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Document Number DOE/EIS-0200-F

EDMC Number 47371

Sec 3

CHAPTER 9
Impacts of the Management of High-Level Waste

Chapter 9 describes the environmental consequences associated with the No Action, Decentralized, Regionalized, and Centralized Alternatives for storing vitrified high-level waste (HLW). This chapter provides information on existing HLW volumes, and existing and planned facilities available at DOE sites. This is followed by an overview of the analysis and assumptions relating to HLW characteristics and the rationale for selecting the sites analyzed under each alternative. The chapter discusses the health risk, environmental impacts, and costs of the alternatives, and provides a comparison of alternatives.

The methods used to evaluate the impacts are outlined in Chapter 5. Impacts tables for each major DOE site are contained in Volume II. Details of the HLW analysis are contained in the technical report entitled "High-Level Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement" (ANL, 1996). Additional information can be found in the complete list of appendices and technical reports provided in Chapter 15.

- *HLW is highly radioactive waste material that results from the reprocessing of spent nuclear fuel and irradiated targets in nuclear defense, research, and production activities.*
- *The WM PEIS only analyzes the impacts of stored vitrified HLW.*
- *HLW has both radioactive and hazardous components and is considered mixed waste.*
- *HLW will be treated and packaged for disposal in a licensed geologic repository.*
- *HLW is currently stored at the Hanford Site, the Idaho National Engineering Laboratory (INEL), the Savannah River Site (SRS), and the West Valley Demonstration Project (WVDP).*
- *Approximately 378,000 cubic meters of HLW have been or will be generated. Treated (vitrified) HLW will require an estimated 21,600 canisters for packaging.*
- *DOE must decide where to store the vitrified HLW canisters.*

9.1 Background

9.1.1 DEFINITION AND ORIGIN

The term HLW means (a) the highly radioactive waste material that results from the reprocessing of spent nuclear fuel (SNF), including liquid waste produced directly from reprocessing and any solid waste derived from the liquid that contains a combination of transuranic and fission product nuclides in quantities that require permanent isolation, and (b) other highly radioactive material that the U.S. Nuclear Regulatory Commission, consistent with existing law, determines by rule requires permanent isolation.

HLW also contains toxic metal, organic materials, or corrosive characteristics that are considered hazardous under the Resource Conservation and Recovery Act (RCRA) (42 USC 6901). Because it is both radioactive and hazardous, HLW is considered mixed waste.

The WM PEIS analyzes only the impacts of stored vitrified HLW. DOE must decide where to store vitrified HLW canisters since the decision to immobilize the HLW prior to transport was made in the early 1980s. Just prior to the passage of the Nuclear Waste Policy Act (NWPA) in 1983, Congress directed the President to prepare a report that would describe plans for permanent disposal of HLW and TRUW resulting from atomic energy defense activities. The President's report (*The Defense Waste Management Plan*, DOE/DP-0015) was submitted to Congress in June 1983. The report describes reference plans for the immobilization of HLW resulting from defense activities at SRS, INEL, and Hanford. (The HLW at WVDP from commercial spent nuclear fuel reprocessing was not addressed in this report, but the West Valley Demonstration Project Act [Public Law 96-368] requires that DOE take similar actions with regard to West Valley's HLW.)

The goal of the HLW management was to end interim storage and to achieve permanent disposal by immobilizing and preparing HLW for shipment to a geologic repository. Each HLW site has taken steps to follow the President's plan regarding immobilizing HLW in a sequential manner. This approach is intended to permit the applicable operating experience gained at the first site to be applied to the other sites, thereby resulting in a more efficient use of resources, including funding.

The Nuclear Waste Policy Act (42 USC 10101–10270) enunciated the national policy that HLW be solidified and disposed of in a mined geologic repository. The U.S. Nuclear Regulatory Commission (NRC) has established requirements for the performance of a geologic repository. DOE must submit an application for a repository license and show that the mined geologic disposal system, including repository site natural barriers, engineered barriers, waste packages, and shaft seals will meet NRC requirements. The U.S. Environmental Protection Agency (EPA) will promulgate public health and safety standards for protection of the public from releases of radioactive materials disposed of in a candidate geologic repository as required by the Nuclear Waste Policy Act and the Energy Policy Act (42 USC 10101–10270).

For purposes of the WM PEIS, a geologic repository candidate site at Yucca Mountain, Nevada, was assumed to be the final disposal site for all HLW. Currently, Yucca Mountain is the only site being characterized as a geologic repository for HLW. If selected as the site for development, it would be ready to accept HLW no sooner than 2015. The potential environmental impacts at a geologic repository from

the disposal of HLW are not yet known and therefore not addressed in the WM PEIS. DOE is preparing another EIS to analyze site-specific environmental impacts from construction, operation, and eventual closure of a potential geologic repository for spent nuclear fuel (SNF) and HLW at Yucca Mountain.

9.1.2 VOLUMES AND LOCATIONS

Government operations from 1944 to the present have generated about 357,000 cubic meters (94 million gallons) of HLW, with approximately 21,000 cubic meters (5.6 million gallons) to be generated within the next 20 years (DOE, 1995e, 1996b). Only four sites either store or manage HLW: the Hanford Site, INEL, SRS, and WVDP. There is a discussion in Section 9.2.3 of the potential additional HLW canisters that may be generated if the Department proposes to chemically process SNF in the future, and a discussion of their potential impacts is in Section 9.4.4.

DOE is proceeding with plans to treat HLW by processing it into a glass form that would not be readily dispersible into air or leachable into ground or surface water. This process is called vitrification. If the existing inventory of HLW is vitrified, the vitrified material will fill an estimated 21,600 canisters. Canisters are assumed to vary in volume of vitrified HLW between 0.62 and 1.17 cubic meters.

Table 9.1–1 shows the projected HLW inventory at the Hanford Site, INEL, SRS, and WVDP; and the projected total vitrified HLW canisters that will be produced as a result of treating the entire HLW inventory.

Table 9.1–1. High-Level Waste Volumes and Projected Number of Estimated HLW Canisters

Site	HLW Volume (m^3)	Total Number of Estimated Canisters to Be Produced
Hanford	213,000	15,000
INEL	10,400	1,700
SRS	152,000	4,572
WVDP	2,200	340
Total	378,000	21,600

Sources: ANL (1996); DOE (1994a; 1995b, d-f; 1996a-c); WINCO (1994).

The estimated number of HLW canisters to be produced at each site shown in Table 9.1–1 is dependent on waste characteristics, volume prior to treatment, final waste loading and immobilized form, and canister size. These factors vary from site to site and result in a nonlinear relationship between the projected number of HLW canisters and the initial waste volume.

The WM PEIS analyses for SRS are based on a total HLW inventory of 4,572 canisters (DOE, 1994a, 1995d). The latest version of the *High-Level Waste System Plan* (1996) projects a total of approximately 6,000 canisters to be produced at SRS. Preliminary analysis indicates that the impacts associated with the higher total number of canisters (6,000) are similar to those for the canister inventory applied in the WM PEIS (4,572). The WM PEIS forecasts conservative results because although the number of canisters applied in the WM PEIS analyses is lower than the number projected in the *High-Level Waste System Plan* (WSRC, 1995), an individual canister has a greater radiological activity when compared with that in the *High-Level Waste System Plan*; thus, an accident associated with this canister would have greater impacts (as an example). Similarly, the occupational dose received by the workforce during interim storage of HLW canisters pending disposal at a national geologic repository appears to be greater when the WM PEIS canister inventory is used, again because of the higher radiological activity of a single canister. The overall risk of transportation would increase on the average by 11% and at most by 14% for the Centralized Alternative, Case 2, when the higher SRS canister number is used. The uncertainty in the total number of canisters at Savannah River does not significantly affect decisions made within the WM PEIS concerning HLW management.

The Hanford Tank Waste Remediation System EIS (DOE, 1996b) presents a total of approximately 12,200 canisters projected to be produced at Hanford. The WM PEIS analyses for the Hanford Site are based on a total HLW canister inventory of 15,000 canisters. Preliminary analysis indicates that the impacts associated with the lower total number of canisters (i.e., 12,200) are similar to those for the canister inventory applied in the WM PEIS (i.e., 15,000). The WM PEIS forecasts conservative results because the number of canisters applied in the WM PEIS analyses is greater than that in the Tank Waste Remediation System EIS (DOE 1996b), and an individual canister has a greater radiological activity (by approximately 50%) compared with the TWRS EIS. Thus, an accident associated with this canister would have greater impacts, and as an example, the occupational dose received by the workforce during interim storage of HLW canisters pending disposal at a national geologic repository appears to be greater using the WM PEIS canister inventory, again due to the higher radiological activity of a single canister. The overall risk of transportation would decrease on the average by 10% and at most by 12% for the No Action Alternative

using the lower Hanford canister number. In general, the final number of canisters at Hanford would depend on the decisions based on the TWRS EIS and performance of separations and treatment processes implemented to treat the HLW. The uncertainty in the total number of canisters at Hanford does not significantly affect decisions made within the WM PEIS concerning HLW management.

Changing the number of canisters at INEL results in comparatively more impacts. As an example, the transportation risk would increase on the average by 20% and at most by 36% for the Centralized Alternative, Case 2. The number of storage facilities would decrease from a total of four for the 8,500-canister total used in the Draft WM PEIS to one for the updated value of 1,700 canisters, with a resulting fourfold decrease in the facility construction and operations impacts. In this case, revision of the number of canisters at INEL could affect decisions made within the WM PEIS concerning HLW management, and it would appear reasonable to consider the more recent HLW canister totals for INEL. For this reason, the Final WM PEIS uses the more current estimate of canisters for INEL.

9.1.2.1 Hanford

HLW has been generated at the Hanford Site as a result of plutonium production, research and development for advanced reactors, renewable energy technologies, waste disposal technologies, and cleanup of contamination from past practices. The Hanford Site began storing liquid HLW in belowground tanks in 1944. Over the years, three substantially different separations processes have been used at the site. In all cases, the acidic wastes were neutralized for storage in carbon steel tanks. Further, in order to remove strontium and cesium from the less active materials at the Hanford Site, several precipitation procedures were employed. These resulted in the concentration of strontium and cesium, now stored in metal, double-walled capsules with an external diameter of approximately 6.7 cm (2.6 in.) and an overall length of about 53 cm (21 in.), and in the introduction of organic and ferrocyanide precipitating agents which have produced potentially dangerous conditions in some of the tanks.

In April 1988, the Hanford Defense Waste EIS Record of Decision was published in the *Federal Register* (53 FR 12449). However, important changes have occurred since the 1988 decision. The Tank Waste Remediation System Final EIS (DOE, 1996b), issued in August 1996, addresses actions to manage and dispose of approximately 213,000 cubic meters (56 million gallons) of radioactive, hazardous, and mixed waste within the Tank Waste Remediation System program at the Hanford Site (61 FR 45949). The EIS

also addresses actions to manage and dispose of the cesium and strontium contained in approximately 1,930 metal, double-walled capsules. The EIS identifies Phased Implementation as the preferred alternative for remediating Hanford's high-level tank waste. (The preferred alternative for the cesium and strontium capsules is to continue storage.) Under the Phased Implementation Alternative, the high-level tank waste would be remediated in a two-phase process. Phase 1 would involve design, construction, and operation of demonstration-scale treatment facilities. Phase 2 would be implemented following Phase 1 and would involve the design, construction, and operation of full-scale treatment facilities to remediate the remainder of the tank waste. Under both phases of the preferred alternative, the HLW would be vitrified and placed into canisters for interim storage pending offsite disposal at a geologic repository.

The tank waste is mainly in three forms — liquid, saltcake, and sludge — and is contained in 177 underground storage tanks (149 single-shell and 28 double-shell tanks) built between 1943 and 1986. Vitrification of all Hanford HLW is expected to be completed by the year 2028.

The estimated number of HLW canisters to be produced from vitrification of the Hanford Site tank waste depends on the performance of separations and treatment processes implemented to treat the HLW. For purposes of the WM PEIS, an estimated 15,000 canisters were assumed to be produced from treating existing HLW (Walters, 1995).

9.1.2.2 INEL

INEL's anticipated generation and management activities will result in approximately 7,600 cubic meters (2 million gallons) of liquid HLW and 3,800 cubic meters (1 million gallons) of calcined HLW in storage at the Idaho Chemical Processing Plant. Liquid HLW has been blended routinely with sodium-bearing liquid and calcinated at the New Waste Calcining Facility, which converts the waste into dry, noncorrosive granules. The calcinated waste is stored in stainless steel closed bins inside near-surface concrete vaults (DOE, 1995b).

Calcination of liquid HLW at INEL results in a solid that is safer to store than liquid waste but does not meet NRC requirements for disposal in a repository. The calcination process may be classified as an interim best demonstrated available technology by EPA under RCRA, pending development of a process to produce

a stable glass, ceramic or glass/ceramic that will meet both Atomic Energy Act and RCRA requirements. Characteristics of INEL waste suggest the waste form will be a borosilicate glass material.

INEL built the New Waste Calcining Facility to convert the liquid HLW at the INEL into dry, noncorrosive granules that are stored in stainless steel, closed bins inside near-surface concrete vaults. The Final Programmatic Spent Nuclear Fuel and INEL Environmental Restoration and Waste Management Programs EIS (DOE, 1995b) analyzed a Waste Immobilization Facility (WIF) Project to immobilize the Idaho Chemical Processing Plant radioactive wastes (sodium-bearing liquid and solid calcine) into forms suitable for permanent disposal. The SNF and INEL EIS, Volume 2, Part B, Section C.4.3.2, presents a project description for calcine treatment technology development. No decision has been made on the construction of the WIF, and no decision has yet been made on whether further treatment of the calcinated waste will occur before shipment to a geologic repository. The WM PEIS assumes that production of HLW canisters will begin in 2015 and be completed in 2035 (DOE, 1995d). An estimated 1,700 HLW canisters will be produced.

9.1.2.3 SRS

An inventory of approximately 131,000 cubic meters (34 million gallons) of HLW is stored in belowground tanks in the F- and H-Areas near the center of SRS. This waste was generated as a result of defense, research, and medical programs. Approximately 22,000 cubic meters (5.8 million gallons) are projected to be generated within the next 20 years.

SRS completed the Defense Waste Processing Facility (DWPF) Supplemental EIS in November 1994 (DOE, 1994a). The DWPF includes the HLW pretreatment process, the Vitrification Facility, saltstone manufacturing and disposal (LLW resulting from the pretreatment of HLW), radioactive glass waste storage facilities, and associated support facilities. The Record of Decision (March 28, 1995) describes the Department's decision to complete construction and begin operation of the DWPF. The DWPF became operational on March 12, 1996. Vitrified HLW canister production began in 1996 and is to be completed in 2020 (DOE, 1994a). For purposes of this EIS, the estimated total number of canisters is assumed to be 4,572, the total planned storage capacity of HLW canisters at SRS (DOE, 1995a).

9.1.2.4 WVDP

The WVDP is being conducted at the Western New York Nuclear Services Center near West Valley, New York. It is owned by the New York State Energy Research and Development Authority. Commercial operations generated HLW from reprocessing spent nuclear fuel at WVDP from 1966 to 1972. Under the West Valley Demonstration Project Act (42 USC 2021a *et seq.*), DOE is demonstrating the solidification for disposal of liquid HLW.

The WVDP HLW inventory is approximately 2,200 cubic meters (580,000 gallons). All the HLW will be blended together with glass-forming materials and vitrified into a borosilicate glass waste form. DOE and the New York State Energy Research and Development Authority (NYSERDA) completed a Final Environmental Impact Statement, *Long Term Management of Liquid High-Level Radioactive Wastes Stored at the Western New York Nuclear Service Center, West Valley* (DOE, 1982). The Record of Decision, issued in September 1982, identified that the liquid HLW would be vitrified and transported to a geologic repository for disposal. Vitrification at the WVDP began on July 2, 1996. Vitrification should result in the production of an estimated 340 canisters (ANL, 1996).

Analysis in the WM PEIS assumes use of existing storage facilities until their capacities are met. If additional capacity is needed, use of new conceptual facilities is assumed. These conceptual facilities provide the difference in storage capacity between existing storage capacity and what is necessary to manage the waste received under any given alternative. Conceptual facilities are based on generic designs with set impacts (e.g., cost, performance/efficiency). When necessary for analysis, an assumption was made that the impact of existing facilities essentially reflects the impact of conceptual facilities.

9.1.3 Existing and Planned Facilities Available at DOE Sites

Each alternative considered in this PEIS for storage of HLW canisters involves three major facilities and features: the HLW canisters, the facilities for the storage of HLW canisters, and the packages for transporting HLW canisters. The following sections briefly describe each of these facilities and features.

9.1.3.1 High-Level Waste Canisters

HLW canisters are large stainless steel cylinders resembling those typically used to store gases (such as oxygen). In the vitrification process, a molten mixture of HLW and glass-forming materials is poured into the canisters. After each canister is filled, it is sealed with a welded plug. After sealing, each canister is tested for leaks and the surface is decontaminated. Following decontamination, the canisters are loaded into a shielded cask and transferred to storage. Table 9.1–2 lists the dimensions, weights, and activity levels of the HLW canisters assumed in this PEIS at the four HLW sites.

9.1.3.2 Storage Facilities for High-Level Waste Canisters

Storage facilities for HLW canisters are buildings containing underground plugged storage vaults within a concrete structure that is designed to withstand earthquakes and other natural disasters. When casks containing HLW canisters are received at a storage facility, the HLW canisters are unloaded. A concrete plug is lifted from the top of the storage vault, or from the floor of the building, and the canisters are lowered into tubes within the cavity. Each storage tube, or sleeve, is then sealed to prevent the canisters from coming into direct contact with cooling or ventilation system air. After the storage tubes are sealed, a concrete plug is lowered over the cavity. Radioactive decay heat from the canisters is transferred to the

Table 9.1–2. Dimensions, Weights, and Activity Content of HLW Canisters

Characteristics	Hanford	INEL	SRS	WVDP
Material	Stainless steel			
Outer diameter (cm)	61	N/A	61	61
Overall height (cm)	300	N/A	300	300
Nominal wall thickness (cm)	0.95	N/A	0.95	0.34
Total weight (kg)	2,150	N/A	2,182	2,152
Activity per canister (curies)	1,373	9,000	2,344	1,043
Decay heat per canister (watts)	389	26	709	311

Notes: The canister dimensions are assumed for this PEIS. Selection of a different size canister could result in a decrease or increase in the number of canisters produced and rate of acceptance at the repository.

Source: ANL (1996).

tubes and removed by a cooling or ventilation system. Although no radioactive emissions are expected during normal operation, a high-efficiency particulate air (HEPA) filtration system would be used to ensure minimal release of radioactivity to the atmosphere in the event a release occurred. Storage facilities for HLW canisters currently exist at SRS and WVDP. Storage facilities are planned for the Hanford Site and INEL.

The Glass Waste Storage Building at SRS has an estimated capacity of 2,286 canisters. The storage vault is designed as an earthquake- and tornado-resistant concrete structure. Radiation shielding protection for Glass Waste Storage Building workers is provided by concrete walls, earth embedment, and a concrete deck that forms the floor of the building and operating area. The building's forced air exhaust system would remove radioactive decay heat. The exhaust air would pass through the building's HEPA filter ventilation system and then be discharged into the atmosphere through the stack. No condensate is expected to accumulate in the ventilation system sump; however, if any does, it would be drummed, monitored for activity, and treated. Depending on activity levels, the condensate would be sent to the F- and H-Area Effluent Treatment Facility or incorporated into the Vitrification Facility wastewater stream for recycling to the SRS HLW tank farm. Although no activity is expected to occur in the condensate or exhaust air, provisions have been made for its management if activity is detected (DOE, 1994a). The construction of a second Glass Waste Storage Building has been approved in the Record of Decision for the Final Supplemental EIS for Defense Waste Processing Facility (DOE, 1995a). Upon completion of this building, total estimated storage capacity at SRS will be 4,572 canisters.

At WVDP, storage racks holding four canisters each would be used to transport HLW canisters to the Waste Canister Storage Facility, located in the existing Chemical Process Cell building which has been decontaminated and modified for storage of HLW canisters. The racks containing the HLW canisters would be stored on two levels to allow for a failed equipment storage area. The canister storage area would be equipped with two coolers to remove heat generated by the HLW canisters. Storage capacity is available for approximately 344 canisters (ANL, 1996).

DOE approved, as part of a previous EIS for the Hanford Site (DOE, 1987), a storage facility that would provide enough storage capacity for approximately 750 HLW canisters. It was assumed in the WM PEIS that the HLW canister storage facility would be operational by 2009.

9.1.3.3 Transportation Packages for High-Level Waste

Transportation of all DOE radioactive material must conform to the Hazardous Materials Transportation Act, Department of Transportation (DOT), and NRC regulations. HLW canisters would be transported in Type B packages, which provide a high degree of assurance that, even in severe accidents, package integrity will be maintained with essentially no loss of radioactive contents or serious impairment of the shielding capability provided by the package. DOE has prepared initial designs for a HLW waste cask for truck transportation based on SRS canister designs. As designed, the HLW waste cask uses a solid body concept to absorb energy during an accident and normal transportation. To minimize the exposure to gamma radiation, shielding would be provided by a depleted uranium liner inside the cask body. The WM PEIS assumed that the HLW truck cask would contain only a single HLW canister; however, it is likely that DOE will develop a multiple-canister truck cask, as well as a cask for transporting HLW canisters by rail. The WM PEIS assumed that five HLW canisters would be shipped per rail cask; therefore, rail transportation could reduce the number of shipments by at least 80%. Further details of the WM PEIS assumptions for transporting HLW canisters are contained in Appendix E. Currently, no casks for shipping HLW canisters by truck or rail have been certified by the NRC (ANL, 1996).

9.2 Analytical Methods and Assumptions

Reported HLW volumes, characteristics, and facilities were used to analyze human health risks, environmental and socioeconomic impacts, and costs associated with each of the HLW alternatives. To facilitate the analysis, DOE made numerous assumptions on HLW characteristics, facilities, and transportation. These assumptions are described below.

9.2.1 CHARACTERISTICS

High-level waste is generated by the chemical reprocessing of SNF and irradiated targets generated in DOE programs for research, development, testing, and production, and from Naval propulsion fuel. The radioactivity from HLW results primarily from radionuclides of cesium, and strontium; a very small amount results from the decay of transuranic radionuclides. HLW also contains toxic metals and organic materials that are considered hazardous under RCRA.

High-level waste may be found in a number of forms: acidic liquid, caustic liquid with or without sludge, saltcake, slurry, or dry granular calcine. As generated, HLW is a highly acidic liquid solution and must be handled and stored in corrosion resistant vessels, generally stainless steel. During World War II, because of a shortage of stainless steel, HLW was neutralized so it could be stored in carbon steel tanks. Treatment of HLW with excess caustic precipitated fission product metal oxides and hydroxides which collected as sludge on the tank floor. Often, high heat from fission product decay caused evaporation of significant amounts of water, leading to a viscous solution with elevated salt content and crystallized salts, commonly referred to as "saltcake." Although SRS and WVDP have neutralized their HLW, the INEL reprocessing plant kept its HLW acidic and stored it in stainless steel tanks pending pretreatment to a granular solid through a process called "calcination." This "calcine" is stored for future processing to a final waste form. Vitrification into a glass form, after radionuclide partitioning, has been chosen for testing for potential use in immobilizing the high-level liquid and calcine waste at the INEL (DOE, 1995c).

Most nuclear radiation from HLW, after several years of initial decay, comes from the fission product radionuclides cesium-137 and strontium-90 (each with a half-life of approximately 30 years) and small amounts of transuranic radionuclides such as plutonium and americium (half-lives of thousands to millions of years). In alkaline solution, cesium remains in solution but strontium and the transuranic metals are found almost entirely in the sludge as insoluble oxides. The primary health risk from HLW arises from the intense radiation, not from chemicals. No matter what the physical form, HLW must be stored behind heavy shielding and handled using remotely operable equipment.

9.2.2 Facilities

Treatment. All four HLW sites are in some stage of planning or constructing facilities to treat HLW into an acceptable waste form for repository disposal. The existing and planned treatment facilities are described in Section 9.1.3.

Storage. For purposes of this PEIS, DOE assumed that storage facilities would be based on a modular design. The Glass Waste Storage Building for SRS was assumed to be the model for future storage facilities. Anticipated capacity for each module is assumed to be 2,286 canisters. DOE also assumed that it would take approximately three years to construct each module. Based on the total estimated number of canisters to be

produced, 12 storage modules would need to be constructed system wide. One module currently exists at SRS and full storage capacity for the WVDP canisters exists at that site.

Disposal. Under the Nuclear Waste Policy Act, HLW is planned to be disposed of at a geologic repository; Yucca Mountain in Nevada is the site currently being studied for suitability to house a geologic repository. The DOE assumes that acceptance of DOE-managed HLW at this facility will begin in 2015. In accordance with the repository program, DOE's annual limit for disposal is 400 metric tons uranium (MTU) equivalent (DOE, 1994c). The WM PEIS assumed that one (1) canister equals 0.5 MTU. Therefore, only 800 canisters per year can be shipped to a geologic repository based on this disposal rate. However, due to the rate at which canisters will be accepted at a geologic repository, storage capacity will have to be constructed for the total number of canisters produced, or production of the canisters will have to be paced to the openings of a geologic repository. Further, although a geologic repository for the permanent disposal of HLW is scheduled to begin accepting DOE-managed HLW in 2015, for purposes of analysis in the WM PEIS, DOE has also analyzed HLW canister storage requirements should the opening of a geologic repository occur some time after 2015.

9.2.3 Canister Production Rates

For purposes of the WM PEIS, the following assumptions were made regarding the production of canisters at each of the four HLW sites:

Hanford[1]

- The No Action Alternative assumes a production rate of 320 canisters per year, based on the Hanford Site EIS (DOE, 1987). The more recent TWRS EIS (DOE, 1996d) indicates an average annual production rate of about 450 canisters per year. All other WM PEIS alternatives assume an average annual production rate of 790 canisters per year.
- Canister production would begin in 2009 and would be completed in 2028.
- The Hanford Site would produce an estimated 15,000 canisters.

[1] The Department's Storage and Disposition PEIS evaluates a "can-in-canister" alternative for the disposition of plutonium in an immobilized form, where small cans of plutonium would be imbedded into larger canisters of vitrified HLW. This alternative could result in the production of a small number of additional canisters at one of these two sites because some of the vitrified HLW would be displaced by the smaller cans of immobilized plutonium. The small number of additional HLW canisters would not affect the conclusions reached in the WM PEIS.

INEL

- An average annual production rate of about 81 canisters per year is assumed for all alternatives, except the No Action Alternative. The No Action Alternative assumes no canister production because INEL does not have existing or planned HLW canister storage facilities and is not authorized for treatment to a final waste form acceptable for disposal in a candidate repository.
- Canister production would begin in 2015, and all HLW would be treated so that it is ready to be moved out of Idaho by a target date of 2035 consistent with the Court's order in the case of Public Service Company of Colorado v. Philip E. Batt Civil No. 91-0054-S-EJL (District of Idaho, Oct. 17, 1995).
- INEL would produce an estimated 1,700 canisters.

SRS[1]

- An annual average production rate of 190 canisters per year is assumed for all alternatives. The *High-Level Waste System Plan* (WSRC, 1995) indicates a maximum production rate of about 300 canisters per year.
- Canister production began in 1996 and will be completed in 2020.
- SRS would produce an estimated 4,572 canisters.

WVDP

- A production rate of approximately 100 canisters per year is assumed for all alternatives.
- Canister production began in 1996 and will be completed in 1998.
- WVDP would produce an estimated 340 canisters, based on the assumption that any retrieved spent fuel fines would be considered residues and handled in a manner consistent with HLW (DOE, 1996a).

Table 9.2–1 provides a summary of anticipated production rates for the No Action Alternative and all other alternatives.

Additional Canisters Generated From Foreign Research Reactor Spent Nuclear Fuel. Additional canisters of HLW could be generated from foreign research reactor SNF and other sources if chemical processing were applied to these materials (DOE, 1996b). These additional canisters could add to the inventory of canisters evaluated in the WM PEIS. It is estimated that up to 200 canisters could be produced at SRS in addition to the 4,572 canisters assumed in the WM PEIS, or alternatively, 300 canisters could

Table 9.2–1. High-Level Waste Canister Production Schedule for the No Action Alternative and All Other Alternatives

Action	Site			
	Hanford	INEL	SRS[a]	WVDP
High-Level Waste Canister Production for the No Action Alternative[b]				
Anticipated start of production	2009	0	1996	1996
Anticipated end of production	2028	0	2020	1998
Anticipated start of shipping to repository	2016	0	2037	2016
Anticipated end of shipping to repository	2036	0	2042	2018
Estimated number of canisters produced	15,000	0	4,572	340
Existing or planned storage?	Yes	No	Yes	Yes
Existing or planned storage capacity, number of canisters	750	0	4,572	340
High-Level Waste Canister Production for All Other Alternatives[b]				
Anticipated start of production	2009	2015	1996	1996
Anticipated end of production	2028	2035	2020	1998
Estimated number of canisters produced	15,000	1,700	4,572	340
Existing or planned storage?	Yes	Yes	Yes	Yes
Existing or planned storage capacity, number of canisters	15,000	1,700	4,572	340

[a] Storage capacity for 2,286 canisters currently exists at SRS. Another 2,286-canister facility has been approved and will be constructed in 2007. Impacts from constructing the second canister storage facility have been included in the WM PEIS analysis.
[b] If there is a delay in the schedule for a geologic repository, all timelines would require adjustment.

be produced at INEL in addition to the 1,700 assumed at INEL. At SRS, the additional 200 canisters would represent an increase of 4.4%, and at INEL, the 300 additional canisters would represent an increase of 18%.

9.2.4 TRANSPORTATION

Transportation by truck is assumed in most calculations. The WM PEIS assumed that a truck cask would contain only a single HLW canister and that five HLW canisters would be shipped per rail cask; therefore, transportation by rail would reduce the number of trips by at least 80%. The routes were selected to be consistent with existing routing practices and all applicable routing regulations and guidelines; however,

because the routes were determined for the purpose of risk assessment, they do not necessarily represent actual routes that would be used to transport HLW in the future. Actual HLW routes will be determined during the transportation planning process described in Section 4.3.10.

Under all alternatives, DOE would be required to complete designs and obtain the necessary certification for transport of casks for HLW canisters to either another site or a geologic repository along transportation routes approved by the DOT. In addition, transportation of all DOE radioactive material would conform to the Hazardous Materials Transportation Act and applicable DOT and NRC regulations.

Transportation of hazardous and radioactive materials, substances, and wastes is governed by the U.S. Department of Transportation, NRC, and EPA regulations and by the Hazardous Materials Transportation Act. These regulations may be found in 49 CFR Parts 171-178, 49 CFR Parts 383-397, 10 CFR Part 71, and 40 CFR Parts 262 and 265, respectively.

9.3 High-Level Waste Alternatives

DOE analyzed five alternatives for HLW within the four broad categories of alternatives: No Action, Decentralized, Regionalized, and Centralized. The foldout table at the end of this chapter shows the sites at which HLW would be stored under each alternative. This table is designed to be used as a quick reference when reading the HLW impact sections.

Each of the alternatives was developed in order to capture and quantify the human health risks, environmental impacts, and costs associated with the range of HLW canister storage options, and to provide input for a decision about where to store HLW. For each of the five alternatives, DOE assumed that a geologic repository would begin accepting DOE-managed HLW in 2015 at the rate of 800 canisters a year. The schedule for acceptance of DOE-managed HLW at the repository is out of scope for this PEIS. However, for purposes of analysis, DOE also evaluated a scenario that assumed that there would be a delay in acceptance of DOE-managed HLW by a geologic repository until some time later than 2015, but at the same rate of acceptance of 800 canisters per year.

9.3.1 No Action Alternative

Under the No Action Alternative, only existing and approved HLW canister storage facilities would be used. The existing HLW canister storage facilities include the Glass Waste Storage Building at SRS with a storage capacity of approximately 2,286 HLW canisters and the Chemical Process Cell at WVDP with a storage capacity of approximately 340 HLW canisters. In addition to these existing HLW canister storage facilities, DOE has authorized the construction of a second glass storage building at SRS having a capacity of 2,286 canisters (DOE, 1994a). DOE also approved a Hanford storage facility that would provide enough storage capacity for approximately 750 HLW canisters (DOE, 1987). This facility is expected to be operational by 2009. The more recent TWRS EIS (DOE, 1996d) considers storage for a total of 12,200 HLW canisters proposed to be produced at the Hanford Site. The WM PEIS applies the storage capacity given in the Record of Decision based on DOE (1987) as the baseline for the No Action Alternative. No HLW canister storage facility exists or is approved for INEL (DOE, 1995c).

Each site would store only those canisters produced at that site. The Hanford Site would run out of HLW canister storage capacity before HLW canister acceptance begins at a geologic repository in 2015 as planned, based on an anticipated HLW canister production rate of 790 canisters per year and the expected startup of vitrification operations in 2009. Without sufficient storage capacity for HLW canisters, the anticipated HLW vitrification operations at the Hanford Site and INEL would be interrupted or delayed until sufficient storage capacity could be built or capacity at a geologic repository is completed as planned.

Figure 9.3–1 illustrates the No Action Alternative. Table 9.3–1 summarizes by site, the number of HLW canisters stored, the shipment destination, and number of canister shipments by truck for the No Action Alternative.

