Establishes DOE policies for and implementation of the management and operation of the Transportation Safeguards System program.
5632.1C	Protection and Control of Safeguards and Security Interests	Establishes policy, responsibilities, and authorities for the protection and control of safeguards and security interests (for example, special nuclear material, vital equipment, classified matter, property, facilities, and unclassified irradiated reactor fuel in transit).
5633.3B	Control and Accountability of Nuclear Materials	Prescribes the minimum DOE requirements and procedures for control and accountability of nuclear materials at DOE-owned and -leased facilities and DOE-owned nuclear materials at facilities that are exempt from licensing by the Nuclear Regulatory Commission. Would apply to materials destined for a repository before the materials reached the repository.

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Table 11-4. Other potentially applicable Federal regulations, orders, standards, and memoranda (page 1 of 3).

Document Number	Title[a]
Code of Federal Regulations	
10 CFR Part 2	Rules of Practice for Domestic Licensing Proceedings and Issuance of Orders
10 CFR Part 19	Notices, Instructions and Reports to Workers: Inspection and Investigations
10 CFR Part 40	Domestic Licensing of Source Material
10 CFR Part 51	Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions
10 CFR Part 75	Safeguards on Nuclear Material-Implementation of US/IAEA Agreement
10 CFR Part 100	Reactor Site Criteria
10 CFR Part 707	Workplace Substance Abuse Programs at DOE Sites
10 CFR Part 830	Nuclear Safety Management
10 CFR Part 835	Occupational Radiation Protection
10 CFR Part 1021	National Environmental Policy Act Implementing Procedures
10 CFR Part 1022	Compliance with Floodplain/Wetlands Environmental Review Requirements
29 CFR Part 1926	Safety and Health Regulations for Construction
29 CFR Part 1960	Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters
30 CFR Part 57	Safety and Health Standards, Underground Metal and Nonmetal Mines
33 CFR Part 323	Permits for Discharges of Dredged or Fill Material into Waters of the United States
33 CFR Chapter I	Coast Guard Department of Transportation (Parts 1-199)
36 CFR Part 296	Permits to Proceed (Objects of Antiquity)
36 CFR Part 800	Protection of Historic and Cultural Properties
40 CFR Part 50	National Primary and Secondary Ambient Air Quality Standards
40 CFR Part 60	Standards of Performance for New Stationary Sources
40 CFR Part 61	National Emission Standards for Hazardous Air Pollutants
40 CFR Part 63	National Emission Standards for Hazardous Air Pollutants for Source Categories
40 CFR Part 122	EPA Administered Permit Programs: The National Pollutant Discharge Elimination System
40 CFR Part 125	Criteria and Standards for the National Pollutant Discharge Elimination System
40 CFR Part 133	Secondary Treatment Regulation
40 CFR Part 136	Guidelines Establishing Test Procedures for the Analysis of Pollutants
40 CFR Part 141	National Primary Drinking Water Regulations
40 CFR Part 142	National Primary Drinking Water Regulations Implementation
40 CFR Part 143	National Secondary Drinking Water Regulations
40 CFR Part 246	Source Separation for Materials Recovery Guidelines
40 CFR Part 257	Criteria for Classification of Solid Waste Disposal Facilities and Practices
40 CFR Part 260	Hazardous Waste Management System: General
40 CFR Part 261	Identification and Listing of Hazardous Waste
40 CFR Part 262	Standards Applicable to Generators of Hazardous Waste
40 CFR Part 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR Part 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR Part 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR Part 268	Land Disposal Restrictions
40 CFR Part 280	Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks
40 CFR Part 503	Standards for the Use or Disposal of Sewage Sludge
40 CFR Part 747	Metalworking Fluids
40 CFR Part 761	Polychlorinated Biphenyls Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
40 CFR Parts 1500 to 1508	Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act

Table 11-4. Other potentially applicable Federal regulations, orders, standards, and memoranda (page 2 of 3).

Document Number	Title[a]
Code of Federal Regulations (continued)	
41 CFR Part 101	Federal Property Management Regulations
43 CFR Parts 3 and 7	Preservation of Antiquities, Protection of Archaeological Resources
43 CFR Part 2300	Land Withdrawal
43 CFR Part 3620	Free Use Permit
43 CFR Part 4100	Grazing Administration, Exclusive of Alaska
49 CFR Part 40	Procedures for Transportation Workplace Drug Testing Programs
49 CFR Part 171	General Information, Regulations and Definitions
49 CFR Part 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications Requirements and Emergency Response Information Requirements
49 CFR Part 173	Shippers – General Requirements for Shipments and Packagings
49 CFR Part 174	Carriage by Rail
49 CFR Part 176	Carriage by Vessel
49 CFR Part 177	Carriage by Public Highway
49 CFR Part 178	Shipping Container Specifications
49 CFR Part 180	Continuing Qualification and Maintenance of Packagings
49 CFR Part 392	Driving of Motor Vehicles
49 CFR Part 393	Parts and Accessories Necessary for Safe Operation
49 CFR Part 395	Hours of Service for Drivers
50 CFR Part 17	Endangered and Threatened Wildlife and Plants
50 CFR Part 400	Endangered Species Act
50 CFR Part 402	Interagency Cooperation – Endangered Species Act of 1973, as Amended
Executive Orders	
Executive Order 11514	National Environmental Policy Act, Protection and Enhancement of Environmental Quality
Executive Order 11988	Floodplain Management
Executive Order 11990	Protection of Wetlands
Executive Order 12856	Right to Know Laws and Pollution Prevention Requirements
Executive Order 12898	Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
Executive Order 13007	Indian Sacred Sites
Executive Order 13084	Consultation and Coordination with Indian Tribal Governments
Executive Order 13132	Federalism
Other documents, orders and directives	
AAR Rule 91	1993 Field Manual of Association of American Railroads Interchange Rules (AAR Interchange Rule 91, Weight Limitations)
BLM Manual, Sec. 9113	Bureau of Land Management Manual, Road Standards
DOE Order 430.1	Life Cycle Asset Management
DOE Order 3790.1	Federal Employees Occupational Safety and Health Program
DOE Order 5480.4	Environmental Protection, Safety, and Health Protection Standards
DOE Order 5632.1	Protection Program Operation
DOE/EA-0179	Environmental Assessment Waste Form Selection for Savannah River HLW
DOE/EH-0256T	DOE Radiological Control Manual
DOE/RW-0184	Characteristics of Potential Repository Wastes, Volumes 1-4
DOE/RW-0194P	Records Management Policies and Requirements
DOE/RW-0328P	Acceptance Priority Ranking
DOE/RW-0333P	OCRWM Quality Assurance Requirements and Description
DOE/RW-0457	1995 Acceptance Priority Ranking and Annual Capacity Report
DOE-STD-1020	Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities
DOE-STD-1021	Natural Phenomena Hazards Performance Categorization Criteria for Structures, Systems and Components
DOE-STD-1022	Natural Phenomena Hazards Site Characterization Criteria

Table 11-4. Other potentially applicable Federal regulations, orders, standards, and memoranda (page 3 of 3).

Document Number	Title[a]
Other documents, orders and directives (continued)	
DOE-STD-1023	Natural Phenomena Hazards Assessment Criteria (Draft)
DOE-STD-1024	Guidelines for Use of Probabilistic Seismic Hazard Curves at Department of Energy Sites
DOE-STD-1062	Ergonomic and Human Factors Design Criteria[b]
Fed-STD-795	Uniform Federal Accessibility Standards
GSA-FSS-W-A-450/1-17	General Service Administration Interim Federal Specification
MOA DP/RW	Policy for Shipping Defense High-Level Waste (DHLW) to a Civilian Radioactive Waste Repository
MOA RW/NS	Nuclear Safety Requirement
MOU DOE/DOL	Mining Safety
NRC RG 1.13	Spent Fuel Storage Facility Design Basis
NRC RG 1.76	Design Basis Tornado for Nuclear Power Plants
NRC RG 8.8	Information Relevant to Ensuring That Occupational Radiation Exposure at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable
NRC RG 8.10	Operating Philosophy for Maintaining Occupational Radiation Exposure As Low As Is Reasonably Achievable
NUREG 0700	Guidelines for Control Room Design Reviews
NUREG 0856	Final Technical Position on Documentation of Computer Codes for High-Level Waste Management
Presidential Memo (04/30/85)	Dispose of Defense Waste in a Commercial Repository

a. IAEA = International Atomic Energy Agency; EPA = Environmental Protection Agency; HLW = high-level radioactive waste; OCRWM = Office of Civilian Radioactive Waste Management.

b. This standard is complete, but has not been formally published at this time. However, it is included here as a source because it consists of a compilation of requirements from accepted sources. Those sources include standards from the Code of Federal Regulations, Nuclear Regulatory Commission regulations, and military, American National Standards Institute, National Aeronautics and Space Administration, and Electric Power Research Institute standards, as well as recognized design handbooks and guides that govern standard engineering practice.

REFERENCES

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103189 DOE 1992 — DOE (U.S. Department of Energy) 1992. *Environmental Assessment for the Shipment of Low Enriched Uranium Billets to the United Kingdom from the Hanford Site, Richland, Washington.* DOE/EA-0787. Richland, Washington: U.S. Department of Energy. ACC: MOL.20010730.0389.

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References

12. REFERENCES

Chapter 12 of the Draft Environmental Impact Statement (EIS) listed all of the references cited in Chapters 1 through 11 of that document. For this Final EIS, the U.S. Department of Energy (DOE or the Department) has put a list of references at the end of each chapter that is specific to that chapter. DOE feels that this makes it easier for the reader to find the complete citations relevant to each chapter. Information regarding the availability of these references can be found in the DOE Reading Rooms (as listed in Appendix D) or on the internet at the Yucca Mountain Project website at *http://www.ymp.gov*.

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Preparers, Contributors, and Reviewers

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13. PREPARERS, CONTRIBUTORS, AND REVIEWERS

13.1 Preparers and Contributors

This chapter lists the individuals who filled primary roles in the preparation of this final environmental impact statement (EIS). Jane R. Summerson of the U.S. Department of Energy (DOE) Yucca Mountain Project Office directed the preparation of the EIS. Primary support and assistance to DOE was provided by the EIS Preparation Team, led by Joseph W. Rivers, Jr., of Jason Technologies Corporation; other members of the team included Tetra Tech NUS Inc., Battelle, and Dade Moeller & Associates. Judith A. Shipman coordinated the work of the Jason Technologies Corporation production team (Elisa Aguilar, Dalene Glanz, Laura Hall, Virginia Hutchins, Robin Klein, Evelyn Mayfield, Aaron McKinnon, and Janet McCreary). Dawn Siekerman supervised the EIS recordkeeping and reference support team (Marcia Gershin, Angelica Marquez, and Jessi Pagel). Glenn Caprio, assisted by Barbara Rhoads, provided scheduling support. Cynthia Langdale and Kathy Grebstad, under the supervision of Diane Morton, ensured EIS revision control accuracy.

DOE provided direction to the EIS Preparation Team, which was responsible for developing the analytical methodology and alternatives, coordinating the work tasks, performing the impact analyses, and producing the document. DOE was responsible for data quality, the scope and content of the EIS, and issue resolution and direction.

In addition, the Management and Operating Contractor to the DOE Yucca Mountain Site Characterization Office (Bechtel SAIC Corporation and its subcontractors) assisted in the preparation of supporting documentation and information for the EIS, as did Sandia, Argonne, and Oak Ridge National Laboratories. These organizations worked closely with the EIS Preparation Team under DOE direction.

DOE independently evaluated all supporting information and documentation prepared by these organizations. Further, DOE retained the responsibility for determining the appropriateness and adequacy of incorporating any data, analyses, and results of other work performed by these organizations in the EIS. The EIS Preparation Team was responsible for integrating such work into the EIS.

As required by Federal regulations (40 CFR 1506.5c), Jason Technologies Corporation and its subcontractors have signed NEPA Disclosure Statements in relation to the work they performed on this EIS. These statements appear at the end of this chapter.

Name	Education	Experience	Responsibility
U.S. Department of Energy			
Jane R. Summerson	Ph.D., Geology, 1991 M.S., Geobiology, 1985 M.A., Anthropology, 1978 B.A., Anthropology, 1977	11 years – waste management projects with the DOE Office of Civilian Radioactive Waste Management	Document Manager
Robin L. Sweeney	Ph.D. student, Environmental Science and Public Policy M.S., Geosciences, 1987 B.S., Biological Sciences, 1980	22 years – hazardous and nuclear waste field; waste management, RCRA/CERCLA facility assessments, sampling and monitoring, project/program management, laboratory research	Senior Technical Specialist; NEPA Compliance Officer

Name	Education	Experience	Responsibility
Joseph D. Ziegler	B.S., Engineering (Nuclear), 1975	26 years – nuclear engineering, nuclear safety, environmental assessment, and project management; Federal and commercial nuclear projects	Senior Technical Advisor
M. Jozette Booth	B.S., Business Administration	18 years – transportation and policy analysis, communications and public participation, intergovernmental and Native American consultations	Technical lead for transportation and American Indian Programs
Wendy R. Dixon	Postgraduate studies, Geology and Environmental Science M.B.A., Business B.A., Sociology	21 years – management of nuclear-related projects; 14 years – regulatory compliance and field management; 6 years – safety and health	Senior Advisor for Environmental Policy
Kenneth J. Skipper	B.S., Geology, 1984	19 years – geotechnical/ environmental project management; Federal civil works projects; planning, construction, operations, and performance monitoring	Document Manager until March 2001
Final EIS Preparation Team			
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Name	Education	Experience	Responsibility
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Ralph E. Best Jason Technologies Corporation	M.B.A., 1981 M.S., Electrical Engineering, 1970 B.S., Engineering Physics, 1964	36 years – energy, transportation, and environmental technology	Lead analyst, transportation
Carol Cole Jason Technologies Corporation	B.S., Experimental Psychology, 1967	20 years – NEPA documents, communications, public participation, media planning	Comment-Response Document
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David Crowl Jason Technologies Corporation	B.A., Computer Science, 1985	16 years – editing and document production	Editor

