Disclaimer
What follows is an excerpted, condensed rendition of the 2002 U.S. Department of Energy's "Final 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." The purpose of this document is to retain the structure and language of the original but in an abbreviated form to achieve greater accessibility for a wider audience. Whilst minor edits have been made in the interest of clarity, this should be considered an abridged reproduction of the original.

Final 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

Volume I Chapter 2 (abridged)
Proposed Action and No-Action Alternative
Pgs. 2-1 – 2-98

2. Proposed Action and No Action Alternative

Under the Proposed Action, the U.S. Department of Energy (DOE) would 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. The Proposed Action includes transportation of spent nuclear fuel and high-level radioactive waste from commercial and DOE sites to the Yucca Mountain site. DOE does not intend to represent the No-Action Alternative as a viable long-term solution but rather to use it as a basis against which the Proposed Action can be evaluated.

As part of the Proposed Action, the Environmental Impact Statement (EIS) analyzes the potential impacts of transporting spent nuclear fuel and high-level radioactive waste to the Yucca Mountain site from 77 sites across the United States. This analysis includes information on such matters as the impacts of truck and rail transportation nationally and in Nevada, as well as impacts in Nevada of alternative intermodal (rail-to-truck) transfer stations, associated routes for heavy-haul trucks, and alternative corridors for a branch rail line.

DOE has identified mostly rail as its preferred mode of transportation, both nationally and in the State of Nevada.

2.1 Proposed Action

In its simplest terms, the proposed repository would be a large underground excavation with a network of drifts (tunnels) that DOE would use for spent nuclear fuel and high-level radioactive waste emplacement. About 600 square kilometers (230 square miles or 150,000 acres) of land in Nye County, Nevada, could be permanently withdrawn from public access for repository use. DOE would dispose of spent nuclear fuel and high-level radioactive waste in the repository using the inherent, natural geologic features of the mountain and engineered (manmade) barriers to help ensure the long-term isolation of the spent nuclear fuel and high-level radioactive waste from the human environment. DOE would build the repository emplacement drifts inside Yucca Mountain at least 200 meters (660 feet) below the surface and at least 160 meters (530 feet) above the present-day water table.

For this EIS, a connected action includes the offsite manufacturing of the containers that DOE would use for the transport and disposal of spent nuclear fuel and high-level radioactive waste and the specialized titanium drip shields and corrosion-resistant emplacement pallets that DOE could install over and under, respectively, the waste packages to improve performance and to reduce uncertainty about the long-term performance of the repository, local government and Native American tribal consultations, environmental and engineering analyses, and National Environmental Policy Act reviews.

The Proposed Action would use two types of institutional controls—active and passive. Active institutional controls (monitored and enforced limitations on site access; inspection and maintenance of waste packages, facilities, equipment, etc.) would be used through closure. Passive institutional controls (markers, engineered barriers, etc., that are not monitored or maintained) would be put in place during closure and used to minimize inadvertent exposures to members of the public in the future.

2.1.1 OVERVIEW OF IMPLEMENTING ALTERNATIVES AND SCENARIOS

2.1.1.1 Packaging Scenarios

The EIS assumes that DOE spent nuclear fuel and high-level radioactive waste would be shipped to the repository in disposable canisters.

2.1.1.2 Repository Operating Modes

The heat generated by spent nuclear fuel and high-level radioactive waste could affect the long-term performance of the repository (that is, the ability of the engineered and natural barrier systems to isolate the emplaced waste from the human environment).

The repository temperature would depend on factors related to the design and operation of the repository including, but not limited to, the age and burnup of the spent nuclear fuel at the time of emplacement, the spacing of the emplacement drifts and the waste packages in them, and the repository ventilation method and duration. The implementation of these design and operational parameters would affect the short-term environmental impacts of the repository.

To construct the analytical basis for evaluation of repository impacts, DOE used widely accepted analytical tools, coupled with the best available information, and cautious but reasonable assumptions where uncertainties exist, to estimate potential environmental impacts.

The short-term impacts (preclosure) would increase with the size of the repository emplacement area and surface facilities. The smallest repository and surface facilities are associated with the higher-temperature repository operating mode and therefore would result in the lowest short-term environmental impacts.

Design parameters include waste package loading, repository ventilation duration, and waste package spacing. In the analyses, DOE maximized each of these parameters in turn, and assumed reasonably conservative values for the other dependent parameters to evaluate the full range of potential environmental impacts.

2.1.1.2.1 Higher-Temperature Repository Operating Mode

The higher-temperature repository operating mode would ensure that a portion of the rock between the drifts would have maximum temperatures below the boiling point of water [96°C (205°F)] at the elevation of the emplacement horizon. This would allow any water mobilized by the higher-temperature conditions in the drifts to drain between the drifts. The development of a localized boiling region around each emplacement drift, rather than a single boiling region encompassing all the emplacement drifts, would ensure that very little water would be able to accumulate above any emplacement drift. This would substantially decrease the likelihood of water penetrating the emplacement drifts by means of fast paths such as fractures.