Because the No Action Alternative is based on existing or approved capacity at each of the four sites and the anticipated acceptance rate by a geologic repository, the following assumptions were developed for performing the No Action Alternative analysis for this PEIS. These assumptions were necessary to allow for the processing of HLW to continue once operations began since not all sites have sufficient storage capacity and the repository is not scheduled to accept DOE-managed HLW until 2015.

HLW No Action Alternative

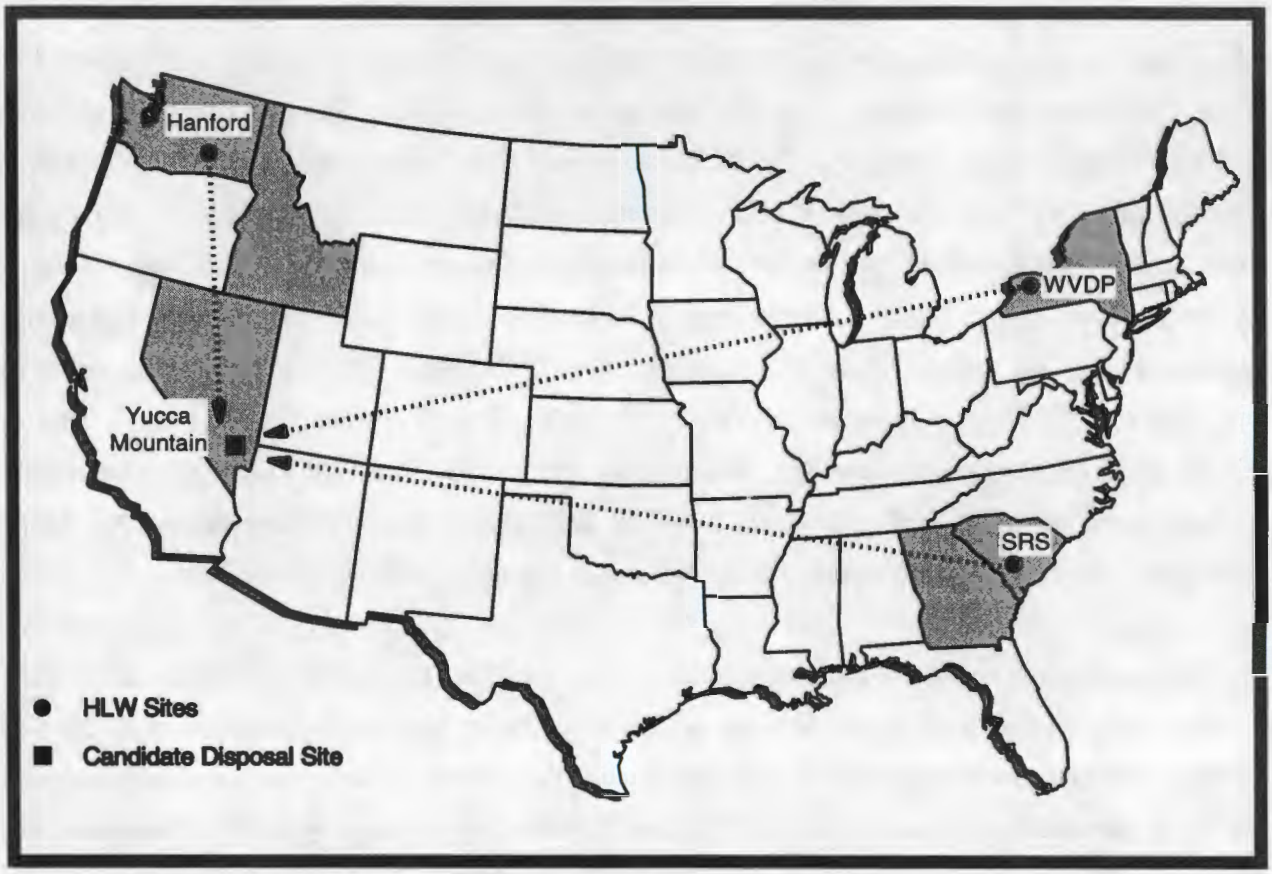

Figure 9.3–1. HLW No Action Alternative

Activity	Hanford	INEL	SRS	WVDP	Totals
Number of Canisters Stored	750	0	4,572	340	5,660
Number of Canister Shipments By Truck	15,000	0	4,572	340	19,900
Shipment Destination	Geologic Repository				

Notes: Estimated number of HLW canisters is based on HLW canister storage capacity authorized in approved NEPA documents. Although the Hanford Site has authorized storage for 750 HLW canisters, under the No Action Alternative, the Hanford Site will ultimately produce an estimated 15,000 HLW canisters.

Table 9.3–1. HLW No Action Alternative Canister Disposition

- Production of HLW canisters under the No Action Alternative would be phased in due to the lack of existing storage capacity at most of the sites and the assumed acceptance rate by a geologic repository of 800 canisters per year. Using this assumption, production of canisters would not stop once it began, but it deviates from actual site-specific planning schedules for the Hanford Site and INEL. This assumption is necessary unless a higher acceptance rate by a geologic repository is allowed.
- If a geologic repository does not begin accepting DOE-managed HLW by January 1, 2016, further delays in the start of production of HLW canisters would occur.
- WVDP—As soon as the repository begins accepting HLW canisters, WVDP would ship canisters at a rate of 100 per year. It would take approximately three years to ship all WVDP HLW canisters.
- Hanford—As soon as the repository begins accepting HLW canisters, the Hanford Site would ship canisters at a rate of 700 per year for the first three years while WVDP ships its canisters, and then ships at a rate of 800 canisters per year. It will take approximately 21 years to ship all Hanford canisters. Since the Hanford Site will construct storage capacity for 750 canisters under the No Action Alternative, DOE assumed that 750 canisters would be in storage the entire time until only 750 canisters are left and then these would be shipped in the last 2 years.
- SRS—The canisters remain in storage until all of Hanford's canisters are shipped to a geologic repository. Storage capacity exists at SRS but not at Hanford. If the Hanford Site began shipping its canisters in 2016, shipment of SRS canisters would begin in 2037 and be completed in 2042 at a rate of 800 canisters per year. If the repository does not open as scheduled, shipment of SRS canisters would start the year Hanford's shipments ended. It would take about 6 years at a rate of 800 canisters per year to ship all SRS canisters to the repository.
- INEL—INEL has no HLW storage capacity under the No Action Alternative because there are no existing or planned HLW canister storage facilities onsite and because no decision has been made on whether further treatment of the calcinated waste will occur before shipment to a repository (DOE, 1995b). The WM PEIS assumed that the final waste form would be a borosilicate glass.

9.3.2 Decentralized Alternative

Under the Decentralized Alternative, storage capacity equal to the anticipated total production of HLW canisters would be constructed at each site. This would allow each site to start generating HLW canisters as soon as the treatment facilities were available, prior to acceptance by a geologic repository. With adequate storage capacity at all four sites until canister acceptance at a geologic repository in 2015, no

delays in the production of HLW canisters would occur. Figure 9.3–2 illustrates the Decentralized Alternative. Table 9.3–2 summarizes by site, the number of HLW canisters stored, the shipment destination, and number of canisters shipped by truck for the Decentralized Alternative.

9.3.3 REGIONALIZED ALTERNATIVE 1

Under Regionalized Alternative 1, the HLW canisters produced at WVDP would be transported to SRS for storage in approved transportation casks. Adequate storage capacity for HLW canisters would be constructed at the Hanford Site, INEL, and SRS; the canisters would be stored there until a geologic repository opens for operation in 2015. Figure 9.3–3 illustrates Regionalized Alternative 1. Table 9.3–3 summarizes by site, the number of HLW canisters stored, the shipment destination, and number of canisters shipped by truck for Regionalized Alternative 1.

9.3.4 REGIONALIZED ALTERNATIVE 2

Under Regionalized Alternative 2, the HLW canisters produced at WVDP would be transported to the Hanford Site in approved transportation casks. Adequate storage capacity for HLW canisters would be provided at the Hanford Site, INEL, and SRS until HLW canisters were accepted at a geologic repository. Figure 9.3-4 illustrates Regionalized Alternative 2. Table 9.3-4 summarizes by site, the number of HLW canisters stored, the shipment destination, and number of canisters shipped by truck.

9.3.5 CENTRALIZED ALTERNATIVE

Under the Centralized Alternative, the HLW canisters produced at INEL, SRS, and WVDP would be transported to the Hanford Site in approved transportation casks, where adequate storage capacity for HLW waste canisters would be provided at the Hanford Site until the canisters were accepted at a geologic repository. Figure 9.3–5 illustrates the Centralized Alternative. Table 9.3–5 summarizes by site, the number of HLW canisters stored, the shipment destination, and number of canisters shipped by truck.

HLW Decentralized Alternative

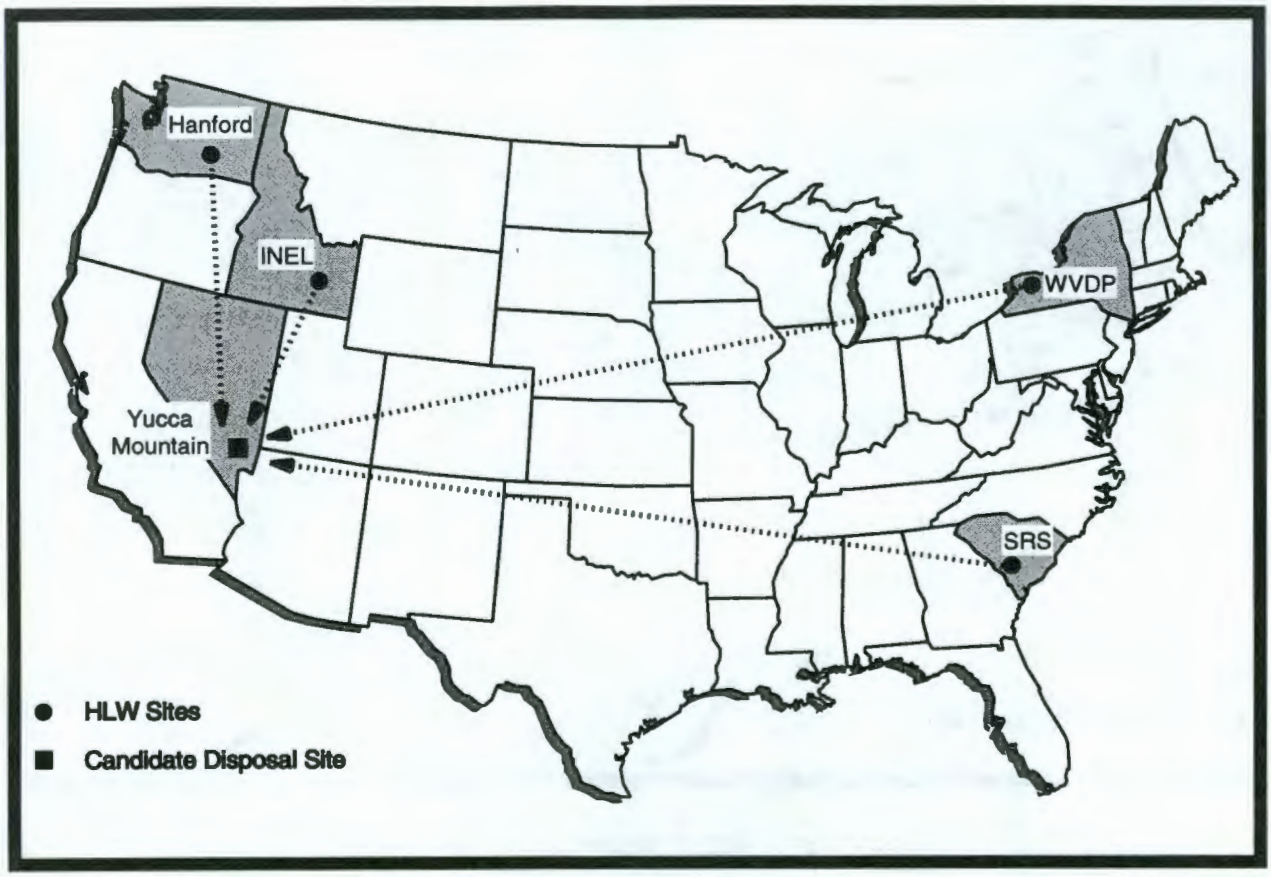

Figure 9.3–2. HLW Decentralized Alternative

Activity	Hanford	INEL	SRS	WVDP	Totals
Number of Canisters Stored	15,000	1,700	4,572	340	21,600
Number of Canister Shipments By Truck	15,000	1,700	4,572	340	21,600
Shipment Destination	Geologic Repository				

Notes: Estimated number of HLW canisters is based on total estimated HLW canister production at the site.

Table 9.3–2. HLW Decentralized Alternative Canister Disposition

HLW Regionalized Alternative 1

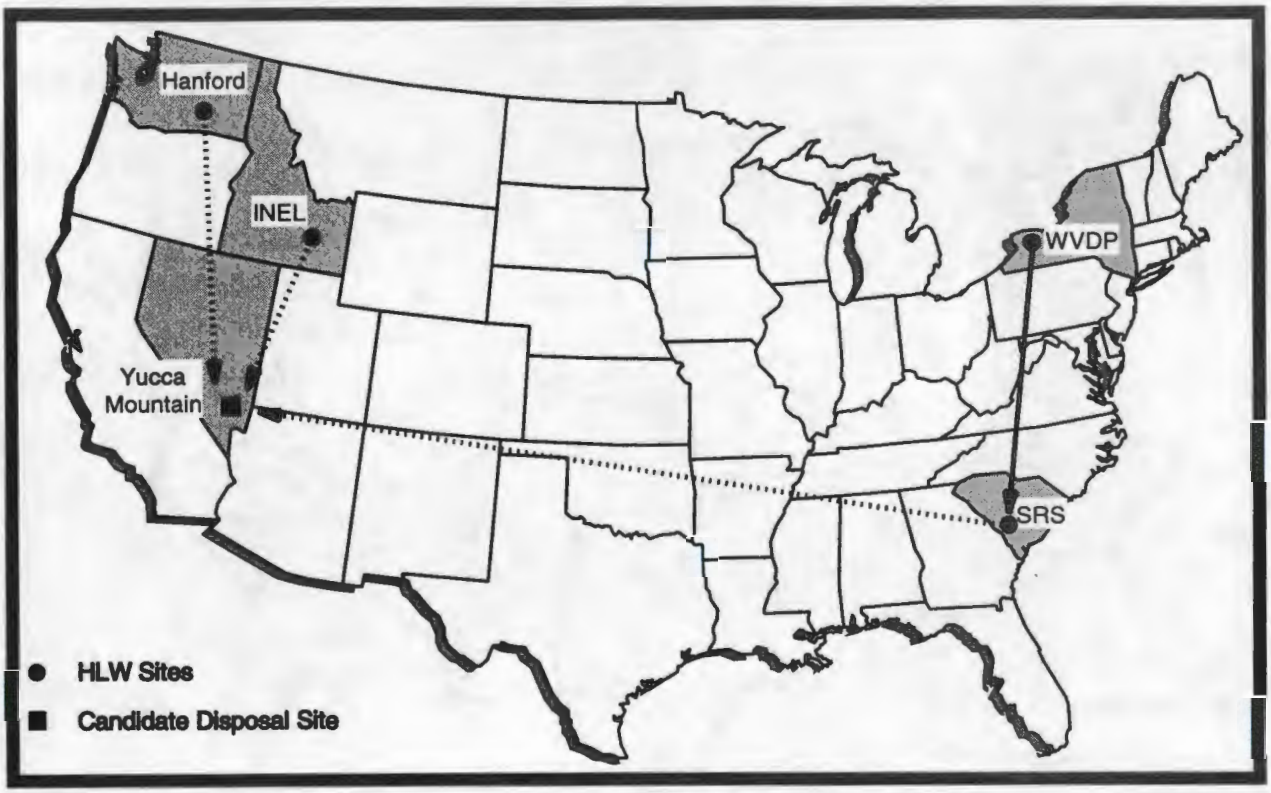

Figure 9.3–3. HLW Regionalized Alternative 1

Activity	Hanford	INEL	SRS[a]	WVDP	Totals
Number of Canisters Stored	15,000	1,700	4,912	0	21,600
Number of Canister Shipments By Truck	15,000	1,700	4,912	340	22,000
Shipment Destination	Geologic Repository			Storage at SRS	

[a] This total number includes the 340 HLW canisters from WVDP that were initially shipped to SRS.

Table 9.3–3. HLW Regionalized Alternative 1 Canister Disposition

HLW Regionalized Alternative 2

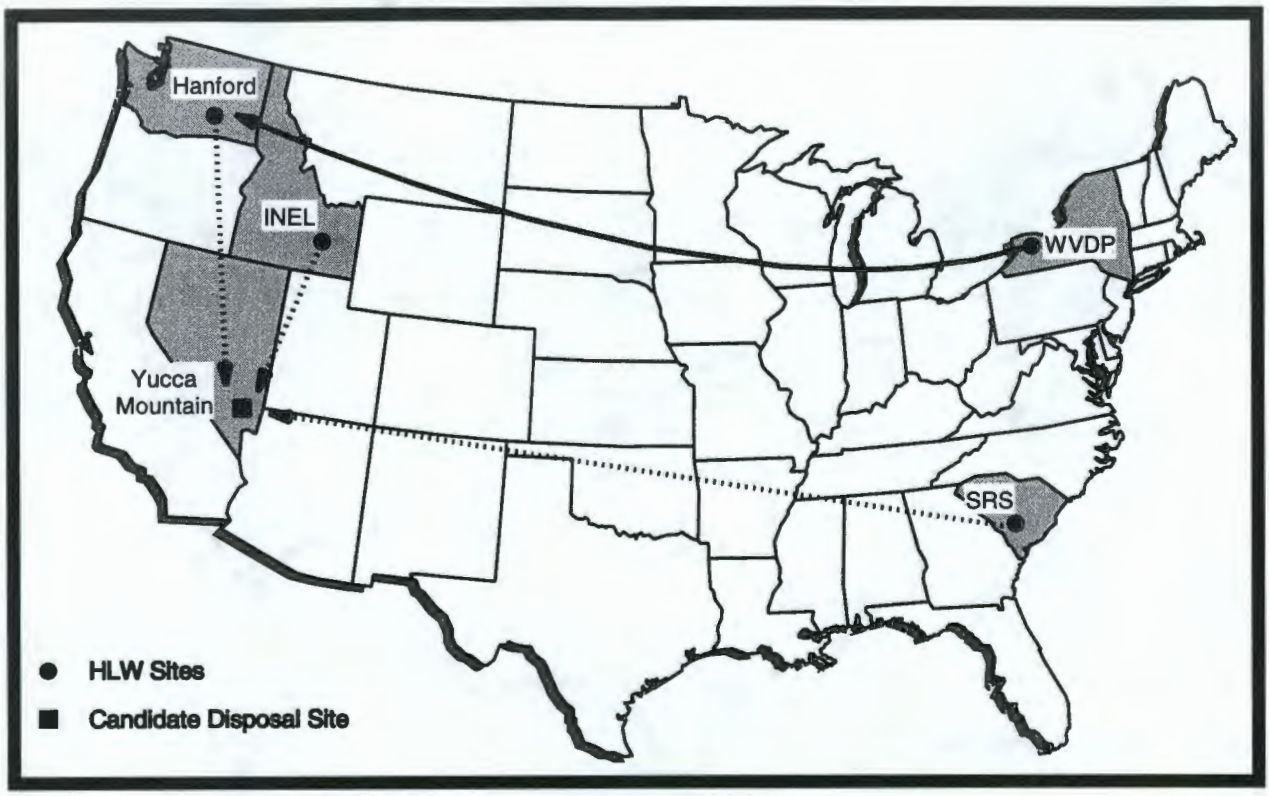

Figure 9.3–4. HLW Regionalized Alternative 2

Activity	Hanford[a]	INEL	SRS	WVDP	Totals
Number of Canisters Stored	15,340	1,700	4,572	0	21,600
Number of Canister Shipments By Truck	15,340	1,700	4,572	340	22,000
Shipment Destination	Geologic Repository			Storage at Hanford	

[a] This number includes the 340 HLW canisters from WVDP that were initially shipped to the Hanford Site.

Table 9.3–4. HLW Regionalized Alternative 2 Canister Disposition

HLW Centralized Alternative—Shipment to Repository in 2015

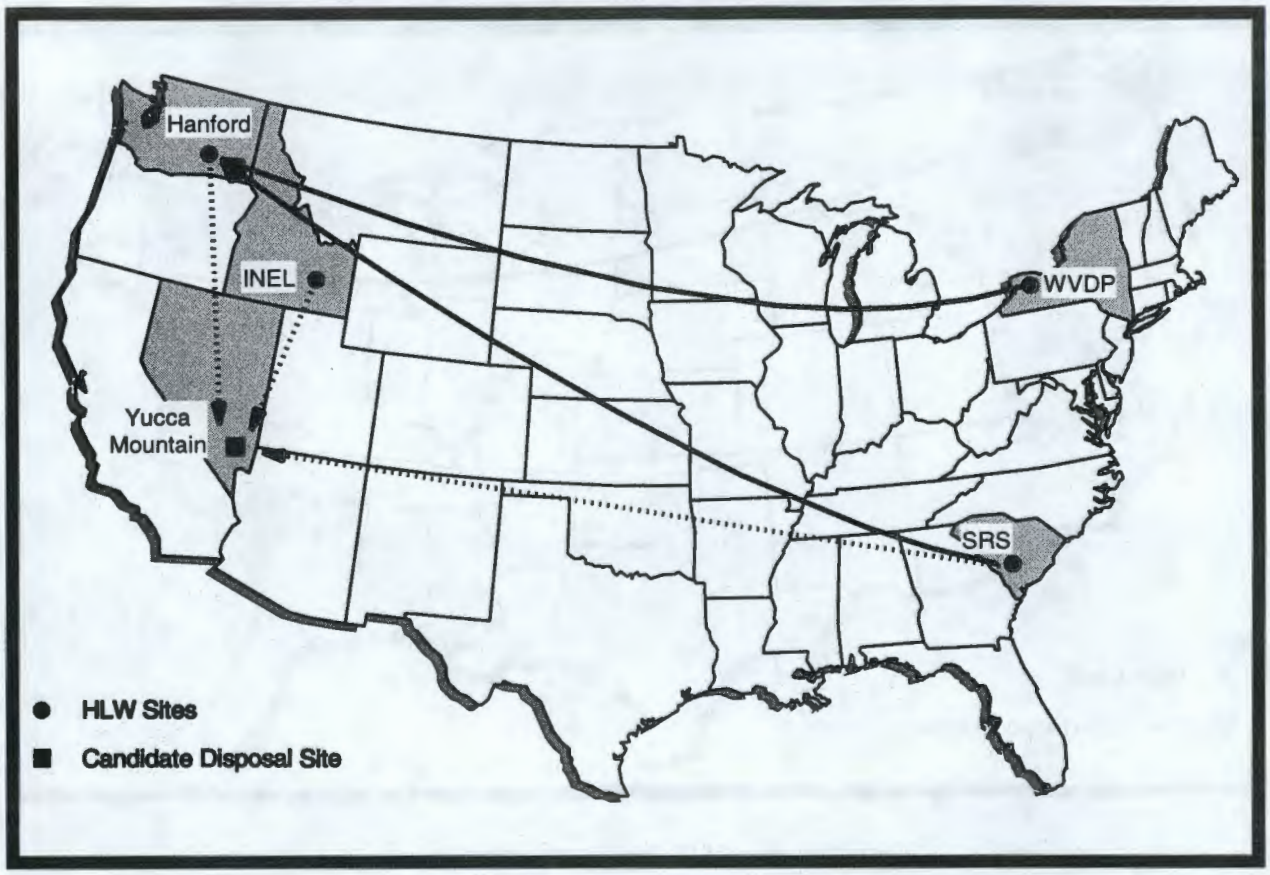

Figure 9.3–5. HLW Centralized Alternative—Geologic Repository Operates in 2015

Activity	Hanford[a]	INEL	SRS		WVDP	Totals
Number of Canisters Stored	17,500	1,700	2,199		0	21,600
Number of Canister Shipments	17,500	1,700	2,199	2,373	340	24,300
Shipment Destination	Geologic Repository	Geologic Repository		Storage at Hanford		

[a] Geologic repository begins accepting DOE-managed HLW in 2015: number of HLW canisters stored and shipped includes the 340 from WVDP and 2,373 from SRS that were initially shipped to the Hanford Site.

Table 9.3–5. HLW Centralized Alternative—Geologic Repository Operates in 2015

If this alternative were selected, the Hanford Site Tri-Party Agreement (1994) may have to be modified in consultation with the State of Washington to include a provision for the storage of INEL, SRS, and WVDP HLW canisters and modify the start-up and completion construction dates for the Hanford Site canister storage facility.

Because the WM PEIS analyzed two different timing assumptions for acceptance of HLW at the repository, the assumptions for the Centralized Alternatives vary. The WM PEIS assumed only that HLW canisters produced before the repository begins accepting DOE-managed HLW in 2015 would be shipped to the Hanford Site for Centralized storage. The remaining canisters produced at SRS and INEL after 2015 would be shipped directly to the repository. WVDP produces all its canisters prior to 2015; therefore, all 340 canisters would be shipped to the Hanford Site. This would be the basis for only a fraction of the total number of canisters being centrally stored at the Hanford Site. For the scenario where acceptance of DOE-managed HLW at the repository is delayed past 2015, all canisters produced at WVDP, SRS, and INEL would be shipped to the Hanford Site for storage prior to shipment to the repository once it begins accepting HLW; this scenario is illustrated in Figure 9.3–6 and Table 9.3–6.

9.3.6 Rationale for Selecting Storage Sites

The five HLW storage alternatives were developed to cover the range of reasonable alternatives. From one to four sites are available for storage of HLW canisters (the Centralized and Decentralized Alternatives, respectively). DOE selected two intermediate alternatives, transporting the relatively small amount of WVDP HLW canisters to either the Hanford Site or SRS. To select the Regionalized Alternatives, DOE focused on the sites with the largest amount of HLW canisters (Hanford) and where transportation would be minimized (SRS). INEL was eliminated from consideration as a Regionalized Alternative site because it has no existing or approved storage facilities.

In the Centralized Alternative, all HLW canisters would be shipped to the Hanford Site for storage. The Hanford Site was selected because it is a reasonable estimate of the impacts no matter which site is ultimately selected. The major variable is the total miles transported between existing DOE sites, the central storage site and the repository. Consolidating all HLW canisters at the Hanford Site minimizes transportation for Centralized storage, because the largest number of canisters (those produced at Hanford) would be shipped directly to the repository. Choosing an eastern site is not considered reasonable because

HLW Centralized Alternative—Shipment to Repository Later Than 2015

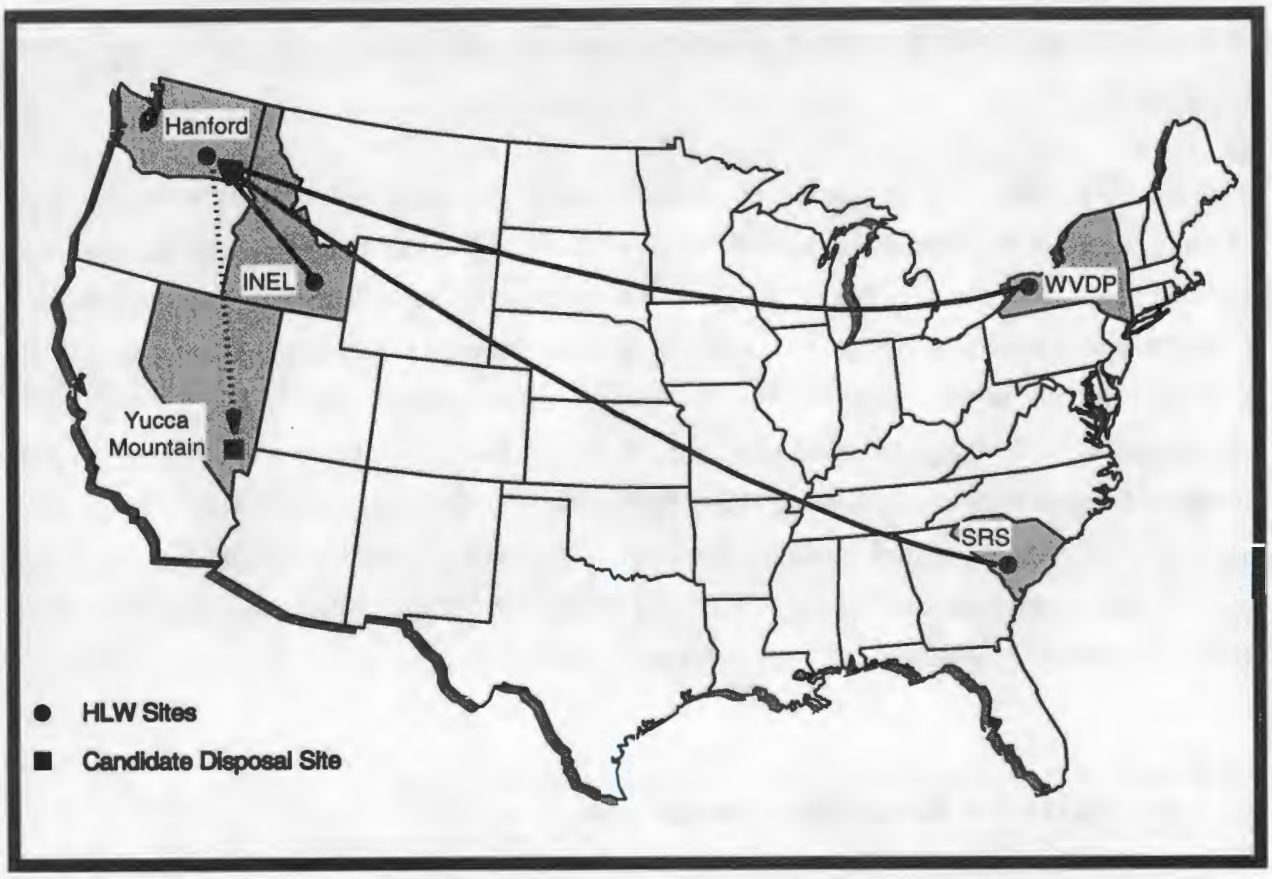

Figure 9.3-6. HLW Centralized Alternative—Geologic Repository Operates Later Than 2015

Activity	Hanford[a]	INEL	SRS	WVDP	Totals
Number of Canisters Stored	21,600	0	0	0	21,600
Number of Canister Shipments	21,600	1,700	4,572	340	28,200
Shipment Destination	Geologic Repository	Storage at Hanford			

[a] Acceptance of DOE-managed HLW at a geologic repository is delayed past 2015: number of HLW canisters stored and shipped includes 340 from WVDP, 4,572 from SRS, and 1,700 from INEL that were initially shipped to the Hanford Site.

Table 9.3-6. HLW Centralized Alternative—Geologic Repository Operates Later Than 2015

it would require the greatest number of canisters (those at Hanford and INEL) to be transported twice across the United States (the only site currently under consideration as a candidate repository is Yucca Mountain, Nevada). WVDP was eliminated from consideration for the Centralized Alternative because it has the smallest volume of HLW canisters, only 1.6% of the total HLW canisters, and would be inconsistent with the West Valley Demonstration Project Act.

9.4 Health Risks

Both fatalities and cancer incidences for WM workers are comparable for the Decentralized, Regionalized, and Centralized Alternatives and do not favor one alternative over another. Worker cancer fatalities from radiation exposure exceed fatalities from physical hazards. Transportation risks are approximately the same for all alternatives.

Health risk impacts can result from exposure to radiation and from physical trauma associated with constructing and operating storage facilities or transporting waste. Health effects resulting from radiation, whether from sources external or internal to the body, can affect either the exposed individual (known as a "somatic" effect [e.g., cancer]) or descendants of the exposed individual (known as a "genetic" effect). This section discusses the estimated adverse health impacts resulting from radiation exposure as well as the physical hazards for each HLW storage alternative. Details of the HLW results are contained in Appendices D, E, and F. Methodology details are contained in Chapter 5 and in ORNL technical reports (ORNL, 1995a-c).

The potential health risks from the construction and routine operation of HLW storage facilities were evaluated for the waste management worker population (or "WM workers"). The WM worker population includes onsite employees working in a site's waste management facilities, construction workers who build the waste management facilities, and those operating the trucks and trains that transport the waste. Other receptor groups were not considered for routine facility operation impacts. The offsite population and noninvolved worker population (see Section 5.4.1.2) were considered in the evaluation of potential HLW storage facility accidents (Section 9.4.3).