Name	Education	Experience	Responsibility
Keith D. Davis, PE Jason Technologies Corporation	M.S., Civil and Environmental Engineering, 1976 B.S., Civil Engineering, 1973	25 years – civil and environmental engineering; waste management; facility permitting and closure; site investigations, feasibility studies, and remedial action planning; 8 years – NEPA documentation	Hydrology; soils
Peter R. Davis Jason Technologies Corporation	Oak Ridge School of Reactor Technology, 1962 B.S. Physics, 1961	38 years – nuclear reactor and nuclear facility safety analysis and risk assessment	Lead analyst, accidents, inventory
Ted B. Doerr Jason Technologies Corporation	Ph.D., Wildlife and Fisheries Sciences, 1988 M.S., Range Science, 1980 B.S., Wildlife and Fisheries Sciences, 1977	19 years – NEPA implementation, ecology, environmental and ecological risk assessments, mitigation development, and regulatory compliance	Project Manager, Draft EIS
Sara A. Doersam Jason Technologies Corporation	B.A., Psychology, 1982	9 years – editing and publishing; 14 years – health administration	Editor
Paul W. Eslinger Battelle – Pacific Northwest National Laboratories	Ph.D., Statistics, 1983 M.A., Mathematics, 1978 B.S., Mathematics, 1976	18 years – environmental risk and human and ecological risk analysis	Long-term performance analysis
Suzanne Fiscus Jason Technologies Corporation	B.S., Mechanical Engineering, 1987	12 years - DOE nuclear projects; safety analysis, design and testing, waste characterization	Offsite manufacturing of disposal containers, shipping casks, drip shields, emplacement pallets, and related components
Philip C. Fulmer Dade Moeller & Associates	Ph.D., Nuclear Engineering, 1993 M.S., Health Physics, 1990 B.S., Health Physics, 1989	7 years – preparation of NEPA documents; 12 years – radiation protection, internal radiation dosimetry, external radiation dosimetry	Lead analyst, cumulative impacts
Gary Gunter Tetra Tech NUS Inc	B.S., Geology, 1984	5 years – preparation of NEPA documents; 13 years – assessments, remedial action	Lead analyst, land use; aesthetics

Name	Education	Experience	Responsibility
Ernest C. Harr, Jr. Jason Technologies Corporation	B.S., Zoology/Chemistry, 1977	12 years – preparation of NEPA documents; acted as DOE EM Headquarters NEPA Compliance Officer; reviewed many DOE waste management NEPA documents.	Deputy Project Manager, Draft EIS; Project Manager, 1999-2000
Mary N. Hoganson Tetra Tech NUS Inc.	M.S., Biology, 1989 B.S., Biology, 1984	14 years – waste management and waste minimization; 6 years – NEPA document preparation	Lead analyst, waste management and hazardous materials
Richard H. Holder Jason Technologies Corporation	M.B.A., Business Administration, 1986 M.S., Electrical Engineering, 1970 B.S., Electrical Engineering, 1966	33 years – team and line management for nuclear utility, industrial, and overseas projects	Proposed Action, alternatives, summary of findings and comparison
R. Kingsley House, PE Jason Technologies Corporation	M.S., Engineering Science/Nuclear Option, 1963 B.S., Mechanical Engineering, 1960 Nevada Registration No. 13062, 1997	40 years – nuclear and non-nuclear facility design, construction, testing, and operation; hazards analysis, safety analysis, and environmental impact analysis	Lead analyst, utilities, energy, materials, and site services; offsite manufacturing of disposal containers, shipping casks, drip shields, waste package supports, and related components
Tracy A. Ikenberry, CHP Dade Moeller & Associates	M.S., Radiology & Radiation Biology, 1982 B.A., Biology, 1979	19 years - environmental and occupational radiation protection; 7 years - NEPA document management and technical analysis	Lead analyst, short-term repository impacts, air quality; human health and safety
David H. Lester Jason Technologies Corporation	Ph.D., Chemical Engineering, 1969 M.S., Chemical Engineering, 1966 B.Che., Chemical Engineering, 1964	28 years – hazardous and nuclear waste management; nuclear Safety Analysis Reports, hazards analysis of waste storage operations, risk assessment of low-level nuclear waste burial operations, groundwater contamination transport modeling, performance assessment of high-level nuclear waste systems, design of treatment systems, design and analysis of high-level waste packages, and soil remediation studies	Lead Analyst, long-term performance

Name	Education	Experience	Responsibility
Steven Maheras Battelle Memorial Institute	Ph.D., Health Physics, 1988 M.S., Health Physics, 1985 B.S., Zoology, 1982 Certified Health Physicist, 1992	13 years – transportation risk assessment and radiological assessment; environmental and occupational radiation protection	Transportation
Thomas McSweeney Battelle Memorial Institute	Ph.D., Chemical Engineering, 1967 M.A., Mathematics, 1964 M.S., Chemical Engineering, 1961 B.S., Chemical Engineering, 1960	34 years – risk and safety analysis; 14 years – transportation risk analysis	Transportation
William E. Nichols Battelle – Pacific Northwest National Laboratories	M.S., Civil Engineering, 1990 B.S., Agricultural Engineering, 1987	12 years – subsurface flow and transport modeling and model development, environmental dispersion modeling and model development, probabilistic risk assessment, total systems modeling for geologic radioactive waste disposal evaluation, and NEPA documents	Long-term performance analysis
Paul R. Nickens Battelle – Pacific Northwest National Laboratories	Ph.D., Anthropology, 1977 M.A., Anthropology, 1974 B.A., Anthropology, 1969	25 years – cultural resource management and Native American consultation	Cultural resources
Donna L. Osborne Jason Technologies Corporation	20 years experience	20 years – technical editing, document production and coordination; 2 years – NEPA documentation	Editor
W. Kent Ostler Jason Technologies Corporation	Ph.D., Plant Ecology, 1979 M.S., Botany, 1976 B.S., Botany, 1974	22 years – plant ecology and arid land reclamation; identification of techniques to mitigate human impacts on biotic communities; surveys and research on endangered and threatened species; mitigation strategies for recovery of species	Biological resources

Name	Education	Experience	Responsibility
Ted M. Poston Battelle – Pacific Northwest National Laboratories	M.S., Fisheries, 1978 B.A., Biology,1973	19 years – noise analysis; 26 years – environmental research and toxicology; 24 years – NEPA experience	Lead analyst, noise and ground vibration
Eugene M. Rollins Dade Moeller & Associates	M.S.P.H., Health Physics, 1976 B.S., Nuclear Engineering, 1973	25 years – technical and management experience in health physics and risk assessments related to the nuclear fuel cycle	Lead analyst, No-Action Alternative
Steven B. Ross Battelle Memorial Institute	M.S., Nuclear Engineering, 1987 B.S., Nuclear Engineering, 1985	16 years – safety analysis, risk assessment, transportation, regulatory analysis, and fire risk assessment	Transportation
Dillard B. Shipler Battelle Memorial Institute	M.S., Major in Physics, 1967 B.S., Major in Science & Math, 1957 Certified Health Physicist, 1983	40 years – environment, safety, and health protection; occupational health and safety; radiation protection; high-level waste management; risk assessment; regulatory compliance; NEPA; systems engineering; and project/program management.	Transportation; Comment-Response Document
Judith A. Shipman Jason Technologies Corporation	A.A., General Studies, 1991	26 years – NEPA documentation, document production coordination, editing	Production Coordinator, Editor; Comment-Response Document
Sandra Snyder Battelle Memorial Institute	M.S.P.H., Radiological Hygiene, 1991 B.S., Environmental Resource Management, 1986	10 years – assessment of environmental and occupational exposure to radionuclides and chemicals	Air quality
Dennis Strenge Battelle Memorial Institute	M.S., Chemical Engineering, 1968 B.S., Chemical Engineering	33 years – environment exposure analysis and dosimetry for accidental and chronic releases of radionuclides and chemicals	Accidents
Lucinda Low Swartz Battelle Memorial Institute	J.D., 1979 B.A., Political Science and Administrative Studies, 1976	21 years – environmental law and regulation, specializing in NEPA compliance	Summary

Name	Education	Experience	Responsibility
John E. von Reis Jason Technologies Corporation	J.D., 1969 B.A., English (Prelegal), 1966	28 years – energy, environmental, resource and regulatory issues	Lead analyst, purpose and need, regulatory requirements, mitigation, unavoidable adverse impacts, environmental justice
Dee H. Walker Jason Technologies Corporation	Ph.D., Chemical Engineering, 1963 M.S., Chemical Engineering, 1962 Oak Ridge School of Reactor Technology, 1954 B.S., Chemical Engineering, 1953	48 years – nuclear engineering; 11 years – effects of radiological releases on humans and the environment	Health and safety
Jeffrey L. Weiler Jason Technologies Corporation	M.S., Resource Economics/ Environmental Management, 1974 B.A., Political Science, 1970	28 years – management of large interdisciplinary project teams; interagency coordination; stakeholder involvement; NEPA compliance	Document Manager, Draft EIS; Comment-Response Document
Ruth Weiner Jason Technologies Corporation	Ph.D., Chemistry, 1962 M.S., Chemistry, 1959 M.S., Physics, 1957 B.S., Physics, 1956	14 years – risk assessment of airborne pollutants and transportation risks, decision analysis; 25 years – environmental impact assessment; 35 years – professor of chemistry and environmental studies; 15 years – radioactive waste disposal, radioactive waste policy and regulation	Transportation
Thomas J. Winnard Battelle Memorial Institute	B.S., Geology, 1984	12 years – information systems	Transportation

13.2 Reviewers

The DOE Yucca Mountain Project Office incorporated input into the preparation of this EIS from a number of other DOE offices that reviewed the document while it was under development. These included the Offices of Environmental Management, Naval Reactors, Nuclear Energy, Materials Disposition, the National Spent Fuel Program, and the National High-Level Waste Program. The DOE Yucca Mountain Site Characterization Office, Nevada Operations Office, Idaho National Engineering and Environmental Laboratory, Hanford Site, and Savannah River Site also participated in the reviews of this EIS. In addition, personnel on assignment to the Yucca Mountain Project Office from the U.S. Department of the Interior Bureau of Reclamation provided technical review and other support, as did personnel from the DOE Office of Civilian Radioactive Waste Management Technical Support Services Contractor (Booz-Allen & Hamilton and its subcontractors).

QUALIFICATION CRITERION NO. 1

NEPA DISCLOSURE STATEMENT FOR
PREPARATION OF THE
ENVIRONMENTAL IMPACT STATEMENT FOR A GEOLOGIC REPOSITORY FOR THE DISPOSAL OF SPENT NUCLEAR FUEL AND HIGH-LEVEL RADIOACTIVE WASTE AT YUCCA MOUNTAIN, NYE COUNTY, NEVADA

CEQ Regulations at 40 CFR 1506.5(c), which have been adopted by the DOE (10 CFR 1021), require contractors who will prepare and EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project" for purpose of this disclosure is defined in the March 23, 1981, guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations", 46 FR 18026-18038 at Question 17a and b.

"Financial or other interest in the outcome of the project" includes "any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)". See 46 FR 18026-18031.

In accordance with these requirements, the offeror and the proposed subcontractors hereby certify as follows. (check either (a) or (b) and list financial or other interest if (b) is checked)

(a) ☑ Contractor has no financial or other interest in the outcome of the project.

(b) ☐ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interest

1.

2.

3.

Certified By:

[signature]
Signature

James S. Holm
Name (Printed)

Director of Contracts
Title

Jason Associates Corporation
Company

June 7, 1999
Date

QUALIFICATION CRITERION NO. 1

NEPA DISCLOSURE STATEMENT FOR
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Financial or Other Interest

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2.

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Certified by:

[signature]
Signature

Janet M. Mandel
Name (Printed)

Manager, Contract Operations
Title

Tetra Tech NUS, Inc.
Company

June 4, 1999
Date

QUALIFICATION CRITERION NO. 1

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Financial or Other Interest

1.

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3.

Certified By:

Signature

RALPH K. HENRICKS
Name (Printed)

CONTRACTING OFFICER
Title

BATTELLE MEMORIAL INSTITUTE
COLUMBUS OPERATIONS
Company

June 7, 1999
Date

QUALIFICATION CRITERION NO. 1

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Financial or Other Interest

1.

2.

3.

Certified By:

[signature]
Signature

Matthew P. Moeller
Name (Printed)

Vice President
Title

Dade Moeller & Assoc.
Company

June 4, 1999
Date

14

Glossary

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14. GLOSSARY

(Note: A number of the terms in the Glossary emphasize their project-specific relationship to the Yucca Mountain Repository EIS. Words in *italics* refer to other words in the glossary.)

10,000-year peak of the mean annual dose
: For this EIS, the largest annual *dose* analyzed within the first 10,000 years. See *peak of the mean annual dose (post-10,000 years)*.

100-year flood
: A flood event of such magnitude that it occurs, on average, every 100 years; this equates to a 1-percent chance of its occurring in a given year.

500-year flood
: A flood event of such magnitude that it occurs, on average, every 500 years; this equates to a 0.2-percent chance of its occurring in a given year.

A-weighted decibel scale
: See *decibel, A-weighted*.

accessible environment
: For this EIS, all points on Earth outside the surface and subsurface area controlled over the long term for the repository, including the atmosphere above the *controlled area*.

accident
: An unplanned sequence of events that results in undesirable consequences. Examples in this EIS include an inadvertent release of *radioactive* or hazardous materials from their containers or *confinement* to the *environment*; vehicular accidents during the transportation of highly radioactive materials; and industrial accidents that could affect workers in the facilities.

acre-foot
: The volume of water required to cover 1 acre to a depth of 1 foot (about 1,200 cubic meters or 330,000 gallons).

actinide
: Any one of a series of chemically similar elements of *atomic numbers* 89 (actinium) through 103 (lawrencium). All actinides are *radioactive*.

active institutional control
: Continued Federal control of the Yucca Mountain Repository site including access control, maintenance, monitoring, and surveillance of facilities and waste. See *institutional control*.

aerosol
: A suspension of tiny, *colloid*-size particles or liquid droplets in air. Fog and smoke are common examples of aerosols.

affected environment
: For an EIS, a description of the existing *environment* (that is, site description) covering information that relates directly to the scope of the *Proposed Action*, the *No-Action Alternative*, and the *implementing alternatives* being analyzed; in other words, the information necessary to assess or understand the *impacts*. This description must contain enough detail to support the

impact analysis. The information must highlight “environmentally sensitive resources,” if present; these include floodplains and wetlands, *threatened* and *endangered species*, prime and unique agricultural lands, and property of historic, archaeological, or architectural significance.

aging
: Retaining *commercial spent nuclear fuel* on the surface at the proposed repository for future emplacement in an underground *drift*. DOE could retain the spent nuclear fuel in either wet or dry storage. If the Department used dry storage, it would place the spent nuclear fuel in a storage module licensed by the Nuclear Regulatory Commission.

affected unit of local government
: The unit local government with jurisdiction over the site of a repository or a monitored retrievable storage facility. This term may, at the discretion of the Secretary of Energy, include units of local government that are contiguous with such unit. For the proposed, Yucca mountain Repository, the affected units of local government are Nye County, which has jurisdiction over the repository site and counties contiguous to Nye county (that is, Clark, Lincoln, White Pine, Eureka, Lander, Churchill, Mineral, and Esmeralda Counties in Nevada and Inyo County in California).

air lock
: A chamber or room in which air pressure can be regulated, usually between two regions of unequal pressure. The isolation air locks each consist of two *bulkheads* with doors that open and close in sequence.

air quality
: A measure of the concentrations of pollutants, measured individually, in the air.