2.1.1.2.2 Lower-Temperature Repository Operating Mode

The lower-temperature operating mode range includes conditions under which the drift rock wall temperatures would be below the boiling point of water [96ºC (205ºF)] at the elevation of the repository, as well as conditions under which waste package average surface temperatures would not exceed 85ºC (185ºF).

DOE is considering the lower-temperature operating mode to reduce some of the uncertainties associated with assessing long-term repository performance. The primary variables governing a lower waste package surface temperature and the thermal response of the surrounding rock would be the heat generation rate of the waste packages, the linear spacing of the waste packages in the emplacement drifts, and the rate and duration of ventilation after waste package emplacement in the drifts. These three operational parameters are interrelated; that is, they would work together to achieve the desired result.

2.1.1.3 National Transportation Scenarios

DOE would use both legal-weight truck and rail transportation, and would determine the number of shipments by either mode as part of future transportation planning efforts. More explanation follows.

2.1.1.4 Nevada Transportation Scenarios and Rail and Intermodal Implementing Alternatives

The transportation of spent nuclear fuel and high-level radioactive waste to the proposed repository would affect the states through which the shipments would travel, including Nevada.

DOE is looking at three transportation scenarios for Nevada. These scenarios include legal-weight truck and rail, which are the same as the national scenarios but highlight the Nevada portion of the transportation, and heavy-haul truck. DOE has identified five potential rail corridors leading to Yucca Mountain and three potential intermodal transfer station locations with five associated potential highway routes for heavy-haul trucks.

2.1.1.5 Continuing Investigation of Design Options

The criteria for selecting these design options are related to improving or reducing uncertainties in repository performance (the potential to provide containment and isolation of radionuclides) and operation (for example, worker and operational safety, ease of operation). DOE has assessed each of the design options still being considered for the expected change it would have on short- and long-term environmental impacts and has compared these impacts to the potential impacts determined for the packaging, operating mode, and transportation scenarios evaluated in the EIS. This assessment found that the changes in environmental impacts for the design options would be relatively minor in relation to the potential impacts evaluated in this EIS.

2.1.2 REPOSITORY FACILITIES AND OPERATIONS

DOE would construct surface facilities at the repository site to receive, prepare, and package spent nuclear fuel and high-level radioactive waste for underground emplacement. In addition, surface facilities would support the construction of subsurface facilities. The following paragraphs contain an overview of the sequence of repository construction, operation and monitoring, and closure.

The construction of repository facilities for the handling of spent nuclear fuel and high-level radioactive waste would begin after the receipt of construction authorization from the Nuclear Regulatory Commission. DOE assumed that construction would begin in 2005. The repository surface facilities, the main drifts, ventilation system, and initial emplacement drifts would be built in approximately 5 years, from 2005 to 2010. The repository design would enable simultaneous construction and emplacement operations, and would physically separate activities on the construction or development side of the repository from activities on the emplacement side.

Monitoring and maintenance activities would start with the first emplacement of waste packages and would continue through repository closure. Immediately after the completion of emplacement, DOE would decontaminate and close the surface facilities that handled nuclear materials to eliminate any potential radioactive material release and would place surface facilities in a standby condition. Future generations would decide whether to continue to maintain the repository in an open, monitored condition or to close it. This EIS evaluates closure of the repository in the lower-temperature mode after forced ventilation for as many as 324 years after the start of emplacement. Closure would take about 10 years for the higher-temperature repository operating mode, and from 11 to 17 years for the lower-temperature repository operating mode.

2.1.2.1 Repository Surface Facilities and Operations

Surface facilities at the repository site would be in three areas—the North Portal Operations Area, the South Portal Development Area, and the Ventilation Shaft Operations Areas. Facilities to support waste emplacement would be concentrated near the North Portal, and facilities to support subsurface facility development would be concentrated near the South Portal.

2.1.2.1.1 North Portal Operations Area

This area would be the largest of the primary operations areas, covering about 0.6 square kilometer (150 acres). It would include two areas: a Radiologically Controlled Area for receipt, handling, and packaging of spent nuclear fuel and high-level radioactive waste prior to emplacement, and a Balance of Plant Area for support services (such as administration, training, and maintenance).

2.1.2.1.1.1 Waste Handling

At the Waste Handling Building carrier bay, the carrier/cask handling system would lift the transportation cask to a vertical position and place it on a cask transfer cart. The Waste Handling Building would have one canister transfer line that moves the disposable canisters through the building to prepare the waste for emplacement in the repository. The canister could go directly into a disposal container for repository emplacement, or to a holding rack for later placement in a disposal container. The empty cask and cask transporter would return to the Carrier Preparation Building to be readied for offsite shipment.

2.1.2.1.1.2 Approach to Fuel Blending

Because of the variety of waste forms to be disposed of, about 10 different designs for disposal containers (called waste packages after being loaded, sealed, and certified) would be needed. The concentrations of particular isotopes would vary among the different waste forms, and among different fuel assembles in the same type of waste form, so different waste packages would generate different amounts of heat. Because the repository would have established temperature limits, DOE would establish a maximum heat output for all waste packages. By carefully planning and implementing a fuel-blending procedure, DOE could limit and optimize the heat output of the waste packages without increasing their number.