The impacts evaluated were:

- Fatalities from physical hazards
- Cancer fatalities from radiation exposure

- Cancer incidences from radiation exposure
- Genetic effects from radiation exposure

9.4	*Health Risks*
9.5	*Air Quality Impacts*
9.6	*Water Resources Impacts*
9.7	*Ecological Resources Impacts*
9.8	*Economic Impacts*
9.9	*Population Impacts*
9.10	*Environmental Justice Concerns*
9.11	*Land Use Impacts*
9.12	*Infrastructure Impacts*
9.13	*Cultural Resources Impacts*
9.14	*Costs*
9.15	*Comparison of Alternatives Summary*

9.4.1 Routine Operation Impacts

For operations involving storage of HLW canisters, waste management workers directly involved in storage activities are the only population of concern for potential adverse health effects. Waste management workers are at risk of developing adverse health effects as a result of the external dose from the presence of high activity radionuclides in vitrified HLW and from physical trauma resulting from storage facility construction and operation accidents. Health risks from the chemical constituents of vitrified HLW canisters in storage are not estimated since vitrifying the HLW minimizes the exposure to workers and the public. Waste management worker health risks are presented as the *total number* of workers who are estimated to experience adverse health impacts if a particular alternative is implemented. Table 9.4–1 provides the number of waste management storage workers analyzed by alternative. These numbers are derived from generic baselines which established the number of personnel required to operate storage facilities needed to manage a given number of canisters.

Worker risks associated with physical hazards were evaluated for between 20 and 45 years of construction and operation, depending on the site. In addition, these estimates included risks due to loading HLW canisters into storage, storage, and loading HLW canisters onto trucks for shipment. Worker risks from direct radiation exposure were evaluated for an entire lifetime (70 years), because health impacts could occur throughout the lifetime of the exposed individual.

Table 9.4–2 provides an overview of the health risk endpoints, hazard sources, pathways, and exposure periods evaluated for HLW canister storage.

This human health risk analysis includes evaluation of both the potential numbers of fatal cancers as well as the numbers of total cancer incidences induced by exposure to radionuclides and direct radiation. The

Table 9.4–1. Waste Management Storage Workers Population by Alternative

Site	WM Storage Workers Population by Alternative[a]				
	No Action	Decentralized	Regionalized 1	Regionalized 2	Centralized
Hanford	113	197	197	197	210
INEL	0	81	81	81	81
SRS	102	102	102	102	93
WVDP	23	23	23	23	23

[a] Values represent the number of full-time equivalents (FTEs) over the entire storage period evaluated.

Table 9.4–2. HLW Health Risk Analysis Components

HLW Canister Storage					
Endpoints	Receptor	Source	Pathways	Exposure Period	Table Reference
Number of trauma fatalities	WM workers	Physical hazards	Physical hazards	20–45 years[a]	9.4–4
Number of cancer fatalities	WM workers	Radionuclides	Inhalation, direct radiation	10–35 years	9.4–4
Number of cancer incidences	WM workers	Radionuclides	Inhalation, direct radiation	10–35 years	9.4–6
Number of genetic effects	WM workers	Radionuclides	Inhalation, direct radiation	10–35 years	9.4–6

[a] Period includes 10-year duration of construction.

numbers of nonfatal cancers can be derived from the cancer incidence values by subtracting the estimated number of fatal cancer cases.

9.4.1.1 Estimated Number of Fatalities

Table 9.4–3 presents an overview, by alternative, of the total program wide fatalities associated with storage of HLW canisters until the repository begins accepting DOE-managed HLW in 2015. For HLW operations, fatalities resulting from direct radiation exposure are estimated to be greater than those from physical hazards for all alternatives.

Table 9.4–3. HLW Canister Storage: Estimated Number of Fatalities Programwide

Alternative	Number of Storage Sites	Storage Acceptance at the Repository Beginning in 2015	
		WM Worker Radiation Exposure	WM Worker Physical Hazards
No Action	4	2	1
Decentralized	4	3	1
Regionalized 1	3	3	1
Regionalized 2	3	3	2
Centralized	1	3	2

Understanding Scientific Notation

Scientific notation is used in the WM PEIS to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers (or exponents) of 10. A number written in scientific notation is expressed as the product of a number between 1 and 10 times a positive or negative power of 10. Some positive and negative powers of 10 include:

Positive Powers of 10
$10^1 = 10 \times 1 = 10$
$10^2 = 10 \times 10 = 100$
and so on, therefore,
$10^6 = 1{,}000{,}000$ *(or 1 million)*
etc.

Negative Powers of 10
$10^{-1} = 1/10 = 0.1$
$10^{-2} = 1/100 = 0.01$
and so on, therefore,
$10^{-6} = 0.000001$ *(or 1 in 1 million)*
etc.

A power of 10 is also commonly expressed as "E," where "E" means "× 10." For example, 3×10^5 *can also be written as 3.0E+05, and* 3×10^{-5} *is equivalent to 3.0E–05. Therefore, 3.0E+05 = 300,000 and 3.0E–05 = 0.00003.*

The health risk data tables in this section use "E" notation with negative exponents. Probability is expressed as a number between 0 and 1. The notation 3.0E–06 can be read 0.000003, which means that there are three chances in 1,000,000 that the associated result (e.g., total cancer) will occur in the period covered by the analysis.

On a site-level basis, the number of latent cancer fatalities from direct radiation exposure is estimated to equal or exceed one only at the Hanford Site under all alternatives and at SRS under No Action and Regionalized Alternative 1. Estimated latent cancer fatalities for HLW can be found in Volume II in the site data tables for Hanford, INEL, SRS, and WVDP.

Cancer fatalities were also evaluated as annual incremental risks for each year past 2015 if acceptance of DOE-managed HLW by the repository is delayed. Estimated annual fatality risks for both radiation exposure (cancer) and physical hazards varied slightly from site to site; however, for a given site, the estimated values were generally constant across the proposed alternatives. These values are presented in Table 9.4–4.

9.4.1.2 Estimated Number of Cancer Incidences and Genetic Effects

Table 9.4–5 presents an overview, by alternative, of the total programwide estimated cancer incidences and genetic effects associated with direct radiation exposure received as a result of storage of HLW until the repository begins accepting DOE-managed HLW in 2015. Cancer incidence is estimated to exceed one under each alternative; the No Action Alternative has the lowest estimated number of radiation-induced latent cancers. Genetic effects incidence equal to one was estimated only under the Centralized Alternative.

Table 9.4–4. HLW Storage: Incremental Annual Exposure Risks Associated With Storage Beyond 2015

	Hanford		INEL		SRS		WVDP	
Alternative	**WM Worker Radiation Exposure Fatalities**	**WM Worker Physical Hazard Fatalities**	**WM Worker Radiation Exposure Fatalities**	**WM Worker Physical Hazard Fatalities**	**WM Worker Radiation Exposure Fatalities**	**WM Worker Physical Hazard Fatalities**	**WM Worker Radiation Exposure Fatalities**	**WM Worker Physical Hazard Fatalities**
No Action	2E–03	1E–03	0	0	7E–03	3E–03	2E–03	7E–04
Decentralized	4E–02	2E–02	3E–03	1E–03	7E–03	3E–03	2E–03	7E–04
Regionalized 1	4E–02	2E–02	3E–03	1E–03	7E–03	3E–03	0	0
Regionalized 2	4E–02	2E–02	3E–03	1E–03	7E–03	3E–03	0	0
Centralized	5E–02	2E–02	0	0	0	0	0	0

Table 9.4–5. HLW Canister Storage: Estimated Number of Cancer Incidences and Genetic Effects Programwide

Alternative	Number of Storage Sites	Storage Assuming Acceptance at the Repository Beginning in 2015		
		WM Worker Population Dose (person-rem)	WM Worker Radiation Cancer Incidence	WM Worker Radiation Genetic Effects
No Action	4	5,400	8	*
Decentralized	4	8,100	11	*
Regionalized 1	3	8,100	11	*
Regionalized 2	3	8,200	12	*
Centralized	1	8,400	12	1

Note: * = greater than 0 but less than 0.5.

On a site-level basis, estimated cancer incidences equaled or exceeded one at the Hanford Site, INEL, and SRS under all alternatives. Genetic effects incidence was not estimated to exceed one at any site under any alternative. Estimated cancer incidences and genetic effects for HLW can be found in Volume II in the site data tables for Hanford, INEL, SRS, and WVDP.

Estimated cancer incidence and genetic effects incidence were evaluated as annual incremental risks for each year past 2015 if acceptance of DOE-managed HLW by the repository is delayed. Estimated annual cancer incidence and genetic effects risks varied slightly from site to site; however, for a given site, the estimated values were generally constant across the proposed alternatives. The estimated annual cancer incidence and genetic effects incidence risks are presented in Table 9.4-6.

9.4.2 Transportation-Related Impacts

The transportation of HLW canisters between sites and to the repository is expected to affect the health of the truck or rail crew and the public along the transportation route because of exposure to radiation and vehicle exhaust and physical trauma from vehicle accidents. Appendix E contains a description of the methods used to estimate transportation risks.

Table 9.4–6. HLW Storage: Incremental Annual Exposure Risks Associated With Storage Beyond 2015

Alternative	Hanford		INEL		SRS		WVDP	
	WM Worker Radiation Cancer Incidence	WM Worker Radiation Genetic Effects	WM Worker Radiation Cancer Incidence	WM Worker Radiation Genetic Effects	WM Worker Radiation Cancer Incidence	WM Worker Radiation Genetic Effects	WM Worker Radiation Cancer Incidence	WM Worker Radiation Genetic Effects
No Action	8E–03	4E–04	0	0	3E–02	1E–03	6E–03	2E–04
Decentralized	1E–01	5E–03	1E–02	5E–04	3E–02	1E–03	6E–03	2E–04
Regionalized 1	1E–01	5E–03	1E–02	5E–04	3E–02	1E–03	0	0
Regionalized 2	1E–01	5E–03	1E–02	5E–04	3E–02	1E–03	0	0
Centralized	2E–01	8E–03	0	0	0	0	0	0

Table 9.4–7 presents the estimated transportation fatality totals for workers and the public resulting from radiation exposure associated with vitrified HLW canisters and vehicle exhaust emissions, as well as from vehicle accidents. Shipment of vitrified HLW canisters by truck is estimated to produce approximately five deaths in the crew and the public from radiological exposure and traffic accident injuries, whereas, one death might be expected from rail shipments. The estimated number of radiation-induced cancer fatalities listed in Table 9.4–7 is higher for the public than the crew because the public, as a group of receptors, contains more individuals than the crew. As described in Appendix E, the public includes individuals living along the transportation route, people traveling along the highway, and individuals at rest stops. The public would receive a higher collective dose than the crew, but more individuals of the public are potentially exposed, with a single member of the public receiving a much lower dose than a member of the crew.

9.4.3 Facility Accident Impacts

Vitrified HLW is very stable; therefore, the only accident likely to occur is the dropping of a vitrified HLW canister in a storage facility. To determine the consequences of a storage facility accident, a hypothetical accident was analyzed in

Maximally Exposed Individual (MEI)

In keeping with the standard risk assessment methodology, DOE analyzed the impacts to a "maximally exposed individual." The MEI is the hypothetical person within the receptor group who has the highest exposure. This individual is assumed to be located at the point of maximum concentration of contaminants.

Table 9.4–7. HLW Truck and Rail Transportation: Estimated Fatalities From Vehicular Accidents and Exposure to Radiation and Fuel Emissions

Alternative	Number of Shipments		Shipment Miles in Millions		Estimated Number of Radiological Fatalities[a]					
					Routine Operations Public		Routine Operations Crew		Exposure From Traffic Accidents	
	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail
No Action	19,912	3,983	29.4	6.68	2	*	1	*	*	*
Decentralized	21,612	4,323	30.7	6.93	2	*	1	*	*	*
Regionalized 1	21,952	4,391	31.0	7.04	2	*	1	*	*	*
Regionalized 2	21,952	4,391	31.2	7.03	2	*	1	*	*	*
Centralized 1[b]	24,325	4,866	34.6	7.70	2	*	1	*	*	*
Centralized 2[c]	28,224	5,646	39.5	8.74	2	*	1	*	*	*

Alternative	Number of Shipments		Shipment Miles in Millions		Estimated Number of Nonradiological Fatalities			
					Fuel Emission		Injury From Traffic Accidents	
	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail
No Action	19,912	3,983	29.4	6.68	*	*	2	*
Decentralized	21,612	4,323	30.7	6.93	*	*	2	*
Regionalized 1	21,952	4,391	31.0	7.04	*	*	2	*
Regionalized 2	21,952	4,391	31.2	7.03	*	*	2	*
Centralized 1[b]	24,325	4,866	34.6	7.70	*	*	2	*
Centralized 2[c]	28,224	5,646	39.5	8.74	*	*	2	*

Notes: * = greater than 0 but less than 0.5.
[a] Fatalities are from radiation-induced latent cancer.
[b] Centralized Alternative 1 assumes storage until repository begins accepting DOE-managed HLW in 2015.
[c] Centralized Alternative 2 assumes acceptance at the repository is delayed past 2015.

which a severe drop caused a breach in a vitrified HLW canister. The canister would be inside a contained, shielded environment, but a small quantity of radioactive material could be released to the air because of the breach. Table 9.4–8 contains the results of the analysis for potential storage facility accidents. If a facility's HEPA filtration system was not functioning, allowing the entire quantity of contaminated air released from the canister to escape from the building, no deaths among the offsite population or workers are estimated from such an accident. Appendix D contains additional details.

Table 9.4–8. HLW Facility Accidents: Cancer Fatalities From Potential Maximum Reasonably Foreseeable Storage Facility Accidents

Filtered Canister Breach Accident	Hanford	SRS	WVDP	INEL
Offsite population	*	*	*	*
Offsite MEI	3E–08	4E–12	2E–10	2E-11
Noninvolved worker population	*	*	*	*
Noninvolved worker MEI	1E–09	4E–11	2E–11	3E-12
Waste management workers	*	*	*	*
Unfiltered Canister Breach Accident[a]				
Offsite population	*	*	*	*
Offsite MEI	3E-06	2E–06	9E–05	9E-06
Noninvolved worker population	*	*	*	*
Noninvolved worker MEI	4E-05	2E–05	1E–05	2E-06
Waste management workers	*	*	*	*

Notes: * = greater than 0 but less than 0.5; NA = not applicable. The values for offsite population, noninvolved worker population, and waste management workers are numbers of latent cancer fatalities; the values for MEIs are probabilities of fatality. Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.

[a] The unfiltered canister breach accident is included due to its high consequences, even though it is not a "reasonably foreseeable" accident in terms of frequency (i.e., annual frequency of occurrence less than 1E–06).

9.4.4 Risks From Canisters From Foreign Reactor Spent Nuclear Fuel

As discussed in Section 9.2.3, additional canisters of HLW would be generated from foreign research reactor spent nuclear fuel and other sources during chemical processing. At SRS, an additional 200 canisters would represent an increase of 4.4%. At INEL, an additional 300 canisters would represent an increase of 18%. Although the WM PEIS did not quantitatively evaluate the storage and transport of these additional canisters, the incremental risks associated with their storage, handling, and shipment are expected to be small, assuming that the canisters are similar to others being managed at each site.

For canisters with comparable radiological characteristics, the additional risks would be proportional to the increase in the number of canisters. The additional canisters would add between 0.04–0.05 expected worker fatalities at SRS and approximately 0.02 worker fatalities at INEL for the range of alternatives. Truck transport of the additional canisters would increase the total HLW transport mileage by 0.6% to 3.2%, depending on the alternative selected, leading to 0.04–0.02 total additional fatalities from transportation. Transport by rail would result in even lower risks.

9.5 Air Quality Impacts

The management of HLW would not appreciably affect the air quality at any site. No criteria air pollutants would exceed standards at any site. Emissions of hazardous air pollutants (including radionuclides) and toxic air pollutants from storage facilities, were assumed to be negligible.

As illustrated in Table 9.5–1, DOE evaluated air quality impacts at each proposed HLW canister storage site based on estimated increases in emissions of the six criteria air pollutants. Hazardous air pollutant emissions (which include radionuclides), and toxic air pollutant emissions from HLW canister storage facilities were assumed to be negligible given the physical form of vitrified HLW. Once HLW is vitrified, the glass matrix binds the radionuclides and hazardous chemicals preventing releases to the atmosphere. Criteria air pollutant emission estimates were made for HLW facility construction activities and for operation and maintenance activities.

The Clean Air Act (42 USC 7401 *et seq.*) regulates emissions of air pollutants. In those areas where air pollution standards are not met (known as "nonattainment areas"), activities that introduce new sources of emissions from both "stationary" (e.g., storage facilities) and mobile (e.g., vehicles and construction equipment) sources are regulated under the "General Conformity Rule." In this rule, EPA has established limits for each criteria air pollutant. An entity which seeks to engage in an activity that will result in emissions that equal or exceed those limits in a nonattainment area must first obtain a permit.

Table 9.5–1. Air Quality Impacts Evaluated for HLW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Criteria air pollutant emissions	Construction	Estimated for construction equipment and worker vehicles	Percent of standard	Text discussion only
	Operations and maintenance	Estimated for fuel use by HLW facilities, for worker vehicles, and for waste shipment vehicles	Percent of standard	Text discussion only

In "attainment areas" (where air pollution standards are met), only new sources of emissions from stationary sources are regulated. In these areas, regulations for the Prevention of Significant Deterioration (PSD) of ambient air quality apply. Allowable emission increases are known as PSD increments. A permit is required for a new stationary source that equals or exceeds the allowable increase. However, a permit is not required for criteria air pollutant emissions from mobile sources.

9.5.1 Criteria Air Pollutant Emissions From Construction

Criteria air pollutants can be emitted from construction equipment and from vehicles that workers use to drive to the construction site ("mobile sources").

For purposes of analysis, DOE identified sites in nonattainment areas where construction activities under all the HLW alternatives would result in emissions that would equal or exceed 10% of the allowable limit of a particular criteria air pollutant. DOE chose the 10% threshold to highlight those sites where criteria air pollutant emissions could result in adverse air quality impacts.

Major Types of Air Pollutants

***Criteria Air Pollutants**: carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), and particulate matter less than or equal to 10 micrometers in diameter (PM_{10})*

***Hazardous Air Pollutants**: 189 hazardous substances (including radionuclides) whose emissions are regulated by the Clean Air Act*

***Toxic Air Pollutants**: Other toxic compounds regulated by EPA and state or local governments*

DOE estimates that no site would have emissions from construction activities that would equal or exceed 10% of allowable levels. Therefore, no site would need to obtain a Clean Air Act permit.

9.5.2 Criteria Air Pollutant Emissions From Operations and Maintenance

Criteria air pollutants are also emitted during operations and maintenance (O&M) of HLW facilities ("stationary sources") and by vehicles that are driven by workers to the facility or used to transport waste ("mobile sources"). DOE evaluated air quality impacts for these pollutants at each site by comparing estimated increases in tons per year to the allowable emission limits (General Conformity Rules in nonattainment areas or PSD increments in attainment areas).

DOE estimates that no site would have emissions from O&M activities that would equal or exceed 10% of allowable levels. Therefore, no site would need to obtain a Clean Air Act permit.

The most stringent PSD requirements are for Class I areas. Class I areas are regions of special concern because they include national parks, monuments, seashores, wildlife refuges, or wilderness areas. A proposed action may affect air quality in a PSD Class I area if it will emit more than the allowable PSD increment of a criteria air pollutant and will be located within 100 km (62 miles) of a PSD Class I area. INEL is the only site proposed for HLW activities that is located within 100 km of a PSD Class I area, although emissions would be below levels that may affect a Class I area.

Concentrations resulting from criteria air pollutant emissions from stationary-sources were not compared to the National Ambient Air Quality Standards (NAAQS) (40 CFR 50) since there would be no stationary-sources (treatment facilities) for HLW.

9.5.3 Hazardous and Toxic Air Pollutant Emissions

Hazardous air pollutant (which include radionuclides) and toxic air pollutant emissions from HLW canister storage facilities were assumed to be negligible due to the physical form of the vitrified HLW. Once HLW is vitrified, the glass matrix binds the radionuclides and hazardous chemicals, such that releases to the atmosphere are negligible.

9.6 Water Resources Impacts

Major impacts to water resources at all affected sites are unlikely even if the HLW repository does not begin to accept DOE-managed HLW in 2015 and long-term storage of HLW canisters at the sites is required.

As illustrated in Table 9.6–1, DOE analyzed the impacts on water resources of HLW canister storage activities. DOE evaluated the effects on water availability from building and operating storage facilities. The impacts of long-term storage were also evaluated should the HLW repository be unable to accept DOE HLW beginning in 2015.

Table 9.6–1. Water Resource Impacts Evaluated for HLW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Water availability	Construction	Estimated for water used: • by personnel • for concrete • for dust suppression	Percent increase in current water use	Text discussion only
			Percent decrease in stream flow	Text discussion only
	Operations	Estimated for water used: • by personnel • by storage processes	Percent increase in current water use	Text discussion only
			Percent decrease in stream flow	Text discussion only
		Estimated for effluent discharged from sanitary and process wastewater treatment facilities	Percent increase in stream flow	Text discussion only

In addition, the following impacts were examined for all waste types collectively, and are discussed in Chapter 5, Section 5.4.3:

- Impacts on surface water caused by floodplain encroachment
- Impacts on surface water from runoff and sedimentation
- Impacts on surface water and groundwater quality from wastewater discharges
- Impacts on small onsite streams from wastewater discharges
- Impacts on existing areas of groundwater contamination from groundwater withdrawal
- Impacts on surface and groundwater water quality from routine transportation and transportation accidents

9.6.1 WATER AVAILABILITY

Impacts on surface water and groundwater availability were assessed by comparing current water use rates from municipal, surface water, or groundwater sources to projected requirements for construction or operation of HLW canister storage facilities. In addition, impacts on surface water were further assessed by examining the effect of potential withdrawals from and discharges to a major offsite stream at a given site.

As shown in the Volume II tables, projected water usage would increase by more than 1% only at WVDP. The 1% threshold is based on the assumption that lesser changes are not likely to have significant impacts.

Water use at WVDP would be 1.4% of current use for all alternatives under both sets of timing assumptions. The 1,000 gallons per day required for operations at WVDP would be supplied by surface water taken from two onsite reservoirs. Since normal household water use in the United States is estimated at approximately 105 gallons per day per person (Solley et al., 1988), water use rates that are equivalent to the water used by approximately 10 people are unlikely to cause major changes in surface water flow rates and levels.

As shown in the Volume II tables, for DOE sites that withdraw water directly from a surface water source (the Hanford Site and WVDP), water use would be less than 1% of the average flow in the surface water body. In addition, for this analysis, it was assumed that 100% of the water used at the facility during operations would be discharged as effluent from a wastewater treatment plant. For sites that discharge wastewater to natural surface waters (SRS and WVDP), effluent discharges would be less than 1% of the average flow in the principal receiving water body at all sites. These are negligible changes in flow that would not affect surface water levels.

9.6.2 Water Quality

Impacts to groundwater quality were not evaluated for HLW since disposal is not within the scope of the WM PEIS. However, groundwater quality will be addressed in the environmental impact statement for the repository.

9.7 Ecological Resources Impacts

Loss of limited acreages of habitat at the DOE sites during construction of HLW canister storage facilities should not affect populations of nonsensitive plant and animal species because these species habitats are well established regionally. Operation of HLW canister storage facilities would not affect ecological resources because airborne emissions and liquid effluents are expected to be negligible. DOE would be able to locate new HLW canister storage facilities to avoid impacts to nearby wetlands and other sensitive habitats because construction site acreages are small compared to the total acreage at each site suitable for waste operations. When specific HLW facility locations are proposed, DOE will conduct site- and project-level analyses to determine if any sensitive species, including Federally and State-listed endangered and threatened species, may be affected and will establish appropriate protection measures. Transportation accidents involving shipment of HLW canisters would be extremely rare and would not affect aquatic habitats because of the vitrified form of the HLW and special packaging.

DOE analyzed the ecological impacts of constructing HLW canister storage facilities (Table 9.7–1). The ecological impacts of operating HLW canister storage facilities and shipping HLW canisters among sites or to a geologic repository were not analyzed quantitatively. Airborne emissions and liquid effluents from HLW canister storage facilities and any resulting exposures of nearby ecological communities are expected to be negligible. HLW transportation accidents involving a spill into an aquatic environment are expected

Table 9.7–1. Ecological Resources Impacts Evaluated for HLW Alternatives

Ecological Impact Analyzed	Affected Ecological Resource	Analysis Method	Presentation of Results
Nonsensitive habitat effects	Terrestrial plants and animals	Comparison of habitat loss at HLW construction sites to general habitat range	Text discussion
Sensitive habitat effects	Nearby wetlands and other sensitive habitats	Likelihood of impacts to nearby sensitive habitats by comparing construction acreage to available acreage of nonsensitive habitats	Text discussion
Sensitive species concerns	Sensitive species including Federally and State-listed endangered and threatened species	Numbers of Federally and State-listed species displayed by site/alternative	Text discussion

to be extremely rare. Even if such an accident does occur, the vitrified form of HLW, and the design of the Type B shipping cask will prevent any substantial release of radionuclides. Type B shipping casks are designed to maintain the integrity of the package with essentially no loss of radionuclide content or serious impairment of the shielding capability even in a severe accident.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to sensitive species and habitats based on site-specific conditions.

9.7.1 General Impacts of Site Clearing

The extent of construction site clearing would be extremely small for any HLW alternative at any site relative to the extent of the general habitats supported at the sites. Acreage requirements for alternatives involving storage of HLW canisters ranged from 1 acre at the Hanford Site under the No Action Alternative to 16 acres at the Hanford Site under the Centralized Alternative. Therefore, although site clearing will destroy individual plants and will kill or displace individual animals, particularly small mammals and song birds with limited home ranges, no significant effects to general species populations or communities are expected from implementation of any HLW alternatives.

9.7.2 Site Clearing Effects on Sensitive Habitats

All four HLW sites contain sensitive habitats. The closer the HLW canister storage facility construction activities are to those habitats, the more likely that they would be affected by noise or vibration disturbance, human presence, vehicle or equipment emissions, runoff, or encroachment. Avoiding such impacts depends on DOE's ability to avoid locating the facilities near these habitats. A measure of this ability is the percentage of available land that facility construction under any HLW alternative requires at a site. Available acreage was estimated from site development plans, either as land designated for waste operations or by subtracting the acreage of existing structures and sensitive habitats, such as wetlands and wildlife management areas, from the total site acreage. The analysis showed that the percent of available acreage ranged from 0.001% under several alternatives to about 0.26% at the Hanford Site under the Centralized

Alternative. DOE would therefore have a great degree of flexibility in siting facilities and effects on sensitive habitats should be avoided. Even if these habitats could not be avoided, mitigation measures could be employed.

Aquatic resources may be indirectly affected through increased runoff and sedimentation loadings to surface waters from disturbed terrestrial areas. However, the use of various mitigation techniques should minimize potential storage facility construction impacts to aquatic ecological resources. Direct discharges to surface waters from the routine operation of HLW canister storage facilities are expected to be limited by the use of engineering control practices. Therefore, the impacts to aquatic organisms are expected to be minimal.

9.7.3 Consideration of Sensitive Species

Federally and State-listed endangered species can be found on all four HLW sites. The number of species occurring or potentially occurring at each of the HLW sites is—the Hanford Site: 3/11, INEL: 2/2, SRS: 8/8, and WVDP: 1/8; where the first number indicates Federally listed species and the second number indicates State-listed species. No major construction is proposed at WVDP under any of the HLW alternatives nor INEL under the No Action Alternative. Major construction actions are proposed at INEL for all other alternatives and at the Hanford Site and SRS under all HLW alternatives. However, site-specific analysis would be required to assess these impacts. Such analysis would take into account specific siting locations for the HLW canister storage facilities in relation to the location of sensitive habitats and sensitive species at each site, including those listed by the U.S. Fish and Wildlife Service as endangered or threatened.

9.7.4 Effects of HLW Transportation Accidents

The ecological impacts of a transportation accident involving shipment of HLW canisters on aquatic environments are expected to be minimal. Like TRUW, HLW will be shipped in type B Casks/Containers, which should limit any potential release of radionuclides or hazardous chemicals in the waste to surface waters. In addition, vitrification of the HLW further limits any potential releases if the shipping casks were breached during an accident.

9.8 Economic Impacts

HLW canister storage facility construction and operations expenditures would minimally benefit the local economy at the four HLW sites because estimated job and personal income for all HLW alternatives are well below 1% of regional employment and income at all sites. None of the HLW alternatives would significantly affect the national economy, although 400 to 1,400 jobs would be directly or indirectly financed.

DOE estimated the effects of expenditures for HLW management on the local and national economies. Local economic effects were based on direct expenditures at each site for construction, operation and maintenance, and decontamination of HLW canister storage facilities. The socioeconomic region of influence (ROI), consists essentially of the counties of residence of site employees. The local economy at each site was represented by employment, personal income, and industry data. Local increases in jobs and personal income were considered to be substantial benefits where they were 1% or greater than the 1990 baseline. Transportation expenditures were considered at a national level only.

Local economic effects were estimated on an annual basis (Table 9.8–1). Activities at the HLW sites vary from site to site among alternatives, many continuing well beyond the anticipated repository acceptance date of 2015.

Because the regional economies are subject to changes induced by many different variables other than DOE expenditures, DOE believed that estimating economic benefits beyond 2015 would be speculative. Therefore, the analysis was confined to estimating the economic effects of the total HLW canister storage facility construction and operations expenditures at each site for the 20-year period from 1996 to 2015. Costs beyond 2015 were not used to estimate economic benefits but are compared to show overall HLW alternative differences. Five years was added to the base 20-year period for determining annual economic impacts to account for the continued effects of DOE expenditures on employment and income after the end of the base period. Job and personal income increases are shown for each site in the Volume II site tables.

Table 9.8-1. Economic Impacts Evaluated for HLW Alternatives

Economic Effects Analyzed	Affected Economic Resource	Analysis Method	Presentation of Results
Increased regional employment	Regional employment for direct, indirect, and induced jobs	Proposed site expenditures multiplied by regional employment multiplier at each HLW site	Text discussion
Increased regional incomes	Regional personal income	Proposed site expenditures multiplied by regional income multiplier at each HLW site	Text discussion
National economic effects	National economy	Proposed site expenditures plus total transportation expenditures multiplied by national employment and income multipliers	Text discussion
Costs beyond the year 2015	Continued annual program effects on regional and national employment and personal income	Display minimum and maximum costs beyond 2015 by site and alternative	Text discussion

9.8.1 ACCEPTANCE AT THE REPOSITORY BEGINNING IN 2015

Across the HLW alternatives, none of the sites would experience a 1% or greater increase in the number of jobs or in personal income between 1996 and 2015 as a result of expenditures for HLW. A comparison of alternatives reveals that the number of new direct, indirect, and induced jobs from the construction and operation and maintenance activities in the ROIs range from 410 (under the No Action Alternative) to 670 (under the Regionalized 2 Alternative).

In addition to an evaluation of the effects on the regional economy, a comparison of these effects was made on the national economy. None of the HLW alternatives would substantially affect employment in the national economy. The number of jobs generated in the national economy from combined weighted construction and operations phase activities ranges from 480 under the No Action Alternative to 1,200 under the Centralized Alternative. Although the number of jobs appears large in absolute terms, 1,200 jobs represent 0.0009% of the 137 million jobs in the national economy. There are no substantial changes in personal income for the nation as a whole as a result of implementing any of the alternatives. It is likely that any changes would represent a shift in the source of income from previous employment to employment in HLW projects, rather than a net change in national personal income.

9.8.2 Repository Acceptance Delayed Past 2015

Across the HLW alternatives, none of the sites would experience a 1% or greater change in jobs or personal income. The number of new direct, indirect, and induced jobs from HLW canister activities between 1996 and 2015 ranges from 410 (under the No Action Alternative) to 690 (under the Centralized Alternative).

The HLW alternative would only minimally benefit employment in the national economy even if acceptance of HLW canisters at a geologic repository is delayed past 2015. The number of jobs generated in the national economy ranges from 480 under the No Action Alternative to almost 1,400 under the Centralized Alternative. The 1,400 jobs represent 0.001% of the 137 million jobs in the national economy. It is likely that any changes would represent a shift in the source of income from previous employment to employment in HLW canister storage projects, rather than a net change in national personal income.

Any economic impacts of expenditures beyond 2015 were not included but would derive from expenditures for additional storage of the canisters that are currently assumed to go straight to the repository. The additional interim storage at the Hanford Site, location of potential greatest impact, could cost as much as $180 million to construct storage for 3,887 additional canisters in the Centralized Alternative.

9.9 Population Impacts

The overall population in-migration remains relatively constant under all proposed alternatives and does not result in a major increase at any site. No corresponding changes to community characteristics or the provision of services would be anticipated.

Potential population changes in the ROI at each HLW site were estimated using the direct labor requirement to calculate potential worker in-migration. These estimates were used to evaluate the likelihood that associated effects would result, such as changes in community size and diversity, or changes in the provision of necessary services.

Because the scope of activity and the associated labor requirement proposed under each of the alternatives is relatively small, the overall impact of population in-migration would be negligible. No site would

experience ROI population increases greater than 0.1% of the current ROI population under any of the alternatives.

9.10 Environmental Justice Concerns

Assessment of potential environmental justice impacts from management of HLW canisters indicated that minority and low-income populations at the HLW sites would not experience disproportionately high and adverse health risks or environmental impacts under any of the HLW alternatives.

Analysis of environmental justice impacts from management of HLW canisters was based on a review of the impacts reported in this chapter regarding the HLW alternatives. This analysis was performed to identify any disproportionately high and adverse human health or environmental impacts on minority populations or low-income populations surrounding each of the four HLW sites. Chapter 5 summarizes the methods and Appendix C provides the details of how this analysis was done. Appendix C also provides maps illustrating the distribution of minority and low-income populations within 50 miles of each HLW site.