ALARA
: See *as low as reasonably achievable.*

alcove
: A small excavation (room) off the main tunnel of a repository used for scientific study or for installing equipment.

alien species
: With respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem.

alignment
: As used in the transportation analysis in this EIS, the location of a rail line in a *corridor*.

alkali flat
: A level area or plain in an *arid* or semiarid region encrusted with alkali salts that become concentrated by evaporation and poor drainage. *Cap.* (Alkali Flat): An example of such terrain, approximately 25 miles south of the location in Amargosa Valley formerly known as Lathrop Wells along the Amargosa River.

alkalinity
: Acid-neutralizing capacity of a substance. High alkalinity conditions can promote metal *corrosion*.

Alloy-22

A *corrosion*-resistant, high-nickel alloy used for the outer shell of the *disposal container/waste package*, and for the parts of the emplacement pallet that would contact the waste package.

alluvial fan

A low, outspread, relatively flat to gently sloping mass of loose rock material, shaped like an open fan or a segment of a cone, deposited by a stream where it issues from a narrow mountain valley on a plain or broad valley.

alluvium

Sedimentary material deposited by flowing water.

alpha particle

A positively charged particle ejected spontaneously from the *nuclei* of some *radioactive* elements. It is identical to a helium nucleus and has a mass number of 4 and an electrostatic charge of +2. It has low penetrating power and a short range (a few centimeters in air). See *ionizing radiation.*

alternate

As used in the transportation analysis in this EIS, a variation of a rail corridor segment to mitigate a potential adverse environmental or engineering factor. See *variation*, *option*, *corridor*.

alternative

One of two or more actions, processes, or propositions from which a *decisionmaker* will determine the course to be followed. The *National Environmental Policy Act*, as amended, states that in preparing an EIS, an agency "shall ... (s)tudy, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources" [42 U.S.C. 4321, Title I, Section 102 (E)]. The regulations of the Council on Environmental Quality that implement the National Environmental Policy Act indicate that the alternatives section in an EIS is "the heart of the environmental impact statement" (40 CFR 1502.14), and include rules for presenting the alternatives, including no action, and their estimated impacts.

This EIS has two alternatives: the *Proposed Action* under which DOE would construct, operate and monitor, and eventually close a *monitored geologic repository* for the *disposal* of *spent nuclear fuel* and *high-level radioactive waste* at Yucca Mountain, and the *No-Action Alternative* under which DOE would end *site characterization* activities at Yucca Mountain, and spent nuclear fuel and high-level radioactive waste at commercial storage sites and DOE facilities would continue to accumulate. The *Nuclear Waste Policy Act* states that this EIS does not have to discuss alternatives to geologic disposal or alternative sites to Yucca Mountain; DOE included the analysis of the No-Action Alternative to provide a basis for comparison with the Proposed Action. See *implementing alternative*.

DOE will base its decision on whether the repository program should proceed toward a site recommendation for Yucca Mountain in part on the Final EIS.

Amargosa Desert

The basin area lying south of Beatty, Nevada, and extending southeast some 80 kilometers (50 miles) to the area of Alkali Flat in California. The unincorporated Town of Amargosa Valley, Nevada, lies in the central portion of Amargosa Desert. Amargosa Desert is also the name of *hydrographic area* number 230 which is part of the Death Valley Groundwater Region; both are designations used by the State of Nevada in its water planning and appropriations efforts. The boundaries of the Amargosa Desert hydrographic area closely resemble those of the geographic area.

Amargosa River

The main drainage system of the *Amargosa Desert*. The Amargosa River drainage basin originates in the Pahute Mesa-Timber Mountain area north of Yucca Mountain and includes the main tributary systems of *Beatty Wash* and *Fortymile Wash*. The river, which is frequently dry along much of its length, flows southeastward through the Amargosa Desert and ends in the internal drainage system of Death Valley.

ambient

(1) Undisturbed, natural conditions such as ambient temperature caused by climate or natural *subsurface* thermal gradients. (2) Surrounding conditions.

ambient air

The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures. It is not the air in the immediate proximity to emission sources.

ambient air quality standards

Standards established on a Federal or state level that define the limits for airborne concentrations of designated *criteria pollutants* [nitrogen dioxide, *sulfur dioxide*, *carbon monoxide*, *particulate matter* with aerodynamic diameters less than 10 microns (PM_{10}), *ozone*, and lead] to protect public health with an adequate margin of safety (primary standards) and to protect public welfare, including plant and animal life, visibility, and materials (secondary standards). See *criteria pollutants.*

analyzed land withdrawal area

See *land withdrawal area.*

aquifer

A *subsurface* saturated rock unit (formation, group of formations, or part of a formation) of sufficient *permeability* to transmit *groundwater* and yield usable quantities of water to wells and springs.

aquitard

A rock unit or layer or layer that stores water and allows it to move only at a very slow rate.

areal mass loading

As used in *thermal loading* calculations, the amount of *heavy metal* (usually expressed in metric tons of uranium or equivalent) emplaced per unit area in the proposed repository.

arid

(1) Areas where mean annual evaporation exceeds mean annual precipitation; (2) having insufficient rainfall to support agriculture; (3) the hyper-arid zone (arid index 0.03) comprises dryland areas without vegetation with the exception of a few scattered shrubs. Annual rainfall is low, rarely exceeding 100 millimeters (4 inches). In the arid zone (arid index 0.03-0.20), the native vegetation is sparse, being comprised of annual and perennial grasses and other herbaceous vegetation, and shrubs and small trees. There is high rainfall variability, with annual amounts ranging between 100 and 300 millimeters (4 and 12 inches).

as low as reasonably achievable

A process that applies a graded approach to reducing *dose* levels to workers and the public, and releases of *radioactive* materials to the *environment*. The goal of this process, often referred to as ALARA, is not merely to reduce doses, but to reduce them to levels that are as low are reasonable achievable.

assembly

See *fuel assembly*.

atmospheric dispersion

Movement of a *contaminant* as a result of the cumulative effect of the wind patterns and random motions of the air.

atomic mass

The mass of a neutral atom, based on a relative scale, usually expressed in atomic mass units. See *atomic weight.*

atomic number

The number of protons in an atom's nucleus.

atomic weight

The relative mass of an atom based on a scale in which a specific carbon atom (carbon-12) is assigned a mass value of 12. Also known as relative *atomic mass*.

autolytic criticality

A transient *criticality* in which the usual mechanisms that tend to shut down a criticality are delayed until a high *fission* rate is achieved.

backfill

The general fill that is placed in the excavated areas of an underground facility. Backfill for the proposed repository could be *tuff* or other material.

background radiation

Radiation from cosmic sources, naturally occurring *radioactive* materials such as granite, and global fallout from nuclear testing.

Bare Mountain

An upfaulted mountain block that bounds the west side of *Crater Flat*.

barrier

Any material, structure, or condition (as a thermal barrier) that prevents or substantially delays the movement of water or *radionuclides*. See *natural barrier*.

basalt

A dark gray to black, dense to fine-grained *igneous* rock.

baseline

Documentation of current conditions so that changes can be identified.

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Beatty Wash
A tributary drainage to the *Amargosa River*; drains the west and north sides of the Yucca Mountain area.

berm
A mound or wall of earth.

beta particle
A negatively charged *electron* or positively charged positron emitted from a *nucleus* during decay. Beta decay usually refers to a radioactive transformation of a nuclide by electron emission, in which the atomic number increases by 1 and the mass number remains unchanged. In positron emission, the atomic number decreases by 1 and the mass number remains unchanged. See *ionizing radiation.*

biosphere
The ecosystem of the Earth and the living *organisms* inhabiting it.

blending
See *fuel blending.*

block-bounding fault
A high-angle, normal fault with relatively large displacement that bounds one or both sides of the fault-block mountains typical of the Basin and Range province.

boiling-water reactor (BWR)
A *nuclear reactor* that uses boiling water to produce steam to drive a turbine.

borehole
For this EIS, a hole drilled for purposes of collecting *site characterization* data or for supplying water.

borosilicate glass
High-level radioactive waste matrix material in which boron takes the place of the lime used in ordinary glass mixtures.

borrow areas
Areas outside the rail corridor where construction personnel could obtain materials to be used in the establishment of a stable platform (subgrade) for the rail track. Aggregate crushing operations could occur in these areas.

buffer cars
Railcars in front of or in back of those carrying *spent nuclear fuel* and *high-level radioactive waste* to provide additional distance to possibly occupied railcars or to railcars carrying hazardous materials other than *radioactive* materials. Federal regulations require the separation of a railcar carrying spent nuclear fuel and high-level radioactive waste from a locomotive, occupied caboose, carload of undeveloped film, or railcar carrying another class of hazardous material by at least one buffer car. These could be DOE railcars or, in the case of general freight service, commercial railcars.

bulkhead

A wall or embankment in a mine or tunnel that protects against earthslide, fire, water, or gas.

burnup

A measure of *nuclear reactor* fuel consumption expressed either as the percentage of fuel atoms that have undergone *fission* or as the amount of energy produced per unit weight of fuel.

caldera

An enlarged volcanic crater formed by explosion or collapse of the original crater.

cancer

A malignant tumor of potentially unlimited growth, capable of invading surrounding tissue or spreading to other parts of the body.

candidate species

Species for which the U.S. Fish and Wildlife Service has enough substantive information on biological status and threats to support proposals to list them as threatened or endangered under the Endangered Species Act. Listing is anticipated but has been precluded temporarily by other listing activities.

canister

An unshielded metal container used as: (1) a pour mold in which molten vitrified *high-level radioactive waste* can solidify and cool; (2) the container in which DOE and electric utilities place intact *spent nuclear fuel*, loose rods, or nonfuel components for shipping or storage; or (3) in general, a container used to provide radionuclide *confinement*. Canisters are used in combination with specialized overpacks that provide structural support, shielding or confinement for storage, transportation, and *emplacement*. Overpacks used for transportation are usually referred to as transportation *casks*; those used for emplacement in a repository are referred to as *waste packages*.

capillary barrier

A contact in the *unsaturated zone* between a *geologic* unit containing relatively small-diameter openings and a unit containing relatively large-diameter openings across which water does not flow.

carbon monoxide

A colorless, odorless, poisonous gas produced by incomplete fossil-fuel combustion; one of the six pollutants for which there is a national *ambient air quality standard*.

carbon steel

A steel that is tough but malleable and contains a small percentage of carbon. The inner *barrier* of *waste packages* is composed of carbon steel.

carcinogen

An agent capable of producing or inducing *cancer*.

carcinogenic

Capable of producing or inducing *cancer*.

cask

(1) A heavily shielded container that meets applicable regulatory requirements used to ship *spent nuclear fuel* or *high-level radioactive waste*; (2) a heavily shielded container used by DOE and utilities for the *dry storage* of spent nuclear fuel; usable only for storage, not for transportation to or *emplacement* in a repository.

chain reaction

A process in which some of the *neutrons* released in one *fission* event cause other fission events that in turn release *neutrons*.

characterization

Activities in the laboratory or the field undertaken to establish the geologic conditions and the ranges of the parameters of a candidate site relevant to the location of a repository. These activities include borings, surface excavations, excavations of exploratory shafts, limited *subsurface* lateral excavations and borings, and *in situ* testing to evaluate the suitability of a candidate site for the location of a repository, but do not include preliminary borings and geophysical testing to assess if *site characterization* should be undertaken.