2.1.2.1.1.3 Generation of Wastes

Waste generated at the repository from the decontamination of canisters and shipping casks and from other repository housekeeping activities would be collected, processed, packaged, and staged in the Waste Treatment Building before being shipped off the site for disposal at permitted facilities.

2.1.2.1.2 South Portal Development Area

The South Portal Development Area would cover about 0.15 square kilometer (37 acres) immediately adjacent to the South Portal of the subsurface facility.

2.1.2.1.3 Ventilation Shaft Operations Areas

The Ventilation Shaft Operations Area would have separately developed areas of approximately 0.012 square kilometer (3 acres) each for the emplacement intake, development intake, and exhaust shafts.

2.1.2.1.4 Support Facilities and Utilities

2.1.2.1.4.1 Storage of Excavated Rock.

Repository support facilities and utilities would be on the surface in the general vicinity of the North Portal Operations Area and the South Portal Development Area. The storage area for excavated rock would be the largest support area.

2.1.2.1.4.2 Wastewater and Stormwater Facilities.

The repository site would have two evaporation ponds for industrial wastewater, one near the North Portal and one near the South Portal. The North Portal pond would cover about 0.024 square kilometer (6 acres). The evaporation pond at the South Portal would be about 0.0024 square kilometer (0.6 acre). The North Portal Operations Area would also include an approximately 0.13-square-kilometer (32-acre) stormwater retention pond to control stormwater runoff from the area.

2.1.2.1.4.3 Solid Waste Disposal and Hazardous Waste Management.

DOE would package hazardous waste and ship it off the site for treatment and disposal. The Department would develop an appropriately sized landfill [approximately 0.036 square kilometer (9 acres)] at the repository site for nonhazardous and nonradiological construction and sanitary solid waste and for similar waste generated during the operation and monitoring and closure phases.

2.1.2.1.4.4 Electric Power.
The repository would use the Nevada Test Site electric power distribution system, which would require upgrades to handle the demand for the various operational modes considered. Backup equipment and uninterruptible electric power would ensure personnel safety and operations requiring electric power continuity. Diesel generators and associated switchgear would provide the backup power capability. In addition, DOE would use electricity from renewable energy sources at the repository.

2.1.2.1.4.5 Water Supply
DOE would continue to use existing wells about 5.6 kilometers (3.5 miles) southeast of the North Portal Operations Area to supply water for repository activities for both operating modes.

2.1.2.1.4.6 Fossil Fuel
Fuel supply systems would include fuel oil for a central heating (hot water) plant, which would consist of a main tank and a day tank.

2.1.2.2 Repository Subsurface Facilities and Operations
DOE would construct the subsurface facilities of the repository and emplace the waste packages above the water table in a mass of volcanic rock (referred to as the repository block).

2.1.2.2.1 Subsurface Facility Design and Construction
The subsurface design would incorporate most of the drifts developed during the site characterization activities. Other areas would be excavated during the repository construction phase. Excavated openings would include gently sloping access ramps to enable rail-based movement of construction and waste package handling vehicles between the surface and subsurface, subsurface main drifts to enable the movement of construction and waste package handling vehicles, emplacement drifts for the placement of waste packages, exhaust mains to transfer air in the subsurface area, and ventilation shafts to transfer air between the surface and the subsurface.

2.1.2.2.2 Ventilation
The repository design uses ventilation shafts to provide airflow to the subsurface during construction, emplacement, and performance monitoring. It also provides positive pressure ventilation flow for the construction and development of the repository and negative pressure ventilation flow in the emplacement drifts.

Fans at the surface ends of the exhaust shafts would provide the moving force for the subsurface repository airflow. The fans would have enough power to exhaust the maximum amount of air required during the emplacement, monitoring, and closure periods. The volume of air moved by the fans would be adjustable to meet cooling requirements as they varied over time.

2.1.2.2.3 Waste Package Emplacement Operations
DOE would transport both the waste package and metal emplacement pallet as an integral unit from the Waste Handling Building to the prepared ground support in the emplacement drift. All waste packages would be transported by trolley underground through the North Ramp and into the emplacement area main drift.

DOE has developed plans for waste package retrieval for normal and off-normal conditions. Waste package retrieval under normal conditions would use the same subsurface equipment and facilities as emplacement.

2.1.2.2.4 Engineered Barrier Design

Engineered barriers would include those components in the emplacement drifts that would contribute to waste containment and isolation. The design includes the following components as engineered barriers: (1) waste package, (2) emplacement drift invert, (3) drip shield, and (4) to a lesser extent, ground support.

2.1.2.2.4.1 Waste Package and Drip Shields.
During the operation and monitoring phase, the waste packages would function as the vessels for safely handling, emplacing and, if necessary, retrieving their contents. After closure, the waste packages would be the primary engineered barrier to inhibit the release of radioactive material to the environment. The waste package would have a corrosion-resistant Alloy-22 outer shell and a stainless-steel (Type 316NG) inner shell to provide structural support. In addition, the waste package would have a top lid design that consisted of three lids. The highly corrosion-resistant Alloy-22 outer shell of the waste package would protect the underlying structural material from corrosive degradation, while the strong internal structural material would support the thinner corrosion-resistant material.