9.10.1 Results

The potential is low for adverse human health effects from exposure to radionuclide emissions from HLW canister storage facility operations. The calculated risk of cancer fatalities (see Section 9.4.1) associated with storage facility operations is small for radionuclide-related cancer for the offsite maximally exposed individual. Therefore, disproportionately high and adverse health effects to any segment of the population, minorities and low-income populations included, from HLW canister storage facility accidents are not expected to occur.

9.10.1.1 Transportation

Because incident-free HLW transportation and reasonably foreseeable transportation accidents are not expected to result in disproportionately high and adverse human health effects to minority or low-income

populations, no environmental justice impacts are expected. As Section 9.4.2 indicates, the total number of potential fatalities is the sum of the fatalities caused by exposure to radiation and the fatalities caused by exposure to vehicular emissions. The total number of truck shipments during HLW canister storage facility operations would vary from about 20,000 under the No Action Alternative to about 28,000 shipments under the Centralized Alternative 2. The estimated total cancer fatalities resulting from incident-free transportation range from less than 0.5 to 3 fatalities under the HLW alternatives. This small number of collective population fatalities is spread across a large number of shipments. A disproportionate share of minority and low-income populations reside near interstate highways and railroads; however, the major routine risks to the public from truck transportation are from exposure during rest stops to travelers who are at the same rest stops. Minority and low-income populations are found to be disproportionately lower in representation at highway rest stops (DOT, 1992). For rail shipments, the primary risks to the public are from radiological exposure during railcar classification in railyards, primarily at the start and end of each shipment, and from the emission of diesel exhaust from the trains in urban areas.

The expected number of cancer fatalities due to radiation exposure from transportation accident releases is less than 0.5 under all alternatives. The expected number of transportation accident fatalities from trauma is also less than 0.5 under any HLW alternative. Therefore, no disproportionately high and adverse effects are expected to any particular segment of the population, including minority or low-income groups.

9.10.1.2 Environmental Impacts

In addition to the above, reviews of other technical disciplines pursuant to the methodology in Section 9.10.1 did not indicate any adverse impacts to air quality, water resources, ecology, economics, populations, land use, infrastructure, or cultural resources impacts. Therefore, no disproportionately high and adverse environmental impacts are expected for any segment of the populations at the HLW sites, including minorities and low-income populations.

9.11 Land Use Impacts

No impacts to current onsite or offsite land uses would result from implementing any of the HLW alternatives because for all the sites, land requirements to build HLW canister storage facilities are less than 1% designated or suitable lands. In addition, the proposed HLW canister storage facilities do not conflict with the development plans for any site.

DOE examined the impacts of the alternatives on land use by comparing the acreage required for new HLW canister storage facilities to the acreage either designated for waste operations or suitable for development (see Table 9.11–1). Suitable land is the total site acreage, minus the acreage required for existing facilities and roads, known cultural resource areas, sensitive habitats (including wetlands and wildlife management areas), prohibitive topographic features, and surface waters. Available site development plans were also used to identify potential conflicts between the proposed facilities required under each alternative and plans for future site uses.

The land requirements analysis indicated that, for all of the sites under all the HLW alternatives, land requirements to build HLW canister storage facilities were less than 1% of designated or suitable lands. DOE should have considerable flexibility in locating HLW canister storage facilities and no land use impacts onsite are expected. For the same reason, no conflicts with adjacent land uses are expected. In addition, none of the site development plans indicated any instances where future use would conflict with the proposed HLW management actions.

Table 9.11–1. Land Use Impacts Evaluated for HLW Alternatives

Land Use Impact	Affected Resource	Analysis Method	Presentation of Results
Effect on land use onsite at each HLW site	Land use shown in site development plans	Comparison of the required acreage with amount designated (or estimated) for HLW in site development plan—all instances where requirements are 1% were noted	Text discussion
Conflicts with offsite uses	Adjacent land use	Consideration of conflict between proposed waste management uses and nearby land uses	Text discussion

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential land-use conflicts or restrictions at particular locations on a site.

9.12 Infrastructure Impacts

Proposed HLW activities show no potential for effects to onsite infrastructure. No offsite infrastructure impacts are expected at any site. Estimated new requirements for wastewater treatment at the Hanford Site increase current demand in all alternatives, except No Action. Employment increases do not approach or exceed 5% of current site employment at any site. Traffic increases would be minimal during construction, and would not affect onsite transportation infrastructure.

DOE evaluated the impacts on site infrastructure by comparing existing onsite capacities to requirements for water, wastewater treatment, and electrical power (See Table 9.12–1). Water and power were evaluated for both construction and operations; wastewater treatment was evaluated only for operations because wastewater produced by construction activities was assumed to be negligible. Where onsite maximum capacity information was unavailable, the proposed requirement was evaluated as a percentage of current use. Increased site employment was used as an indicator of potential impacts to the onsite transportation infrastructure. Offsite infrastructure impacts were evaluated using estimates of increased population from the proposed activities as an indicator of increased demand on community infrastructure.

Proposed HLW activities show no potential for effects on onsite infrastructure. No offsite infrastructure impacts are expected. Proposed HLW activities show no potential for effects on onsite or offsite demand for potable water, wastewater treatment, and power infrastructure.

Table 9.12–1. Infrastructure Impacts Evaluated for HLW Alternatives

Infrastructure Impact Analyzed	Affected Infrastructure Elements	Analysis Method	Presentation of Results
Onsite capacity to support HLW canister storage facilities	Capacity of onsite water, electrical power, and wastewater systems	Add increased HLW facility use to current use—compare to current capacities	Text discussion
	Onsite transportation infrastructure	Compare new site employment with current site employment as an index of increased stress	Text discussion
Capacity of community infrastructure to support increased worker populations and their families	Regional water, electrical power, wastewater, and transportation infrastructure	Compare population increase with current regional population as an index of increased demand	Text discussion

Employment increases from the construction of HLW canister storage facilities do not approach or exceed 5% of current site employment. Therefore, it is expected that traffic increases will be minimal during construction, and will not substantially affect onsite transportation infrastructure.

9.13 Cultural Resources Impacts

Construction and operation of HLW canister storage facilities could adversely affect cultural resources. When selecting locations for waste management facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to cultural resources based on site-specific conditions.

Cultural and paleontological resources, including prehistoric, historic, fossil, and Native American sacred sites (Executive Order 13007), may be affected at sites where HLW canister storage facilities are proposed. Table 4.3–8 in Chapter 4 describes the status of cultural resources surveys and the reported resources at the four HLW sites. However, the impacts of the construction of HLW canister storage facilities on cultural resources cannot be effectively analyzed at the programmatic level because the extent of those impacts depends upon their specific location at a site.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to cultural resources based on site-specific conditions.

The acreage requirements at all sites under all alternatives are only a small fraction of the areas available for waste operations so DOE should be able to avoid impacts to any known cultural resources or any identified during pre-construction site surveys. If not, measures would be taken to mitigate negative effects on these resources.

9.14 Costs

The costs of storing HLW canisters remain relatively stable at approximately $3 billion, for all alternatives. Costs do rise slightly when storage is Centralized. Delay in disposing the waste at a geologic repository causes the life-cycle costs to increase at a rate of 0.2% per year of delay, not counting inflation.

As indicated in Table 9.14–1, DOE estimated costs for building and operating storage facilities for canisters of vitrified HLW and for transportation (ANL, 1996). DOE evaluated costs associated with HLW canister storage and transportation from both a life-cycle and process perspective, using 1994 dollars.

Table 9.14–1. Components of Cost Analysis

Impacts Assessed	Function Analyzed	Activities for Which Impacts Are Assessed	Location of Impacts Assessment
Process Costs	Storage	Life-cycle costs for HLW canister storage facilities, including facilities and loading and unloading of canisters into and out of storage.	Table 9.14–2
Transportation Costs	Truck Rail	Inter-site common carrier costs for transportation from generating sites to storage sites, and to the candidate geologic repository.	Table 9.14–2

9.14.1 Facility Costs

DOE evaluated facility costs for two phases of the life-cycle of the HLW canister storage facilities: construction and O&M costs were estimated. Facility construction cost formulas were based on similar facility estimates made by DOE for HLW vitrification and storage facilities at SRS, WVDP, the Hanford Site, and INEL. Operations and maintenance cost formulas were also based on similar storage facilities. Facility costs do not include speculative factors, such as impacts to long-term land value.

9.14.2 Process Costs

DOE also analyzed costs based on storage and handling activities. Storage costs include the construction and operation of HLW canister storage facilities. Handling costs include the loading and unloading of HLW canisters from the production line into storage, and for transportation to follow-on storage sites or to the candidate geologic repository. Based on the advanced conceptual design of the candidate geologic repository, plans are to receive 800 canisters per year from DOE (March 1994).

Transportation costs include the costs associated with the movement of the HLW canisters from one site to another for either treatment or disposal. Transportation costs are evaluated for both truck and rail shipments (ANL, 1996).

The summary of costs is shown in Table 9.14–2 (ANL, 1996). The No Action Alternative includes the production of all required canisters, but does not include storage beyond that already approved. With no increase in approved storage facilities, the canisters are shipped to the repository, phasing by site in the following order—WVDP, the Hanford Site, and SRS. No vitrification is performed at INEL because the site-specific plan has not yet been approved. When approved, the cost of the No Action Alternative will increase by $280 million. The No Action Alternative provides a baseline by which to compare the other alternatives.

Considering the Decentralized, Regionalized and Centralized Alternatives, construction accounts for 12% to 13% of the total cost, and operations account for 71% to 73% of those costs. The stability of costs is driven by the preponderance of canisters produced at the Hanford Site (15,000 of 21,600 canister total in the complex). The small variations of the Decentralized and Regionalized Alternatives costs are driven

Table 9.14–2. Life-Cycle Costs (Billions of 1994 Dollars)

Alternatives	Description	HLW—Cost in Billions of 1994 Dollars						
		Total Cost[a]	Life-Cycle Costs (Construction and O&M Phases)		Process Costs[b]		Transportation Costs	
			Construction	O&M	Storage	Handling	Truck	Rail
No Action	Current Program	1.47	0.07	1.00	0.21	0.87	0.39	0.57
Decentralized	Storage of HLW canisters at generator sites until acceptance at Repository begins in 2015	2.69	0.33	1.95	0.60	1.68	0.41	0.59
Regionalized 1	Canisters from WVDP stored at SRS	2.72	0.33	1.98	0.61	1.70	0.41	0.60
Regionalized 2	Canisters from WVDP stored at Hanford	2.72	0.33	1.98	0.61	1.70	0.41	0.60
Centralized	Canisters from WVDP and SRS stored at Hanford	2.85	0.37	2.02	0.73	1.66	0.46	0.68

[a] The facility costs in this table are presented in two ways: as life-cycle costs (construction and O&M phases) and as process costs (storage and handling only). Life-cycle costs are equal to process costs. Total costs are obtained by adding truck costs to life-cycle costs or to process costs. Thus, "total costs" = sum of life-cycle and truck costs = sum of process and truck costs.
[b] The costs of storage after the manufacture of canisters filled with vitrified HLW were included in this PEIS. The costs of storage of waste prior to treatment were included in the site infrastructure costs, which are not part of this PEIS.

by the storage of the 340 canisters from WVDP. The increase in costs for the Centralized Alternative is driven by the canisters at SRS (2,373), which have been shipped to the Hanford Site for follow-on storage before the geologic repository opens.

If the opening of the geologic repository is delayed past 2015, costs will increase $4 million for every year of additional storage required.

9.15 Environmental-Restoration-Transferred Waste

There is no environmental-restoration-transferred HLW.

No HLW will be generated during environmental restoration activities and, therefore, such waste is not considered in this analysis.

9.16 Comparison of Alternatives Summary

Health Risks. Both fatalities and cancer incidences for waste management workers are comparable for the Decentralized, Regionalized, and Centralized Alternatives and do not favor one alternative over another. Worker cancer fatalities from radiation exposure exceed fatalities from physical hazards. The Decentralized, Regionalized, and Centralized Alternatives each have three estimated cancer fatalities and one to two estimated fatalities from physical hazards. Truck transportation risks are slightly higher for the Centralized Alternative when the opening of a geologic repository is delayed than for other alternatives in the categories of radiological risks and physical trauma from traffic accidents. Fatalities from facility accidents are less than one for each of the HLW alternatives.

Air Quality Impacts. The management of HLW canisters would not appreciably affect the air quality at any site. No criteria air pollutants would exceed standards at any site. Emissions of hazardous air pollutants (including radionuclides) and toxic air pollutants from storage facilities, were assumed to be negligible.

Water Resources Impacts. Major impacts to water resources at all affected sites are unlikely even if the HLW repository does not begin to accept DOE-managed HLW in 2015 and extended storage of HLW canisters at the sites is required.

Ecological Resources Impacts. Loss of limited acreages of habitat at the DOE sites during construction of HLW canister storage facilities should not affect populations of nonsensitive plant and animal species because these species habitats are well established regionally. Operation of HLW canister storage facilities should not affect ecological resources because airborne emissions and liquid effluents are expected to be negligible. When specific HLW canister storage facility locations are proposed, DOE will conduct site- and

project-level analyses to determine if any sensitive species, including Federally and State-listed endangered and threatened species, may be affected and will establish appropriate protection measures. DOE should be able to locate new HLW canister storage facilities to avoid impacts to nearby wetlands and other sensitive habitats, because construction site acreages are small compared to the total acreage at each site suitable for waste operations. Transportation accidents involving shipment of HLW canisters should be extremely rare and should not affect aquatic habitats because of the vitrified form of the HLW and special packaging.

Economic Impacts. HLW canister storage facility construction and operations expenditures would minimally benefit the local economy at the four HLW sites because estimated jobs and personal income are well below 1% of regional employment and income at all sites under all the alternatives. None of the HLW alternatives would affect the national economy, although 328 to 1,200 jobs would be directly or indirectly financed.

Population Impacts. The overall population in-migration remains relatively constant under all proposed alternatives and does not result in a major increase at any site. No corresponding changes to community characteristics or the provision of services would be anticipated; however, some impacts to the social environment are evident under all of the alternatives. The most serious concerns exist for the No Action Alternative, where existing limitations on HLW canister storage capability restrict canister production at the Hanford Site and INEL, and delay removal of untreated HLW from all sites; and for the Centralized Alternative, where the Hanford Site would receive large quantities of additional treated HLW for storage from other sites. Although the number of canisters received at the Hanford Site and SRS would be substantially lower in the Regionalized Alternatives, some public opposition to receipt of WVDP's HLW canisters could occur at these sites.

Environmental Justice Concerns. Assessment of potential environmental justice impacts from management of HLW canisters indicated that minority and low-income populations at the HLW sites would not experience disproportionately high and adverse health risks or environmental impacts under any of the HLW alternatives.

Land Use Impacts. No impacts to current onsite or offsite land uses would result from implementing any of the HLW alternatives because for all the sites, land requirements to build HLW canister storage facilities are less than 1% designated or suitable lands. In addition, the proposed HLW canister storage facilities do not conflict with the development plans for any site.

Infrastructure Impacts. Proposed HLW activities show a potential for effects to onsite infrastructure only at the Hanford Site although the effects would be minor. No offsite infrastructure impacts are expected at any site. Estimated new requirements for wastewater treatment at the Hanford Site increase current demand in all alternatives, except No Action. Employment increases do not approach or exceed 5% of current site employment. Traffic increases would be minimal during construction, and would not affect onsite transportation infrastructure.

Cultural Resources Impacts. Construction and operation of HLW canister storage facilities could adversely affect cultural resources. Potential adverse effects at specific candidate construction locations will be considered in sitewide or project-level NEPA reviews.

Costs. The costs of HLW canister storage and transportation remain relatively stable at approximately $3 billion, for all alternatives except No Action. Costs do rise slightly when HLW canister storage is Centralized. Delay in disposing the waste at the geologic repository causes the life-cycle costs to increase at a rate of 0.2% per year of delay.

Summary of Impacts by Alternatives. Table 9.16–1 summarizes the key impacts for each HLW alternative.

The Preferred Alternative. The Department's preferred alternative at this time is to store its HLW where the waste is treated pending a decision on its disposal or other disposition. Because it is impractical to ship liquid HLW for treatment, the Department had previously decided that each of the four sites with HLW (Hanford, INEL, SRS, and WVDP) will treat its own waste onsite.

The potential impacts of DOE's preferred alternative are presented under the Decentralized Alternative for HLW. This alternative minimizes the transportation of treated HLW, makes use of existing storage capacity at WVDP and SRS, and would cost less than regionalized or centralized storage. The potential environmental impacts of all alternatives for HLW evaluated in the WM PEIS are small.

Table 9.16–1. Comparison of HLW Alternatives—Selected Impacts

Alternative	Number of Sites Storing	Worker Physical Hazard Fatalities	Worker Cancer Fatalities	Truck Radiation Fatalities	Truck Non-Radiation Fatalities	Truck Shipments	Cost ($ Billions)
No Action	4	1	2	3	2	20,000	1.5
Decentralized	4	1	3	3	2	22,000	2.7
Regionalized 1	3	1	3	3	2	22,000	2.7
Regionalized 2	3	2	3	3	2	22,000	2.7
Centralized	1	2	3	3	2	24,000	2.9

Note: * = greater than 0 but less than 0.5.

Chapter 9

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WSRC. *See* Westinghouse Savannah River Company.

High-Level Waste Alternatives

Alternative	Store	Hanford	INEL	SRS	WVDP
No Action	4	S	S	S	S
Decentralized	4	S	S	S	S
Regionalized 1	3	S	S	S	
Regionalized 2	3	S	S	S	
Centralized[a]	1	S			

Note: Blanks indicate that storage of HLW does not occur at a site under the alternative specified.

[a] Canisters generated at WVDP, SRS, and INEL prior to acceptance at the candidate repository in 2015 would be shipped to the Hanford Site for storage. Canisters generated at SRS and INEL after 2015 would be shipped directly to the candidate repository. If acceptance of the DOE-managed HLW is delayed past 2015, then all HLW canisters would be shipped to Hanford for storage.

CHAPTER 10
Impacts of the Management of Hazardous Waste

Chapter 10 describes the environmental consequences associated with the No Action, Decentralized, Regionalized, and Centralized Alternatives for hazardous waste (HW). This chapter provides information on existing HW volumes, and existing and planned facilities available at DOE sites. This is followed by an overview of the analysis and assumptions relating to HW characteristics, the treatment and disposal technologies considered, and the rationale for selecting the specific sites analyzed under each alternative. The chapter discusses the human health risks, environmental impacts, and costs of the alternatives, and provides a comparison of alternatives.

The methods used to evaluate the impacts are outlined in Chapter 5. Impacts tables for each major DOE site are contained in Volume II. Details of the HW analysis are contained in a technical report entitled "Hazardous Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement" (ANL, 1996). Additional information can be found in the complete list of appendices and technical reports listed in Chapter 15.

10.1 Background

10.1.1 DEFINITION AND ORIGIN

- *HW is nonradioactive chemical waste.*
- *HW is generated as a result of research and development and as a byproduct of nuclear weapons production and dismantlement.*
- *HW is generated or exists at most DOE sites.*
- *Most nonwastewater DOE HW is treated commercially.*
- *DOE needs to decide whether to develop additional capacity of its own to treat HW.*

Hazardous waste consists of nonradioactive waste materials generated as a result of nuclear weapons production and other research and development activities. HW is any solid waste, not otherwise precluded from regulation under the Resource Conservation and Recovery Act (RCRA), that exhibits the characteristics of ignitability, corrosivity, reactivity, or toxicity, as defined by RCRA, or which has otherwise been determined to pose a hazard and which has been designated by the RCRA as a listed HW. RCRA defines a "solid" waste to include solid, semi-solid, liquid or contained gas (42 USC 6901).

In addition to HW as defined by RCRA, DOE manages some State-regulated HW and those wastes specified in the Toxic Substances Control Act (TSCA) (15 USC 2601). Special nuclear material and byproduct

materials, as defined by the Atomic Energy Act, are specifically excluded from definition of wastes defined under RCRA.

Most DOE HW consists of wastewater that contains less than a 1% concentration of organic HW materials. Nonwastewater HW consists of sludges, solids and organic liquids (water containing higher concentrations of organic HW than wastewater). Wastewater HW is generated as a result of operations such as metal cleaning, etching and plating. DOE currently treats wastewater HW onsite and will continue to do so in the future because wastewater is not difficult to treat, but is difficult and not cost-effective to transport. Wastewater HW is treated to regulatory standards and released into the environment (EI, 1993).

The remainder of this chapter focuses on the nonwastewater HW. DOE currently ships most of this HW offsite to commercial facilities for treatment and disposal, and two sites (ORR and INEL) have the capability to treat nonwastewater HW thermally. DOE needs to decide the extent to which it should continue its reliance on the offsite treatment of nonwastewater HW.

In accordance with RCRA, the U.S. Environmental Protection Agency (EPA) has established requirements for managing HW:

- HW must be treated before land disposal and is subject to land disposal restrictions (LDRs) "best demonstrated available technology" (BDAT) requirements (e.g., thermal treatment units).
- HW storage is allowed only for a limited time to accumulate sufficient quantities for treatment.
- Disposal facilities must meet RCRA minimum technology requirements.

DOE must make decisions within the framework of these requirements to ensure that adequate treatment is available for HW. These decisions involve the location and construction of DOE facilities, and the extent to which the commercial HW facilities should be utilized for nonwastewater HW.

10.1.2 Volumes and Locations

HW has been generated, or is projected to be generated at most DOE sites. Naval Nuclear Propulsion Program sites identified in this document may generate HW. Their management of this waste type is not considered in this PEIS analysis, and they are not subject to associated decisions. Although HW generation from the production of nuclear weapons has essentially stopped, many chemicals and chemical residues

were abandoned or left in containers and process lines. These wastes must be treated to comply with Federal and State hazardous waste regulations. The projected generation of HW from ongoing DOE research and development activities will include chemical wastes, organic solvents from incomplete chemical reactions, sludges from degreasing operations, and heavy metals from unrecycled batteries.

Based on RCRA uniform HW shipping manifests (40 CFR 262.20), facility reports, and HW generation and disposal information dating back to 1984, DOE estimates that more than 90% of the total HW (wastewater and nonwastewater) in a given year is generated by 11 or fewer of the 54 DOE sites, although these 11 sites are not always the same every year. Table 10.1–1 provides the quantities of HW at the 11 large HW generators used for the evaluation of the WM PEIS alternatives. Onsite treatment and storage tonnage was derived from 1991 data in biennial and annual reports (40 CFR 262.41). The offsite shipments to commercial treatment were derived from fiscal year 1992 shipping manifests, and include only RCRA-defined wastes. The focus of the WM PEIS alternatives is on the RCRA-defined waste shipped offsite and waste thermally treated[1] or used for fuel burning onsite—approximately 3,440 metric tons, almost all of which is nonwastewater (DOE[2]).

For purposes of this PEIS analysis, DOE assumed that these volumes of HW are representative of DOE's current HW treatment requirements. Of the 3,440 metric tons of HW sent from DOE sites to commercial facilities for treatment in FY 1992, about half of this amount was thermally treated. Another third was treated offsite to recover either solvents (distillation) or energy (phase separation and fuel blending), and the remainder was treated by stabilization, metal removal and recovery, deactivation, and aqueous treatment methods.

Analysis in the WM PEIS assumes use of existing and planned treatment facilities until their capacities are met. If additional capacity is needed, use of new conceptual DOE facilities or offsite commercial facilities is assumed. These new conceptual commercial facilities provide the difference in treatment capacity between the baseline (ANL, 1996) and what is necessary to manage the waste received under any given alternative. Conceptual treatment facilities are based on generic designs with set impacts (e.g., cost, performance/efficiency). An assumption was made that the impact of operating existing/planned facilities is essentially identical to the impact of operating conceptual facilities.

[1] The form of thermal treatment discussed in this chapter is incineration.

[2] DOE (1995; 1994a-e; 1993a,b; 1992a-c; 1987; 1982).

Table 10.1–1. HW at 11 Large DOE Generators[a] (metric tons[b]/year)

DOE Site	Total Wastewater Treated Onsite[c]	Onsite Thermal Treatment and Fuel Burning[c]	Other Onsite Treatment and Storage[c]	Offsite Commercial Treatment[d]
ANL-E	0	0	2	206
Fermi	0	0	12	49
Hanford	0	0	140	302
INEL	33,000	35	80	160
KCP[e]	343,000	0	80	600
LANL	0	0	40	246
LLNL	250	0	230	629
ORR	624,000	66	14,600	207
Pantex	3,000	0	2,700	512
SNL-NM	130,000	0	0	153
SRS[e]	59,000	0	50	273
Total	1,192,250	101	17,934	3,337

[a] These sites represent the largest DOE HW generators for the time periods indicated. HW volumes generated vary annually among all sites, but these sites typically accounted for more than 90% of the DOE HW.
[b] Metric ton = 1,000 kilograms = 2,205 lb. One metric ton of HW is approximately one cubic meter in volume.
[c] Based on 1991 data taken from biennial and annual reports.
[d] Based on FY 1992 manifests. Includes only RCRA-defined waste; an additional 6,600 metric tons of TSCA, State-regulated HW, environmental restoration generated HW was shipped to commercial treatment in FY 1992.
[e] Excludes wastewater treatment of groundwater remediation waste reported in KCP and SRS biennial reports.

In addition to the RCRA-regulated HW shipped in FY 1992, 6,600 metric tons of TSCA, State-regulated HW, and HW generated as a result of environmental restoration activities were generated at DOE sites in 1992.[3] All of these wastes were sent offsite, with about one-third of these wastes sent to commercial facilities for treatment and the other two-thirds sent directly to RCRA and TSCA approved landfills for disposal.

[3] The extent to which the volume of HW generated as a result of environmental restoration activities could affect the WM PEIS analysis is discussed in Section 10.15.

10.2 Analytical Methods and Assumptions

10.2.1 CHARACTERISTICS

DOE HW can be categorized as RCRA-defined wastes, State-regulated waste, and TSCA-defined wastes. HW that is classified as RCRA waste is further categorized into three groups as shown in Table 10.2–1. The principal State-regulated wastes that DOE manages are waste oils and petroleum contaminated soils. The primary TSCA wastes managed by DOE are polychlorinated biphenyls (PCBs) and asbestos.

10.2.2 TECHNOLOGIES AND TREATMENT PROCESSES

Under RCRA, all HW must be treated to meet certain standards before the waste (or its treatment residues) may be placed on the land for final disposal. These treatment standards may be either concentration-based or technology-based. EPA regulations identify the treatment technologies that EPA recognizes as appropriate for HW. These technologies serve as the basis for DOE treatment technology groups. The nine major treatment technology groups, along with a brief description of each, are as follows:

Organic Destruction. Destruction of organic liquids and solids can be accomplished by a broad spectrum of technologies that include the following subgroups: incineration, other thermal technologies (e.g., metal melting, plasma torch), biological treatment, and chemical destruction. Besides neutralizing toxic organic constituents of the waste, organic destruction can significantly reduce the primary waste volume.

Table 10.2–1. Three Categories of RCRA Hazardous Waste

Listed Hazardous Wastes	Characteristic Hazardous Wastes	Other Hazardous Wastes
• Nonspecific sources • Specific sources • Commercial chemical products—acutely hazardous • Commercial chemical products—nonacutely hazardous	• Ignitable • Corrosive • Reactive • Toxic	• Mixtures (hazardous and nonhazardous) • Derived from wastes (treatment residues) • Materials containing listed hazardous wastes

Aqueous Treatment. This group incorporates a number of specialized treatment technologies. Examples include biological treatment, wet oxidation, and chemical oxidation/reduction. These technologies are often very specialized and waste specific. As such, they are generally not as readily available on a commercial basis as some of the other treatment technologies.

Deactivation/Neutralization. The technologies in this group refer to processes that remove the hazardous characteristics of a waste when these characteristics are based on ignitability, explosivity, corrosivity, and/or reactivity. Commercially, deactivation/neutralization is most commonly employed in the neutralization of corrosive wastes, while deactivation is also the preferred technology for most reactive wastes.

Organic Removal/Recovery. Along with incineration, organic removal/recovery is one of the most common forms of commercial treatment for organic liquids. This group encompasses a wide range of technologies including solvent recycling and distillation, fuel substitution (organic liquid hazardous wastes with high energy content are substituted for virgin fuels in industrial equipment permitted by EPA to burn hazardous waste fuel), carbon absorption, steam stripping, liquid-liquid extraction, and chemical/physical phase separation. Of the above, solvent distillation and fuel substitution are the most readily available on a commercial basis.

Metal Removal/Recovery. This technology group incorporates processes that are designed to remove and/or recover heavy metals present in RCRA wastes. The technologies most commonly used for metal removal/recovery include ion exchange, resin or solid adsorption, reverse osmosis, chelation/solvent extraction, ultrafiltration, and/or simple chemical precipitation. Some thermal processes may be used as well. Frequently, some form of physical phase separation or concentration techniques such as decantation, filtration and centrifugation are used in conjunction with the technologies noted above.

Mercury Recovery/Removal. As a technology group, mercury recovery/removal is actually a subset of the metal removal/recovery treatment technology group. From a practical standpoint, it is addressed separately because the commercial facilities that manage waste with high levels of mercury are usually very specialized. The actual technologies employed include amalgamation and recovery, mercury retorting, and thermal treatment with specialized control equipment.

Stabilization/Solidification. Stabilization and/or solidification refers to processes that tend to immobilize waste through chemical and/or physical means. Stabilization is one of the most common forms of treatment for inorganic wastes. Stabilization occurs when HW is mixed with a solidification agent such as Portland cement, fly ash, or cement kiln dust to form a solid. Stabilization generally requires a special design mix between the waste and the solidification agent to ensure that the concentration based LDRs standards are met. Stabilization is generally followed by land disposal at a HW landfill.

Recycling. Many of the technologies and technology groups described above incorporate some type of recycling (e.g., metal removal/recovery, organic removal/recovery, etc.). Recycling, in the context of the WM PEIS, refers to the use of materials that would otherwise be a hazardous waste as a direct substitute for raw materials. Most waste that meets these criteria would be exempt from regulation under RCRA although many States would require that a HW shipping manifest be used when the waste is transported.

Land Disposal. Though not an actual form of treatment and not evaluated in the WM PEIS alternatives, land disposal is included as a technology group and discussed here since some direct disposal of HW in permitted landfills still occurs. The types of HW that might be deposited directly into a landfill include newly identified wastes (wastes that have been identified since 1984) for which no treatment standards have been established (e.g., 25 newly identified Toxicity Characteristic Leaching Procedure organic wastes) and wastes that are covered by a variance under the LDRs.

10.2.3 WM PEIS Assumptions: Facilities, Treatment, and Disposal

Key assumptions and considerations used in the WM PEIS to characterize HW, develop treatment alternatives, and analyze associated impacts include the following:

- Wastewater HW, previously buried or disposed HW, waste generated by environmental restoration activities, or waste generated as a result of decontamination operations are not part of the HW loads considered in the WM PEIS and are not included in the HW alternatives analysis.
- Wastewater HW will continue to be treated onsite at DOE facilities.
- Future HW generation rates are assumed to be the same as those identified in Table 10.1–1.
- Factors that could result in a decline in the quantities of HW (e.g., waste minimization efforts, reconfiguration of the DOE Nuclear Weapons Complex, reductions in generated HW from cancellation of DOE weapons programs) will not affect the analysis of the HW alternatives.

- Factors that could result in an increase in HW quantities (e.g., reclassification of low-level mixed waste (LLMW) or HW generated from the dismantlement of weapons) will not affect the analysis of the HW alternatives.
- Since onsite storage of HW is limited under RCRA to 90 days without a RCRA Part B permit, HW inventories will not accumulate at generator sites.
- The estimated cost associated with the commercial treatment of HW assumes that the treated residue is disposed of in compliance with applicable Federal and State LDRs.

10.3 Hazardous Waste Alternatives

The WM PEIS HW analysis considers four alternatives for treatment facilities within the broad categories of management alternatives: No Action, Decentralized, and two Regionalized. The alternatives were selected to provide representative results for the range of onsite options. Thus, the alternatives evaluate 3%, 9%, 50%, and 90% of the DOE RCRA waste (excluding wastewater) being treated onsite. The Centralized Alternative for the management of HW was not considered a prudent alternative from the standpoint of cost, health risk, and environmental or socioeconomic impacts and from the standpoint of a number of practical considerations, such as the significant amount of transportation that would be required even under the best waste minimization programs. The foldout table at the end of this chapter shows the sites at which HW would be treated under each alternative. The table is designed to be used as a quick reference when reading the HW impact sections.

Each of the alternatives was developed in order to capture and quantify the human health risks, environmental impacts, and costs associated with the range of HW treatment options available to DOE and to provide input for a decision about whether to continue to rely on offsite treatment of HW.

Public and worker risks and environmental impacts were not analyzed quantitatively for commercial treatment facilities for all four alternatives. Each of those facilities has obtained its own RCRA permit, which involved separate risk assessments done in support of the permitting process. In addition, the DOE portion of the annual waste processed by those facilities is less than 5% per year.

10.3.1 No Action Alternative

Under this alternative, the current operations would be maintained. HW that is currently being treated onsite at DOE facilities (e.g., incineration of organic materials at ORR and INEL) will continue to be treated onsite, and other HW will continue to be treated offsite at commercial facilities. Figure 10.3–1 and Table 10.3–1 illustrate the No Action Alternative.