Civilian Radioactive Waste Management System

The organizational system of the DOE Office of Civilian Radioactive Waste Management; it is the composite of the sites and all facilities, systems, equipment, materials, information, activities, and personnel required to perform the activities necessary to manage *radioactive* waste *disposal*.

cladding

The metallic outer sheath of a fuel element generally made of stainless steel or a *zirconium alloy*. It is intended to isolate the fuel element from the external *environment*.

clastic

Describing a rock or sediment composed mainly of broken fragments of preexisting minerals or rocks that have been transported from their places of origin.

climate states

Representations of climate conditions. Six different climate states are used to represent changes in climate over the periods of interest: Interglacial Climate (the same as present-day), Glacial-Transition (also known as Intermedial Climate), Intermediate/Monsoon Climate, Glacial Climate Stage 8/10, Glacial Climate Stage 6/16, and Glacial Climate Stage 4.

closure

See *repository phases*.

co-disposal

A packaging method for *disposal* of *radioactive* waste in which two types of waste, such as *commercial spent nuclear fuel* and defense *high-level radioactive waste*, are combined in *disposal containers*. Co-disposal takes advantage of otherwise unused space in disposal containers and is more cost-effective than other methods to limit the reactivity of individual *waste packages*.

collective dose

See *population dose*.

colloid

Small particles in the size range of 10^{-9} to 10^{-6} meters that are suspended in a solvent. Naturally occurring colloids in *groundwater* arise from clay minerals.

colluvium

Loose earth material that has accumulated at the base of a hill, through the action of gravity.

commercial spent nuclear fuel

Commercial nuclear fuel rods that have been removed from *reactor* use. See *spent nuclear fuel* and *DOE spent nuclear fuel*.

conceptual model

A set of *qualitative* assumptions used to describe a system or subsystem for a given purpose. Assumptions for the model should be compatible with one another and fit the existing data within the context of the given purpose of the model.

confinement

As it pertains to *radioactivity*, the retention of *radioactive* material within some specified bounds. Confinement differs from containment in that there is no absolute physical *barrier* in the former.

construction

See *repository phases*.

construction/demolition debris

Discarded solid wastes resulting from the construction, remodeling, repair, and demolition of structures, road building, and land clearing that are inert or unlikely to create an environmental hazard or threaten the health of the general public. Such debris from repository construction would include materials such as soil, rock, masonry materials, and lumber.

construction support areas

Areas along the rail route that could be used as temporary residences for construction crews, material and equipment storage areas, and concrete production areas. Such camps probably would be for the construction of routes far from population centers.

contaminant

A substance that contaminates (pollutes) air, soil, or water. Also, a hazardous substance that does not occur naturally or that occurs at levels greater than those that occur naturally in the surrounding *environment*.

contaminant flux

Movement of a *contaminant* across a surface boundary per unit time (for example, *curies* per year; milligrams per year).

contamination

The intrusion of undesirable elements (unwanted physical, chemical, biological, or radiological substances, or matter that has an adverse effect) to air, water, or land.

controlled area

The area restricted for the long term for the repository, as identified by passive institutional controls DOE would install at *closure*. The controlled area is 300 square kilometers (about 120 square miles) maximum surface and subsurface area that extends in the predominant direction of groundwater flow no farther south than 36 degrees, 40 minutes, 13.6661 seconds north latitude (the present southwest corner of the Nevada Test Site), and no more than 5 kilometers (3 miles) from the repository footprint in any other direction. (See 40 CFR 197.12.)

convection
: (1) Thermally driven *groundwater* flow or a heat-transfer mechanism for a gas phase. The bulk motion of a flowing fluid (gas or liquid) in the presence of a gravitational field, caused by temperature differences that, in turn, cause different areas of the fluid to have different densities (for example, warmer is less dense). (2) One of the processes that moves solutes in *groundwater*.

corridor
: As used in the transportation analysis in this EIS, a strip of land, approximately 400 meters (0.25 mile) wide, that encompasses one of several possible routes through which DOE could build a branch rail line to transport *spent nuclear fuel*, *high-level radioactive waste,* and other material to and from the proposed Yucca Mountain Repository.

corrosion
: The process of dissolving or wearing away gradually, especially by chemical action.

corrosion-resistant material
: *Disposal container* material, such as Alloy-22, that oxidizes slowly in a corrosive environment.

cosmic radiation
: A variety of high-energy particles including protons that bombard the Earth from outer space. They are more intense at higher altitudes than at sea level where the Earth's atmosphere is most dense and provides the greatest protection.

cosmogenic radionuclides
: Radioactive nuclides generated when the upper atmosphere interacts with many of the cosmic radiations. Common cosmogenic radionuclides include carbon-14, tritium, and beryllium-7.

Crater Flat
: A north-trending, 6- to 11-kilometer (4- to 7-mile)-wide area west of Yucca Mountain; bounded by *Bare Mountain* on the west and Yucca Mountain on the east.

credible event/credible accident
: An event or *accident* scenario that the design of the *geologic repository* considers reasonably foreseeable with a possibility of at least 1 in 10 million.

criteria pollutants
: Six common pollutants (*ozone*, *carbon monoxide*, *particulates*, *sulfur dioxide*, lead, and nitrogen dioxide) known to be hazardous to human health and environment and for which the U.S. Environmental Protection Agency sets National Ambient Air Quality Standards under the Clean Air Act. See *toxic air pollutants*.

criticality
: The condition in which nuclear fuel sustains a *chain reaction*. It occurs when the number of neutrons present in one generation cycle equals the number generated in the previous cycle.

criticality control

Set of measures taken to maintain nuclear materials, including *spent nuclear fuel*, in a *subcritical* condition during storage, transportation, and *disposal*, so no self-sustaining nuclear *chain reaction* can occur. Subcriticality is maintained by loading spent nuclear fuel in specific configurations that meet requirements related to fuel age, enrichment, and reduction in nuclear fuel reactivity through *burnup*.

cross drift

An approximately 2,800-meter (9,200-foot)-long *drift* excavated to provide researchers new opportunities to study the geologic profile of the rock in the proposed repository area beneath Yucca Mountain. Researchers will conduct a new battery of tests in the cross drift as part of ongoing studies to determine if Yucca Mountain would be a suitable host for a deep *monitored geologic repository* for *spent nuclear fuel* and *high-level radioactive waste*. The cross drift begins inside the *Exploratory Studies Facility* approximately 2,000 meters (6,600 feet) from the northern entrance and cuts through the entire stratigraphic section of the potential Upper Block emplacement area.

crud

The *radionuclide* contribution from activated *corrosion* products deposited on the surfaces of *fuel assemblies* during reactor operations.

cumulative impact

The *impact* on the *environment* that results from the incremental impact(s) of an action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

curie

A unit of *radioactivity* equal to 37 billion *disintegrations* per second.

decay (radioactive)

The process in which one radionuclide spontaneously transforms into one or more different radionuclides called decay products.

decibel (dB)

A standard unit for measuring sound-pressure levels based on a reference sound pressure of 0.0002 dyne per square centimeter. This is the smallest sound a human can hear.

decibel, A-weighted (dBA)

A measurement of sound approximating the sensitivity of the human ear and used to characterize the intensity or loudness of sound.

decisionmaker

The group or individual responsible for making a decision on constructing and operating a *monitored geologic repository* for the disposal of *spent nuclear fuel* and *high-level radioactive waste* at Yucca Mountain.

decommissioning

The process of removing from service a facility in which nuclear materials are handled. It usually involves decontaminating the facility so that it may be dismantled or dedicated to other purposes.

decontamination

A process that removes, destroys, or neutralizes chemical, biological, or radiological contamination from a person, object, or area.

dedicated freight rail service

A train that handles only one commodity (in this case, *spent nuclear fuel* or *high-level radioactive waste*); this separate train with its own crew would limit switching between trains of the railcars carrying these materials.

defense-in-depth

(1) A design strategy based on a system of multiple, independent, and redundant *barriers*, designed to ensure that failure in any one barrier does not result in failure of the entire system. (2) The term used to describe a system of multiple barriers that mitigate *uncertainties* in conditions, processes, and events.

deformation

A change in the shape and size of a body.

design alternative

A fundamentally different conceptual design for a repository, which could stand alone as the License Application repository design concept.

design-basis event

Naturally or humanly induced events that are reasonably likely to occur one or more times before permanent closure of the *geologic repository's* operations area; in addition, any other natural or human-induced event that is unlikely, but is sufficiently credible to warrant consideration, taking into account the potential for significant radiological impacts on public health and safety.

design enhancement

An engineered *barrier* system feature that DOE is considering for possible inclusion in the design for the Yucca Mountain Repository. Design enhancements are not considered to be essential to the successful performance of the repository. The EIS analysis of the *Proposed Action* will not include design enhancements, but will identify them as possible means of *mitigation*. If a design enhancement is added to the reference design in time for inclusion in the EIS, it will be evaluated as part of the Proposed Action design.

deterministic

A single calculation using only a single value for each of the model parameters. A deterministic system is governed by definite rules of system behavior leading to cause and effect relationships and predictability. Deterministic calculations do not account for *uncertainty* in the physical relationships or parameter values.

dip-slip fault

A fault in which the relative displacement is along the direction of dip of the fault plane. If the block above the fault has moved downward it is a *normal fault*; upward movement indicates a *reverse fault*.

direct impact

Effect that results solely from the construction or operation of a proposed action without intermediate steps or processes. Examples include habitat destruction, soil disturbance, air emissions, and water use.

discretization

The process of dividing geometry into smaller pieces (finite elements) to prepare for analysis. For example, for the EIS analysis DOE divided the broad volume of the *unsaturated zone* beneath the proposed repository into smaller portions, each of which has its own set of characteristics, to model water flow and potential transport of *radionuclides* from the repository to the *saturated zone*.

disintegration

Any transformation of a *nucleus*, whether spontaneous or induced by *irradiation*, in which the nucleus emits one or more particles or *photons*.

disposable canister

A metal vessel for commercial or DOE *spent nuclear fuel* assemblies or solidified *high-level radioactive waste* with specialized overpacks to enable storage, transportation, and *emplacement* in a repository.

disposal

The *emplacement* in a repository of *high-level radioactive waste*, *spent nuclear fuel*, or other highly *radioactive* material with no foreseeable intent of recovery, whether or not such emplacement permits the recovery of such waste, and the *isolation* of such waste from the *accessible environment*.

disposal container

The vessel consisting of the *barrier* materials and internal components in which the canistered or uncanistered waste form would be placed. The disposal container would include the container barriers or shells, spacing structures or baskets, shielding integral to the container, packing contained within the container, and other absorbent materials designed to be placed internal to the container or immediately surrounding the disposal container (that is, attached to the outer surface of the container). The filled, sealed, and tested disposal container is referred to as the *waste package*, which would be emplaced in the repository.

disproportionately high and adverse environmental impacts

An environmental *impact* that is unacceptable or above generally accepted norms; these would include economic impacts of the *Proposed Action*. A disproportionately high impact is one (or the risk of one) to a *low-income population* or *minority population* that significantly exceeds the impact to the general population. In assessing cultural and aesthetic impacts, agencies consider impacts that would have unique effects on geographically dislocated or dispersed low-income or minority populations.

disproportionately high and adverse human health effects

Effects that occur when *impacts* to a *minority population* or *low-income population* from exposure to an environmental hazard significantly exceed the impacts to the general population and, where available, to an appropriate comparison group.

disruptive event

An unexpected event which, in the case of the repository, includes *human intrusion*, volcanic activity, *seismic* activity, and nuclear *criticality*. Disruptive events have two possible effects: (1) direct release of *radioactivity* to the surface, or (2) alteration of the expected behavior of the system.

dissolution

Molecular dispersion of a solid in a liquid.

distribution

As used in analyses of long-term performance, a range of values and probabilities associated with each value (or subrange of values) within the range. This can be in the form of a mathematical function or a table of values. *See normal distribution.*

DOE spent nuclear fuel

Radioactive waste created by defense activities that consists of more than 250 different waste forms. The major contributor to this waste form is the N-Reactor fuel currently stored at the Hanford Site. This waste form also includes 65 MTHM of *naval spent nuclear fuel*.

dose

The amount of radioactive energy taken into (absorbed by) living tissues.

dose equivalent

(1) The number (corrected for background) zero and above that is recorded as representing an individual's *dose* from external *radiation* sources or internally deposited *radioactive* materials; (2) the product of the absorbed dose in *rads* and a quality factor; (3) the product of the absorbed dose, the quality factor, and any other modifying factor. The dose equivalent quantity is used for comparing the biological effectiveness of different kinds of radiation (based on the quality of radiation and its spatial distribution in the body) on a common scale; it is expressed in *rem*.

dose rate

The *dose* per unit time.

dose risk

The product of a radiation dose and the probability of its occurrence.

drift

From mining terminology, a horizontal underground passage. Includes excavations for *emplacement* (emplacement drifts) and access (access mains).

drip shield

A corrosion-resistant engineered *barrier* that would be placed above the *waste package* to prevent seepage water from directly contacting the waste packages for thousands of years. The drip shield would also offer protection to the waste package from rockfall.

dry storage

Storage of *spent nuclear fuel* without immersing the fuel in water for cooling or shielding; it involves the encapsulation of spent fuel in a steel cylinder that might be in a concrete or massive steel *cask* or structure.

dual-purpose canister

A metal vessel suitable for storing (in a storage facility) and shipping (in a shipping cask) commercial *spent nuclear fuel* assemblies. At the repository, dual-purpose canisters would be removed from the shipping cask and opened. The *spent nuclear fuel* assemblies would be removed from the canister and placed in a *disposal container* or in the fuel pool to accomodate *blending*. The opened canister would be recycled or disposed of offsite as low-level *radioactive* waste.

earthquake

A series of elastic waves in the crust of the Earth caused by abrupt movement easing strains built up along *geologic* faults or by volcanic action and resulting in movement of the Earth's surface.

electron

A stable elementary particle that is the negatively charged constituent of ordinary matter.

emplacement

The placement and positioning of *waste packages* in the repository emplacement *drifts*.

endangered species

A species that is in danger of extinction throughout all or a significant part of its range; a formal listing of the U.S. Fish and Wildlife Service under the Endangered Species Act.

Energy Policy Act of 1992 (Public Law 102-486, 106 Stat. 2776)

Legislation that amends the *Nuclear Waste Policy Act* by directing (1) the Environmental Protection Agency to set site-specific public health and safety radiation protection standards from Yucca Mountain, and (2) the Nuclear Regulatory Commission to modify its technical requirements and licensing criteria to be consistent with the Environmental Protection Agency site-specific standards.

engineered barrier system

The designed, or engineered, components of the underground facility, including the *waste packages* and other engineered *barriers*.

enhanced design alternative

A combination (or variation) of one or more design alternatives and design features.

environment

(1) Includes water, air, and land and all plants and humans and other animals living therein, and the interrelationship existing among these. (2) The sum of all external conditions affecting the life, development, and survival of an *organism*.

environmental impact statement (EIS)

A detailed written statement which describes:

> "...the environmental impact of the proposed action; any adverse environmental effects which cannot be avoided should the proposal be implemented; alternatives to the proposed action (although the Nuclear Waste Policy Act, as amended, precludes consideration of certain alternatives); the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented."

Preparation of an EIS requires a public process that includes public meetings, reviews, and comments, as well as agency responses to the public comments.

environmental justice

The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

environmental monitoring

The process of sampling and analyzing environmental media in and around a facility to (1) confirm compliance with performance objectives and (2) detect *contamination* entering the *environment* to facilitate timely remedial action.

environmental resource areas

Areas examined for potential environmental impacts as part of the *National Environmental Policy Act* analysis process. Examples include air quality, hydrology, and biological resources.

ephemeral

Used in this EIS in reference to a nonpermanent stream or other body of water.

equilibrium

The state of a chemical system in which the phases do not undergo any spontaneous change in properties or proportions with time; a dynamic balance.

erionite

A natural fibrous *zeolite* in the rocks at Yucca Mountain that is listed as a known human carcinogen by recognized international agencies such as the International Agency for Research on Cancer.

escort cars

Railcars in which escort personnel would travel on trains carrying *spent nuclear fuel* or *high-level radioactive waste*.

evapotranspiration

The combined processes of evaporation and plant *transpiration* that remove water from the soil and return it to the air.