A drip shield with a nominal thickness of 1.5 centimeters (0.6 inch) of highly corrosion-resistant titanium would be placed over the waste package just before repository closure. The titanium drip shield and the Alloy-22 outer cylinder would provide two diverse engineered corrosion barriers to protect the waste from contact with water. The use of two distinctly different corrosion-resistant materials would reduce the probability that a single mechanism could cause the failure of both materials.

[PAGE 2-34 MISSING FROM REPORT]

After the repository ventilation was stopped and heat produced by the waste packages had decreased (both of which would happen after closure), moisture could enter the emplacement drifts in liquid or vapor form. The function of the drip shields would be to divert water that dripped from the drift walls and water vapor that condensed on the surface of the drip shields away from waste packages, prolonging their longevity and structural integrity.

2.1.2.2.4.2 Ground Support Structures.
In underground openings, ground support structures provide tunnel stability and help prevent rockfall. For the proposed repository, the ground support system would address in-place loads, construction loads, potential loads from repository operations, and loads from potential seismic occurrences. The system would consist of steel sets with welded-wire fabric and fully grouted rockbolts.

2.1.2.2.4.3 Emplacement Pallets.
The repository design uses emplacement pallets to support the waste packages. A waste package would be placed horizontally on its support (an emplacement pallet) in the Waste Handling Building and transported to the drifts as a unit. The emplacement pallets would be made of Alloy-22 plates welded together to form the waste package.

[PAGE 2-37 MISSING FROM REPORT]

2.1.2.3 Performance Confirmation Program
Performance confirmation refers to the program of tests, experiments, and analyses that DOE would conduct to evaluate the adequacy of the information used to demonstrate compliance that the repository would meet performance objectives. Performance confirmation drifts would be built about 15 meters (50 feet) above and below the emplacement drifts. DOE would acquire performance confirmation data by sampling and mapping, from instruments in performance confirmation drifts or along the perimeter mains, ventilation exhaust monitoring, remote inspection systems in emplacement drifts, and monitoring of water quality in wells.

2.1.2.4 Repository Closure
The postclosure monitoring program, as required by Section 801(c) of the Energy Policy Act of 1992 and as required by the Nuclear Regulatory Commission (10 CFR Part 63), would include the monitoring

activities that would be conducted around the repository after the facility had been closed and sealed. For the higher-temperature repository operating mode, this EIS assumes closure would begin 100 years after the start of emplacement (76 years after the completion of emplacement). In contrast, repository closure for the lower-temperature repository operating mode could begin 125 to 300 years after the completion of emplacement. Decommissioning surface facilities would include decontamination activities, if required, and facility dismantling and removal. Equipment and materials would be salvaged, recycled, or reused, if possible. Site reclamation would include restoring the site to as near its preconstruction condition as practicable.

2.1.3 TRANSPORTATION ACTIVITIES

The Naval Nuclear Propulsion Program would transport naval spent nuclear fuel from the Idaho National Engineering and Environmental Laboratory to the repository. Naval spent nuclear fuel is one of the DOE fuels considered in this EIS.

2.1.3.1 Loading Activities at Commercial and DOE Sites

This EIS assumes that at the time of shipment the spent nuclear fuel and high-level radioactive waste would be in a form that met approved acceptance and disposal criteria for the repository.

2.1.3.2 National Transportation

National transportation includes the transport of spent nuclear fuel and high-level radioactive waste from the commercial and DOE sites to the Yucca Mountain site using existing highways and railroads. Section 180(c) of the NWPA requires DOE to provide technical and financial assistance to states and tribes for training public safety officials in jurisdictions through which it plans to transport spent nuclear fuel and high-level radioactive waste. The training is to include procedures for the safe routine transportation of these materials and for emergency response.

2.1.3.2.1 National Transportation Shipping Scenarios

This EIS considers two national transportation mode-mix scenarios, which for simplicity are referred to as the mostly legal-weight truck scenario and the mostly rail scenario. These scenarios encompass the broadest range of operating conditions relevant to potential impacts to human health and the environment.

2.1.3.2.2 Mostly Legal-Weight Truck Shipping Scenario

Under this scenario, DOE would ship all high-level radioactive waste and most spent nuclear fuel from commercial and DOE sites to the Yucca Mountain site by legal-weight truck. About 53,000 shipments of these materials would travel on the Nation's Interstate Highway System during a 24-year period. With proper labels and vehicle placards (hazard identification) and vehicle and cask inspections, a truck carrying a shipping cask of spent nuclear fuel or high-level radioactive waste would travel to the repository on highway routes selected in accordance with U.S. Department of Transportation regulations (49 CFR 397.101), which require the use of preferred routes.

2.1.3.2.3 Mostly Rail Shipping Scenario

Under this scenario, DOE would ship most spent nuclear fuel and high-level radioactive waste to Nevada by rail, with the exception of material from commercial nuclear sites that do not have the capability to load large-capacity rail shipping casks. Those sites would ship spent nuclear fuel to the repository by legal-weight truck. Under this scenario, about 9,000 to 10,000 railcars of spent nuclear fuel and high-level radioactive waste would travel on the nationwide rail network over a period of 24 years.