HW No Action Alternative (Treatment of 3% of Nonwastewater HW at 2 Sites; 97% at Commercial Facilities)

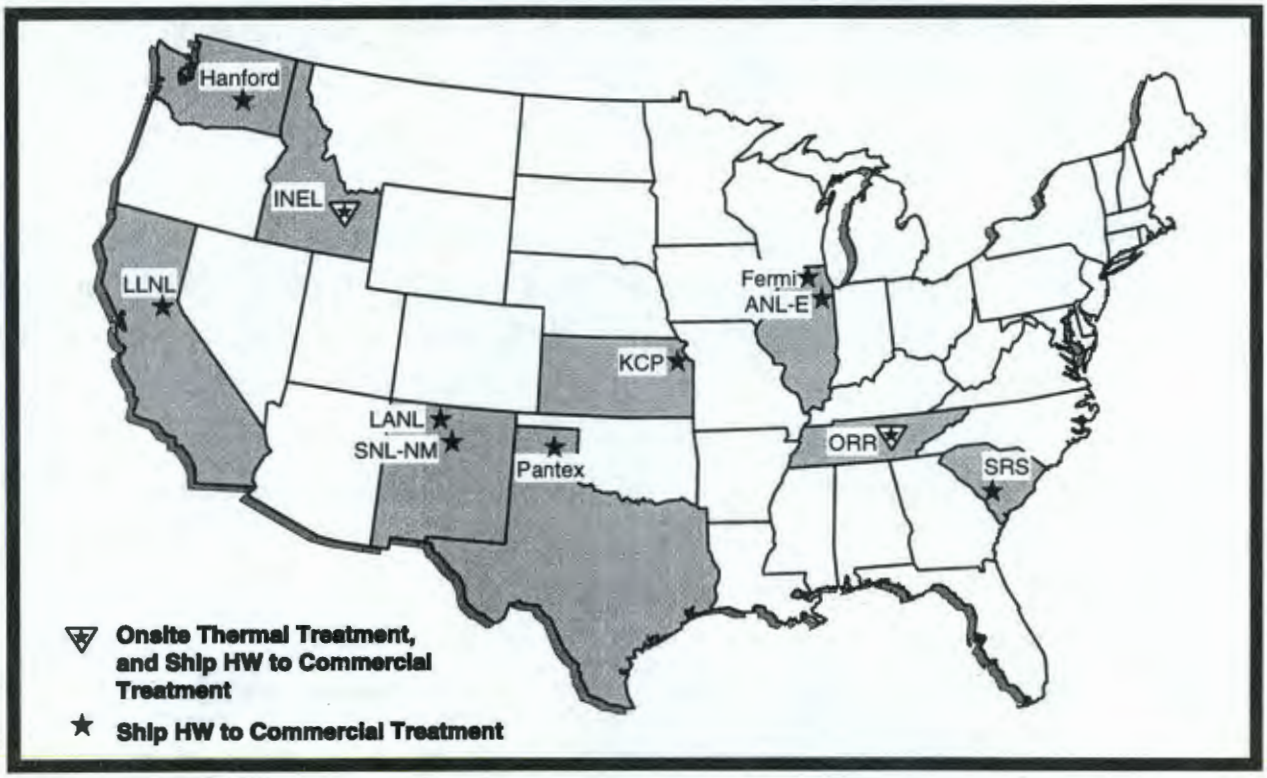

Figure 10.3–1. HW No Action Alternative

	Generating Sites		
	INEL	ORR	ANL-E, Fermi, Hanford, INEL, KCP, LANL, LLNL, ORR, Pantex, SNL-NM, SRS
Treat	INEL	ORR	Commercial treatment

Table 10.3–1. HW No Action Alternative

10.3.2 DECENTRALIZED ALTERNATIVE

Under this alternative, DOE would implement thermal treatment at the Idaho National Engineering Laboratory (INEL), the Oak Ridge Reservation (ORR), and the Savannah River Site (SRS). DOE modified the Decentralized Alternative to replace LANL with INEL as a candidate site for onsite treatment of HW. This change reflects the fact that INEL currently has thermal HW treatment capacity, while LANL does not. In addition, the use of commercial facilities would continue as needed, with greater DOE controls on the number of facilities used, the services provided, and the performance delivered. The use of brokers, companies that consolidate HW from more than one customer to reduce storage and improve the economics of shipping, would be reduced. Brokering of HW usually increases total transport miles to get a waste package from the generator to the facility site because the packages are frequently brought to a collection site to be sorted and combined with similar packages for shipment to a facility location.

The main difference between the No Action and Decentralized Alternatives is a 6% shift in the waste totals for thermal treatment and fuel substitution from offsite treatment (No Action) to onsite treatment (Decentralized). Because of this relatively small difference, the No Action and Decentralized Alternatives are discussed together.

The waste management strategy for the No Action and Decentralized Alternatives can be summarized as follows:

- Package HW and ship it to commercial treatment facilities.
- Maintain and operate existing and planned DOE HW storage facilities and limited treatment facilities at DOE sites in accordance with applicable permit requirements for treatment facilities.
- Minimize generation of HW to the greatest extent possible.
- The Decentralized Alternative would involve thermal treatment at three sites (INEL, SRS, and ORR).

Figure 10.3-2 illustrates the Decentralized Alternative. Table 10.3-2 shows that most of the HW loads at the major HW sites would be transferred to commercial facilities. Except for wastes to be thermally treated or treated through fuel burning at INEL, ORR, and SRS, most wastes generated by the other major sites would also be sent to commercial facilities. The change of use in facilities between the No Action and Decentralized Alternatives is summarized in Table 10.3-3. The total net change in going from the No Action to the Decentralized Alternatives would be an increase of approximately 180 metric tons/yr in thermal treatment and 43 metric tons/yr in onsite fuel burning.

HW Decentralized Alternative (Treatment of 9% of Nonwastewater HW at 3 DOE Sites; 91% at Commercial Facilities)

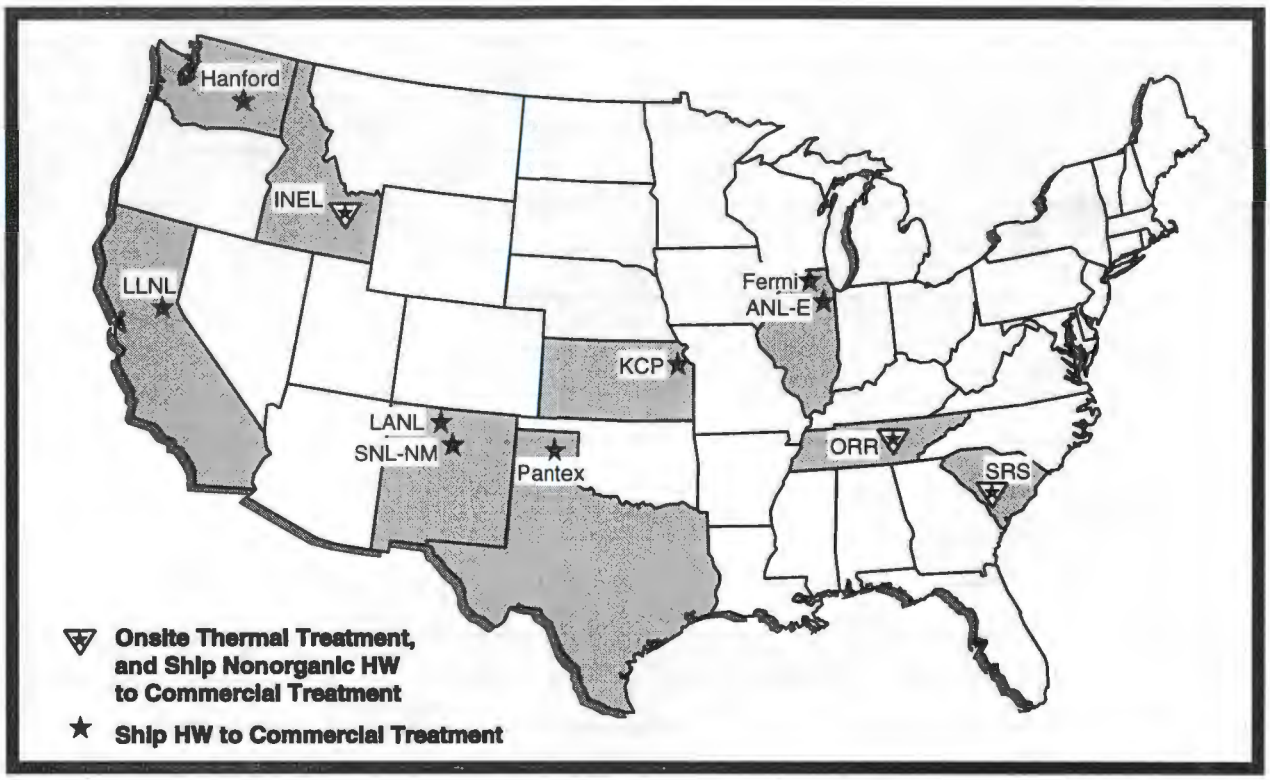

Figure 10.3–2. HW Decentralized Alternative

	Generating Sites			
	INEL	ORR	SRS	ANL-E, Fermi, Hanford, INEL, KCP, LANL, LLNL, ORR, Pantex, SNL-NM, SRS
Treat	INEL	ORR	SRS	Commercial treatment

Table 10.3–2. HW Decentralized Alternative

Table 10.3–3. Change in Use of Onsite Thermal Destruction and Waste-Fuel Burning Under No Action and Decentralized Alternatives

Site and Treatment	HW Treated by Thermal Destruction and Fuel Burning (metric tons/year)	
	No Action Alternative	Decentralized Alternative
INEL		
Thermal treatment	17.4	17.4
Fuel burning	17.4	17.4
ORR		
Thermal treatment	53.203	116.6
Fuel burning	12.6	27.7
SRS		
Thermal treatment	0	116.6
Fuel burning	0	27.7
Total		
Thermal treatment	70.6	250.6
Fuel burning	30.0	72.8

Tables 10.3–4 and 10.3–5 depict the No Action and Decentralized Alternatives in terms of HW treatment by treatment technology group for the major DOE HW sites. The treatment technology group of Organic Removal/Recovery involves three types of treatments: fuel blending, fuel burning, and solvent recycling. Because HW treated by fuel blending is ultimately burned, the amounts for fuel blending are included in the fuel burning row. The totals for treatment at commercial facilities are based on the overall amounts shipped offsite for FY 1992.

10.3.3 Regionalized Alternatives

Under Regionalized Alternative 1, half of the HW generated by 11 major HW sites would be retained and treated at five onsite DOE treatment centers or hubs: Hanford, INEL, LANL, ORR, and SRS. Each regional hub would be permitted under RCRA and onsite treatment facilities would be constructed for thermal treatment and organic removal/recovery. Figure 10.3–3 and Table 10.3–6 illustrate Regionalized Alternative 1.

Table 10.3-4. No Action Alternative: HW Treatment for 11 Large DOE HW Sites (in metric tons)

Site	Organic Destruction by Thermal Treatment[a]	Organic Removal and Recovery			Stabilization	Deactivation	Metal Removal and Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending[b]	Fuel Burning	Solvent Recycling[c]			Non-Hg	Hg			
ANL-E											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	72.0	0	0	1.2	19.0	20.0	3.4	90.0	0	0	205.6
Site total	**72.0**	**NA**	**0**	**1.2**	**19.0**	**20.0**	**3.4**	**90.0**	**0**	**0**	**205.6**
Fermi											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	28.0	0	0	10.6	2.2	7.5	0.1	0.6	0	0	49.0
Site total	**28.0**	**NA**	**0**	**10.6**	**2.2**	**7.5**	**0.1**	**0.6**	**0**	**0**	**49.0**
Hanford											
Onsite	0	0	0	0	0	0	0	0	0[e]	0	0
Commercial	22.0	0	151.8	78.2	3.0	45.0	0.1	1.5	0[e]	0.7	302.3
Site total	**22.0**	**NA**	**151.8**	**78.2**	**3.0**	**45.0**	**0.1**	**1.5**	**0[e]**	**0.7**	**302.3**
INEL											
Onsite	17.4	30.5	17.4	0	0	0	0	0	0	0	34.8
Commercial	93.5	0	13.1	15.7	9.3	15.0	7.4	1.7	3.7	0.5	159.9
Site total	**110.9**	**NA**	**30.5**	**15.7**	**9.3**	**15.0**	**7.4**	**1.7**	**3.7**	**0.5**	**194.7**
KCP											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	380.0	0	70.0	35.0	50.0	12.0	50.0	2.5	1.0	0	600.5
Site total	**380.0**	**NA**	**70.0**	**35.0**	**50.0**	**12.0**	**50.0**	**2.5**	**1.0**	**0**	**600.5**
LANL											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	48.0	110.0	110.0	56.4	11.0	13.5	2.0	4.0	0	0.7	245.6
Site total	**48.0**	**NA**	**110.0**	**56.4**	**11.0**	**13.5**	**2.0**	**4.0**	**0**	**0.7**	**245.6**
LLNL											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	268.0	0	160.3	82.7	57.0	1.2	5.3	4.3	48.0	2.0	628.8
Site total	**268.0**	**NA**	**160.3**	**82.7**	**57.0**	**1.2**	**5.3**	**4.3**	**48.0**	**2.0**	**628.8**

Table 10.3–4. No Action Alternative: HW Treatment for 11 Large DOE HW Sites (in metric tons)—Continued

Site	Organic Destruction by Thermal Treatment[a]	Organic Removal and Recovery			Stabilization	Deactivation	Metal Removal and Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending[b]	Fuel Burning	Solvent Recycling[c]			Non-Hg	Hg			
ORR											
Onsite	53.2	42.7	12.6	0	0	0	0	0	0	0	65.8
Commercial	102.3	0	30.1	22.8	13.0	20.8	10.4	2.3	5.0	0.7	207.4
Site total	**155.5**	**NA**	**42.7**	**22.8**	**13.0**	**20.8**	**10.4**	**2.3**	**5.0**	**0.7**	**273.2**
Pantex											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	319.0	0	0	26.0	60.0	106.1	0	0.6	0	0	511.7
Site total	**319.0**	**NA**	**0**	**26.0**	**60.0**	**106.1**	**0**	**0.6**	**0**	**0**	**511.7**
SNL											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	93.0	0	0	17.0	24.0	11.0	5.5	0.9	0	1.5	152.9
Site total	**93.0**	**NA**	**0**	**17.0**	**24.0**	**11.0**	**5.5**	**0.9**	**0**	**1.5**	**152.9**
SRS[d]											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	155.5	42.7	42.7	22.8	13.0	20.8	10.4	2.3	0.5	0.7	273.2
Site total	**155.5**	**NA**	**42.7**	**22.8**	**13.0**	**20.8**	**10.4**	**2.3**	**0.5**	**0.7**	**273.2**
Total											
Onsite	70.6	NA	30.0	0	0	0	0	0	0	0	100.6
Commercial	1,581.3	NA	578	368.4	261.5	272.9	94.6	110.7	62.7	6.8	3,336.9
Site Total	**1,651.9**	**NA**	**608**	**368.4**	**261.5**	**272.9**	**94.6**	**110.7**	**62.7**	**6.8**	**3,437.5**

Notes: Hg = mercury; NA = not applicable.

[a] Assumes that this technology was the appropriate technology for 1992 amounts incinerated. Much of this waste could have gone to removal and recovery of organics or was corrosive and could have been deactivated.

[b] The amount blended was not counted in the total waste amount generation; amount was counted when burned as fuel.

[c] At each location, some of these solvents (approximately 10%) were also recycled by Safety-Kleen.

[d] Waste amounts were derived from manifests. Because of the moratorium, the precise amount of actual waste generated cannot be determined at this time. For this table, amounts for SRS are assumed to be the same as those for ORR.

Table 10.3–5. Decentralized Alternative: HW Treatment for 11 Large DOE HW Sites (in metric tons)

Site and Location of HW Treatment	Organic Destruction by Thermal Treatment[a]	Organic Removal and Recovery			Stabilization	Deactivation	Metal Removal and Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending[b]	Fuel Burning	Solvent Recycling[c]			Non-Hg	Hg			
ANL-E											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	72.0	0	0	1.2	19.0	20.0	3.4	90.0	0	0	205.6
Site total	**72.0**	**NA**	**0**	**1.2**	**19.0**	**20.0**	**3.4**	**90.0**	**0**	**0**	**205.6**
Fermi											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	28.0	0	0	10.6	2.2	7.5	0.1	0.6	0	0	49.0
Site total	**28.0**	**NA**	**0**	**10.6**	**2.2**	**7.5**	**0.1**	**0.6**	**0**	**0**	**49.0**
Hanford											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	22.0	0	151.8	78.2	3.0	45.0	0.1	1.5	0	0.7	302.3
Site total	**22.0**	**NA**	**151.8**	**78.2**	**3.0**	**45.0**	**0.1**	**1.5**	**0**	**0.7**	**302.3**
INEL											
Onsite	17.4	0	17.4	0	0	0	0	0	0	0	34.8
Commercial	93.5	0	13.1	15.7	9.3	15.0	7.4	1.7	3.7	0.5	159.9
Site total	**110.9**	**NA**	**30.5**	**15.7**	**9.3**	**15.0**	**7.4**	**1.7**	**3.7**	**0.5**	**194.7**
KCP											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	380.0	0	70.0	35.0	50.0	12.0	50.0	2.5	1.0	0	600.5
Site total	**380.0**	**NA**	**70.0**	**35.0**	**50.0**	**12.0**	**50.0**	**2.5**	**1.0**	**0**	**600.5**
LANL											
Onsite	0[d]	0	0	0	0		0	0	0	0	0
Commercial	48.0	110.0	110.0	56.4	11.0	13.5	2.0	4.0	0	0.7	245.6
Site total	**48.0**	**NA**	**110.0**	**56.4**	**11.0**	**13.5**	**2.0**	**4.0**	**0**	**0.7**	**245.6**
LLNL											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	268.0	0	160.3	82.7	57.0	1.2	5.3	4.3	48.0	2.0	628.8
Site total	**268.0**	**NA**	**160.3**	**82.7**	**57.0**	**1.2**	**5.3**	**4.3**	**48.0**	**2.0**	**628.8**

Table 10.3-5. Decentralized Alternative: HW Treatment for 11 Large DOE HW Sites (in metric tons)—Continued

Site	Organic Destruction by Thermal Treatment[a]	Organic Removal and Recovery			Stabilization	Deactivation	Metal Removal and Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending[b]	Fuel Burning	Solvent Recycling[c]			Non-Hg	Hg			
ORR											
Onsite	116.6[e]	42.7	27.7	0	0	0	0	0	0	0	144.3
Commercial	38.9	0	15.0	22.8	13.0	20.8[e]	10.4	2.3	5.0	0.7	128.9
Site total	**155.5**	**NA**	**42.7**	**22.8**	**13.0**	**20.8**	**10.4**	**2.3**	**5.0**	**0.7**	**273.2**
Pantex											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	319.0	0	0	26.0	60.0	106.1	0	0.6	0	0	511.7
Site total	**319.0**	**NA**	**0**	**26.0**	**60.0**	**106.1**	**0**	**0.6**	**0**	**0**	**511.7**
SNL											
Onsite	0	0	0	0	0	0	0	0	0	0	0
Commercial	93.0	0	0	17.0	24.0	11.0	5.5	0.9	0	1.5	152.9
Site total	**93.0**	**NA**	**0**	**17.0**	**24.0**	**11.0**	**5.5**	**0.9**	**0**	**1.5**	**152.9**
SRS[f]											
Onsite	116.6[e]	42.7	27.7	0	0	0	0	0	0	0	144.3
Commercial	38.9	0	15.0	22.8	13.0	20.9	10.4	2.3	5.0	0.7	128.9
Site total	**155.5**	**NA**	**42.7**	**22.8**	**13.0**	**20.9**	**10.4**	**2.3**	**5.0**	**0.7**	**273.2**
Total											
Onsite	250.6	NA	72.8	0	0	0	0	0	0	0	323.4
Commercial	1,401.3	NA	535.2	368.4	261.5	272.9	94.6	110.7	62.7	6.8	3,114.1
Total	**1,651.9**	**NA**	**608**	**368.4**	**261.5**	**272.9**	**94.6**	**110.7**	**62.7**	**6.8**	**3,437.5**

Notes: Hg = mercury; NA = not applicable.

[a] Assumes that this technology was the appropriate technology for 1992 amounts thermally treated. Much of this waste could have gone to removal and recovery of organics or was corrosive and could have been deactivated.

[b] The amount blended was not counted in the total waste amount generation; amount was counted when burned as fuel.

[c] At each location, some of these solvents (assuming approximately 10%) were also recycled by Safety-Kleen.

[d] Assumes onsite thermal treatment can destroy 50% of generated liquid HW that can be thermally treated.

[e] Assumes that onsite thermal treatment at ORR and SRS can destroy 75% of generated liquid HW that can be thermally treated.

[f] Waste amounts were derived from manifests. The precise amount of actual waste generated cannot be determined at this time. For this table, amounts for SRS are assumed to be the same as those for ORR.

HW Regionalized Alternative 1 (Treatment of 50% of Nonwastewater HW at 5 DOE Sites; 50% at Commercial Facilities)

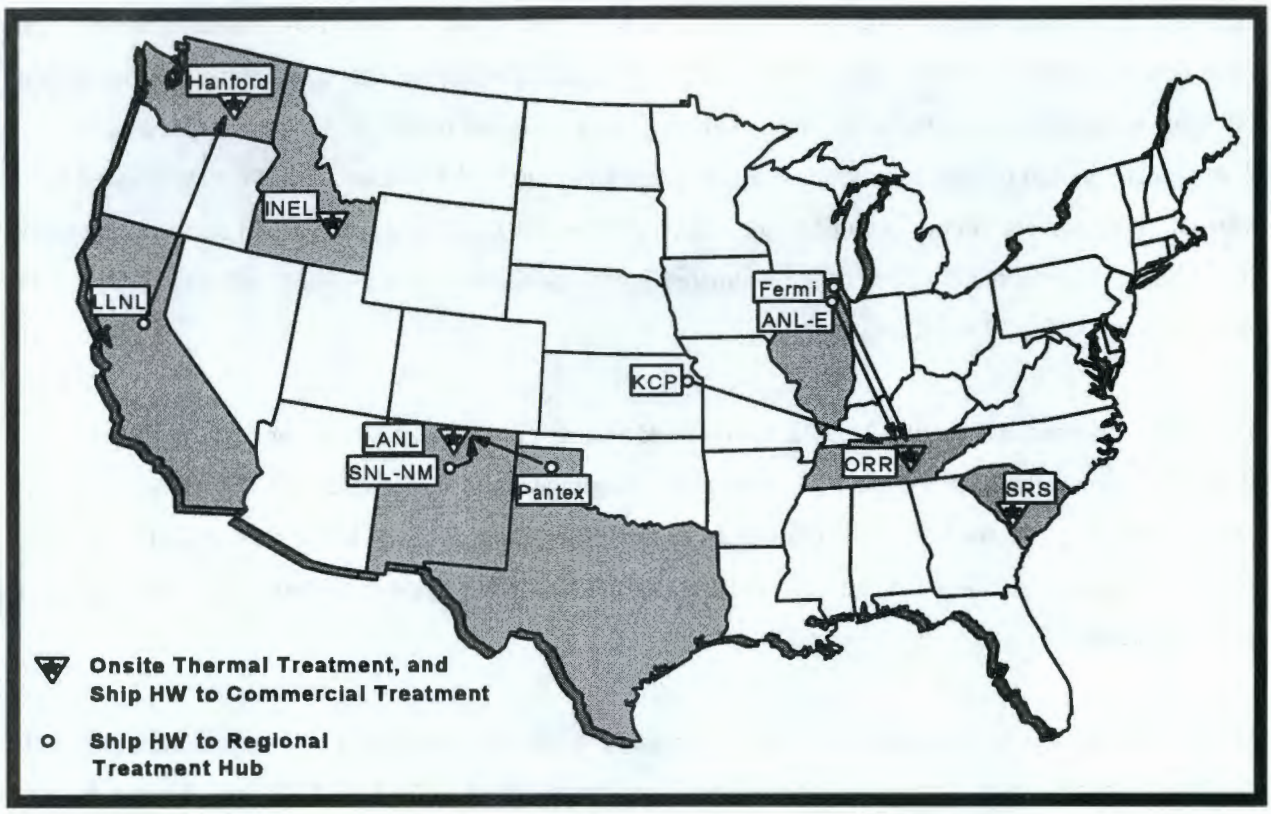

Figure 10.3–3. HW Regionalized Alternative 1

	Generating Sites					
	Hanford, LLNL	INEL	LANL, Pantex, SNL-NM	ANL-E, Fermi, KCP, ORR	SRS	Hanford, INEL, LANL, ORR, SRS
Treat	Hanford	INEL	LANL	ORR	SRS	Commercial treatment

Table 10.3–6. HW Regionalized Alternative 1

Data for Regionalized Alternative 1 are presented in Table 10.3–7. Under this alternative, HW that could be treated through the organic removal/recovery technologies would be sent to five regional hub sites from the major generating sites. The hub sites would treat two-thirds of the received HW and send the other one-third to commercial facilities. For HW that could be treated through thermal treatment, two-thirds would be sent to the regional hubs from the generating sites, and the other third would be sent directly to commercial thermal treatment facilities from the generating sites. The amounts of HW to be treated by the various treatment technology groups at the regional hubs and associated commercial facilities are shown in the table. Approximately 50% of the estimated 3,437 metric tons of HW listed in Table 10.3–7 would be treated at DOE HW facilities.

Under Regionalized Alternative 2, DOE would build facilities at INEL and ORR for organic treatment and deactivation/neutralization. Figure 10.3–4 illustrates Regionalized Alternative 2. All HW treatable in these facilities would be shipped from the other sites presented in Table 10.3–8. Metal recovery and recycling, battery recycling, stabilization, and land disposal would continue to be provided by offsite commercial establishments.

Under Regionalized Alternative 2, all deactivation waste would be treated at the appropriate hub, with INEL the only hub expected to receive such waste. The Pantex Plant, LANL, LLNL, the Sandia National Laboratories-New Mexico (SNL-NM) and the Nevada Test Site (NTS) would ship to INEL for thermal deactivation. Approximately 90% or 3,058 metric tons of HW listed in Table 10.3–9 would be treated at DOE HW facilities.

10.3.4 CENTRALIZED ALTERNATIVE

A single site Centralized Alternative for the management of HW was not considered in this PEIS because the DOE decision of concern is whether DOE should continue to use commercial facilities for the treatment and disposal of HW, or construct its own facilities. Current policy is the decentralized or regionalized use of commercial facilities. This PEIS seeks to compare decentralization and regionalization of proposed DOE facilities to the current HW practices.

Table 10.3–7. Regionalized Alternative 1: HW Treatment for 11 Large DOE HW Sites (in metric tons)

Hub	Organic Destruction by Thermal Treatment[a]	Organic Removal/Recovery[b]			Stabilization	Deactivation	Metal Removal/ Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending	Fuel Burning	Solvent Recycling[c]			Non-Hg	Hg			
Hanford Hub (Hanford; LLNL)											
Onsite	191.5	(312.0)[d]	206.0	106.0	0	0	0	0	0	0	503.5
Commercial	98.5	0	106.1	54.9	60.0	46.2	5.4	5.8	48.0	2.7	427.6
Hub total	**290.0**	**NA**	**312.1**	**160.9**	**60.0**	**46.2**	**5.4**	**5.8**	**48.0**	**2.7**	**931.1**
INEL Hub (INEL)											
Onsite	73.2	(30.5)[d]	30.5	0	0	0	0	0	0	0	103.7
Commercial	37.7	0	0	15.7	9.3	15.0	7.4	1.7	3.7	0.5	91.0
Hub total	**110.9**	**NA**	**30.5**	**15.7**	**9.3**	**15.0**	**7.4**	**1.7**	**3.7**	**0.5**	**194.7**
Los Alamos Hub (LANL; SNL; Pantex)											
Onsite	303.6	(137.6)[d]	73.3	66.3	0	0	0	0	0	0	443.2
Commercial	156.4	0	36.7	33.1	95.0	130.6	7.5	5.5	0	2.2	467.0
Hub total	**460.0**	**NA**	**110.0**	**99.4**	**95.0**	**130.6**	**7.5**	**5.5**	**0**	**2.2**	**910.2**
Oak Ridge Hub (ORR; Fermi; KCP; ANL-E)											
Onsite	420.0	(120.4)[d]	75.1	46.4	0	0	0	0	0	0	538.8
Commercial	215.5	0	37.6	23.2	84.2	60.3	63.9	95.4	6.0	0.7	589.5
Hub total	**635.5**	**NA**	**112.7**	**69.6**	**84.2**	**60.3**	**63.9**	**95.4**	**6.0**	**0.7**	**1,128.3**
Savannah Hub (SRS)											
Onsite	102.6	(42.7)[d]	28.0	15.0	0	0	5.2	0	0	0	150.8
Commercial	52.9	0	14.7	7.8	13.0	20.8	5.2	2.3	5.0	0.7	122.4
Hub total	**155.5**	**NA**	**42.7**	**22.8**	**13.0**	**20.8**	**10.4**	**2.3**	**5.0**	**0.7**	**273.2**
Total											
Onsite	1,090.9	(643.2)[d]	412.9	233.7	0	0	5.2	0	0	0	1,738.1
Commercial	560.9	(0)	195.1	134.7	261.5	272.9	89.5	110.7	62.7	6.8	1,698.2
Total	**1651.9**	**NA**	**608**	**368.4**	**261.5**	**272.9**	**94.6**	**110.7**	**62.7**	**6.8**	**3437.5**

Notes: Hg = mercury; NA = not applicable.
[a] Assumes that 2/3 of all material that can be thermally treated is thermally treated at regional hub and 1/3 at commercial facilities.
[b] Assumes that 2/3 of removal and recovery of organics is conducted onsite at regional hub and 1/3 at commercial facilities.
[c] Some of these solvents (approximately 10%) are also recycled by Safety-Kleen at each individual site location.
[d] This amount was not counted on overall treatment totals when blended. Rather, amount was counted when burned as fuel.

HW Regionalized Alternative 2 (Treatment of 90% of Nonwastewater HW at 2 DOE Sites; 10% at Commercial Facilities)

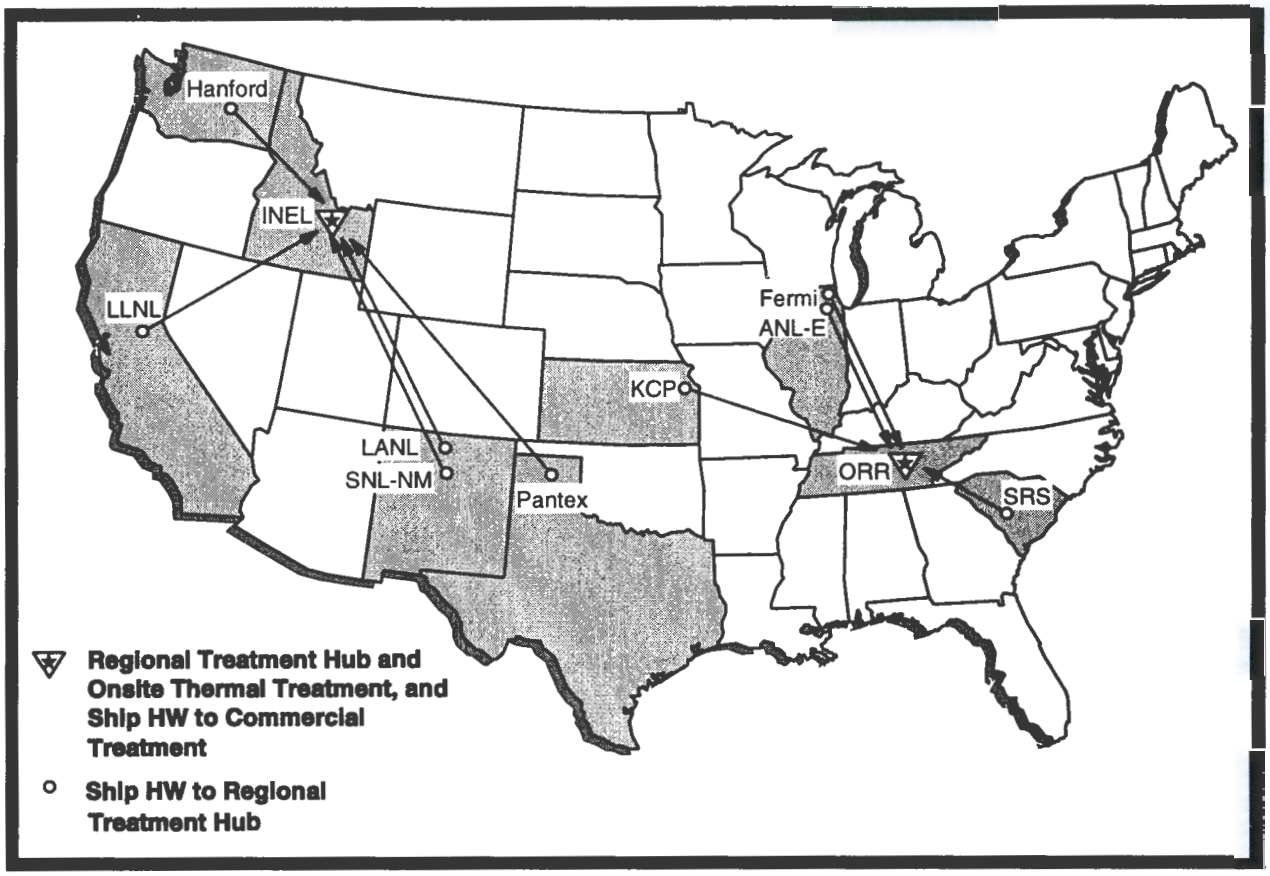

Figure 10.3–4. HW Regionalized Alternative 2

	Generating Sites		
	Hanford, INEL, LANL, LLNL, Pantex, SNL-NM	ANL-E, Fermi, KCP, ORR, SRS	INEL, ORR
Treat	INEL	ORR	Commercial treatment

Table 10.3–8. HW Regionalized Alternative 2

Table 10.3–9. Regionalized Alternative 2: HW Treatment for 11 Large HW Sites (in metric tons)

Hub and Location of HW Treatment	Organic Destruction by Thermal Treatment[a]	Organic Removal and Recovery			Stabilization	Deactivation	Metal Removal and Recovery		Aqueous Treatment	Recycling (Batteries)	Total
		Fuel Blending	Fuel Burning	Solvent Recycling[b]			Non-Hg	Hg			
INEL Hub (western region) (Hanford; INEL; LLNL; LANL; SNL-NM; Pantex)											
Onsite	860.9	(445.0)[c]	452.6	276.0	0	191.8	20.3	0	51.7	0	1,853.3
Commercial	0	0	0	0	164.3	0	0	13.0	0	5.4	182.7
Hub total	**860.9**	**NA**	**452.6**	**276.0**	**164.3**	**191.8**	**20.3**	**13.0**	**51.7**	**5.4**	**2,036.0**
ORR Hub (eastern region) (KCP; Fermi; ANL-E; SRS; ORR)											
Onsite	791.0	(163.0)[c]	155.4	92.4	0	81.1	74.3	0	11.0	0	1,205.2
Commercial	0	0	0	0	97.2	0	0	97.7	0	1.4	196.3
Hub total	**791.0**	**NA**	**155.4**	**92.4**	**97.2**	**81.1**	**74.3**	**97.7**	**11.0**	**1.4**	**1,401.5**
Total											
Onsite	1,651.9	(608.0)[c]	608.0	368.4	0	272.9	94.6	0	62.7	0	3,058.5
Commercial	0	(0)	0	0	261.5	0	0	110.7	0	6.8	379.0
Total	**1,651.9**	**NA**	**608.0**	**368.4**	**261.5**	**272.9**	**94.6**	**110.7**	**62.7**	**6.8**	**3,437.5**

Notes: Hg = mercury; NA = not applicable.
[a] In some cases, attaining 90% onsite treatment without conducting stabilization and land disposal may not be possible.
[b] Some solvents (approximately 10%) would still be handled on a decentralized basis through Safety-Kleen.
[c] This amount is only counted in total when burnt as fuel.