Exploratory Studies Facility

An underground laboratory at Yucca Mountain that includes an 8-kilometer (5-mile) main loop (tunnel), a 3-kilometer (2-mile) *cross drift*, and a research *alcove* system constructed for performing underground studies during *site characterization*. The data collected will contribute toward determining the suitability of the Yucca Mountain site as a repository. Some or all of the facility could be incorporated into the proposed repository.

exposure (to radiation)

The incidence of *radiation* on living or inanimate material by accident or intent. Background exposure is the exposure to natural *ionizing radiation*. Occupational exposure is the exposure to ionizing radiation that occurs during a person's working hours. Population exposure is the exposure to a number of persons who inhabit an area.

exposure pathway

The course a chemical or physical agent takes from the source to the exposed *organism*; describes a unique mechanism by which an individual or population can become exposed to chemical or physical agents at or originating from a release site. Each exposure pathway includes a source or a release from a source, an exposure point, and an exposure route.

far-field

The area of the geosphere and *biosphere* far enough away from the repository that, when numerically modeled, releases from the repository are represented as a homogeneous, single-source effect.

fault

A *fracture* or a fracture zone in crustal rocks along which there has been movement of the fracture's two sides relative to one another, so that what were once parts of one continuous rock stratum or vein are now separated.

Fiscal Year

A 12-month period to which a jurisdiction's annual budget applies and at the end of which its financial position and the results of its operations are determined. For example, the Fiscal Year for Clark and Nye Counties, the Cities of Las Vegas and North Las Vegas, the Towns of Tonopah and Pahrump, and the Clark County and Nye County School Districts runs from July 1 through the following June 30; the Federal Fiscal Year runs from October 1 through the following September 30.

fission

The splitting of a *nucleus* into at least two other nuclei, resulting in the release of two or three *neutrons* and a relatively large amount of energy.

fission products

Radioactive or nonradioactive atoms produced by the *fission* of heavy atoms, such as uranium.

flexible design

As used in this EIS, the repository design and operating modes presented in the *Yucca Mountain Science and Engineering Report: Technical Information Supporting Site Recommendation Consideration*. See *higher-temperature repository operating mode* and *lower-temperature repository operating mode*.

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

Fortymile Wash
A major tributary to the *Amargosa River*; drains *Jackass Flats* to the east of Yucca Mountain; usually dry along most of its length.

fracture
A general term for any break in a rock, whether or not it causes displacement, caused by mechanical failure from stress. Fractures include cracks, joints, and *faults*. Fractures can act as pathways for rapid *groundwater* movement.

fuel assembly
A number of fuel elements held together by structural materials, used in a *nuclear reactor*. Sometimes called a fuel bundle.

fuel blending
The process of loading low-heat-output waste with high-heat-output waste in a *waste package* to balance its total heat output. This process would apply only to *commercial spent nuclear fuel*.

fugitive dust
Particulate matter composed of soil; can include emissions from haul roads, wind erosion of exposed soil surfaces, and other activities in which soil is removed or redistributed.

fugitive emissions
Emissions released directly into the *atmosphere* that could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening.

GENII
A *deterministic* computer software code that evaluates *dose* from the migration of radionuclides introduced into the *accessible environment*, or *biosphere*, that may eventually affect humans through ingestion, inhalation, or direct *radiation*. It is used to develop biosphere dose conversion factors.

gamma ray
The most penetrating type of radiant nuclear energy. It does not contain particles and can be stopped by dense materials such as concrete or lead. *See ionizing radiation.*

general freight rail service
Railroad line service that uses trains that move railcars, each of which might contain a different commodity. Railcars carrying *spent nuclear fuel* or *high-level radioactive waste* could be switched (in railyards or on sidings) successively from one general freight train to another as they traveled from the commercial and DOE locations to Nevada.

geologic
Of or related to a natural process acting as a dynamic physical force on the Earth (faulting, erosion, mountain building resulting in rock formations, etc.).

geologic repository
A system for disposing of *radioactive* waste in excavated *geologic* media, including surface and *subsurface* areas of operation, and the adjacent part of the geologic setting that provides *isolation* of the radioactive waste in the *controlled area*.

Great Basin
A subprovince of the Basin and Range province, generally characterized by north-trending mountain ranges and intervening basins, stretching from eastern Oregon to southern California.

Greater-Than-Class-C waste
Low-level nuclear waste generated by the commercial sector that exceeds U.S. Nuclear Regulatory Commission concentration limits for Class-C low-level waste, as specified in 10 CFR Part 61. DOE is responsible for disposing of this type of waste from its nondefense programs.

Gross Regional Product
The dollar value of all final goods and services produced in a given year in a specific region (such as the *region of influence*).

ground support
The system (rock bolts with wire mesh, steel structures, cast or precast concrete sections) used to line the main and emplacement *drifts* to minimize rock or earth falling into the drifts.

ground vibration
The rapid linear motion of a compression wave in the ground caused by a single or repeated force or impact to the ground as in the action of a pile driver or a tire hitting a bump or pothole in a road.

groundwater
Water contained in pores or fractures in either the *unsaturated zone* or *saturated zone* below ground level.

habitat
Area in which a plant or animal lives and reproduces.

half-life (radiological)
The time in which half the atoms of a *radioactive* substance decay to another nuclear form. Half-lives range from millionths of a second to billions of years depending on the stability of the nuclei.

hazardous chemical
As defined under the Occupational Safety and Health Act and the Community Right-to-Know Act, a chemical that is a physical or health hazard.

hazardous pollutant
Hazardous chemical that can cause serious health and environmental hazards, and listed on the Federal list of hazardous air pollutants (42 U.S.C. 7412). See *toxic air pollutants*.

hazardous waste
Waste designated as hazardous by Environmental Protection Agency or State of Nevada regulations. Hazardous waste, defined under the Resource Conservation and Recovery Act, is

waste that poses a potential hazard to human health or the environment when improperly treated, stored, or disposed of. Hazardous wastes appear on special Environmental Protection Agency lists or possess at least one of the following characteristics: ignitability, corrosivity, toxicity, or reactivity. Hazardous waste streams from the repository could include certain used rags and wipes contaminated with solvents. (Note: The proposed Yucca Mountain Repository would not accept hazardous waste, either solid or liquid, and DOE would dispose of all repository-generated hazardous waste at offsite facilities.)

heavy-haul truck

An overweight, overdimension vehicle that must have permits from state highway authorities to use public highways; a vehicle DOE would use on public highways to move *spent nuclear fuel* or *high-level radioactive waste shipping casks* designed for a railcar.

heavy metal

All uranium, plutonium, and thorium used or generated in a manmade *nuclear reactor*.

high-efficiency particulate air filter

A filter with an efficiency of at least 99.95 percent that separates particles from an air exhaust stream before the air is released to the atmosphere.

higher-temperature repository operating mode

The *flexible design* would maintain the repository host rock temperatures below the boiling point of water [96°C (205°F) at the elevation of the repository] during the preclosure period with continuous ventilation of the *emplacement drifts*. After mechanical ventilation was discontinued at closure, host rock temperatures would increase above the boiling point of water, and moisture around the emplacement drifts would evaporate and be driven away from the drifts as water vapor. A boiling zone would develop around each emplacement drift, but it would not extend all the way across the *pillars*. This mode would allow percolation of moisture downward past the *emplacement horizon* through central portions of the rock pillars between the drifts. See *lower-temperature repository operating mode.*

high-level radioactive waste

(1) The highly *radioactive* material that resulted from the reprocessing of *spent nuclear fuel*, including liquid waste produced directly in reprocessing, and any solid material derived from such liquid waste that contains *fission* products in sufficient concentrations. (NOTE: DOE would vitrify liquid *high-level radioactive waste* before shipping it to the repository.) (2) Other highly radioactive material that the Nuclear Regulatory Commission, consistent with existing law, determines by rule requires permanent *isolation*.

Highway Route-Controlled Quantities of Radioactive Material

Thresholds for certain quantities of *radioactive* materials above which shipments are subject to specific routing controls that apply to the highway carrier. These thresholds are defined by U.S. Department of Transportation regulations (49 CFR Part 177). (49 CFR Part 397 Subpart D defines routing requirements.)

horizon

See *repository horizon*.

human intrusion

The inadvertent disturbance of a *disposal* system by the activities of humans that could result in release of *radioactive* waste. 40 CFR Part 191 Subpart B requires that *performance assessments* consider the possibility of human intrusion.

hydrogeology

A study that encompasses the interrelationships of *geologic* materials and processes involving water.

hydrographic area

In reference to Nevada *groundwater*, divisions of the State into groundwater basins and sub-basins based primarily on topographic features such as mountains and valleys. The State uses the map of hydrographic areas as the basis for water planning, management, and administration. (Because they are based heavily on topographic features, hydrographic area boundaries sometimes differ from groundwater basin designations developed from studies of inferred or measured groundwater flow patterns.)

hydrology

(1) The study of water characteristics, especially the movement of water. (2) The study of water, involving aspects of geology, oceanography, and meteorology.

igneous

(1) A type of rock formed from a molten, or partially molten, material. (2) An activity related to the formation and movement of molten rock either in the *subsurface* (plutonic) or on the surface (volcanic).

impact

For an EIS, the positive or negative effect of an action (past, present, or future) on the natural *environment* (land use, air quality, water resources, geological resources, ecological resources, aesthetic and scenic resources) and the human environment (infrastructure, economics, social, and cultural).

impact limiters

Devices attached to rail and truck *shipping casks* that would help absorb impact energy in the event of a collision.

implementing alternative

An action or proposition by DOE necessary to implement the *Proposed Action* and to enable the estimation of the range of reasonably foreseeable *impacts* of that action or proposition.

- The implementing rail/intermodal alternatives for Nevada transportation are the five corridors for a new rail spur:
  - Caliente
  - Carlin
  - Caliente-Chalk Mountain
  - Jean
  - Valley Modified

- The five *intermodal transfer station*/heavy-haul route combinations:
  - Caliente intermodal transfer station, Caliente route
  - Caliente intermodal transfer station, Caliente-Chalk Mountain route
  - Caliente intermodal transfer station, Caliente-Las Vegas route
  - Sloan/Jean intermodal transfer station, Sloan/Jean route
  - Apex/Dry Lake intermodal transfer station, Apex/Dry Lake route

DOE decisions on implementing alternatives will be made when they are ripe for decisionmaking, which might occur after a decision to construct and operate the Yucca Mountain Repository.

inadvertent intrusion

The unintended disturbance of a *disposal* facility or its immediate *environment* by a future occupant that could result in a loss of *containment* of the waste or *exposure* of people.

incident-free transportation

Routine transportation in which cargo travels from origin to destination without being involved in an *accident*.

indirect impact

An effect that is related to but removed from a proposed action by an intermediate step or process. Examples include surface-water quality changes resulting from soil erosion at construction sites, and reductions in productivity resulting from changes in soil temperature.

industrial wastewater

Liquid wastes from industrial processes that do not include sanitary sewage. Repository industrial wastewater would include water used for dust suppression and process water from building heating, ventilation, and air conditioning systems.

inert

Lacking active thermal, chemical, or biological properties. An inert atmosphere is incapable of supporting combustion.

infiltration

The process of water entering the soil at the ground surface and the ensuing movement downward. Infiltration becomes *percolation* when water has moved below the depth at which it can return to the atmosphere by evaporation or *evapotranspiration*.

infrastructure

Basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and communication systems. These include surface and *subsurface* facilities (for example, service drifts, transporters, electric power supplies, waste handling buildings, administrative facilities).

in situ

In its natural position or place. The phrase distinguishes in-place experiments, conducted in the field or underground facility, from those conducted in the laboratory.

institutional control

Monitoring and maintenance of storage facilities to ensure that radiological releases to the *environment* and *radiation* doses to workers and the public remain within Federal limits and DOE

Order requirements. *Active institutional control* would require the presence of humans to safeguard and maintain the site; passive institutional control would include such devices as permanent markers and land records to warn future generations of dangers.

intermodal transfer station
: A facility at the juncture of rail and road transportation used to transfer *shipping casks* containing *spent nuclear fuel* and *high-level radioactive waste* from rail to truck and empty casks from truck to rail.

intermodal transfer station candidate area
: Area near one or more existing main rail lines that DOE is considering for the location of an *intermodal transfer station*.

intrablock fault
: A relatively minor fault that lies between the major north-trending, block-bounding faults. Also called subsidiary fault.

intrusive sound
: A new sound that, either because of its loudness in relation to the local *ambient* sound level, or because of such characteristics as tone content, impulsive or unexpected nature, or high information content, is annoying or detracts from the usual ambiance of the receptor location. See *noise*.

invasive species
: An *alien species* whose introduction does or is likely to cause economic or environmental harm or harm to human health.

invert
: The structure constructed in a *drift* to provide the floor of that drift. In an *emplacement* drift, ballast in the invert would serve as a *barrier* to migration of *radionuclides* that escaped from breached *waste packages*.

involved worker
: A worker who would be directly involved in the activities related to facility construction and operations, including excavation activities; receipt, handling, packaging, and *emplacement* of waste materials; and *monitoring* of the condition and performance of the *waste packages*. See *noninvolved worker*.

ion
: (1) An atom that contains excess *electrons* or is deficient in electrons, causing it to be chemically active. (2) An electron not associated with a *nucleus*.

ionizing radiation
: (1) *Alpha particles*, *beta particles*, *gamma rays*, *X-rays*, *neutrons*, high-speed *electrons*, high-speed *protons*, and other particles capable of producing *ions*. (2) Any radiation capable of displacing electrons from an atom or molecule, thereby producing ions.

irradiation
: Exposure to *radiation*.

isolation

Inhibiting the transport of *radioactive* material so that the amounts and concentrations of this material entering the *accessible environment* stay within prescribed limits.

isotope

One of two or more atomic *nuclei* with the same number of *protons* (that is, the same *atomic number*) but with a different number of *neutrons* (that is, a different *atomic weight*). For example, uranium-235 and uranium-238 are both isotopes of uranium.