2.1.3.3 Nevada Transportation

Depending on how a shipment was transported, DOE could use one of three options or modes of transportation in Nevada to reach the Yucca Mountain site: legal-weight trucks, rail, or heavy-haul trucks. Rail access is not currently available to the Yucca Mountain site, so DOE would have to build a branch rail line from an existing mainline railroad to the site or transfer rail casks to heavy-haul trucks at an intermodal transfer station for transport to the repository.

2.1.3.3.1 Nevada Legal-Weight Truck Scenario

Under this scenario, DOE would use legal-weight trucks in Nevada to transport spent nuclear fuel and high-level radioactive waste to the repository. Naval spent nuclear fuel would be transported to Nevada by rail. Legal-weight truck shipments would use existing routes that satisfy regulations of the U.S. Department of Transportation for the shipment of highway route-controlled quantities of radioactive materials. Legal-weight trucks would enter Nevada on I-15 from the north or south, bypass the Las Vegas area on the proposed beltway, and travel north on U.S. 95 to the Nevada Test Site and then to the Yucca Mountain site

2.1.3.3.2 Nevada Rail Scenario.

Under this scenario, DOE would construct and operate a branch rail line in Nevada.

2.1.3.3.2.1 Rail Line Construction.

Rail line construction along any of the corridors would take between 3 and 4 years. The construction of a rail line would require the clearing and excavation of previously undisturbed lands in the corridor and the establishment of borrow and spoils areas outside the corridor.

2.1.3.3.2.2 Rail Line Operations

The operational interface between the Union Pacific and the branch rail line would be determined by whether the waste was shipped to Nevada by dedicated rail service or by general freight rail service.

2.1.3.3.3 Nevada Heavy-Haul Truck Scenario

Under this scenario, rail shipments to Nevada would go to an intermodal transfer station where shipping casks would transfer from railcars to heavy-haul trucks. The heavy-haul trucks would travel on existing roads to the repository, once the roads were appropriately upgraded.

2.1.3.3.3.1 Intermodal Transfer Stations.

To enable intermodal transfers and heavy-haul shipments to the repository, an intermodal transfer station would be built and operated in Nevada. The intermodal transfer station would be a fenced area of about 250 meters (820 feet) by 250 meters and a rail siding that would be about 2 kilometers (1.2 miles) long. The estimated total area occupied by the facility and support areas would be about 0.2 square kilometer (50 acres). Construction of an intermodal transfer station would take an estimated 1.5 years.

The loading and unloading process would begin with the return of a heavy-haul truck from the repository. The empty cask returning from the repository would be lifted from the truck, loaded on an empty railcar, and secured. The gantry or mobile crane would then remove a loaded cask from another railcar and transfer it to the same truck, where it would be secured and inspected before shipment to the repository. At the completion of the 24 years of shipping, the intermodal transfer station would be decommissioned and, if possible, reused.

2.1.3.3.3.2 Highway Routes for Heavy-Haul Shipments

The heavy-haul truck would weigh about 91,000 kilograms (200,000 pounds) unloaded and would be up to 67 meters (220 feet) long. It would be custom-built for repository shipments. Typical range of open-road speeds would be 32 to 80 kilometers (20 to 50 miles) per hour.

2.1.3.4 Shipping Cask Manufacturing, Maintenance, and Disposal

To transport spent nuclear fuel and high-level radioactive waste to the repository, DOE would use existing or new shipping casks that met Nuclear Regulatory Commission regulations. One or more qualified companies that provide specialized metal structures, tanks, and other heavy equipment would manufacture new shipping casks.

2.1.4 ALTERNATIVE DESIGN CONCEPTS AND DESIGN FEATURES

2.1.4.1 Design Features and Alternatives To Control the Thermal/Moisture Environment in the Repository and To Limit Release and Transport of Radionuclides

This represents the current state of the ongoing process that identifies and develops ideas through conceptual, then preliminary, then more detailed designs to produce a design that DOE would use for purposes of the Secretary of Energy's determination of whether to recommend approval of the Yucca Mountain site to the President for development of a geologic repository.

DOE believes that the natural system and the robust flexible design would accommodate unquantified and residual uncertainties through performance margin (design and safety) and defense-in-depth. Defense-in-depth is a design approach that relies on a series of barriers, both natural and manmade, that would work in a complementary manner to minimize the amount of radioactive material that could eventually travel from the repository to the human environment.

As an example of ongoing studies, DOE is examining the use of an extended period of natural ventilation of emplacement drifts after a period of forced-air ventilation. The heat generated by the spent nuclear fuel and high-level radioactive waste could develop and maintain a temperature difference to drive passive ventilation of the emplacement drifts throughout the maximum time the repository would remain open. Findings in numerous caves that are analogous to a deep geologic repository support the idea that the environment of a naturally ventilated underground system could, under certain conditions, preserve materials for several thousand years and could greatly reduce waste package degradation.