The Regionalized 2 Alternative includes waste treatment using two sites, one east and one west of the Mississippi River. These locations are reasonable locations considering that DOE sites are spread throughout the continental United States. Treatment at two sites would lead to risk and cost reductions over using a single U.S. site.

10.3.5 Rationale for Selection of Sites

The HW treatment alternatives were selected to cover the range of reasonable alternatives based on two primary criteria: (1) site experience with key HW treatment technologies, and (2) location of sites. As in the case of evaluating alternatives for the management of the radioactive waste types, consideration was given to avoiding the introduction of HW to DOE sites for treatment that do not generate HW. These criteria and considerations serve to minimize the costs and impacts associated with the alternatives and sites selected.

The technologies evaluated for onsite treatment of HW are thermal treatment, fuel burning, and deactivation. Five of the sites listed in Table 10.3–1 for the No Action Alternative (current HW management approach)—the Hanford Site, INEL, LANL, ORR, and SRS—have operated or plan to operate thermal treatment systems.

Regionalized Alternative 1 uses the five DOE sites with the operational or planned thermal treatment systems satisfying the criterion for site technology experience. The location criterion is addressed in that the five sites are somewhat regionally distributed which serves to minimize transportation of HW and associated risks.

Regionalized Alternative 2 is based on using two sites for HW treatment. The two sites proposed, INEL and ORR, satisfy the technology experience criterion since they are among the five sites discussed above, and their locations (west and east in the United States) require the least transportation of HW compared to other site combinations. Onsite deactivation, or neutralizing, also considered in this alternative, is planned for the two hub-sites.

In calculating the mileage traveled in each HW alternative, the mileage to commercial facilities was included along with the mileage to DOE hub facilities. In this way, total mileage is calculated from the shipper to the location where final treatment takes place. A set of commercial facilities was chosen to represent the most probable choices of commercial facilities nearby, considering the types of waste needing treatment at the various DOE facilities.

10.4 Health Risks

The health risk estimates include a fraction of a single fatality for each of the proposed HW alternatives from vehicle accidents associated with HW transportation. The Regionalized Alternatives result in greater worker exposure to HW chemicals than the No Action and Decentralized Alternatives because DOE treats more HW under the Regionalized Alternatives. This analysis did not evaluate the risk to workers at commercial facilities which are the principal HW treatment facilities under the No Action and Decentralized Alternatives. It is expected that HW worker risks would be the same regardless of whether commercial or DOE facilities are used. In view of this, there is no significant difference between the alternatives with regard to HW worker risk.

Health risk impacts can result from exposure to hazardous chemicals and from physical trauma associated with constructing and operating treatment facilities or transporting waste. This section discusses the estimated adverse health impacts resulting from chemical exposure as well as the physical hazards for each HW treatment alternative. Details of the HW results are contained in Appendices D, E, and F. Methodology details are contained in Chapter 5 and in ORNL technical reports (ORNL, 1995a-c). Potential health risks to a number of receptor populations and individuals are reported including:

- The offsite population—those individuals living within a 50-mile radius of the site, as well as along transportation routes
- Noninvolved workers population—the workers on DOE sites who are not involved directly in waste management activities.
- Waste management worker population (or "waste management workers")—onsite employees working in a site's waste management facilities, including workers involved in the waste management process, construction workers who build the waste management facilities, and those operating the trucks and

trains that transport the waste. Although DOE treats more of its HW under the Regionalized Alternatives, whereas commercial HW treatment facilities are used under the No Action and Decentralized Alternatives, worker risk is assumed to be similar whether HW treatment is conducted at a DOE or a commercial facility.

10.4 Health Risks
10.5 Air Quality Impacts
10.6 Water Resources Impacts
10.7 Ecological Resources Impacts
10.8 Economic Impacts
10.9 Population Impacts
10.10 Environmental Justice Concerns
10.11 Land Use Impacts
10.12 Infrastructure Impacts
10.13 Cultural Resources Impacts
10.14 Costs
10.15 Environmental Restoration Analysis
10.16 Comparison of Alternatives Summary

- Maximally exposed individual (MEI) for the offsite population—hypothetical individual in the offsite population who would receive the highest total lifetime multimedia dose
- MEI for the noninvolved worker population—hypothetical individual in the noninvolved worker population who would receive the highest total lifetime multimedia dose.
- A most-exposed waste management worker— an individual who would experience potential noncancer effects, as estimated using the Exposure Index, following exposure to HW.
- The human health and environmental impacts at and surrounding the commercial facilities involved in hazardous waste treatment were not considered quantitatively in this WM PEIS. Each of those facilities has obtained its own RCRA permit, which involved separate risk assessments done in support of the permitting process. In addition, the DOE portion of the annual waste processed by those facilities is less than 5% per year.

Maximally Exposed Individual

In keeping with standard risk assessment methodology, DOE analyzed the impacts to a "maximally exposed individual." The MEI is the hypothetical person within the receptor group who has the highest exposure. This individual is assumed to be located at the point of maximum concentration of contaminants 24 hours a day, 7 days a week, for the 10-year period of treatment operations analyzed in the WM PEIS.

The impacts evaluated were:

- Fatalities from physical hazards
- Cancer incidence from chemical exposure
- Noncancer effects from chemical exposure (for example, headaches, nasal irritation, liver or kidney toxicity, neurotoxicity, immunotoxicity, and reproductive and developmental toxicity)

Interpreting the results of health risk analyses involves consideration of both uncertainties and appropriate standards. See Section 5.4.1 and Appendix D for a further discussion of these issues.

10.4.1 Routine Operation Impacts

For operations involving HW treatment, health effects were evaluated for the offsite population, the onsite worker population not involved in HW treatment ("noninvolved workers"), and waste management workers directly involved in treatment activities. Impacts were quantified using two approaches: analysis of *population* health risk impacts and analysis of *individual* health risk impacts. Table 10.4–1 presents the sizes of offsite populations and waste management treatment worker populations used in the health risk analysis.

Population impacts focus on the *total number* of people in each receptor population who would experience adverse health impacts if a particular alternative is implemented.

Population impacts focus on the *total number* of people in each receptor population who would experience adverse health impacts if a particular alternative is implemented.

Individual impacts focus on the *probability* that the "maximally exposed individual" (MEI) within each receptor population would experience an adverse health impact. Because the focus is on the MEI, the risk

Table 10.4–1. Offsite and Waste Management Treatment Worker Populations

Site	Offsite Population[a]	WM Treatment Worker Population by Alternative[b]			
		No Action	Decentralized	Regionalized 1	Regionalized 2
Hanford	377,645	--	--	91	--
INEL	153,061	16	16	35	160
LANL	159,152	--	--	88	--
ORR	881,652	36	36	101	212
SRS	620,618	--	--	40	--

Note: -- = no waste treatment at this site under this alternative.
[a] Within 50-mile radius of sites.
[b] Waste management worker population estimates represent full-time equivalents (FTEs) over the entire construction and operation periods.

is presented as a probability (e.g., one in one million, or 1E–06) of that individual experiencing an adverse health impact, rather than the total number of impacts for a selected population.

DOE analyzed the potential effects of exposure to hazardous chemicals on the receptor groups. The pathways of exposure analyzed were inhalation of contaminated air and ingestion of contaminated plants and animals.

Worker risks associated with physical hazards were evaluated for 20 years: a 10-year period of construction of treatment facilities, and a subsequent 10-year period of operation. However, worker and public risks from exposure to chemicals (received during the 10-year operation period) were evaluated for an entire lifetime (70 years), because health impacts from airborne contaminants could occur throughout the lifetime of the exposed individual.

Table 10.4–2 provides an overview of the health risk endpoints, receptor groups, hazard sources, pathways, and exposure periods evaluated for HW treatment.

Table 10.4–2. HW Health Risk Analysis Components

Endpoints	Receptor	Source	Pathways	Exposure Period	Table References
Number of Trauma Fatalities	WM Workers	Physical Hazards	Physical Hazards	20 years	Text only
Number of Cancer Incidences	Offsite Population	Chemicals	Inhalation, Ingestion	10 years	10.4–3
	Noninvolved Workers		Inhalation		
	WM Workers		Inhalation		
Probability of Cancer Incidence	Offsite MEI	Chemicals	Inhalation, Ingestion	10 years	10.4–4
	Noninvolved Worker MEI		Inhalation		
Noncancer Risk	Offsite MEI	Chemicals	Inhalation, Ingestion	10 years	10.4–5
	Noninvolved Worker MEI		Inhalation		
	WM Worker		Inhalation		

Understanding Scientific Notation

Scientific notation is used in the WM PEIS to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers (or exponents) of 10. A number written in scientific notation is expressed as the product of a number between 1 and 10 times a positive or negative power of 10. Some positive and negative powers of 10 include:

Positive Powers of 10	***Negative Powers of 10***
$10^1 = 10 \times 1 = 10$	$10^{-1} = 1/10 = 0.1$
$10^2 = 10 \times 10 = 100$	$10^{-2} = 1/100 = 0.01$
and so on; therefore,	*and so on; therefore,*
$10^6 = 1{,}000{,}000$ *(or 1 million)*	$10^{-6} = 0.000001$ *(or 1 in 1 million)*
etc.	*etc.*

A power of 10 is also commonly expressed as "E," where "E" means "× 10." For example, 3×10^5 *can also be written as 3.0E+05, and* 3×10^{-5} *is equivalent to 3.0E-05. Therefore, 3.0E+05 = 300,000 and 3.0E-05 = 0.00003.*

The health risk data tables in this section use "E" notation with negative exponents.

Probability is expressed as a number between 0 and 1. The notation 3.0E-06 can be used as 0.000003, which means that there are three chances in 1,000,000 that the associated result (e.g., fatal cancer) will occur over the period covered by the analysis.

The health risk impacts associated with the routine operation of HW treatment facilities are presented in several tables in this section. Summary tables show programwide results by alternative. The site data tables in Volume II present the health impacts for all sites.

10.4.1.1 Estimated Number of Fatalities

On a programwide basis, waste management worker physical hazard fatalities did not equal or exceed one under any of the alternatives evaluated. On a site-level basis, worker fatalities did not equal or exceed one at any HW treatment site under any alternative.

10.4.1.2 Estimated Number of Cancer Incidences

Table 10.4–3 presents an overview, by alternative, of the total estimated programwide cancer incidences associated with treatment of HW. These impacts result from chemical exposures of the offsite population, noninvolved workers, and waste management workers.

The number of cancer incidences on a programwide basis are estimated to be less than one for all receptor groups except waste management workers. Programwide waste management worker cancer incidences of one and two were estimated under the Regionalized 1 and 2 alternatives, respectively. On a site-level basis, one waste management worker cancer was estimated at ORR under Regionalized Alternative 2 as a result of exposure to chromium VI. The chromium cancer risk is probably an overestimate, since all of the chromium available for exposure was conservatively assumed to be in the form of chromium VI. Cancer incidences of less than one were estimated for the offsite and noninvolved worker populations at all sites under all alternatives.

10.4.1.3 Probability of MEI Cancer Incidence

Table 10.4–4 summarizes, by alternative, the highest estimated *probability* at any site of cancer incidences resulting from chemical exposure. This table presents these estimated risks for the MEIs within the offsite population and noninvolved worker population.

Table 10.4–3. HW Treatment: Estimated Number of Cancer Incidences Programwide

Alternative	Sites[a]	Offsite Population Chemical Cancer Incidence	Noninvolved Worker Chemical Cancer Incidence	WM Worker Chemical Cancer Incidence
No Action	2	*	*	*
Decentralized	3	*	*	*
Regionalized 1	5	*	*	1
Regionalized 2	2	*	*	2

Note: * = greater than 0 but less than 0.5.
[a] Number of DOE sites treating.

Table 10.4–4. HW Treatment: Greatest Probability of Cancer Incidence at Any HW Site

Alternative	Sites[a]	Offsite MEI Cancer[b] Incidence Probability	Noninvolved Worker MEI Cancer Incidence Probability
No Action	2	4E–07	2E–06
Decentralized	3	4E–07	2E–06
Regionalized 1	5	2E–06	1E–05
Regionalized 2	2	5E–06	3E–05

Note: Please refer to Section 5.4.1 of Volume I for guidance in interpreting MEI risks.
[a] Number of DOE sites treating.
[b] The impacts presented in this table refer only to offsite populations surrounding DOE sites. Impacts to offsite populations from treatment at commercial facilities are not included.

The probability of a cancer incidence to the MEI was calculated for each site and the highest values under each alternative are presented in Table 10.4–4. The MEI risk is not a combined total of risks across all of the sites under an alternative.

The probabilities for the Regionalized Alternatives are relatively higher by about one order of magnitude (10 times) than the probabilities estimated for the No Action and Decentralized Alternatives. Four sites (the Hanford Site, INEL, LANL, ORR) are estimated to have the highest offsite or noninvolved worker MEI cancer incidence probabilities (greater than one-in-one million) from implementation of HW alternatives. Exposure to chromium VI drives the cancer risk at these sites.

10.4.1.4 MEI Noncancer Risks

The "Hazard Index" is an EPA standard indicator of potential noncancer toxicity caused by exposure to hazardous chemicals. It is derived by comparing the estimated exposure concentrations of noncarcinogenic chemicals to concentrations presumed to be protective of human health over an entire lifetime, assuming continuous low-level exposure. If the Hazard Index exceeds one, the estimated exposure concentrations exceed the concentrations presumed to be without adverse health effects. In the WM PEIS, the Hazard Index was estimated for the MEI of the offsite and noninvolved worker populations.

For waste management workers, an "Exposure Index" rather than a Hazard Index was estimated. The Exposure Index is derived by comparing the estimated exposure concentrations to appropriate occupational exposure limits. The Exposure Index was considered to be a better measure for waste management workers

because the Hazard Index uses standards designed to protect the health of the general population, including sensitive subgroups, such as children. Workers are generally assumed to be healthier than the general population, and worker populations do not contain sensitive subgroups. Therefore, the concentrations of noncarcinogenic chemicals presumed to be protective of human health are different for these two groups of receptors. If the Exposure Index exceeds one, the estimated concentrations exceed the concentrations presumed to be without adverse health effects.

Table 10.4–5 summarizes, by alternative, the programwide noncancer health risks resulting from chemical exposures associated with each HW alternative. This table presents the greatest noncancer health risks (presented as "Hazard Index") to the MEIs within the offsite and noninvolved worker populations, and to an individual waste management worker (presented as "Exposure Index") across the treatment sites.

None of the alternatives are estimated to produce noncancer risks at levels of concern to the MEIs of the offsite and noninvolved worker populations. However, the Exposure Index values for the waste management workers exceed one for each of the alternatives, indicating the potential for adverse noncancer health effects as a result of worker exposures. Five sites (the Hanford Site, INEL, LANL, ORR, and SRS) are estimated to have noncancer risks to the most exposed waste management worker, with Exposure Indices equal to or greater than one. Noncancer risks are of concern at ORR under each of the alternatives. At the other sites, noncancer risks are estimated mainly under the regionalized alternatives, although INEL

Table 10.4–5. HW Treatment: Greatest Noncancer Health Risks at Any HW Site

Alternative	Sites[a]	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Incidence	WM Worker Exposure Index
No Action	2	*	*	4
Decentralized	3	*	*	4
Regionalized 1	5	*	*	6
Regionalized 2	2	*	*	6

Notes: Hazard Index = sum of Hazard Quotient values for all noncarcinogenic chemicals; Hazard Quotient = the chemical-specific ratio of media exposure concentration to concentrations believed to have no appreciable adverse effects; Exposure Index = ratio of exposure concentration to chemical-specific occupational threshold limit; * = greater than 0 but less than 0.5.
[a] Number of DOE sites treating.

and LANL have such risks under the No Action and Decentralized Alternatives, respectively. Hydrogen chloride is the noncancer risk driver at these sites.

10.4.2 TRANSPORTATION-RELATED IMPACTS

Although HW can be transported both by truck and rail, truck transportation is the predominant shipping method. Therefore, transportation impacts were estimated based solely on truck transportation. Potential health impacts from the transportation of HW were considered to be the result of exposure to vehicle exhaust during transportation operations, and exposure to HW chemicals due to transportation accidents in which HW shipment containers are breached. Physical injuries and fatalities sustained during vehicle accidents were also included in the transportation-related health impacts. The populations potentially affected in the transportation of HW are the public along transportation routes and the truck crews transporting the HW.

Some HW would be shipped to commercial vendors for treatment under all HW management alternatives. Therefore, shipments of HW were considered to occur uniformly over the 20-year construction and operation period. Appendix E describes the methods used to estimate the health risks from transporting HW.

Table 10.4–6 presents the health risk impacts from exposure to HW chemicals released as a result of transportation accidents. The estimated health risk impacts are based on the types of HW chemicals present and differing levels of concentrations released.

The exposed population includes the truck transportation workers and assumes the accident and release of HW chemicals take place in a populated urban area. The probability of an accident occurring with the most toxic chemicals present in large quantities, high population density, and meteorological conditions favoring extremely limited dispersal of the chemicals would be very low. For example, 285 of the estimated 1,700 shipments over a 20-year period under the No Action Alternative would involve HW chemicals that are considered as having a potential for causing "any adverse effect." Of those 285 shipments, only 36 of the shipments contain the combinations of HW chemicals that would contribute more than 50% of the adverse health risk. This amounts to 2/100ths of 1% of all HW shipments over 20 years. This relationship would also be true for the other HW alternatives.

Table 10.4–6. Health Risks From Chemical Exposure Following HW Transportation Accidents

HW Alternatives	Sites[a]	Shipment Miles (Millions)	Number of Shipments	Number of Potential Life Threatening Effects	Number of Potential Cancers	Number of Potential Adverse Noncancer Effects
No Action	2	20	34,000	*	2	78
Decentralized	3	19	41,500	*	1	49
Regionalized 1	5	35	50,000	*	3	86
Regionalized 2	2	19	34,000	*	2	60

Note: * = greater than 0 but less than 0.5.
[a] Number of DOE sites treating.

Table 10.4–7 summarizes the total number of estimated fatalities associated with truck transportation of HW and provides the total number of shipments, the total shipment miles, and the source of the fatalities for each alternative. Regionalized Alternative 1 is the only alternative that is estimated to result in a fatality as a result of traffic accidents. None of the other alternatives are estimated to produce fatalities as a result of implementation of HW alternatives.

Table 10.4–7. Estimated Fatalities for HW Truck Transportation From Vehicular Accidents

Alternative	Sites[a]	Number of Shipments	Shipment Miles (Millions)	Source of Fatalities	
				Fuel Emissions	Injury from Traffic Accidents
No Action	2	34,000	20	*	*
Decentralized	3	41,500	19	*	*
Regionalized 1	5	50,000	35	*	1
Regionalized 2	2	34,000	19	*	*

Note: * = greater than 0 but less than 0.5.
[a] Number of DOE sites treating.

10.4.3 FACILITY ACCIDENT IMPACTS

10.4.3.1 Storage Facility Accidents

Although DOE does not intend to make any HW storage decisions as a result of this PEIS, limited storage (or staging) is necessary to facilitate treatment. Therefore, health risks were evaluated for a number of potential HW storage facility accidents. The accidents analyzed included: (1) a fire that engulfs a significant number of HW containers; (2) an earthquake that ruptures a significant number of containers; and (3) the crash of a large or small aircraft into the facility resulting in fire and explosion. Additional information about the methods and assumptions used in the facility accident analysis, as well as details about the individual accident scenarios, can be found in Appendices D and F. Note that facility accidents were analyzed only under the regionalized alternatives because these alternatives had the largest estimated inventories of waste, and therefore, the largest potential consequences following an accident. Analyzing only these alternatives should provide an estimate of the potential maximum risks under all alternatives.

Table 10.4–8 summarizes the estimated cancer incidences resulting from chemical exposures associated with potential storage facility accidents. This table contains cancer incidence and frequency of occurrence estimates for the maximum reasonably foreseeable accident scenario at several sites under Regionalized Alternatives 1 and 2. None of the receptor groups are estimated to have cancer incidences equal to or greater than one as a result of accidents related to storage of HW at any of the sites evaluated.

Table 10.4–9 summarizes the estimated noncancer risks to the MEI resulting from chemical exposures associated with potential HW storage facility accidents. This table contains noncancer risk and frequency of occurrence estimates (presented as a "Hazard Index" or an "IDLH [Immediately Dangerous to Life and Health] Index") for the maximum reasonably foreseeable accident scenario at several sites under Regionalized Alternatives 1 and 2.

Regionalized Alternative 2 appeared to have the higher risks of the two alternatives evaluated, although noncancer risks are estimated to occur in each of the receptor groups at each of the sites evaluated under both alternatives if the accidents were to occur.

Table 10.4–8. Cancer Incidences From Potential Maximum Reasonably Foreseeable HW Storage Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite Population Number of Cancer Incidences	Noninvolved Workers Number of Cancer Incidences	WM Workers Number of Cancer Incidences
Regionalized Alternative 1					
Hanford	Storage facility fire	1.0E–04 to 1.0E–02	*	*	*
INEL	Large aircraft crash	<1.0E–06	*	*	*
LANL	Small aircraft crash	<1.0E–06	*	*	*
ORR	Small aircraft crash	<1.0E–06	*	*	*
SRS	Large aircraft crash	<1.0E–06	*	*	*
Regionalized Alternative 2					
INEL	Large aircraft crash	<1.0E–06	*	*	*
ORR	Small aircraft crash	<1.0E–06	*	*	*

Note: * = greater than 0 but less than 0.5.

Table 10.4–9. Noncancer Risks From Potential Maximum Reasonably Foreseeable HW Storage Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker IDLH Index
Regionalized Alternative 1					
Hanford	Large aircraft crash	<1.0E–06	1	6	1,400
INEL	Large aircraft crash	<1.0E–06	2	14	530
LANL	Small aircraft crash	<1.0E–06	32	450	2,700
ORR	Small aircraft crash	<1.0E–06	77	850	680
SRS	Large aircraft crash	<1.0E–06	2	110	1,300
Regionalized Alternative 2					
INEL	Large aircraft crash	<1.0E–06	37	330	6,200
ORR	Small aircraft crash	<1.0E–06	240	2,600	2,300

Note: IDLH = immediately dangerous to life and health.

10.4.3.2 Treatment Facility Accidents

The thermal treatment facility (incinerator) accidents evaluated included: (1) explosion and resulting feedstock fire; (2) earthquake followed by a facility fire; and (3) the crash of a large or small aircraft into the facility resulting in a facility fire.

Table 10.4–10 summarizes the estimated cancer incidences resulting from chemical exposures associated with potential treatment facility accidents. This table contains cancer incidence and frequency of occurrence estimates for the maximum reasonably foreseeable accident scenario at several sites under Regionalized Alternatives 1 and 2. None of the receptor groups are estimated to have cancer incidences equal to or greater than one as a result of accidents related to treatment of HW at any of the sites evaluated.

Table 10.4–11 summarizes the estimated noncancer risks to the MEI resulting from chemical exposures associated with potential treatment facility accidents. This table contains noncancer risk estimates for the maximum reasonably foreseeable accident scenario at several sites under Regionalized Alternatives 1 and 2. Noncancer risks are estimated to occur in each of the receptor groups at most of the sites evaluated under both alternatives if the accidents were to occur.

Table 10.4–10. Cancer Incidences From Potential Maximum Reasonably Foreseeable HW Treatment Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite Population Number of Cancer Incidences	Noninvolved Workers Number of Cancer Incidences	WM Workers Number of Cancer Incidences
Regionalized Alternative 1					
Hanford	Large aircraft crash	<1.0E–06	*	*	*
INEL	Large aircraft crash	<1.0E–06	*	*	*
LANL	Earthquake and fire	1.0E–06 to 1.0E–04	*	*	*
ORR	Small aircraft crash	<1.0E–06	*	*	*
SRS	Large aircraft crash	<1.0E–06	*	*	*
Regionalized Alternative 2					
INEL	Earthquake and thermal treatment unit fire	<1.0E–06	*	*	*
ORR	Small aircraft crash	<1.0E–06	*	*	*

Note: * = greater than 0 but less than 0.5.

Table 10.4–11. Noncancer Risks From Potential Maximum Reasonably Foreseeable HW Treatment Facility Accidents

Site	Accident Type	Estimated Annual Accident Frequency	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker IDLH Index
Regionalized Alternative 1					
Hanford	Large aircraft crash	<1.0E–06	0.2	1	360
INEL	Large aircraft crash	<1.0E–06	0.08	0.5	230
LANL	Earthquake and fire	1.0E–06 to 1.0E–04	1	8	200
ORR	Small aircraft crash	<1.0E–06	7	7	320
SRS	Large aircraft crash	<1.0E–06	0.08	4	120
Regionalized Alternative 2					
INEL	Earthquake and thermal treatment unit fire	<1.0E–06	2	12	990
ORR	Small aircraft crash	<1.0E–06	11	11	560

Note: IDLH = immediately dangerous to life and health.

10.5 Air Quality Impacts

The management of HW would not appreciably affect the air quality at most sites. No site would equal or exceed criteria air pollutant standards. However, regionalization of treatment facilities at LANL and ORR could cause adverse air quality impacts requiring additional emission control measures primarily due to emissions of hazardous pollutants from thermal treatment.

As illustrated in Table 10.5–1, DOE evaluated air quality impacts at each proposed HW treatment site based on estimated increases in emissions of the six criteria air pollutants, hazardous air pollutants (HAPs), and toxic air pollutants (TAPs). Emissions of radionuclides are not applicable because HW does not contain radionuclides. DOE estimated pollutant emissions for HW facility construction activities and for operation and maintenance activities.

The Clean Air Act (42 USC 7401 *et seq.)* regulates emissions of air pollutants. In those areas where air pollution standards are not met (known as "nonattainment areas"), activities that introduce new emissions from both "stationary" (e.g., treatment facilities) and "mobile" (e.g., vehicles and construction equipment) sources are regulated under the "General Conformity Rule." In this rule, EPA has established limits for

Table 10.5-1. Air Quality Impacts Evaluated for HW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Criteria air pollutant emissions	Construction	Estimated for construction equipment and worker vehicles	Percent of standard	Text discussion only
	Operations	Estimated for thermal treatment units, for fuel use by all other HW facilities, for worker vehicles, and for waste shipment vehicles	Percent of standard	Table 10.5-2
Hazardous and toxic air pollutant emissions	Operations	For all HW treatment facilities	Percent of standard	Table 10.5-3

each criteria air pollutant for nonattainment areas. An entity which seeks to engage in an activity that will result in emissions equal to or exceeding those limits in a nonattainment area must first obtain a permit.

In "attainment areas" (where air pollution standards are met), only new emissions from stationary sources are regulated. In these areas, regulations for the Prevention of Significant Deterioration (PSD) of ambient air quality apply. Allowable emission increases are known as PSD increments. A permit is required for a new stationary source that equals or exceeds the allowable increase. However, a permit is not required for criteria air pollutant emissions from mobile sources.

10.5.1 Criteria Air Pollutant Emissions From Construction

Criteria air pollutants can be emitted from construction equipment and from vehicles that workers use to drive to the construction site (mobile sources).

For purposes of analysis, DOE identified sites in nonattainment areas where construction activities under the HW alternatives would result in

Major Types of Air Pollutants

***Criteria Air Pollutants**: carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), and particulate matter less than or equal to 10 micrometers in diameter (PM_{10})*

***Hazardous Air Pollutants**: 189 hazardous substances (including radionuclides) whose emissions are regulated by the Clean Air Act*

***Toxic Air Pollutants**: Other toxic compounds regulated by EPA and state or local governments*

emissions that would equal or exceed 10% of the allowable limit of a particular criteria air pollutant. DOE chose the 10% threshold to highlight sites where criteria air pollutant emissions could result in adverse air quality impacts.

DOE estimates that no site would have emissions from construction activities that would equal or exceed 10% of allowable levels. Therefore, no site would need to obtain a Clean Air Act permit.

10.5.2 CRITERIA AIR POLLUTANT EMISSIONS FROM OPERATIONS AND MAINTENANCE

Criteria air pollutants are also emitted during operation and maintenance of HW facilities (stationary sources) and by vehicles that are driven by workers to the facility or used to transport waste (mobile sources). DOE evaluated air quality impacts for these pollutants at each site by comparing estimated increases in tons per year to the allowable emission limits (General Conformity Rules in nonattainment areas or PSD increments in attainment areas).

Of the nine major HW sites, only ORR and INEL would equal or exceed 10% of applicable air pollutant emission standards (Table 10.5–2). Both sites are located in attainment areas. Although ORR would equal or exceed 10% of the PM_{10} standard under both the Regionalized Alternatives 1 and 2 and INEL would exceed 10% of the PM_{10} standard under Regionalized 2, no site would equal or exceed any of the criteria air pollutant emission standards or need to obtain a Clean Air Act permit.

The most stringent PSD requirements are for Class I areas. Class I areas are regions of special concern because they include national parks, monuments, seashores, wildlife refuges, or wilderness areas. A proposed action may affect air quality in a PSD Class I area if it will emit more than the allowable PSD increment of a criteria air pollutant and will be located within 100 km (62 miles) of a PSD Class I area. Five sites proposed for HW activities under the alternatives are located within 100 km of a PSD Class I area: INEL, LANL, LLNL, ORR, and SNL-NM. None of these would have sufficient quantities of emissions to affect a PSD Class I area.

Estimated concentrations resulting from criteria air pollutant emissions from facilities were also compared to the National Ambient Air Quality Standards (NAAQS) (40 CFR 50). No site was estimated to equal or exceed 10% of the standards.

Table 10.5-2. Percent of Sites' Allowable Air Emissions Discharged During Operations—HW Sites Equaling or Exceeding 10% of Standard

Alternative	Number of Treatment Sites	Criteria Pollutants (PM_{10})	
		Operation and Maintenance	
		INEL[a]	ORR[a]
No Action	2		
Decentralized	3		
Regionalized 1	5		10
Regionalized 2	2	17	13

Note: PM_{10} = particulate matter less than or equal to 10 micrometers in diameter. Values less than 10% are shown as blanks.
[a] Attainment area for this pollutant; PSD regulations are applied; total % represents stationary-source emissions only.

10.5.3 Hazardous and Toxic Air Pollutant Emissions

Thermal treatment of HW will result in emission of small quantities of hazardous and toxic air pollutants. Hazardous air pollutants (HAPs), other than radionuclides, and toxic air pollutants (TAPs) were evaluated by comparing estimated ambient concentrations to EPA guidelines and State Ambient Allowable Limits (AALs). Radionuclides emissions are not applicable because HW does not contain radionuclides.