Jackass Flats

A broad asymmetric basin 8 to 10 kilometers (5 to 6 miles) wide and 20 kilometers (12 miles) long that is east of Yucca Mountain and is drained by *Fortymile Wash*.

juvenile failure

Premature failure of a *waste package* because of material imperfections or damage by rockfall during *emplacement*.

land withdrawal area

An area of Federal property set aside for the exclusive use of a Federal agency. For the analyses in this EIS, DOE used an assumed land withdrawal area of 600 square kilometers, or 150,000 acres.

Las Vegas Valley shear zone

A major right-lateral strike-slip zone of faulting.

latent cancer fatality

A death resulting from *cancer* that has been caused by exposure to *ionizing radiation*. For exposures that result in cancers, the generally accepted assumption is that there is a latent period between the time an exposure occurs and the time a cancer becomes active.

legal-weight truck

A truck with a gross vehicle weight (both truck and cargo weight) of less than 36,300 kilograms (80,000 pounds), the loaded weight limit for commercial vehicles operated on public highways without special state-issued permits. In addition, the dimensions, axle spacing, and, if applicable, axle loads of these vehicles must be within Federal and state regulations.

License Application

An application to the Nuclear Regulatory Commission to construct a *geologic repository* for the disposal of *spent nuclear fuel* and *high-level radioactive waste*. The application would be considered by the Nuclear Regulatory Commission in any decision whether to grant DOE authorization to begin constructing a repository.

line-loading repository design

A waste *emplacement* design in which *waste packages* would be spaced closely enough along the axis of the *drift* such that the heat source could be assumed to be continuous in long-term performance analyses.

linear thermal load

Heat output per unit length of the emplacement *drift*; expressed in kilowatts per meter.

lithology

The study and description of the general, gross physical characteristics of a rock, especially sedimentary *clastics*, including color, grain size, and composition.

lost workday cases

Incidents that result in injuries that cause the loss of work time.

lower-temperature repository operating mode

The *flexible design* would have the ability to hold repository host rock temperatures below the boiling point of water [96°C (205°F) at the elevation of the repository] after closure by a combination of methods such as increasing the continuous ventilation period, aging the fuel prior to *emplacement*, and increasing the spacing between emplaced waste packages. The mode ranges include conditions under which the drift rock wall temperatures would be below the boiling point of water, and conditions under which the waste package surface temperature would not exceed 85ºC (185ºF). To bound the impact analysis, DOE considered conditions under which the rock wall temperatures would be above the boiling point of water, and conditions under which waste package surface temperatures would not exceed 85ºC. See *higher-temperature repository operating mode*.

low-income population

One in which 20 percent or more of the persons in the population live in poverty, as reported by the Bureau of the Census in accordance with Office of Management and Budget requirements.

low-level radioactive waste

Radioactive waste that is not classified as *high-level radioactive waste*, *transuranic waste*, or byproduct tailings containing uranium or thorium from processed ore. Usually generated by hospitals, research laboratories, and certain industries.

maintenance

Activities during the repository operation and monitoring phase including maintenance of *subsurface* monitoring and instrumentation systems and utilities (compressed air, water supply, fire water, wastewater system, power supply, and lights), maintenance of the main ventilation fan installations and surface facilities related to underground activities, and site security. Maintenance also preserves the capability to retrieve emplaced *waste packages*. See *repository phases*.

matrix (geology)

The solid, but porous, portion of rock.

maximally exposed individual

A hypothetical individual whose location and habits result in the highest total radiological or chemical exposure (and thus *dose*) from a particular source for all exposure routes (for example, inhalation, ingestion, direct exposure). The EIS analyses used the concept of the maximally exposed individual to evaluate potential short-term impacts to individuals around the repository and from transportation (and for some aspects of the *No-Action Alternative*). The EIS analyses used the concept of the maximally exposed individual to evaluate potential short-term impacts to individuals around the repository and from transportation (and for some aspects of the No-Action Alternative. For potential impacts to individuals from long-term repository performance, see *receptor*.

Maximum Contaminant Level

Under the Safe Drinking Water Act, the maximum permissible concentrations of specific constituents in drinking water that is delivered to any user of a public water system that serves 15 or more connections and 25 or more people; the standards established as maximum contaminant levels consider the feasibility and cost of attaining the standard.

maximum reasonably foreseeable accident

An accident characterized by extremes of mechanical (impact) forces, heat (fire), and other conditions that would lead to the highest foreseeable consequences. In general, accidents with conditions that have a chance of occurring more often than 1 in 10 million in a year are considered to be reasonably foreseeable.

metamorphic

Rock in which the original mineralogy, texture, or composition has changed due to the effects of pressure, temperature, or the gain or loss of chemical components.

metric tons of heavy metal (MTHM)

Quantities of *spent nuclear fuel* without the inclusion of other materials such as *cladding* (the tubes containing the fuel) and structural materials. A metric ton is 1,000 kilograms (1.1 tons or 2,200 pounds). Uranium and other metals in spent nuclear fuel (such as thorium and plutonium) are called *heavy metals* because they are extremely dense; that is, they have high weights per unit volume.

millirad

One one-thousandth (0.001) of a *rad*.

millirem

One one-thousandth (0.001) of a *rem*.

minority population

A community in which the percent of the population of a racial or ethnic minority is 10 points higher than the percent found in the population as a whole.

mitigation

Actions and decisions that (1) avoid *impacts* altogether by not taking a certain action or parts of an action, (2) minimize impacts by limiting the degree or magnitude of an action, (3) rectify the impact by repairing, rehabilitating, or restoring the *affected environment*, (4) reduce or eliminate the impact over time by preservation and maintenance operations during the life of the action, or (5) compensate for an impact by replacing or providing substitute resources or *environments*.

mixed-oxide fuel

A mixture of uranium oxide and plutonium oxide that could be used to power commercial nuclear reactors.

monitored geologic repository

A system, requiring licensing by the U.S. Nuclear Regulatory Commission, intended or used for the permanent underground *disposal* of *radioactive* waste (including *spent nuclear fuel*). A *geologic repository* includes (1) the geologic repository operations area, and (2) the geologic setting in the *controlled area* that provides *isolation* of the radioactive waste. The repository would be monitored between *emplacement* of the last *waste package* and closure.

monitoring

Activities during the repository operation and monitoring phase including the surveillance and testing of *waste packages* and the repository for *performance confirmation*. See *repository phases*.

National Environmental Policy Act, as amended (NEPA; 42 U.S.C. 4321 *et seq.*)

The Federal statute that is the national charter for protection of the *environment*. The Act is implemented by procedures issued by the Council on Environmental Quality and DOE.

native species

With respect to a particular ecosystem, a species that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem.

natural barrier

The physical components of the geologic *environment* that individually and collectively act to limit the movement of water or radionuclides. See *barrier*.

natural system

A host rock suitable for repository construction and waste *emplacement* and the surrounding rock formations. It includes *natural barriers* that provide *containment* and *isolation* by limiting radionuclide transport through the geohydrologic *environment* to the *biosphere* and provide conditions that will minimize the potential for *human intrusion* in the future.

natural ventilation

Ventilation driven by a difference in density between the air columns in connected *shafts* or ramps. The density difference is generally caused by a difference in air temperature between the shafts, which results in a pressure differential that induces the air flow. This phenomenon, which is common in underground mines, can be enhanced by differences in elevation between the intake and exhaust locations. In relation to this EIS, the repository would be unique in that, due to the heat output of the emplaced waste, the exhaust air temperature would virtually always be higher than the intake temperature. The heat supplied by the waste and the difference in elevation between the intake and exhaust shaft portals would mean that there would always be a pressure differential, and that it would always be positive (that is, it would induce flow from the intakes to the exhausts).

naval spent nuclear fuel

Spent nuclear fuel discharged from reactors in surface ships, submarines, and training reactors operated by the U.S. Navy.

near-field

The area of and conditions in the repository including the *drifts* and *waste packages* and the rock immediately surrounding the drifts. The region around the repository where the natural hydrogeologic system would be significantly impacted by the excavation of the repository and the *emplacement* of waste.

neutron

An atomic particle with no charge and an atomic mass of 1; a component of all atoms except hydrogen; frequently released as *radiation*.

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neutron absorber

A material (such as boron or gadolinium) that absorbs neutrons. Used in *nuclear reactors*, transportation *casks*, and *waste packages* to control neutron activity and prevent criticality.

nitrogen oxides

Gases formed in great part from atmospheric nitrogen and oxygen when combustion occurs under conditions of high temperature and high pressure; a major air pollutant. Two primary nitrogen oxides, nitric oxide (NO) and nitrogen dioxide (NO_2), are important airborne *contaminants*. Nitric oxide combines with atmospheric oxygen to produce nitrogen dioxide. Both nitric oxide and nitrogen dioxide can, in high concentration, cause lung cancer. Nitrogen dioxide is a *criteria pollutant*.

No-Action Alternative

The *Nuclear Waste Policy Act* states that this EIS does not have to discuss *alternatives* to geologic disposal or alternative sites to Yucca Mountain; DOE included the analysis of the No-Action Alternative to provide a basis for comparison with the *Proposed Action*. For this EIS, under the No-Action Alternative DOE would end *site characterization* activities at Yucca Mountain and continue to accumulate *spent nuclear fuel* and *high-level radioactive waste* at commercial storage sites and DOE facilities. See *alternative*.

noble gas

Any of a group of rare gases that include helium, neon, argon, krypton, xenon, and radon and that exhibit great chemical stability and extremely low reaction rates; also called *inert* gas. Xenon and radon exhibit extremely low reaction rates.

noise

Any sound that is undesirable because it interferes with speech and hearing; if intense enough, it can damage hearing.

nominal scenario

Long-term performance of the proposed repository using the Proposed Action modeled inventory, undisturbed by volcanic activity or human intrusion, but including seismic activity.

nonattainment area

An area that does not meet the *ambient air quality standard* for one or more criteria pollutants. Further designations (for example, serious, moderate) describe the magnitude of the nonattainment.

noninvolved worker

A worker who would perform managerial, technical, supervisory, or administrative activities but would not be directly involved in construction, excavation, or operations activities. See *involved worker*.

normal distribution

As used in analyses of long-term performance, a special type of symmetrical distribution known in the science of statistics as the Gaussian Distribution and commonly known as the “bell-shaped curve.” *See distribution.*

normal fault
: *A fault* in which the relative displacement is along the direction of dip of the fault plane (*dip-slip fault*) where the block above the fault has moved downward in relation to the block below the fault. See *reverse fault*.

nuclear radiation
: *Radiation* that emanates from an unstable atomic *nucleus*.

nuclear reactor
: A device in which a nuclear *fission chain reaction* can be initiated, sustained, and controlled to generate heat or to produce useful radiation.

nuclear waste
: Unusable by-products of nuclear power generation, nuclear weapons production, and research, including *spent nuclear fuel, high-level radioactive waste*.

Nuclear Waste Policy Act (NWPA; 42 U.S.C. 10101 *et seq.*)
: The Federal statute, originally enacted in 1982 (Public Law 97-425; 96 Stat. 2201), that established the Office of Civilian Radioactive Waste Management and defines its mission to develop a Federal system for the management and geologic disposal of *commercial spent nuclear fuel* and other *high-level radioactive wastes*, as appropriate. The Act also specifies other Federal responsibilities for nuclear waste management, establishes the Nuclear Waste Fund to cover the cost of geologic *disposal*, authorizes interim storage under certain circumstances, and defines interactions between Federal agencies and the states, local governments, and Native American tribes. The Act was substantially amended in 1987 (see *Nuclear Waste Policy Act Amendments of 1987*) and 1992 (see *Energy Policy Act of 1992*).

Nuclear Waste Policy Act Amendments of 1987 (Public Law 100-203; 101 Stat. 1330)
: Legislation that amended the *Nuclear Waste Policy Act* to limit repository *site characterization* activities to Yucca Mountain, Nevada; establish the Office of Nuclear Waste Negotiator to seek a state or Native American tribe willing to host a repository or monitored retrievable storage facility; create the *Nuclear Waste Technical Review Board*; and increase state and local government participation in the waste management program.

Nuclear Waste Technical Review Board
: An independent body established within the executive branch, created by the *Nuclear Waste Policy Amendments Act of 1987* to evaluate the technical and scientific validity of activities undertaken by the U.S. Department of Energy, including *site characterization* activities and activities relating to the packaging or transportation of *high-level radioactive waste* or *spent nuclear fuel*. Members of this Board are appointed by the President from a list prepared by the National Academy of Sciences.

nucleus
: The central, positively charged, dense portion of an atom. Also known as atomic nucleus.

nuclide
: An atomic *nucleus* specified by its *atomic weight*, *atomic number*, and energy state; a radionuclide is a *radioactive* nuclide.

oblique-slip fault

A *fault* that combines some purely horizontal motion (*strike-slip fault*) with some along the direction of the dip of the fault plane (*dip-slip fault*).

offsite

Physically not in a repository-related area managed by DOE.

onsite

Physically in an area managed by DOE where access can be limited for any reason. The site boundary encompasses *controlled areas*. The site comprises the various Operations Areas and the areas between and immediately surrounding them.

operational storage

A storage capacity DOE could use to collect material shipped to the repository before (or after) its insertion in *waste packages* and *emplacement* in the repository.

operation and monitoring

See *repository phases*.

option

As used in the transportation analysis in this EIS, a variation based on a determination that the location of a rail *corridor* segment is essentially equivalent to that of another option considering environmental and engineering factors. See *variation*, *alternate*, *corridor*.

organism

An individual constituted to carry on the activities of life by means of organs separate but mutually dependent; a living being.

overburden

Geologic material of any nature, consolidated or unconsolidated, that overlies a deposit of useful materials. As used by the Yucca Mountain Project, this is geologic material overlying the *repository block*.

overweight, overdimension truck

Semi- and tandem tractor-trailer trucks with gross weights over 80,000 pounds that must obtain permits from state highway authorities to use public highways.

ozone (O_3)

The triatomic form of oxygen; in the *stratosphere*, ozone protects the Earth from the Sun’s *ultraviolet radiation*, but in lower levels of the atmosphere it is an air pollutant.