2.1.4.2 Design Features and Alternatives to Support Operational and CostConsiderations

Uncertainties in future funding profiles or the order of spent nuclear fuel or high-level radioactive waste shipments could result in development of the repository in a sequential or modular manner (that is, constructing the surface and subsurface facilities in portions, or "modules"). This approach would facilitate the ability to incorporate "lessons learned" from initial work into subsequent modules, reduce initial construction costs and investment risk, and potentially increase confidence in meeting the schedule for waste receipt and emplacement.

2.1.5 ESTIMATED COSTS ASSOCIATED WITH THE PROPOSED ACTION

DOE has estimated the total cost of the Proposed Action to construct, operate and monitor, and close a geologic repository at Yucca Mountain, including the transportation of spent nuclear fuel and high-level radioactive waste to the repository.

The total future costs from 2002 to closure for the flexible design would range from about $42.7 to $57.3 billion (in 2001 dollars). DOE is reporting future costs for comparison with the No-Action Alternative. Historical costs through 2001 are $8.8 billion (in 2001 dollars). The most recent estimates show that approximately 70 percent of the repository-related costs would be paid from the Nuclear Waste Fund (fees collected by nuclear utilities from ratepayers) and about 30 percent from taxpayer revenues (primarily to pay for disposal of DOE spent nuclear fuel and high-level radioactive waste).

<u>2.2 No-Action Alternative</u>

Under the No-Action Alternative, and consistent with the Nuclear Waste Policy Act, as amended, DOE would terminate activities at Yucca Mountain and undertake site reclamation to mitigate any significant adverse environmental impacts. Commercial nuclear power utilities and DOE would continue to manage spent nuclear fuel and high-level radioactive waste at 77 sites in the United States.

The No-Action Alternative did not consider redistribution or centralizing of spent nuclear fuel. In light of the uncertainties described above, 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)

• Long-term storage at the current storage sites with no effective institutional control after about 100 years (Scenario 2)

2.2.1 YUCCA MOUNTAIN SITE DECOMMISSIONING AND RECLAMATION

Under the No-Action Alternative, site characterization activities would end at Yucca Mountain and decommissioning and reclamation would begin as soon as practicable and could take several years to complete. Decommissioning and reclamation would include removing or shutting down surface and subsurface facilities, and restoring lands disturbed during site characterization.

2.2.2 CONTINUED STORAGE OF SPENT NUCLEAR FUEL AND HIGH-LEVEL RADIOACTIVE WASTE AT COMMERCIAL AND DOE SITES

Under the No-Action Alternative, spent nuclear fuel and high-level radioactive waste would be managed at the 72 commercial and 5 DOE sites (the Hanford Site, the Idaho National Engineering and Environmental Laboratory, the Savannah River Site, Fort St. Vrain, and the West Valley Demonstration Project).

2.2.2.1 Storage Packages and Facilities at Commercial and DOE Sites

Most commercial nuclear utilities currently store their spent nuclear fuel in water-filled basins (fuel pools) at the reactor site. Some utilities have built independent spent fuel storage installations in which they store spent nuclear fuel dry, above ground, in metal casks or in weld-sealed canisters inside reinforced concrete storage modules. This EIS assumes that all commercial spent nuclear fuel would be in dry storage at independent spent fuel storage installations at existing locations. This includes spent nuclear fuel at sites that no longer have operating nuclear reactors.

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 properly maintained. The reinforced concrete storage module would provide shielding against the radiation emitted by the spent nuclear fuel. The concrete storage module would also provide protection from damage from such occurrences as aircraft crashes, earthquakes, and tornadoes.

With one exception, this analysis assumed that high-level radioactive waste would be stored in a below-grade solidified high-level radioactive waste storage facility. At the West Valley Demonstration Project, it was assumed that DOE would use a dry storage system similar to a commercial spent nuclear fuel storage installation for high-level radioactive waste storage.

2.2.2.2 No-Action Scenario 1

In No-Action Scenario 1, DOE would continue to manage its spent nuclear fuel and high-level radioactive waste in above- or below-grade dry storage facilities at five sites around the country. Commercial utilities would continue to manage their spent nuclear fuel at 72 sites. The commercial and DOE sites would remain under effective institutional control for at least 10,000 years. DOE based the 10,000-year analysis period on the generally applicable Environmental Protection Agency regulation for the disposal of spent nuclear fuel and high-level radioactive waste (40 CFR Part 191), even though the regulation would not apply to disposal at Yucca Mountain.

Under Scenario 1, the storage facilities would be completely replaced every 100 years. They would undergo one major repair during the first 100 years, because this scenario assumes that the design of the first storage facilities at a site would include a facility life of less than 100 years. The 100-year lifespan of future storage facilities is based on analysis of concrete degradation and failure in regions throughout the United States.

2.2.2.3 No-Action Scenario 2

In No-Action Scenario 2, spent nuclear fuel and high-level radioactive waste would remain in dry storage at commercial and DOE sites and would be under effective institutional control for approximately 100 years (the same as Scenario 1). Beyond that time, the scenario assumes no effective institutional control. Therefore, after about 100 years and up to 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 the radioactive materials in them could eventually be released to the environment.