As shown in Table 10.5-3, only vinyl chloride concentrations at LANL and ORR were estimated to equal or exceed 10% of the applicable guidelines or standards. These concentrations exceeded the standard for

Table 10.5-3. Percent of the Standard for Hazardous and Toxic Air Pollutants—HW Sites Equaling or Exceeding 10% of Standard

Alternative	Number of Treatment Sites	HAPs/TAPs (Vinyl Chloride[a])	
		LANL	ORR
No Action	2		14
Decentralized	3		35
Regionalized 1	5	153	120
Regionalized 2	2		322

Notes: HAPs = hazardous air pollutants; TAPs = toxic air pollutants. Values less than 10% are shown as blanks.
[a] Vinyl chloride exceeds 10% of the EPA Integrated Risk Information System annual toxic value of 0.012 $\mu g/m^3$.

both LANL and ORR in Regionalized Alternative 1, and ORR in Regionalized Alternative 2. These results are primarily due to the thermal treatment of HW, and may require additional control measures to reduce emissions to acceptable levels.

10.6 Water Resources Impacts

Major impacts to water resources at the HW sites are unlikely for treatment under any alternatives.

As illustrated in Table 10.6–1, DOE analyzed the impacts on water resources of HW treatment activities. Disposal of HW is not within the scope of the WM PEIS. DOE evaluated the effects on water availability from building and operating treatment facilities.

In addition, the following impacts were examined for all waste types collectively, and are discussed in Chapter 5, Section 5.4.3:

- Impacts on surface water caused by floodplain encroachment
- Impacts on surface water from runoff and sedimentation
- Impacts on surface water and groundwater quality from wastewater discharges
- Impacts on small onsite streams from wastewater discharges
- Impacts on existing areas of groundwater contamination from groundwater withdrawal
- Impacts on surface and groundwater water quality from routine transportation and transportation accidents

10.6.1 Water Availability

Impacts on surface water and groundwater availability were assessed by comparing current water use rates from municipal, surface water, or groundwater sources to projected requirements for construction or operation of HW facilities. In addition, impacts on surface water were further assessed by examining the effect of potential withdrawals from and discharges to the major offsite stream at a given site.

Table 10.6–1. Water Resource Impacts Evaluated for HW Alternatives

Impacts Assessed	Period of Analysis	Activities for Which Impacts Are Assessed	Impacts Measure	Location of Impacts Assessment
Water availability	Construction	Estimated for water used: • by personnel • for concrete • for dust suppression	Percent increase in current water use	Text discussion only
			Percent decrease in stream flow	Text discussion only
	Operations	Estimated for water used • by personnel • by treatment processes	Percent increase in current water use	Text discussion only
			Percent decrease in stream flow	Text discussion only
		Estimated for effluent discharged from sanitary and process wastewater treatment facilities	Percent increase in stream flow	Text discussion only

As shown in the Volume II tables, projected water usage would be less than 1% of current use at all sites. The 1% threshold is based on the assumption that changes less than or equal to 1% are not likely to have significant impacts. Therefore, no site is likely to experience adverse impacts because of the relatively small amount of additional water needed.

For DOE sites that withdraw water directly from a surface water source (the Hanford Site and ORR), water use would be less than 1% of the average flow in the surface water body. In addition, for this analysis, it was assumed that 100% of the water used at the facility during operations would be discharged as effluent from a wastewater treatment plant. For sites that discharge wastewater to natural surface waters (ANL-E, ORR, and SRS), effluent discharges would be less than 1% of the average flow in the principal receiving water body at all sites. These are negligible changes in flow that would not affect surface water levels.

10.6.2 Water Quality

Impacts to groundwater quality were not evaluated for HW. Because HW disposal is conducted by commercial disposal facilities, the impacts to water quality would be analyzed by the commercial operator.

10.7 Ecological Resources Impacts

Loss of limited acreages of habitat at some HW sites during construction of HW facilities would not affect populations of nonsensitive plant and animal species because these species habitats are well established regionally. DOE should be able to locate new HW facilities to avoid impacts to nearby wetlands and other sensitive habitats because construction site acreages are small compared to the total acreage at each site suitable for waste operations. A screening-level risk assessment of facility airborne emissions indicated that terrestrial wildlife species are not likely to be affected. Transportation accidents leading to spills of HW into aquatic environments could have serious short- and long-term consequences, but the long-term consequences could be mitigated in many instances through emergency response cleanup activities.

As illustrated by Table 10.7–1, DOE analyzed the effects of construction site clearing to build HW treatment facilities, and the operation of treatment facilities on ecological resources at the five large HW treatment sites. DOE qualitatively considered the effects of accidental spills of HW during transport.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to sensitive species and habitats based on site-specific conditions.

10.7.1 General Impacts of Site Clearing

None of the alternatives would require extensive site clearing for construction of HW facilities. Acreage requirements at any site under any alternative are less than or equal to the 3 acres required at INEL under the Regionalized Alternative 2. These acreage requirements are minimal compared with the regional extent of habitats for nonsensitive species at the sites. Although site clearing would destroy individual plants and would kill or displace individual animals (particularly small mammals and song birds with limited home ranges), no significant effects to populations of these species are expected from implementation of any HW alternative.

Table 10.7-1. Ecological Resource Impacts Evaluated for HW Alternatives

Ecological Impact Analyzed	Affected Ecological Resource	Analysis Method	Presentation of Results
Nonsensitive habitat effects	Terrestrial plants and animals	Comparison of habitat loss at HW construction sites to general habitat range.	Text discussion
Terrestrial species exposures	Terrestrial animal species	Comparison of estimated hazardous chemical exposures for representative species with the toxicity standard.	Text discussion
Sensitive habitat effects	Nearby wetlands and other sensitive habitats	Likelihood of impacts to nearby sensitive habitats based on comparing construction acreage to available acreage of nonsensitive habitats.	Text discussion
Sensitive species concerns	Federally and State-listed endangered and threatened species	Numbers of Federally- and State-listed species displayed by site/alternative.	Table 10.7-2
Effects of transportation accidents	Aquatic species in streams crossing transportation corridors	Comparison of accidental spills into aquatic habitats based on number of HW shipments.	Text discussion

10.7.2 SITE CLEARING EFFECTS ON SENSITIVE HABITATS

For those sites that contain sensitive habitats, the degree to which they may be affected by noise or vibration disturbance, human presence, vehicle or equipment emissions, runoff, or encroachment by nearby HW construction activities depends on DOE's ability to avoid siting near these habitats. A measure of this ability is the percentage of available land required for facility construction at a site under any HW alternative. Available acreage was estimated from site development plans either using land designated for waste operations or subtracting the acreage of existing structures and sensitive habitats, such as wetlands and wildlife management areas, from the total site acreage. The analysis showed that the percent of available acreage ranged from 0.0007% at SRS under the Decentralized Alternative and Regionalized Alternative 1 to 0.04% at ORR under the Regionalized Alternative 2. Considering these small fractions of available land required for the HW facilities, DOE would have a great degree of flexibility in its siting and can employ a range of mitigative measures, so that site clearing to implement any of the HW alternatives should not affect adjacent sensitive habitats.

Aquatic resources may be indirectly affected through increased runoff of water and soil to surface waters from construction sites. However, proper construction practices would minimize these effects. Direct

discharges to surface waters from the routine operation of treatment facilities would comply with applicable regulations and would be limited by the use of accepted engineering techniques. Therefore, the impacts to aquatic organisms are expected to be minimal.

10.7.3 EFFECTS OF HW TREATMENT FACILITY EMISSIONS

DOE used atmospheric emissions and deposition modeling to estimate the toxicity to terrestrial animals from airborne emissions of hazardous chemicals from treatment facilities. This analysis used the same atmospheric emissions estimates as the human health risk assessment and provided estimates of chemicals deposited on surface soils.

For this analysis, DOE examined those sites with the highest anticipated emissions. Emissions of the following hazardous chemicals were evaluated: arsenic; cadmium; chromium (VI); copper; lead; mercury; nickel, zinc, dioxins, and furans. Hazard Indices were computed for each selected site-alternative combination as composite ratios between the estimated species exposures to the contaminants and known toxic levels for the species. Hazard Indices greater than one would indicate a potential for the combined exposures to adversely affect the health of the species. The maximum estimated Hazard Index values were less than 0.01 for all sites under all alternatives. Therefore, no impacts to terrestrial receptor populations from emissions of hazardous chemicals from HW treatment facilities are expected. Additional information on the methods used to assess potential toxicity to terrestrial animals and on the results of the analysis is presented in Section C.4.4 of Volume III and the Appendix C technical report.

10.7.4 CONSIDERATION OF SENSITIVE SPECIES

For comparison of the HW management program's potential to affect sensitive species, Table 10.7–2 lists the numbers of Federally- and State-listed sensitive species occurring or potentially occurring at each HW site that is proposed to treat HW under each alternative. Site-specific analysis would be required for an assessment of sensitive species impacts. That analysis would take into account specific locations for the HW facilities in relation to the location of sensitive habitats and sensitive species at each site, including species listed by the U.S. Fish and Wildlife Service as either endangered or threatened.

Table 10.7–2. Numbers of Federal/State-Listed Endangered and Threatened Species Occurring or Potentially Occurring at the Five Proposed HW Treatment Sites

Alternative	Number of Treatment Sites	Hanford	INEL	LANL	ORR	SRS
No Action	2	--	2/2	--	1/11	--
Decentralized	3	--	2/2	--	1/11	8/8
Regionalized 1	5	3/11	2/2	2/4	1/11	8/8
Regionalized 2	2	--	2/2	--	1/11	--

Note: -- = no major HW actions proposed at the site under the alternative.

10.7.5 Effects of HW Transportation Accidents

Transportation accidents involving spills of HW into aquatic environments would be rare. The number of expected accidents is related to the total number of miles traveled during HW shipment (also shipment routes near aquatic habitats). Thus, as fewer shipments of HW occur, as in Regionalized Alternative 2, the number of accidents would be expected to decrease. The potential for impacts to aquatic habitats would also decrease with a decrease in miles traveled. The toxic effects on aquatic resources from HW transportation accidents could be severe immediately following a spill, but are unlikely to have long-term effects due to emergency spill response efforts.

10.8 Economic Impacts

The HW alternatives would only minimally benefit the regional and national economies. The jobs involved in managing HW under the alternatives did not equal 1% of regional employment at any site. The greatest economic effects nationally were estimated to occur under Regionalized Alternative 1, and would result in an increase of 460 jobs.

DOE estimated the effects of expenditures for HW management on the local and national economies (See Table 10.8–1). Local economic effects were based on direct expenditures at each of the five large HW generator sites that treat HW for construction, operation and maintenance, and decontamination of treatment facilities. The socioeconomic region-of-influence (ROI) consists essentially of the counties of residence of

Table 10.8–1. Economic Impacts Evaluated for HW Alternatives

Economic Impact Analyzed	Affected Aspect of the Economy	Analysis Method	Presentation of Results
Increased regional employment	Regional employment for direct, indirect, and induced jobs	Proposed site expenditures for HW management multiplied by regional employment multiplier at each of the five HW treatment sites	Text discussion
Increased regional incomes	Regional personal income for direct, indirect, and induced jobs	Proposed site expenditures multiplied by regional income multiplier at each site	Text discussion
National economic effects	National employment and personal income	Proposed site expenditures at all HW sites and transportation expenditures multiplied by national employment and income multipliers	Text discussion

site employees. The local economy at each site of the five sites was represented by employment, personal income, and industry data. Local increases in jobs and personal income were considered to be substantial benefits where they were 1% or greater than the 1990 baseline. Transportation expenditures were considered at a national level only.

Local economic effects were estimated on an annual basis. The impacts resulting from the construction and operation phase expenditures were combined and weighted to estimate annual project effects at each site. For all alternatives, construction was assumed to take 4 years of the 10-year construction period; the operations phase was assumed to take 12 years (a 10-year operations and maintenance period and a 2-year decontamination period undertaken after the conclusion of operations). Five years was added to the decontamination and decommissioning phase to account for the continued effects on employment and income after this latter project phase ends. The sum of construction phase and operations phase effects was then divided by the total 21 years to determine the combined weighted average annual effects. Annual job and personal income increases are shown for each of the five large HW treatment sites in the Volume II site data tables.

Across the HW alternatives, the regions at all five sites would experience less than a 1% change in the number of jobs as a result of expenditures. No region would experience a 1% or greater increase in personal income under any of the alternatives. A comparison of alternatives reveals that the number of new direct, indirect, and induced jobs from the combined and weighted construction and operations and

maintenance activities across site ROIs ranges from 21 (under the No Action Alternative) to about 250 (under Regionalized Alternative 2).

In addition to analyzing these impacts on the regional economy, a comparison of these impacts on the national economy was made. The HW alternatives would only minimally benefit the national economy. The total number of jobs generated in the national economy from combined weighted construction and operations phase activities range from about 150 (under the No Action Alternative) to 460 jobs (under Regionalized Alternative 1) which represents 0.0003% of the 137 million jobs in the national economy. There are no substantial changes in personal income for the nation as a whole as a result of implementing any of the alternatives. It is likely that any changes would represent a shift in the source of income from previous employment to employment in HW projects, rather than a net change in national personal income.

10.9 Population Impacts

Population increases resulting from proposed HW alternatives would be minor for all sites. Community characteristics and services would not be affected.

Population changes as a result of the in-migration of new HW workers to the ROI at each HW site were used as a basis to evaluate the likelihood of changes to the local environment. These include community size, diversity, and the provision of necessary services.

Impacts resulting from population changes were not estimated to be major for any of the proposed HW alternatives. The labor requirements and associated population in-migration were not estimated to be sufficient to change the overall population within the ROI at any site by more than 0.1%.

10.10 Environmental Justice Concerns

Assessment of potential environmental justice impacts from management of HW indicated that minority and low-income populations at the HW sites would not experience disproportionately high and adverse health risks or environmental impacts under any of the HW alternatives.

Analysis of environmental justice impacts from management of HW was based on a review of the impacts reported in this chapter regarding the HW alternatives. This analysis was performed to identify any disproportionately high and adverse human health or environmental impacts on minority populations or low-income populations surrounding each of the 5 large HW generator sites that serve as onsite HW treatment sites. Chapter 5 summarizes the methods and Appendix C provides the details of how this analysis was done along with maps illustrating the distribution of minority and low-income populations within 50 miles of each of these 5 large HW sites.

10.10.1 Results

The potential for adverse human health effects from exposures to chemical emissions from HW treatment facility operations and from reasonably foreseeable accidents is low for all HW management alternatives for all HW sites. Likewise, the number of cancer incidences due to chemical exposures and the number of fatalities from fuel emissions from truck or rail transportation of HW is small.

Incident-free HW treatment facility operations were analyzed in terms of risk to workers and the public. Incident-free operations present no significant risk and do not constitute a reasonably foreseeable adverse impact to the surrounding population. Table 10.4–3 in the health risk section of this chapter indicates that under all the alternatives, the estimated number of offsite population cancer incidence across all HW sites from the normal operation of DOE HW treatment facilities would be less than 0.5 during the conduct of the entire HW program.

10.10.1.1 Transportation

Incident-free HW transportation and reasonably foreseeable transportation accidents are not expected to result in disproportionately high and adverse human health effects to minority or low-income populations. For incident-free transportation, the total number of life-threatening effects is less than 0.5 for any HW alternative. Fatalities from fuel emissions are expected to be less than 0.5 across the HW sites under all alternatives, and the expected number of transportation accident fatalities from trauma is no higher than one under any HW alternative.

10.10.1.2 Environmental Impacts

In addition to the above, reviews of other technical disciplines pursuant to the methodology in Section 10.10.1 did not indicate any adverse impacts to water resources, ecology, economics, populations, land use, infrastructure, or cultural resources impacts. Air quality impacts are possible at three sites but because the air quality impacts can be mitigated by emission control measures or by using a nonthermal treatment technology. DOE does not anticipate any disproportionately high and adverse air quality impacts to any segment of the populations, including minority or low income populations, at the HW sites.

10.11 Land Use Impacts

Land required to construct HW facilities does not exceed 1% of suitable land for any site under any HW Alternative. Therefore, no impacts to current onsite land uses and no conflicts with offsite uses are expected. Site development plans indicated no conflict between proposed treatment facilities and other plans for the sites.

DOE examined the impacts of the HW alternatives on land use by comparing the acreage required for new treatment facilities to the acreage either designated for waste operations or suitable for development (See Table 10.11-1). Suitable land is the total site acreage, minus the acreage required for known cultural resource areas, sensitive habitats (including wetlands and wildlife management areas), prohibitive topographic features, and surface waters. Available site development plans were also used to identify potential conflicts between the proposed facilities required under each alternative and plans for future site uses.

Table 10.11–1. Land Use Impacts Evaluated for HW Alternatives

Land Use Impact	Affected Resource	Analysis Method	Presentation of Results
Effect on land use onsite at each HW site	Land use shown in site development plans	Comparison of required acreage with amount designated (or estimated) for HW in site development plan—all instances where requirements are 1% or higher are noted	Text discussion only
Conflicts with offsite uses	Adjacent land use	Consideration of conflict between proposed HW uses and nearby land uses	Text discussion only

None of the development plans at affected sites indicated any conflicts between planned future uses and the proposed HW alternatives. Because the analysis showed that HW facilities would require less than 1% of the designated or suitable land at any site under any alternative, DOE should have considerable flexibility in locating them and no significant land use impacts onsite are expected. For the same reason, no conflicts with adjacent land uses are expected. In addition, none of the site development plans indicated any instances where future uses would conflict with the proposed HW management actions.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential land-use conflicts or restrictions at particular locations on a site.

10.12 Infrastructure Impacts

Proposed HW activities show minimal potential to affect onsite or offsite infrastructure. In no case does an estimated new onsite requirement for water, wastewater treatment, or electric power approach 5% of current system capacity. Similarly, site employment increases from construction of HW facilities do not approach 5% of current site employment. Therefore, traffic increases would be minimal and would not substantially affect onsite transportation infrastructure.

DOE evaluated the impacts on site infrastructure by comparing existing onsite capacities to requirements for water, wastewater treatment, and electric power (See Table 10.12–1). Water and power were evaluated for both construction and operations; wastewater treatment was evaluated only for operations because wastewater from construction activities was assumed to be negligible. Where onsite maximum capacity information was unavailable, the proposed requirement was evaluated as a percentage of current use. Increased site employment was used as an indicator of potential impacts to the onsite transportation infrastructure. Offsite infrastructure impacts were evaluated using estimates of increased population from the proposed activities as an indicator of increased demand on community infrastructure.

Proposed HW activities show no potential for substantial effects on onsite or offsite demand for water, wastewater treatment, and power infrastructure. Estimated new requirements for wastewater treatment or power for proposed HW facilities do not exceed 5% of current system capacity at any site. Employment increases never approach 5% of current site employment needed to build and operate HW facilities. Therefore, it is expected that traffic increases will be minimal, and will not substantially affect onsite transportation infrastructure. Operations phase site employment will be lower than construction phase employment so no transportation infrastructure effects are expected.

Table 10.12–1. Infrastructure Impacts Analyzed for HW Alternatives

Infrastructure Impact Analyzed	Affected Infrastructure Elements	Analysis Method	Presentation of Results
Onsite capacity to support HW facilities	Capacity of onsite water, power, and wastewater systems	Add increased HW facility use to current use—compare to current capacities	Text discussion only
	Onsite transportation infrastructure	Compare new site employment with current site employment as an indicator of increased stress	Text discussion only
Capacity of community infrastructure to support increased worker populations and their families	Regional water, power, wastewater, and transportation infrastructure	Compare population increase with current regional population as an index of increased demand	Text discussion only

10.13 Cultural Resources Impacts

Construction and operation of HW facilities could adversely affect cultural resources. DOE will conduct further impact assessment cultural resources surveys when specific HW facility locations are proposed to ensure that any potential impacts are mitigated.

Cultural and paleontological resources, including prehistoric, historic, fossil, and Native American sacred sites (Executive Order 13007), may be affected at sites where HW treatment facilities are proposed to be built.

Table 4.3–8 in Chapter 4 describes the status of cultural resources surveys at the five major proposed HW sites and lists reported cultural resources at those sites. However, the impacts of the construction of HW facilities on cultural resources cannot be effectively analyzed at the programmatic level because the extent of those impacts depends upon their specific location at a site.

Although DOE intends to select sites for waste management activities based on the WM PEIS, the PEIS will not be the basis for selecting specific locations for facilities on the sites. When selecting locations for facilities on sites, DOE will consider the results of relevant existing or required new sitewide or project-level NEPA analyses, which would include analyses of potential impacts to cultural resources based on site-specific conditions.

Land requirements for the construction of HW waste management facilities are sufficiently small under all alternatives that DOE would probably have enough flexibility in siting HW facilities to avoid impacts on cultural resources. If not, measures would be taken to mitigate negative effects on these resources.

10.14 Costs

Costs for commercial treatment are less than for government treatment because of the relatively small volume of HW generation reported. Transportation costs are 15% to 34% of total costs.

As indicated in Table 10.14–1, DOE estimated costs for building and operating treatment facilities, and for transportation (INEL, 1995a,b). DOE evaluated costs associated with HW management from both a life-cycle and process perspective, using 1994 dollars.

10.14.1 Life-Cycle Costs

DOE evaluated government facility costs for four phases representing the life-cycle of the facilities and their operations: pre-operations, construction, operations and maintenance, and decontamination and decommissioning. These phases have been described in previous Chapters 6–8, and are the same for the HW cost estimate. Commercial costs are contractor payments, which fall wholly within the operations phase of the life-cycle. The transportation cost estimates include costs of truck transportation from generating sites to treating sites or to commercial vendors. Life-cycle costs do not include speculative factors, such as impacts to long-term land values.

10.14.2 Process Costs

DOE also analyzed costs based on treatment and storage activities. Government treatment costs include costs to build and operate treatment facilities (such as thermal treatment units) and common support facilities (such as maintenance, and certification/shipping facilities). Facilities are assumed to be Government-owned,

Table 10.14–1. Components of Cost Analysis

Impacts Assessed	Function Analyzed	Activities for Which Impacts Are Assessed	Location of Impacts Assessment
Process costs	Government treatment[a]	Life-cycle costs for facilities	Table 10.14–2
	Commercial treatment[a]	Life-cycle costs for facilities	Table 10.14–2
Transportation costs[b]	Truck[a]	Inter-site common carrier costs for transportation from generating sites to treating sites, and to disposal sites	Table 10.14–2

[a] HW would be shipped to commercial vendors for treatment and disposal under all HW management alternatives. Therefore, shipments of HW were considered to occur uniformly over the 20-year construction and operation period.
[b] Rail costs were not estimated because the small volumes did not warrant rail shipment.

contractor-operated on DOE sites. Because of the small volume of most waste streams, it was not economically feasible to construct and operate government facilities. For organic liquids, waste volumes were high enough to warrant evaluation of government owned facilities. The Government facilities included several technologies—thermal treatment, aqueous treatment of scrubber blowdown, and grout solidification of fines and residues. The details of cost estimating are covered in Section 5.3.3, Volume I.

Commercial treatment includes those costs incurred for vendor treatment. DOE applied unit prices derived from vendor quotes for the following: thermal treatment and the supporting treatments of aqueous waste, organic removal, metal recycling, reactive metal deactivation, mercury recovery, and grout solidification.

As shown in Table 10.14–2 (INEL, 1996), the No Action Alternative is the least costly of the alternatives at an estimated $144 million, with only 3% of the nonwastewater HW being treated by government facilities. The Decentralized Alternative, which treats 9% of the nonwastewater HW in government facilities at three sites, is the second least expensive alternative at $183 million. Regionalized Alternative 1, which treats 50% of the nonwastewater HW in government facilities at five sites, is the most expensive at $376 million, closely followed by Regionalized Alternative 2, which treats 90% of the nonwastewater HW

Table 10.14–2. Life-Cycle Costs (Millions of 1994 Dollars)

Alternatives	Number of Treatment Sites	Total Costs (including truck transportation)	Life-Cycle Costs				Process Costs[a]		Transport Costs
			Pre-ops	Const	O&M	D&D	Comml T	Govt T&D	Truck
No Action	2	144	0	0	95	0	73	22	49
Decentralized	3	183	3	20	104	7	71	63	49
Regionalized 1	5	376	18	83	183	5	50	239	87
Regionalized 2	2	318	18	75	172	6	28	243	47

Notes: Pre-ops = preoperations; Const = construction; O&M = operations and maintenance; D&D = decontamination and decommissioning; Comml T = commercial treatment; Govt T&D = government treatment; Total costs = sum of life cycle costs plus truck transport = sum of process costs plus truck transport.

[a] Total Facility Costs are presented twice in this table: as life-cycle costs and as process costs. The sum of life-cycle costs is equal to the sum of process costs. Total Costs, also in the table, add truck costs to the facility costs. Therefore, Total Costs equals the sum of life-cycle costs and truck costs and also equals the sum of process costs and truck costs.

at two sites and costs $318 million. Conversely, commercial treatment costs are highest for the No Action Alternative and lowest for the Regionalized Alternative 2. Based on the reported waste volumes of 3,400 metric tons per year, the continued use of commercial vendors is the most cost-effective method of treatment. Transportation costs are relatively constant at $47–49 million for all alternatives except the Regionalized Alternative 1. Regionalized Alternative 1 has a much higher transportation cost ($87 million) because the shipping configuration includes a much larger number of small local shipments, thereby losing the economy of scale associated with larger capacity shipments (INEL, 1995a).

For the purpose of the WM PEIS analysis, DOE assumed existing storage capacity would be sufficient. Therefore, estimates of costs for HW do not include storage facilities.

10.15 Environmental-Restoration-Transferred Waste

DOE anticipates that volumes of HW generated during environmental restoration activities would be treated offsite at commercial facilities. Environmental-restoration HW will not be transferred to DOE HW treatment facilities.

10.16 Comparison of Alternatives Summary

Health Risk Impacts. The risk estimates indicate a fraction of a single fatality for each of the proposed HW alternatives from vehicle accidents associated with HW transportation. The Regionalized Alternatives result in greater worker exposure to HW chemicals than the No Action and Decentralized Alternatives because DOE treats more HW under the Regionalized Alternatives. This analysis did not evaluate the risk to workers at commercial facilities which are the principal HW treatment facilities under the No Action and Decentralized Alternatives. It is expected that HW worker risk would be the same regardless of whether commercial or DOE facilities are used. In view of this, there is no significant difference between the alternatives with regard to HW worker risk.

Air Quality Impacts. The management of HW would not appreciably affect the air quality at most sites. No criteria air pollutants would exceed standards at any site. However, regionalization of treatment facilities at LANL and ORR would cause adverse air quality impacts requiring additional emission control measures

for vinyl chloride. The exceedances at LANL and ORR are primarily due to emissions from thermal treatment. Emissions of radionuclides are not applicable since HW does not contain radioactive constituents.

Other Environmental Impacts. Results for ecological, cultural, and other environmental impacts did not indicate significant impacts for any of the HW alternatives, and therefore no meaningful comparison or discriminators between alternatives can be determined from these impact areas.

Commercial Treatment. In addition to worker risks, the environmental impacts were not analyzed for commercial treatment facilities which treat almost all nonwastewater DOE HW under the No Action and Decentralized alternative. Analysis of these impacts would require being able to determine the fraction of DOE HW contained in all waste treated at every commercial facility, the environmental setting and meteorology of each facility, and the total number of workers at each facility. Not all of this information is publicly available, and analyzing potential impacts at each facility based on fractional contributions of DOE HW would be extremely difficult with potentially large uncertainties and inaccuracies.

The No Action and Decentralized Alternatives are unique in several specific areas:

- Health risks were not estimated for commercial facilities as discussed above, but should not be different from risks estimated for the alternatives involving DOE treatment.
- Construction jobs would increase in the short term if DOE builds its own treatment facilities, but a one-for-one switch of commercial jobs to Federal jobs would be expected as operation of DOE facilities displaces operations in commercial facilities.
- Impacts dependent on location of facilities (e.g., air quality, water resources, ecological, environmental justice) may be more likely for commercial than DOE facilities since commercial facilities would probably be located in more densely populated areas than DOE sites.

The fundamental differences among the alternatives involve transportation and the implementation costs of the HW alternatives. Table 10.16–1 presents a summary of the transportation and cost differences among the alternatives.

The Preferred Alternative. The Department's preferred alternative for HW is the No Action Alternative, which means the Department would continue to use commercial facilities to treat most of its nonwastewater HW. The transportation and environmental impacts are low for all of the alternatives for HW evaluated in the WM PEIS; however, the No Action Alternative costs less than the Decentralized or Regionalized

Alternatives for HW treatment. The impacts for the preferred alternative are those presented for the No Action Alternative throughout Chapter 10.

Table 10.16–1. Summary Comparison of the HW Alternatives

Alternative	Sites	Shipments		Costs[c]			Transportation Risks[d]
		Mileage[a]	Number[b]	Transport	Project Life-Cycle	Total	
No Action	2	20	34	49	95	144	*
Decentralized	3	19	41	49	134	183	*
Regionalized 1	5	35	50	87	289	376	1
Regionalized 2	2	19	34	47	271	318	*

Note: * = greater than 0 but less than 0.5.
[a] Mileage in millions.
[b] Number of shipments in thousands.
[c] Cost in millions of dollars.
[d] Transportation risks in fatalities.

Chapter 10
References

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Hazardous Waste Alternatives

Alternative	Sites[a]	ANL-E[b]	Hanford	INEL	LANL	LLNL[b]	ORR	Pantex[b]	SNL-NM[b]	SRS
No Action	2			T			T			
Decentralized	3			T			T			T
Regionalized	5		T	T	T		T			T
Regionalized	2			T			T			

Notes: T = treatment. A blank indicates that a site does not treat HW under the specified alternative. Fermi and KCP were not included in this table because they were not major sites (as described in Section 1.6 of Chapter 1) and impacts were not evaluated at those sites.

[a] Number of sites treating HW.

[b] These sites are listed because they are major sites that are large HW generators. However, because they are assumed to continue to ship nonwastewater HW offsite for treatment, no significant impacts are expected at these sites under any of the HW alternatives.

CHAPTER 11
Cumulative Impacts

Chapter 11 discusses the combined impacts that could result from locating facilities for management of different waste types at each of the 17 major waste management sites, the cumulative impacts that could result at each of the 17 major sites and their surrounding regions, and the cumulative impacts of transporting waste. The chapter presents the minimum and maximum impacts of the waste management program at each site as well as the impacts of the preferred alternatives at each site.

Cumulative impacts are those impacts that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions. Examples of past and present actions include potential impacts from contaminated sites, ongoing activities that result in waste generation and waste management activities outside the scope of the WM PEIS. Both the Council on Environmental Quality and the U.S. Department of Energy (DOE) regulations for implementing National Environmental Policy Act (NEPA) (42 USC 4321 *et seq.*) require the assessment of cumulative impacts because significant impacts can result from several smaller actions that, by themselves, may not have significant impacts. To conduct the cumulative impacts analysis, DOE first examined the **combined impacts** of waste management alternatives (including the preferred alternatives identified in Section 3.7) for the five types of wastes analyzed in the WM PEIS for each of the 17 major sites. To these combined impacts, DOE then added the impacts of other past, present, and reasonably foreseeable future actions external to the WM PEIS analysis in order to assess the **cumulative impacts**.

***Combined Impacts**, in this WM PEIS, are those impacts resulting from the operations of multiple waste management facilities at a particular site, as defined in the WM PEIS analysis of alternatives.*

***Cumulative Impacts**, as defined by the Council on Environmental Quality NEPA regulations, are the impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions (40 CFR 1508.7).*

11.1 Combined Waste Management Impacts

The combined impact analysis considers the following impact areas:

Human Health Risk

- Collective radiation dose and cancer risk for the public (over the 10-year period of operations)

- Annual radiation dose for the hypothetical maximally exposed offsite individual resulting from normal operations
- Collective radiation dose and cancer risk for noninvolved workers (over the 10-year period of operations)
- Annual radiation dose for the hypothetical maximally exposed offsite individual resulting from waste shipments

Environmental Quality

- Air quality exceedances (list of those emissions that could exceed air quality standards)
- Groundwater quality exceedances (list of contaminants that could exceed drinking water standards as a result of disposal of LLMW and LLW)

Resource and Infrastructure Requirements

- Land requirements (acres of land occupied by new facilities)
- Water use (gallons of water used per day during operations)
- Wastewater production (gallons of sanitary wastewater produced each day during operations)
- Power requirements (megawatts of power used during operations)

Socioeconomic Factors

- Regional employment (percent change in regional employment resulting from operations)
- Regional population (percent change in regional population resulting from operations)
- Cost (life-cycle cost in 1994 dollars)

These are the major factors that might be additive across waste types and could logically be combined.

Other impacts that were addressed in Chapters 6 through 10 were not considered part of the identification of combined impacts for several reasons. Some impacts, such as impacts to ecological resources and cultural resources, were not combined because they are dependent on the facility location within the site boundary and location-specific environmental factors. This programmatic EIS does not address these issues. Some impacts, such as impacts of waste facility accidents, were not combined because it is highly improbable that they would occur together. Risks to individual waste management workers were not considered part of the

combined impact analysis because each worker was assumed to be dedicated to a single waste type (i.e., the worker at one waste type facility would not simultaneously be working at another waste type facility). In addition, DOE limits the dose to each involved worker through the use of health and safety standards and monitoring. Finally, human health risks resulting from potential groundwater contamination after the disposal of low-level waste (LLW) and low-level mixed waste (LLMW) were not considered because it was assumed that they would neither merge nor co-mingle within 300 m of a single unit. At greater distances, groundwater plumes from multiple units probably do mix, but it is likely that dilution and dispersion would lower concentrations to less than those estimated at 300 m.