Paleozoic Era

A geologic era extending from the end of the Precambrian to the beginning of the Mesozoic, dating from about 600 to 230 million years ago.

particulate matter

Fine liquid or solid particles such as dust, smoke, mist, fumes, or smog, found in air or emissions. See PM_{10}.

pathway
: A potential route by which radionuclides might reach the *accessible environment* and pose a threat to humans.

peak of the mean annual dose (post-10,000 years)
: For this EIS, the maximum of the mean annual *dose* analyzed for the 1-million-year postclosure period. Because the dose would decline after this peak, this would be the peak for all time after closure. See *10,000-year peak of the mean annual dose*.

pediment
: A planar sloping rock surface forming a ramp to a front of a mountain range in an arid region. It might be covered locally by a thin *alluvium*.

perched water
: A *saturated zone* condition that is not continuous with the *water table*, because there is an impervious or semipervious layer underlying the perched zone or a *fault* zone that creates a *barrier* to water movement and perches water. See *permeable*.

percolation
: The passage of a liquid through a porous substance. In rock or soil it is the movement of water through the interstices and pores under hydrostatic pressure and the influence of gravity. The downward or lateral flow of water that becomes net *infiltration* in the *unsaturated zone*.

perennial yield
: The amount of usable water from a *groundwater* aquifer that can be economically withdrawn and consumed each year for an indefinite period. It cannot exceed the natural recharge to that aquifer and ultimately is limited to the maximum amount of discharge that can be used for beneficial use.

performance assessment
: An analysis that estimates the potential behavior of a system or system component under a given set of conditions. Performance assessments include estimates of the effects of *uncertainties* in data and modeling. See *Total System Performance Assessment.*

performance confirmation
: The program of tests, experiments, and analyses conducted to evaluate the accuracy and adequacy of the information used to determine with reasonable assurance that the performance objectives for the period after *permanent closure* will be met.

permanent closure
: Final sealing of *shafts* and *boreholes* of the underground facility, including the installation of permanent monuments to mark the location and boundaries of the repository.

permeable
: Pervious; a permeable rock is a rock, either porous or cracked, that allows water to soak into and pass through it freely.

permeability
: In general terms, the capacity of such mediums as rock, sediment, and soil to transmit liquid or gas. Permeability depends on the substance transmitted (oil, air, water, etc.) and on the size and shape of the pores, joints, and fractures in the medium and the manner in which they

interconnect. “Hydraulic conductivity” is equivalent to “permeability” in technical discussions relating to *groundwater*.

person-rem

A unit used to measure the *radiation* exposure to an entire group and to compare the effects of different amounts of radiation on groups of people; it is the product of the average *dose equivalent* (in *rem*) to a given organ or tissue multiplied by the number of persons in the population of interest.

pH

A number indicating the acidity or alkalinity of a solution. A pH of 7 indicates a neutral solution. Lower pH values indicate more acidic solutions while higher pH values indicate alkaline solutions.

photon

A massless particle, the quantum of an electromagnetic field, carrying energy, momentum, and angular momentum.

photovoltaic

Capable of generating a voltage as a result of exposure to *radiation*. Solar power generation systems use photovoltaic energy from the sun’s radiation to produce electricity.

picocurie

One one-trillionth (1×10^{-12}) of a *curie*.

pillar

The rock section between adjacent *emplacement drifts*.

PM_{10}

All *particulate matter* in the air with an aerodynamic diameter less than or equal to a nominal 10 micrometers (0.0004 inch). Particles less than this diameter are small enough to be breathable and could be deposited in lungs.

polycyclic volcanism

Multiple cycles of volcanic activity, as in describing a cinder cone that resulted from numerous volcanic events separated by significant intervals of time (as opposed to a cone generated by a single event or a tightly grouped series of events).

population dose

A summation of the radiation doses received by individuals in an exposed population; equivalent to *collective dose*; expressed in *person-rem*.

portal

Surface entrance to a mine, particularly in a *drift* or tunnel. The North and South Portals are the two primary entrances to the *subsurface* facilities.

postclosure controlled area

See *controlled area*.

preferred route

A public highway route that satisfies the requirements of U.S. Department of Transportation regulations (49 CFR Part 397, Subpart D) to be acceptable for shipments of *Highway Route-Controlled Quantities of Radioactive Material*.

pressurized-water reactor (PWR)

A nuclear power *reactor* that uses water under pressure as a coolant. The water boiled to generate steam is in a separate system.

prime farmland

Land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion.

probabilistic

(1) Based on or subject to *probability*. (2) Involving a variable factor, such as temperature or porosity. At each instance of time, the factor may take on any of the values of a specified set with a certain probability. Data from a probabilistic process is an ordered set of observations, each of which is one item in a probability distribution.

probability

The relative frequency at which an event can occur in a defined period. Statistical probability is about what actually happens in the real world and can be verified by observation or sampling. Knowing the exact probability of an event is usually limited by the inability to know, or compile the complete set of, all possible outcomes over time or space. Probability is measured on a scale of 0 (event will *not* occur) to 1 (event *will* occur).

probable maximum flood

The hypothetical flood (peak discharge, volume, and hydrographic shape) that is considered to be the most severe reasonably possible, based on comprehensive hydrometeorological application of probable maximum precipitation and other hydrologic factors, such as sequential storms and snowmelts, that are favorable for maximum flood runoff.

proposed action

The activity proposed to accomplish a Federal agency's purpose and need. An EIS analyzes the environmental *impacts* of the Proposed Action. A proposed action includes the project and its related support activities (preconstruction, construction, and operation, along with postoperational requirements). The Proposed Action in this EIS is the construction, operation and monitoring, and eventual closure of a *monitored geologic repository* for *spent nuclear fuel* and *high-level radioactive waste* at Yucca Mountain in Nevada (see *repository phases*).

proton

An elementary particle that is the positively charged component of ordinary matter and, together with the *neutron*, is a building block of all atomic *nuclei*.

pyroclastic

Of or relating to individual particles or fragments of *clastic* rock material of any size formed by volcanic explosion or ejected from a volcanic vent.

qualitative

With regard to a variable, a parameter, or data, an expression or description of an aspect in terms of non-numeric qualities or attributes. See *quantitative*.

quantitative

A numeric expression of a variable. See *qualitative*.

rad

The unit of measure of absorbed *radiation* dose in terms of energy. One rad is equal to an absorbed *dose* of 100 ergs per gram. (In the metric system of measurements, an erg is a unit of energy. One foot-pound is equal to 13,560,000 ergs.)

radiation

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

radioactive

Emitting *radioactivity*.

radioactive decay

The process in which one *radionuclide* spontaneously transforms into one or more different radionuclides, which are called decay products.

radioactivity

The property possessed by some elements (for example, uranium) of spontaneously emitting alpha, beta, or *gamma rays* by the *disintegration* of atomic *nuclei*.

radiologically controlled area

An area of the surface repository enclosed by security fences, control gates, lighting, and detection systems established to prevent the spread of radiological contamination. The area would include the facilities and transportation systems required to receive and ship rail and truck waste shipments, prepare *shipping casks* for handling, and load *waste forms* into disposal containers for *emplacement* in the repository. It would also include the facility and systems required to treat and package site-generated *low-level radioactive waste* for offsite disposal.

radionuclide

See *nuclide*.

rail classification yard

A railroad switching yard where railcars arriving in inbound freight trains are classified and reassembled according to their routing to make up outbound freight trains.

rail route

Route from point of origin to the repository.

reactor

See *nuclear reactor*.

release fraction

The fraction of each *isotope* in *spent nuclear fuel* or *high-level radioactive waste* that could be released from a containment in an *accident*.

real disposable income

The dollar income, including the value of transfer payments, available to individuals after taxes have been paid; also referred to as *real disposable personal income*.

reasonably maximally exposed individual

See *receptor*.

receptor

A hypothetical person who is exposed to environmental contaminants (in this case *radionuclides*) in such a way—by a combination of factors including location, lifestyle, dietary habits, etc.—that this individual is representative of the *exposure* of the general population. DOE used this hypothetical individual to evaluate long-term repository performance. The receptor represents the "Reasonably Maximally Exposed Individual (RMEI)" defined in 40 CFR Part 197. The Draft EIS defined the receptor slightly differently and called this hypothetical person the *maximally exposed individual,* which is still used for evaluating short-term impacts.

recharge

The movement of water from an *unsaturated zone* to a *saturated zone*.

recordable cases

Occupational injuries or occupation-related illnesses that result in (1) a fatality, regardless of the time between the injury or the onset of the illness and death, (2) lost workday cases (nonfatal), and (3) the transfer of a worker to another job, termination of employment, medical treatment, loss of consciousness, or restriction of motion during work activities.

Record of Decision

A document that provides a concise public record of a decision made by a government agency.

region of influence

The physical area that bounds the environmental, sociologic, economic, or cultural features of interest for the purpose of analysis.

rem

A unit of *dose equivalent.*

remediation

Action taken to permanently remedy a release or threatened release of a hazardous substance to the *environment*, instead of or in addition to removal.

repository

See *geologic repository*.

repository block

The portion of rock in Yucca Mountain that would house the repository, if the site was suitable.

repository horizon

The area within the *repository block* where *emplacement drifts* would be excavated. Also called emplacement horizon.

repository phases

The development of a monitored geologic repository at Yucca Mountain, if approved, would have three phases, as follows:

- *Construction:* Activities during this phase would include preparing the site, constructing surface waste handling and support facilities, excavating and equipping a portion of the repository *subsurface* for initial waste *emplacement*, and conducting initial verification testing of components and systems.

- *Operation and monitoring:* Repository operations activities would include waste receipt, repackaging, and emplacement in the repository; continuing subsurface development for waste *emplacement; monitoring; and maintenance*. Monitoring would begin with the initial emplacement of waste in the repository and would end at repository closure. In addition, the maintenance of repository facilities would continue until the closure of the repository. See *monitoring*, *maintenance*.

- *Closure:* The closure of the *subsurface* repository facilities would include the removal and salvage of equipment and materials; filling of the main *drifts*, access ramps, and ventilation shafts; and sealing of openings, including ventilation shafts, access ramps, and *boreholes*. Surface closure activities would include the construction of monuments to mark the repository location, *decommissioning* and demolition of facilities, and restoration of the site to its approximate condition before the construction of the repository facilities.

respirable fraction

The fraction of *aerosol* released in an *accident* that consists of particles or droplets having aerodynamic effective diameters of 10 microns (about 4 millionths of an inch) or less.

retrieval

The act of removing *radioactive* waste from the underground location at which the waste had been previously emplaced for disposal. Retrieval would be a contingency action, performed only if *monitoring* indicated that the waste needed to be retrieved in order to protect the public health and safety or the environment or to recover resources from *spent nuclear fuel*.

reverse fault

A *fault* in which the relative displacement is along the direction of the dip of the fault plane (*dip-slip fault*), and in which the block above the fault has moved upward in relation to the block below the fault.

riparian

Of, on, or pertaining to the bank of a river or stream, or of a pond or small lake.

riprap

Broken stones or chunks of concrete used as foundation material or in embankments to control water flow or prevent erosion.

risk

The product of the probability that an undesirable event will occur multiplied by the consequences of the undesirable event.

safe haven

Designated safe parking locations along transportation routes.

sanitary and industrial solid waste

Solid waste that is neither hazardous nor radioactive. Sanitary waste streams include paper, glass, and discarded office material. State of Nevada waste regulations identify this waste stream as household waste.

sanitary waste

Domestic wastewater from toilets, sinks, showers, kitchens, and floor drains from restrooms, change rooms, and food preparation and storage areas.

saturated zone

The area below the *water table* where all spaces (*fractures* and rock pores*)* are completely filled with water.

scenario

A specific set of actions, activities, and assumptions. Scenarios are identified and analyzed to enable the estimation of the range of environmental impacts associated with the *Proposed Action* and the *No-Action Alternative*. The environmental impacts identified from these scenarios provide environmental information to support Departmental decisions about the *alternatives* and *implementing alternatives*.

scoria

Bubbly, glassy lava rock of basaltic composition that originated as hot, welded materials ejected from a volcano. Small fragments are called “cinders.”

seismic

Pertaining to, characteristic of, or produced by *earthquakes* or earth vibrations.

seismicity

A seismic event or activity such as an *earthquake* or earth tremor; *seismic* action.

sensitive structures

Buildings or structures, usually old and of cultural value, or facilities that house vibration-sensitive equipment, that could be susceptible to ground vibrations, activities, or conditions causing *ground vibrations*.

shaft

For the Yucca Mountain Repository, an excavation or vertical passage of limited area, compared to its depth, used to ventilate underground facilities.

shielding

Any material that provides *radiation* protection.

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shipment

The movement of a properly prepared (loaded, unloaded, or empty) *cask* from one site to another and associated activities to ensure compliance with applicable regulations.

shipping cask

A heavily shielded massive container that meets regulatory requirements for shipping *spent nuclear fuel* or *high-level radioactive waste*. See *cask*.

single-purpose (storage or transportation) cask

A heavily shielded massive container for the dry storage of *spent nuclear fuel*; it is usable for either storage or transportation but not for *emplacement* in a repository. See *cask*.

site boundary

The boundary of the land withdrawal area used for analytical purposes in this EIS. See *land withdrawal area.*

site characterization

Activities associated with the determination of the suitability of the Yucca Mountain site as a *monitored geologic repository*. DOE constructed the *Exploratory Studies Facility* to support the following activities related to the determination of site suitability, including surface facilities and *subsurface* ramps and *drifts*:

- Gather and evaluate surface and subsurface site data
- Predict the performance of the repository
- Prepare the repository design
- Assess the performance of the system against the required Code of Federal Regulations and program performance criteria

Some of the exploratory surface and subsurface facilities would be enhanced during the repository construction phase (see *repository phases*); others would be removed, demolished, or relocated, as necessary. Data gathering associated with site characterization would end with any Site Recommendation decision.

site-generated waste

Waste or wastewater generated at the *monitored geologic repository* and related transportation facilities.

Site Recommendation

A recommendation by the Secretary of Energy to the President that the Yucca Mountain site be approved for development as the Nation’s first *spent nuclear fuel* and *high-level radioactive waste* repository.

soil recovery

The return of disturbed land to a relatively stable condition with a form and productivity similar to that which existed before any disturbance.

sound barrier

Natural or artificial structures that block or interfere with the propagation of sound; examples include terrain features and manmade structures (buildings, walls, etc.).

source term

Types and amounts of radionuclides that are the source of a potential release of *radioactivity*.