2.2.3 NO-ACTION ALTERNATIVE COSTS
The estimated cost (in 2001 dollars) of both Scenarios 1 and 2 for the first 100 years ranges from $55.7 billion to $61.3 billion, depending on whether the dry storage canisters had to be replaced every 100 years. The estimated costs (in 2001 dollars) for the remaining 9,900 years of Scenario 1 range from $519 million to $572 million per year. There would be no costs for Scenario 2 after the first 100 years because the scenario assumes no effective institutional control.

2.3 Alternatives Considered but Eliminated from Detailed Study
2.3.1 ALTERNATIVES ADDRESSED UNDER THE NUCLEAR WASTE POLICY ACT (NWPA)
The NWPA states that, with respect to the requirements imposed by the National Environmental Policy Act, compliance with the procedures and requirements of the NWPA shall be deemed adequate consideration of the need for a repository, the time of the initial availability of a repository, and all alternatives to the isolation of spent nuclear fuel and high-level radioactive waste in a repository. The NWPA states that, for purposes of complying with the requirements of the National Environmental Policy Act, DOE need not consider alternative sites to Yucca Mountain for the repository.

Under the Proposed Action, this EIS does not consider alternatives for the emplacement of more than 70,000 MTHM of spent nuclear fuel and high-level radioactive waste in a repository at Yucca Mountain because the NWPA prohibits the Nuclear Regulatory Commission from approving the emplacement in the first repository of a quantity of spent nuclear fuel containing more than 70,000 MTHM or a quantity of solidified high-level radioactive waste resulting from the reprocessing of such a quantity of spent nuclear fuel until a second repository is in operation.

2.3.2 REPOSITORY DESIGN ALTERNATIVES ELIMINATED FROM DETAILED STUDY
Examples of alternative repository design include placement of the emplacement drifts in the saturated zone (rather than the unsaturated zone); vertical shafts (rather than the gently sloping North and South Ramps); use of drilling and blasting methods for emplacement drift construction (rather than mechanical excavation methods such as tunnel-boring machines); and use of diesel-powered vehicles for waste package emplacement (rather than electrically powered, rail-based vehicles).

2.3.3 TRANSPORTATION ALTERNATIVES ELIMINATED FROM DETAILED STUDY
In response to public comments on the Draft EIS, DOE has evaluated the potential for including a largescale barge scenario and a different mostly rail scenario in which railcars would be used to transport truck casks containing spent nuclear fuel and high-level radioactive waste. The purported advantage of largescale use of barge transportation was that it would reduce the amount of cross-country overland travel that would be required. However, DOE eliminated the barge modal scenario from further consideration in the EIS because it would be overly complex, requiring greater logistical complexity than either rail or legal weight truck transportation; a much greater number of large rail casks than rail transport; much greater cost than either rail or legal-weight truck transportation; long transport distances potentially requiring the transit of the Panama Canal outside U.S. territorial waters; transport on intercoastal and coastal waterways of coastal states and on major rivers through and bordering states; extended transportation times; intermodal transfer operations at ports; and land transport from a western port to Yucca Mountain.

DOE also eliminated the truck-cask-on-railcar modal scenarios from future consideration. In this scenario, legal-weight truck casks would be shipped by rail from generator sites to Nevada and then by legal-weight trucks in the State to a Yucca Mountain repository. The purported advantage of this scenario is that DOE could use rail transportation nationally and would not have to construct and operate a branch rail line or upgrade highways, construct an intermodal transfer station, and use heavy-haul trucks in Nevada. DOE determined that while this scenario would be feasible, it would not be practical. The truck-casks-on-railcars scenario would lead to the highest estimates of occupational health and public health and safety impacts, most coming from rail-traffic related facilities. For these reasons, DOE selected the mostly rail and mostly legal-weight truck transportation scenarios as the basis to estimate impacts of transporting spent nuclear fuel to a Yucca Mountain repository.

2.3.3.1 Potential Rail Routes Considered but Eliminated from Further Detailed Study

2.3.3.2 Potential Highway Routes for Heavy-Haul Trucks and Associated Intermodal Transfer Station Locations Considered but Eliminated from Further Detailed Study

The Department identified highway routes for heavy-haul trucks and associated intermodal transfer station locations to provide reasonable access to existing mainline railroads, to minimize transport length from an existing mainline rail interchange point, and to maximize the use of roads identified by the Nevada Department of Transportation for the highest allowable axle load limits. DOE eliminated the development of a new road for heavy-haul trucks from further detailed evaluation, because the construction of a new branch rail line would be only slightly more expensive and because transportation by rail would not require intermodal transfers and would be more efficient.

2.4 Summary of Findings and Comparison of the Proposed Action and the No-Action Alternative

This EIS defines short-term impacts as those that would occur until and during the closure of the repository and long-term impacts as those that would occur after repository closure and for as long as 10,000 years.