Spaghetti Bowl

As used in this EIS, the intersection of Interstate Highway 15 and U.S. Highway 93/95 in Las Vegas, Nevada.

spalling

(1) Flaking off of corrosion products from the metal *substrate* as it undergoes corrosion. The layer of corroded material thickens. The spalling could be caused by an expansive action of the corrosion products because they occupy a greater volume than the uncorroded metal substrate. (2) Flaking, chipping, or cracking at the opening of a *borehole*, *shaft*, or other rock excavation.

Special-Performance-Assessment-Required (SPAR) wastes

Low-level radioactive wastes generated in DOE production reactors, research reactors, reprocessing facilities, and research and development activities that exceed the Nuclear Regulatory Commission Class C shallow-land burial disposal limits.

spent nuclear fuel

Fuel that has been withdrawn from a *nuclear reactor* following *irradiation*, the component elements of which have not been separated by reprocessing. For this project, this refers to (1) intact, nondefective *fuel assemblies*, (2) failed fuel assemblies in canisters, (3) fuel assemblies in canisters, (4) consolidated fuel rods in canisters, (5) nonfuel assembly hardware inserted in *pressurized-water reactor* fuel assemblies, (6) fuel channels attached to *boiling-water reactor* fuel assemblies, and (7) nonfuel assembly hardware and structural parts of assemblies resulting from consolidation in *canisters*.

spoils areas

Areas outside the rail corridor for the deposition of excavated materials from rail line development.

stakeholder

A person or organization with an interest in or affected by DOE actions (representatives from Federal, state, tribal, or local agencies; members of Congress or state legislatures; unions, educational groups, environmental groups, industrial groups, etc.; and members of the general public).

storage

The collection and containment of waste or *spent nuclear fuel* in a way that does not constitute *disposal* of the waste or *spent nuclear fuel* for the purposes of awaiting treatment or disposal capacity.

storage cask

See *cask*.

storage container

See *cask*.

stratigraphy

The branch of geology that deals with the definition and interpretation of rock strata, the conditions of their formation, character, arrangement, sequence, age, distribution, and especially their correlation by the use of fossils and other means of identification. See *stratum*.

stratosphere

The atmospheric shell above the troposphere and below the mesosphere. It extends from 10 to 20 kilometers (6 to 12 miles) to about 53 kilometers (33 miles) above the surface.

stratum

A sheetlike mass of sedimentary rock or earth of one kind lying between beds of other kinds.

strike-slip fault

A fault with purely horizontal relative displacement.

subcritical

Having an effective multiplication constant less than 1, so that a self-supporting *chain reaction* cannot be maintained in a *nuclear reactor*.

subsidiary fault

See *intrablock fault*.

substrate

Basic surface on which a material adheres.

subsurface

A zone below the surface of the Earth, the *geologic* features of which are principally layers of rock that have been tilted or faulted and are interpreted on the basis of drill hole records and geophysical (*seismic* or rock vibration) evidence. In general, it is all rock and solid materials lying beneath the Earth's surface.

sulfur dioxide

A pungent, colorless gas produced during the burning of sulfur-containing fossil fuels. It is the main pollutant involved in the formation of acid rain. Coal- and oil-burning electric utilities are the major source of sulfur dioxide in the United States. Inhaled sulfur dioxide can damage the human respiratory tract and can severely damage vegetation. See *criteria pollutants*, *ambient air quality standards*.

sulfur oxides

A mixture of sulfur dioxide, sulfur trioxide, and inorganic sulfites and sulfates. Sulfur dioxide combines with oxygen in the air to form sulfur trioxide and microscopic aerosol sulfite and sulfate particles, all of which are lung irritants. See *criteria pollutants*, *ambient air quality standards*.

supernate

A concentrated form of *radioactive* waste that floats to the top of an undisturbed container of liquid *high-level radioactive waste*.

thermal loading

(1) The spatial density at which *waste packages* would be emplaced within the repository as characterized by the areal power density and the *areal mass loading*. (2) The application of heat to a system, usually measured in terms of watts per unit area. The thermal load for a repository would be the watts per acre produced by the *radioactive* waste in the active disposal area.

thermal shunt

A metal structure, usually aluminum, that would be added to *waste packages* as needed to greatly improve heat conduction between the center of the waste package and the outer edge, thereby providing a reliable means to keep the temperature of the *cladding* within design limits.

threatened species

A species that is likely to become an *endangered species* within the foreseeable future throughout all or a significant part of its range.

thrust fault

A *reverse fault* in which the angle of the fault plane is less than 45 degrees.

total employment

The sum of direct and indirect employment resulting from initiation of an activity. Direct employment consists of jobs performing the activity. Indirect employment consists of jobs in other activities supporting the direct employees. Also defined as composite employment.

total population

The sum of all people associated with direct and indirect employees and their families resulting from initiation of an activity.

Total System Performance Assessment

A risk assessment that quantitatively estimates how the proposed Yucca Mountain Repository system could perform under the influence of specific features, events, and processes, incorporating *uncertainty* in the models and data. See *performance assessment*.

toxic air pollutants

Hazardous pollutants not listed as either *criteria pollutants* or *hazardous pollutants*.

traditional cultural property

A property that is eligible for inclusion in the National Register of Historic Places because of its association with cultural practices or beliefs of a living community that are rooted in that community's history, and are important in maintaining the continuing cultural identity of the community. Culture includes the traditions, beliefs, practices, lifeways, arts, crafts, and social institutions of any community, be it a Native American tribe, a local ethnic group, or the people of the Nation as a whole. Properties can include buildings, structures, and sites; groups of buildings, structures, or sites forming historic districts; and individual objects.

transpiration

The process by which water enters a plant through its root system, passes through its vascular system, and is released into the atmosphere through openings in its outer covering. It is an important process for removal of water that has infiltrated below the zone where it could be removed by evaporation.

transuranic waste

Waste materials (excluding *high-level radioactive waste* and certain other waste types) contaminated with alpha-emitting radionuclides that are heavier than uranium with half-lives greater than 20 years and that occur in concentrations greater than 100 nanocuries per gram. Transuranic waste results primarily from treating and fabricating plutonium as well as research activities at DOE defense installations.

trunnion

A projection from a vessel or other piece of equipment that facilitates attachment to a lifting device.

tuff

Igneous rock formed from compacted volcanic fragments from *pyroclastic* (explosively ejected) flows with particles generally smaller than 4 millimeters (about 0.16 inch) in diameter—the most abundant type of rock at the Yucca Mountain site. Nonwelded tuff results when volcanic ash cools in the air sufficiently that it doesn't melt together, yet later becomes rock through compression. See *welded tuff*.

ultraviolet radiation

Electromagnetic radiation with wavelengths from 4 to 400 nanometers. This range begins at the short wavelength limit of visible light and overlaps the wavelengths of long *x-rays* (some scientists place the lower limit at higher values, up to 40 nanometers). Also known as ultraviolet light.

uncanistered spent nuclear fuel

Commercial spent nuclear fuel placed directly into shipping casks. At the repository, *spent nuclear fuel* assemblies would be removed from the *shipping cask* in a *disposal container* or in the fuel pool to accomodate *blending*.

uncertainty

A measure of how much a calculated or estimated value that is used as a reasonable guess or prediction might vary from the unknown true value.

unique farmland

Land other than *prime farmland* that is used for the production of specific high-value food and fiber crops such as citrus, tree nuts, olives, cranberries, fruits, and vegetables.

unsaturated zone

The zone of soil or rock below the ground surface and above the *water table*.

vadose zone

See *unsaturated zone*.

variation

As used in the transportation analysis in this EIS, a strip of land, approximately 400 meters (0.25 mile) wide, from one point along a corridor to another point along the same corridor that describes a different route. See *alternate*, *option*, *corridor*.

Viability Assessment

An assessment of the prospects for geologic disposal at the Yucca Mountain site, based on repository and *waste package* design, a *Total System Performance Assessment*, a *License Application* plan, and repository cost and schedule estimates. DOE issued the *Viability Assessment of a Repository at Yucca Mountain* in December 1998.

vicinity (in relation to the Yucca Mountain Repository)

A general term used in nonspecific discussions in this EIS about the area around the Yucca Mountain site.

viewshed

A total field of vision or a vista. In particular, an area with visual boundaries seen from various points within the area.

vitrification

A waste treatment process that uses glass (for example, *borosilicate glass*) to encapsulate or immobilize *radioactive* wastes.

vitrophyre

A volcanic rock with large crystals embedded in a glassy, obsidian-like matrix.

waste form

A generic term that refers to the different types of *radioactive* wastes.

waste package

A sealed container containing waste that is ready for *emplacement*. The waste package would contain the *waste form* and any internal structures necessary for structural support, thermal control, or nuclear control.

water table

(1) The upper limit of the *saturated zone* (the portion of the ground wholly saturated with water). (2) The upper surface of a zone of saturation above which the majority of pore spaces and fractures are less than 100 percent saturated with water most of the time (*unsaturated zone*) and below which the opposite is true (saturated zone).

welded tuff

A *tuff* deposited under conditions where the particles making up the rock were heated sufficiently to cohere. In contrast to nonwelded tuff, welded tuff is denser, less porous, and more likely to be fractured (which increases *permeability*).

wetland

A shoreline or other area, such as a marsh or swamp, that is saturated with moisture, especially when thought of as the natural habitat of wildlife.

wet storage

Storage of *radioactive* material that uses water for cooling or *shielding*, such as a spent nuclear fuel storage pool.

worker year

2,000 hours of paid labor; a project requiring 1.5 worker years would take 3,000 hours to complete.

X-rays

Penetrating electromagnetic *radiation* having a wavelength much shorter than that of visible light. X-rays are identical to *gamma rays* but originate outside the *nucleus*, either when the inner orbital *electrons* of an excited atom return to their normal state or when a metal target is bombarded with high-speed electrons.

Yucca Mountain Repository EIS

See *environmental impact statement (EIS)*.

Yucca Mountain site (the site):

The area on which DOE has built or would build the majority of facilities or cause the majority of land disturbances related to the proposed repository.

zeolite

Any of a group of hydrated silicates of aluminum with alkali metals, commonly occurring as secondary minerals in cavities in basic volcanic rocks.

zirconium alloy

An alloy material containing the element zirconium that might have any of several compositions. It is used as a *cladding* material.

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15. INDEX

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CONVERSIONS

METRIC TO ENGLISH			ENGLISH TO METRIC		
Multiply	**by**	**To get**	**Multiply**	**by**	**To get**
Area					
Square meters	10.764	Square feet	Square feet	0.092903	Square meters
Square kilometers	247.1	Acres	Acres	0.0040469	Square kilometers
Square kilometers	0.3861	Square miles	Square miles	2.59	Square kilometers
Concentration					
Kilograms/sq. meter	0.16667	Tons/acre	Tons/acre	0.5999	Kilograms/sq. meter
Milligrams/liter	1[a]	Parts/million	Parts/million	1[a]	Milligrams/liter
Micrograms/liter	1[a]	Parts/billion	Parts/billion	1[a]	Micrograms/liter
Micrograms/cu. meter	1[a]	Parts/trillion	Parts/trillion	1[a]	Micrograms/cu. meter
Density					
Grams/cu. cm	62.428	Pounds/cu. ft.	Pounds/cu. ft.	0.016018	Grams/cu. cm
Grams/cu. meter	0.0000624	Pounds/cu. ft.	Pounds/cu. ft.	16,025.6	Grams/cu. meter
Length					
Centimeters	0.3937	Inches	Inches	2.54	Centimeters
Meters	3.2808	Feet	Feet	0.3048	Meters
Kilometers	0.62137	Miles	Miles	1.6093	Kilometers
Temperature					
Absolute					
Degrees C + 17.78	1.8	Degrees F	Degrees F – 32	0.55556	Degrees C
Relative					
Degrees C	1.8	Degrees F	Degrees F	0.55556	Degrees C
Velocity/Rate					
Cu. meters/second	2118.9	Cu. feet/minute	Cu. feet/minute	0.00047195	Cu. meters/second
Grams/second	7.9366	Pounds/hour	Pounds/hour	0.126	Grams/second
Meters/second	2.237	Miles/hour	Miles/hour	0.44704	Meters/second
Volume					
Liters	0.26418	Gallons	Gallons	3.78533	Liters
Liters	0.035316	Cubic feet	Cubic feet	28.316	Liters
Liters	0.001308	Cubic yards	Cubic yards	764.54	Liters
Cubic meters	264.17	Gallons	Gallons	0.0037854	Cubic meters
Cubic meters	35.314	Cubic feet	Cubic feet	0.028317	Cubic meters
Cubic meters	1.3079	Cubic yards	Cubic yards	0.76456	Cubic meters
Cubic meters	0.0008107	Acre-feet	Acre-feet	1233.49	Cubic meters
Weight/Mass					
Grams	0.035274	Ounces	Ounces	28.35	Grams
Kilograms	2.2046	Pounds	Pounds	0.45359	Kilograms
Kilograms	0.0011023	Tons (short)	Tons (short)	907.18	Kilograms
Metric tons	1.1023	Tons (short)	Tons (short)	0.90718	Metric tons
ENGLISH TO ENGLISH					
Acre-feet	325,850.7	Gallons	Gallons	0.000003046	Acre-feet
Acres	43,560	Square feet	Square feet	0.000022957	Acres
Square miles	640	Acres	Acres	0.0015625	Square miles

a. This conversion is only valid for concentrations of contaminants (or other materials) in water.

METRIC PREFIXES

Prefix	Symbol	Multiplication factor		
exa-	E	1,000,000,000,000,000,000	=	10^{18}
peta-	P	1,000,000,000,000,000	=	10^{15}
tera-	T	1,000,000,000,000	=	10^{12}
giga-	G	1,000,000,000	=	10^{9}
mega-	M	1,000,000	=	10^{6}
kilo-	k	1,000	=	10^{3}
deca-	D	10	=	10^{1}
deci-	d	0.1	=	10^{-1}
centi-	c	0.01	=	10^{-2}
milli-	m	0.001	=	10^{-3}
micro-	µ	0.000 001	=	10^{-6}
nano-	n	0.000 000 001	=	10^{-9}
pico-	p	0.000 000 000 001	=	10^{-12}