2.4.1 COMPARISON OF PROPOSED ACTION AND NO-ACTION ALTERNATIVE

In general, the EIS analyses showed that the environmental impacts associated with the Proposed Action would be small to moderate. Although generally small, environmental impacts would occur under the Proposed Action. DOE would reduce or eliminate many such impacts with mitigation measures or implementation of standard Best Management Practices. Under the No-Action Alternative, the short-term impacts would be the same under Scenario 1 or 2.

2.4.2 SHORT-TERM IMPACTS OF THE PROPOSED ACTION REPOSITORY CONSTRUCTION, OPERATION AND MONITORING, AND CLOSURE AND NO-ACTION ALTERNATIVE

The short-term environmental impacts for the Proposed Action and the No-Action Alternative would generally be small and do not differentiate dramatically between the two alternatives. The analyses also included cost estimates for the two alternatives. Estimated short-term (to the end of closure) costs (in 2001 dollars) for the Proposed Action would range from $43 to $58 billion, and those for the No-Action Alternative would be as much as $61 billion for the same period.

For the No-Action Alternative, short-term actions would be limited to termination of activities and reclamation at the Yucca Mountain site, as well as continued management and storage of spent nuclear fuel and high-level radioactive waste at 72 commercial and 5 DOE sites across the United States. For the 77 generator sites, impacts resulting from continued management and storage of spent nuclear fuel and high-level radioactive waste were estimated based on actual operational experience at DOE and commercial storage facilities. In addition, the short-term impacts for the No-Action Scenarios 1 and 2 would be essentially the same because both scenarios assume institutional controls remain in place for the first 100 years.

2.4.3 LONG-TERM IMPACTS OF THE PROPOSED ACTION AND THE NO-ACTION ALTERNATIVE

DOE assessed the impacts from radiological and nonradiological hazardous materials released over a much longer period (100 years to as long as 10,000 years) after the closure of the repository (for the Proposed Action, DOE also estimated the peak dose for the post-10,000 year period). The analysis determined that there would be small or no long-term impacts to land use, noise, socioeconomic resources, cultural resources, surface-water resources, aesthetics, utilities, or site services from the Proposed Action and limited impacts from the No-Action Alternative, depending on the scenario.

2.4.4 IMPACTS OF TRANSPORTATION SCENARIOS

2.4.4.1 National Transportation

shipments of spent nuclear fuel and high-level radioactive waste to Yucca Mountain would be a small fraction of the overall railroad and highway shipping activity in the United States. Thus, the incremental impacts from shipments to Yucca Mountain for the resource areas would be small in comparison to background impacts from all shipping activities, with the exception of potential radiological impacts.

2.4.4.2 Nevada Transportation

With the exception of collective dose, the environmental impacts for shipment by legal-weight truck in Nevada would be smaller than those from the 10 implementing alternatives associated with incoming shipments by mostly rail scenario. However, even for shipment by legal-weight truck in Nevada, the projected collective dose impacts would be small (approximately 0.9 latent cancer fatality to both the public and transportation workers) over 24 years.

2.5 Collection of Information and Analyses

The complexity and variability of the natural system at Yucca Mountain, the long periods evaluated, and factors such as the use of incomplete information or the unavailability of information have resulted in a certain degree of uncertainty associated with the analyses and findings in this EIS.

2.5.1 INCOMPLETE OR UNAVAILABLE INFORMATION

Some of the analyses in this EIS had to use incomplete information. DOE continues to study issues relevant to understanding what could happen in the future at Yucca Mountain and the potential impacts associated with its use as a repository.

2.5.2 UNCERTAINTY

The results and conclusions of analyses often have some associated uncertainty. The uncertainty could be the result of the assumptions used, the complexity and variability of the process being analyzed, the use of incomplete information, or the unavailability of information.

2.5.3 OPPOSING VIEWS

In this EIS, opposing views are defined as differing views or opinions currently held by organizations or individuals outside DOE. These views are considered to be opposing if they include or rely on data or methods that DOE is not currently using in its own impact analysis. The Department identified potential opposing views by reviewing public comments received during the EIS comment period, as well as, published or other information in the public domain. Sources of information included reports from universities, other Federal agencies, the State of Nevada, counties, municipalities, other local governments, and Native American tribes.

2.5.4 PERCEIVED RISK AND STIGMA

Commenters stated that negative perceptions of the repository and associated transportation would result in substantial adverse socioeconomic impacts, particularly in Nevada. In considering the request to evaluate the impacts of risk perception and stigma, DOE recognized that nuclear facilities can be perceived to be either positive or negative, depending on the underlying value systems of the individual forming the perception. Thus, perception-based impacts would not necessarily depend on the actual physical impacts or risk of repository operations, including transportation. A further complication is that people do not consistently act in accordance with negative perceptions, and thus the connection between public perception of risk and future behavior would be uncertain or speculative at best. For these reasons, DOE concluded that including analyses of perception-based and stigma-related impacts in the Draft EIS would not provide meaningful information.

2.6 Preferred Alternative

DOE’s preferred alternative is to proceed with 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. The analyses in this EIS did not identify any potential environmental impacts that would be the basis for not proceeding with the Proposed Action. Further, DOE has identified mostly rail as its preferred mode of transportation, both nationally and in the State of Nevada.