Because the alternatives for the five waste types can be combined in numerous ways (for some sites, there are thousands of possible combinations of alternatives across all the waste types), the combined impacts of placing multiple facilities at each site were determined by identifying the *minimum* and *maximum* values for each of the combined impact areas (listed above) for each waste type. The values were then summed for each impact area to determine the combined minimum and maximum impacts for each site. Table 11.1–1 lists the alternatives under which a waste type facility could be located at each major site, except for onsite LLMW wastewater treatment and LLW minimum treatment facilities that would occur under all the LLMW and LLW alternatives. Table 11.1–2 lists the preferred alternatives for each site and the waste types at these sites. In the following discussions, a combined impacts table is presented for each major site; the table identifies the minimum and maximum impact values and the alternatives associated with these values. The minimum and maximum impact values are based directly on the data contained in the site data tables in Volume II of this WM PEIS for normal facility operations and on ANL (1996a-e) for site-specific transportation effects.

When reviewing the impacts and costs identified for the No Action Alternative for LLMW and TRUW, it is important to realize that the results for indefinite storage of those waste types are based on the initial 20 years of that indefinite period. This is consistent with the period of analysis for the other alternatives; however, not shown are the impacts from storage expected beyond this 20-year time frame. The longer term storage impacts and costs are likely to exceed those for the first 20 years, not only as a result of routine indefinite storage operations, but also from degradation of facilities and containers. This differs from the effects predicted for the action alternatives for management of the 20-year forecast of LLMW and TRUW, where risks to workers and the offsite population, and other impacts and costs, are reduced following disposal. The No Action Alternative does not reduce or avoid impacts and costs; rather it causes impacts and costs to be experienced every year for an indefinite period of time. A discussion of the longer term

Table 11.1-1. Major Waste Management Sites and Alternatives[a]

Sites	Waste Types	Alternatives		
		Treatment	Storage	Disposal
Argonne National Laboratory - East, IL	LLMW	Decentralized	No Action	Decentralized
	LLW	None	None	Decentralized
	TRUW	No Action and Decentralized	No Action and Decentralized	None
Brookhaven National Laboratory, NY	LLMW	Decentralized	No Action	Decentralized
	LLW	None	None	Decentralized
Fernald Environmental Management Project, OH	LLMW	Decentralized and Regionalized 1	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2	None	Decentralized and Regionalized 1 and 2
Hanford Site, WA	LLMW	All	No Action	All
	LLW	Regionalized 2, 4, 5, Centralized 3-5	None	No Action, Decentralized, Regionalized 1-6, Centralized 1, 3, and 5
		All		
	TRUW	None	All	None
	HLW	Regionalized 1	All	None
	HW		None	None
Idaho National Engineering Laboratory, ID	LLMW	All	No Action	All
	LLW	Regionalized 2, 4, 5, Centralized 3 and 4	None	No Action, Decentralized, Regionalized 1-5
	TRUW	No Action, Decentralized, Regionalized 1-3	No Action, Decentralized, Regionalized 1-3	None
	HLW	None	All	None
	HW	No Action, Decentralized, Regionalized 1 and 2	None	None
Lawrence Livermore National Laboratory, CA	LLMW	Decentralized and Regionalized 1	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2 and No Action	None	Decentralized and Regionalized 1 and 2
	TRUW	No Action and Decentralized	No Action and Decentralized	None
Los Alamos National Laboratory, NM	LLMW	Decentralized, Regionalized 1 and 2	No Action	Decentralized, Regionalized 1, 2, and 4
	LLW	Regionalized 2, 4, Centralized 2 and 4	None	No Action, Decentralized, Regionalized 1-5
	TRUW	No Action, Decentralized, Regionalized 1 and 2	No Action, Decentralized, Regionalized 1 and 2	None
	HW	Regionalized 1	None	None
Nevada Test Site, NV	LLMW	Decentralized	No Action	Decentralized, Regionalized 1-4
	LLW	None	None	No Action, Decentralized, Regionalized 1-5, 7, Centralized 2 and 4
	TRUW	No Action and Decentralized	No Action and Decentralized	None
Oak Ridge Reservation, TN	LLMW	All	No Action	Decentralized, Regionalized 1,2,4
	LLW	Regionalized 2, 4, 5, Centralized 3 and 4	None	No Action, Decentralized, Regionalized 1-5
	TRUW	No Action, Decentralized, Regionalized 1 and 2	No Action, Decentralized, Regionalized 1 and 2	None
	HW	No Action, Decentralized, Regionalized 1 and 2	None	None

Table 11.1–1. Major Waste Management Sites and Alternatives[a]—Continued

Sites	Waste Types	Alternatives		
		Treatment	Storage	Disposal
Paducah Gaseous Diffusion Plant, KY	LLMW	No Action, Decentralized, and Regionalized 1	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2	None	Decentralized, Regionalized 1 and 2
	TRUW	No Action and Decentralized	No Action and Decentralized	None
Pantex Plant, TX	LLMW	Decentralized and Regionalized 1	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2	None	Decentralized, Regionalized 1 and 2
Portsmouth Gaseous Diffusion Plant, OH	LLMW	Decentralized, Regionalized 1,2, and 3	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2, 4, Centralized 3 and 4	None	Decentralized, Regionalized 1 and 2
Rocky Flats Environmental Technology Site, CO	LLMW	No Action, Decentralized, Regionalized 1 and 2	No Action	Decentralized and Regionalized 1
	LLW	Regionalized 2, 4, Centralized 3 and 4	None	Decentralized, Regionalized 1 and 2
	TRUW	No Action, Decentralized, Regionalized 1 and 2	No Action, Decentralized, Regionalized 1 and 2	None
Sandia National Laboratories, NM	LLMW	Decentralized	No Action	Decentralized
	LLW	None	None	Decentralized
	TRUW	No Action and Decentralized	No Action and Decentralized	None
Savannah River Site, SC	LLMW	All	No Action	All
	LLW	Regionalized 2, 4–7, Centralized 3 and 4	None	No Action, Decentralized, Regionalized 1–7
	TRUW	No Action, Decentralized, Regionalized 1–3	No Action, Decentralized, Regionalized 1–3	None
	HLW	None	All	None
	HW	Decentralized and Regionalized 1	None	None
Waste Isolation Pilot Plant, NM	TRUW	Centralized	None	Decentralized, Regionalized 1–3, Centralized
West Valley Demonstration Project, NY	LLMW	Decentralized	No Action	Decentralized
	LLW	None	None	Decentralized
	TRUW	No Action and Decentralized	No Action and Decentralized	None
	HLW	None	No Action and Decentralized	None

Notes: LLMW = low-level mixed waste; LLW = low-level waste; TRUW = transuranic waste; HLW = high-level waste; HW = hazardous waste.
[a] The alternatives listed do not include onsite LLMW wastewater treatment facilities and onsite minimum LLW treatment facilities that would occur under all the LLMW and LLW alternatives.

Table 11.1–2. Preferred Alternatives for Major Waste Management Sites

Waste Type	Decision	ANL	BNL	FEMP	Hanford	INEL	LLNL	LANL	NTS	ORR
LLMW	Treatment	D	R1[a]	D	R1	R4	D	D	R1[a]	R2
	Disposal[b]	R	R	R	R	R	R	R	R	R
LLW	Treatment	R3	R3	R3	R3	R3	R3	R3	R3	R3
	Disposal[b]	R	R	R	R	R	R	R	R	R
TRUW	Treatment/ Storage	D			D	R3	D	D	D	R1
HLW	Storage				D	D				
HW	Treatment	N	-	-	N	N	N	N	-	N

Waste Type	Decision	PGDP	Pantex	PORTS	RFETS	SNL-NM	SRS	WVDP	WIPP
LLMW	Treatment	R2	D	D	D	D	R1	R1[a]	
	Disposal[b]	R	R	R	R	R	R	R	
LLW	Treatment	R3	R3	R3	R3	R3	R3	R3	
	Disposal[b]	R	R	R	R	R	R	R	
TRUW	Treatment/ Storage	D	**		D	R1	R1	D	*
HLW	Storage						D	D	
HW	Treatment	-	N	-	-	N	N	-	

Notes: N = No Action; D = Decentralized; R, R1, R2, R3, R4 = Regionalized Alternatives; - = site not analyzed as a major generating site; * = no impacts from treatment/storage; ** = although not analyzed in the WM PEIS, the very small amount of TRUW at Pantex would be shipped to LANL for treatment and storage. A blank cell indicates that the waste type is not found at the site. Cumulative impacts for the preferred alternatives at each site are based on alternatives in this table.

[a] Wastes from these sites (BNL, NTS, and WVDP) are shipped offsite to regional treatment centers.

[b] DOE prefers to further narrow its configuration of LLMW and LLW disposal sites to 2-3 sites. The selection of sites would be made following consultation with regulatory authorities, state and tribal governments, and other interested stakeholders. Impacts for disposal will vary depending on final selection of sites. Cumulative impact estimates use alternatives with maximum potential impacts. For LLMW disposal, Alternative R2 was the basis for INEL, LANL, ORR, and SRS; Alternative R3 was the basis for NTS; and the Alternative C was the basis for Hanford. For LLW disposal, Alternative R3 was used for INEL, LANL, ORR, and SRS; Alternative C1 was used for Hanford; and Alternative C2 was used for NTS.

impacts expected for indefinite storage of LLMW can be found in Section 6.16 of Chapter 6. A brief discussion of the longer term effects of storage of TRUW can be found in Section 8.3.1 of Chapter 8, with a more detailed assessment in the WIPP SEIS-II (DOE, 1996m).

It should also be noted that the No Action Alternative for HLW does not provide enough canister storage for all of the canisters that would be produced after treatment of HLW. Provision of adequate storage capacity would lead to costs and impacts as great as shown for the other HLW alternatives. A discussion of the assumptions made to address this shortage of storage capacity in the HLW analyses is contained in Section 9.3.1 of Chapter 9.

11.2 Cumulative Impacts

The cumulative impacts analysis considers the following impact areas for existing conditions (incorporating past impacts), combined waste management impacts, and impacts of reasonably foreseeable future actions:

Human Health Risk

- Collective radiation dose and cancer risk for the public (over the 10-year period of operations)
- Annual radiation dose for the hypothetical maximally exposed offsite individual
- Collective radiation dose and cancer risk for the worker population at the site (over the 10-year period of operations)
- Number of truck or rail shipments of radioactive waste types to and from each site and the contributions to dose to a maximally exposed individual located 30 m from the site gate

Environmental Quality

- Air quality exceedances (list of those emissions that could exceed air quality standards or guidelines for combined waste management and future actions)
- Groundwater quality exceedances (list of those contaminants that could exceed drinking water standards for combined waste management LLMW and LLW disposal actions and other future actions)

Resource and Infrastructure Requirements

- Land requirements (presented as the percent of suitable land needed for combined waste management and future actions). For purposes of the cumulative impact analysis, the amount of suitable land at each site was based on the total amount of land that could be developed in any way and was defined as the total area of the site minus any areas that are undevelopable because of environmental or other restrictions (e.g., designated wetlands, ecological reserves, and buffer areas). This definition was used for the cumulative impact analysis to enable consideration of the impacts of past and present activities on land availability. In contrast, waste-specific analyses presented in Chapters 6 through 10 were based primarily on land that has been set aside specifically for waste management purposes.
- Percent of current water supply (presented as the percent of existing capacity needed for combined waste management and future actions)
- Percent of current wastewater treatment capacity (presented as the percent of existing capacity needed for combined waste management and future actions)
- Percent of current power capacity (presented as the percent of existing capacity needed for combined waste management and future actions)

Socioeconomic Factors

- Site employment (average number of people employed on an annual basis during operations)

Cumulative impacts for each of the 17 major sites were evaluated by adding the combined impacts of waste management alternatives to the impacts of other past, present, and reasonably foreseeable actions at the site and in the region (largely actions that DOE is considering for other programs). These include actions related to production and management of nuclear materials, management of nuclear fuel, research and development activities, and defense programs as described in various EAs and EISs (Table 11.2–1). Health risks from past DOE operations are not included in the cumulative impact analysis because the data are not currently available for most sites. Although dose reconstruction studies were conducted at several DOE sites, studies have not been conducted at most of the DOE sites.

Section 1.8 describes the relationship between the WM PEIS and other DOE NEPA activities. These other reasonably foreseeable future actions are ones for which an EA or an EIS has been prepared. Activities for which an EIS has not been prepared or for which a permit has not been issued are not considered to be reasonably foreseeable. Where decisions have not been made regarding the preferred alternatives for a

Table 11.2–1. Source Documents Describing Other Activities Included in the Cumulative Impact Analysis

Title	Applicable Sites	Reference
Final Environmental Impact Statement, Waste Isolation Pilot Plant	WIPP	DOE (1980)
Final Supplemental Environmental Impact Statement, Waste Isolation Pilot Plant	WIPP	DOE (1990b)
Final Environmental Impact Statement, Defense Waste Processing Facility	SRS	DOE (1982b)
Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility	SRS	DOE (1994h)
Savannah River Site Waste Management Final Environmental Impact Statement	SRS	DOE (1995c)
Final Environmental Impact Statement, Long-Term Management of Liquid High-Level Radioactive Wastes Stored at the Western New York Nuclear Service Center, West Valley	WVDP	DOE (1982a)
Final Environmental Impact Statement, Management of Spent Nuclear Fuel from the K Basins at the Hanford Site, Richland, Washington	Hanford	DOE (1996a)
Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement	Hanford, INEL, SRS	DOE (1995d)
Storage and Disposition of Weapons-Usable Fissile Materials, Draft Environmental Impact Statement	Hanford, INEL, NTS, ORR, Pantex, SRS	DOE (1996b)
Medical Isotopes Production Project: Molybdenum-99 and Related Isotopes Environmental Impact Statement	LANL, SNL-NM	DOE (1996c)
Dual Axis Radiographic Hydrodynamic Test Facility, Final Environmental Impact Statement	LANL	DOE (1995e)
Final Environmental Impact Statement for the Tank Waste Remediation System	Hanford	DOE (1996d)
Plutonium Finishing Plant Stabilization Final Environmental Impact Statement	Hanford	DOE (1996e)
Draft Programmatic Environmental Impact Statement for Stockpile Stewardship and Management	LLNL, LANL, NTS, ORR, Pantex, SRS	DOE (1996f)
The Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada	NTS	DOE (1996g)
Draft Environmental Impact Statement for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Services Center	WVDP	DOE & NY ERDA (1996h)
Final F-Canyon Plutonium Solutions Environmental Impact Statement	SRS	DOE (1994g)
Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant, Oak Ridge, Tennessee	ORR	DOE (1994i)

Table 11.2–1. Source Documents Describing Other Activities Included in the Cumulative Impact Analysis—Continued

Title	Applicable Sites	Reference
Final Environmental Impact Statement for Continued Operations of Lawrence Livermore National Laboratory and Sandia National Laboratories	LLNL, SNL-CA	DOE (1992b)
Disposition of Surplus Highly Enriched Uranium, Draft Environmental Impact Statement	ORR, SRS	DOE (1995f)
Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling	SRS	DOE (1995a)
Draft Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components	Pantex	DOE (1996i)
Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land Use Plan	Hanford	DOE (1996j)
Final Environmental Impact Statement on the Disposal of Decommissioned, Defueled Cruiser, Ohio Class and Los Angeles Class Naval Nuclear Plants	Hanford	Navy (1996)
Nonnuclear Consolidation Environmental Assessment	LANL, ORR, RFETS, SNL-NM, SRS	DOE (1993)
Proposed 7-GeV Advanced Photon Source Environmental Assessment	ANL-E	DOE (1990c)
Environmental Assessment of the Environmental Restoration Project at Sandia National Laboratories	SNL-NM	DOE (1996k)

Notes: WIPP = Waste Isolation Pilot Plant; SRS = Savannah River Site; WVDP = West Valley Demonstration Project; INEL = Idaho National Engineering Laboratory; NTS = Nevada Test Site; ORR = Oak Ridge Reservation; LANL = Los Alamos National Laboratory; SNL-NM = Sandia National Laboratories (New Mexico); LLNL = Lawrence Livermore National Laboratory.

reasonably foreseeable action, the cumulative impacts analysis considers the range of impacts of those alternatives. Otherwise, only the impacts of the preferred alternative are included in the cumulative impact analysis.

No assumptions are made regarding future baseline conditions at each of the major sites that could potentially reduce impacts, such as cessation of certain ongoing operations that would reduce current levels of radioactive releases. If the preferred alternative of a sitewide EIS identifies changes in site operations, these changes are considered additional foreseeable future actions.

A number of other simplifying assumptions were made to estimate cumulative impacts regarding timing, site location, and consistency of analytical methods. Other existing or planned actions at each site were

assumed to occur over the entire 10-year period of waste management operations. These actions were assumed to be collocated with waste management facilities and therefore assumed to affect the same population and maximally exposed individual. For the assessment of site-specific transportation effects, if shipment contents were not specifically stated in reference documents, it was assumed these contents consisted of HLW, which would result in the highest dose. In addition, some double-counting of impacts occurred in cases where waste management actions would replace some existing activities (e.g., existing shipments of radioactive materials) rather than being added to those activities. These assumptions result in conservative analyses that overestimate actual cumulative impacts. These simplifying assumptions also may result in some differences in estimated impacts between the WM PEIS and site-specific documents. In addition, these simplifying assumptions and other assumptions used in performing calculations can result in some uncertainty regarding projected cumulative impacts. The cumulative impact analysis in the WM PEIS should be used only for evaluating the WM PEIS alternatives; any site-specific analysis is considered to supersede the WM PEIS cumulative analysis for that site.

The impacts of future environmental restoration activities at each of the major waste management sites have been incorporated into the cumulative impact analysis and referenced in all cases where that information is available in existing NEPA documents or in Comprehensive Environmental Response, Compensation, and Liability Act/Resource Conservation and Recovery Act (CERCLA/RCRA) program documents. At some sites, the impacts of future environmental restoration actions cannot be determined because of insufficient characterization of the contamination or because proposals for particular actions are not yet ripe. For these sites, the volumes of environmental restoration wastes are presented in this chapter, and the likely significance of impacts is discussed based on past environmental restoration activities at the site. Cumulative impacts of environmental restoration activities at these sites would be fully analyzed in later site-specific NEPA reviews or in CERCLA/RCRA program documents. Descriptions of the environmental restoration program at each of the major waste management sites are provided in Appendix B. A quantitative evaluation of Greater-than-Class-C waste and special-case waste is not included in the cumulative impact assessment because plans for these activities have not been sufficiently developed (see Sections 1.5.6 and 7.1.1) but would be the subject of site-specific and project-specific evaluations.

The following cumulative impact analyses focus on several key impact categories that include the human health risks to the offsite population and a hypothetical maximally exposed individual as a result of radioactive releases, potential air quality and water quality exceedances, resource and onsite infrastructure impacts, and changes in site employment. The human health risks to the offsite population are reported as

collective exposures and risks for the 10-year period of operation, while the dose to the maximally exposed individual is reported as an annual value. Annual exposures are used for the maximally exposed individual because annual exposures facilitate a direct comparison to the U.S. Environmental Protection Agency's (EPA's) standard of a 10-millirem exposure per year to a maximally exposed individual from atmospheric releases and DOE's standard of a 100-millirem exposure per year to a maximally exposed individual from all pathways. A cumulative impacts table containing the impact categories and the major elements comprising the cumulative impacts is presented for each of the major sites. These elements include the existing conditions at the site (which incorporate residual impacts from past actions), the combined impacts of the waste management alternatives (maximum and minimum alternatives and preferred alternatives) analyzed in this WM PEIS, and the impacts of other reasonably foreseeable future actions as described in recent EISs by DOE and others. The number of impact categories addressed as part of the cumulative impact analysis for each of the major sites is limited both by the availability of information (e.g., estimated chemical cancer incidences as a result of chemical releases are not reported for all other potential actions at a site) and by differences in assessment methodologies.

The following sections identify and discuss the combined and cumulative impacts for each of the major sites, followed by a discussion of combined and cumulative transportation impacts.

11.3 Argonne National Laboratory-East

Argonne National Laboratory-East (ANL-E) conducts programs in basic energy and related sciences. The existing environmental conditions at ANL-E resulting from these ongoing activities are described in Chapter 4.

11.3.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, and TRUW at ANL-E. Table 11.3–1 lists the minimum and maximum combined impacts of the waste management alternatives for ANL-E. Generally, the most adverse impacts that could occur at ANL-E and in the region would result from the Decentralized Alternatives, which involve construction of treatment and disposal facilities for ANL-E to manage its own waste. The least adverse impacts generally would result from the Regionalized and Centralized Alternatives, for which ANL-E would package and ship its waste for offsite treatment and disposal. The impacts of

Table 11.3–1. Argonne National Laboratory-East Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.2E–03	N	5.2E–01	R1-C	5.9E–07	N	2.6E–04	R1-C	6.2E–09	N	6.2E–06
Low Level[a]	N	4.7E–03	D-C5	5.0E–03	N	2.3E–06	D-C5	2.5E–06	--	--	--	--
Transuranic	N	1.2E–03	D	4.0E–03	N	6.2E–07	D	2.0E–06	N	3.8E–10	R1-C	2.9E–09
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**7.1E–03**		**5.3E–01**		**3.5E–06**		**2.6E–04**		**6.6E–09**		**6.2E–06**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	6.5E–09	N	2.8E–06	R1-C	3.3E–12	N	1.4E–09	R1-C	3.9E–14	N	3.9E–11
Low Level[a]	N	2.6E–08	D-C5	2.8E–08	N	1.3E–11	D-C5	1.4E–11	--	--	--	--
Transuranic	N	6.9E–09	D	2.2E–08	N	3.5E–12	D	1.1E–11	D,N	0.0E+00	R1-C	1.3E–14
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.9E–08**		**2.9E–06**		**2.0E–11**		**1.4E–09**		**3.9E–14**		**3.9E–11**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10/yr)				Radiation Dose From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R1-C	20 / 20	N	0.0E+00	R1-C	3.20E–07	N	0.0E+00	R1-C	3.20E–07
Low Level[a]	D	450 / 180	N	1,060 / 400	D	7.20E–06	N	1.70E–05	D	2.90E–06	N	6.40E–06
Transuranic	N	0 / 0	D	590 / 300	N	0.0E+00	D	7.10E–05	N	0.0E+00	D	7.40E–05
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**450 / 180**		**1,670 / 720**		**7.2E–06**		**8.8E–05**		**2.9E–06**		**8.1E–05**

Table 11.3–1. Argonne National Laboratory-East Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.7E–06	N	2.5E–03	R1-C	8.6E–10	N	1.2E–06	R1-C	1.3E–10	N	1.3E–07
Low Level[a]	N	1.9E–05	D-C5	2.0E–05	N	9.3E–09	D-C5	9.8E–09	--	--	--	--
Transuranic	N	6.5E–06	D	2.1E–05	N	3.2E–09	D	1.0E–08	N	8.0E–12	R1-C	6.0E–11
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2.7E–05**		**2.5E–03**		**1.3E–08**		**1.2E–06**		**1.3E–10**		**1.3E–07**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Types of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	N	0.6	D	2.3
Low Level	All/None	All/None	All	None	All	None	N	0.8	D	4.1
Transuranic	All/None	All/None	--	--	--	--	N	0	D	2.7
High Level[b]	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--
Total	**None[d]**	**None**		**None**		**None**		**1.4**		**9.1**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	1,336	D	2,825	N	37	D	919	R1-C	0.01	D	0.31
Low Level	N	1,875	D	12,053	N	640	D	1,014	N	0.11	D	1.70
Transuranic	N	921	D	4,769	N	921	D	1,509	N	0.09	D	0.44
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**4,132**		**19,647**		**1,598**		**3,442**		**0.21**		**2.45**

Table 11.3–1. Argonne National Laboratory-East Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.00	D-C	<0.01	N	0.00	D-C	<0.01	N	22	D	59
Low Level	N,R1-C5	0.00	D	0.01	All	0.00	All	0.00	R1-C5	106	D	389
Transuranic	N	0.00	D-C	0.01	All	0.00	All	0.00	N	104	R2-C	334
High Level[b]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[b]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.00**		**0.02**		**0.00**		**<0.01**		**232**		**782**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (c); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences.

[b] Argonne National Laboratory-East does not have high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[c] Maximum and minimum alternatives for truck and rail transport are the same.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

preferred alternatives at ANL-E are below the impacts of the maximum combined waste management alternatives at the site.

11.3.2 CUMULATIVE IMPACTS

Aside from continuing operations, the waste management activities considered in this PEIS, and environmental restoration activities, DOE has no other actions planned at ANL-E. The Advanced Photon Source (APS), an already-constructed accelerator facility (DOE, 1990c), recently became operational; its operation is considered a reasonably foreseeable future action for the purposes of this analysis. No other DOE or non-DOE actions are planned in the ANL-E region that would contribute to the cumulative impact of the alternatives.

The environmental restoration program at ANL-E will address cleanup of an estimated 148,000 m^3 of contaminated media and facilities (140,000 m^3, 8,800 m^3, and 190 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities have had no significant adverse environmental impacts based on the NEPA reviews completed to date. Project-specific environmental evaluations that consider cumulative effects will be conducted prior to implementation of all future environmental restoration activities.

Table 11.3–2 identifies the range of cumulative impacts that could occur at ANL-E. As identified in Table 11.3–2, the minimum and maximum annual radioactive releases from waste management and other future actions (including transportation) would not measurably increase the current levels of risks from radioactive releases. ANL-E would continue to be below the EPA standard of 10 millirems per year to the maximally exposed offsite individual.

ANL-E is in a nonattainment region for particulates and for ozone. While the expected atmospheric emissions of particulates and ozone-producing contaminants under the alternatives would increase the levels of these emissions, the increases would be below the regulated levels in the nonattainment region. Disposal of LLMW or LLW at ANL-E under any alternative are not expected to result in any exceedances of drinking water standards in groundwater.

Table 11.3–2. Argonne National Laboratory-East Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.7E+02	7.1E-03	5.3E-01	4.20E-02	not reported	1.7E+02	1.7E+02	1.7E+02
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0		~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	8.5E-03	3.9E-06	2.9E-04	2.3E-05	6.0E+00	6.0E+00	6.0E+00	6.0E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	4.3E+01	7.9E+01	2.1E+02	1.0E+02	not reported	1.2E+02	2.5E+02	1.4E+02
Number of cancer fatalities from collective dose	(1)	~0	~0	~0	~0		~0	1.0E-01	~0
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	1,080	450	1,670	1,660	0	1,530	2,750	2,740
Number of rail shipments (10 yr)		0	180	720	710	0	180	720	710
Annual dose (mrem) from truck transport		4.3E-01	7.2E-04	8.8E-03	8.83E-03	0.0E+00	4.3E-01	4.4E-01	4.4E-01
Annual dose (mrem) from rail transport		0.0E+00	2.9E-04	8.1E-03	8.06E-03	0.0E+00	2.9E-04	8.1E-03	8.1E-03
Resources and Infrastructure									
Land requirement (% of suitable area)		30%	0.09%	0.61%	0.43%	4.67%	35%	35%	35%
Water use (% of total capacity)		36%	0.23%	1.09%	0.54%	4.50%	41%	41%	41%
Wastewater production (% of treatment capacity)		60%	0.09%	0.19%	0.17%	4.40%	64%	65%	65%
Power demand (% current load)		96%	0.88%	10.21%	4.00%	142.00%	239%	248%	242%
Employment									
Number of site workers	(7)	4,670	86	247	132	300	5,056	5,217	5,102
Air Quality Exceedances	(8)	PM_{10}, ozone	None	None	None	None	PM_{10}, ozone	PM_{10}, ozone	PM_{10}, ozone
Groundwater Quality Exceedances	(9)	5 parameters exceeded	None	None	None	None	5 parameters exceeded	5 parameters exceeded	5 parameters exceeded

[a] Other reasonably foreseeable future actions planned by DOE at ANL include operation of the recently constructed Advanced Photon Source (DOE, 1990c).
[b] Sum of impacts of existing operations, combined waste management impact, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5E-04 cancer fatalities per person-rem. Calculated values less than 1E-01 are reported as approximately zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point. Excludes radon-220, which is not subject to National Emission Standards for Hazardous Air Pollutants (NESHAP) limits. Exposure from existing operations at ANL-E including radon-220 = 0.24 mrem.
(4) Includes both waste management and noninvolved workers. Assumes 4E-04 cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Existing air quality exceedance is for the region in which the site is located and is not an exceedance of existing site emission requirements. Waste management impacts presented indicate whether emissions would result in or be a substantial contributor to nonattainment. PM_{10} = particulate matter measuring less than or equal to 10 microns in diameter.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The combined actions would affect between 1 and 9 acres of land at ANL-E. This area is less than 1% of the total ANL-E site and less than 1% of the area available for waste management facilities. The increased demand for power under the maximum combined alternatives represents about 10% of current capacity, while the combined alternatives would not measurably change the current demand at ANL-E for water or wastewater treatment. Cumulatively, power demand would increase substantially as a result of operation of the new APS facility.

The combined waste management alternatives could add up to 247 jobs at ANL-E, or an approximately 5% increase at the maximum. The maximum increase in jobs at ANL-E would not be expected to result in offsite community infrastructure or institutional impacts because of the extremely large population and employment base of the ANL-E region.

11.4 Brookhaven National Laboratory

Brookhaven National Laboratory (BNL) would continue in the future to conduct programs in basic and applied research in the physical, biomedical, and environmental sciences and selected energy technologies. The existing environmental conditions at BNL resulting from these ongoing activities are described in Chapter 4.

11.4.1 Combined Waste Management Impacts

DOE considered the management of LLMW[1] and LLW at BNL. Table 11.4–1 lists the minimum and maximum combined impacts of the waste management alternatives for BNL. The most adverse impacts at BNL and in the BNL region would result from the decentralized alternatives, for which treatment and disposal facilities would be constructed for BNL to manage its own waste. The least adverse impacts at BNL and in the BNL region generally would result from the regionalized and centralized alternatives for which BNL would package and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at BNL are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

[1] Analysis of LLMW impacts at BNL assumed an inventory of 85 cubic meters and 20-year projected volume of 110 cubic meters. Updated information from the site indicates that there are 10 cubic meters in inventory and a projected 20-year volume of 20-cubic meters. Therefore, LLMW impacts reported for BNL are expected to be conservative.

Table 11.4–1. Brookhaven National Laboratory Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.0E–04	N	2.3E–01	R1-C	5.2E–08	N	1.1E–04	R1-C	9.0E–09	N	8.0E–06
Low Level[a]	D	1.9E–05	R1-C5	4.7E–03	D	9.7E–09	R1-C5	2.3E–06	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.2E–04**		**2.6E–01**		**6.0E–08**		**1.1E–04**		**9.0E–09**		**8.0E–06**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.4E–09	N	3.0E–06	R1-C	7.0E–13	N	1.5E–09	R1-C	1.5E–13	N	1.3E–10
Low Level[a]	D	2.6E–10	R1-C5	6.2E–08	D	1.3E–13	R1-C5	3.1E–11	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.7E–09**		**3.1E–06**		**8.3E–13**		**1.5E–09**		**1.5E–13**		**1.3E–10**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D,N	0 / 0	R1-C	20 / 20	D,N	0.0E+00	R1-C	3.20E–07	D,N	0.0E+00	R1-C	3.20E–07
Low Level	D	0 / 0	N / N, R4,C3, C4	1,360 / 520	D	0.0E+00	N	2.18E–05	D	0.0E+00	N,R4, C3, C4	8.32E–06
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**1,380 / 540**		**0.0E+00**		**2.2E–05**		**0.0E+00**		**8.6E–06**

Table 11.4–1. Brookhaven National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	6.4E–07	N	1.4E–03	R1-C	3.2E–10	N	7.0E–07	R1-C	3.1E–10	N	2.8E–07
Low Level[a]	D	4.8E–08	R1-C5	2.4E–05	D	2.4E–11	R1-C5	1.2E–08	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**6.9E–07**		**1.6E–03**		**3.4E–10**		**7.1E–07**		**3.1E–10**		**2.8E–07**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	R1-C	0.0	D	1.6
Low Level	N,R1-C5/None	D/NO_2	All	None	All	None	N,R1-C5	1.2	D	2.8
Transuranic[a]	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[c]**	**NO_2**		**None**		**None**		**1.2**		**4.4**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	42	D	2,083	R1-C	42	D	370	R1-C	0.06	N	0.23
Low Level	N,R1-C5	1,258	D	8,000	N,R1-C5	441	D	865	N,R1-C5	0.12	D	1.10
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1,300**		**10,083**		**483**		**1,235**		**0.18**		**1.33**

Table 11.4–1. Brookhaven National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,R1-C	0.00	D	0.01	All	0.00	All	0.00	R1-C	8	D	84
Low Level	N,R1-C5	<0.01	D	0.02	N,R1-C5	<0.01	D	0.01	N,R1-C5	111	D	230
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.00**		**0.03**		**0.00**		**0.01**		**119**		**314**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Brookhaven National Laboratory does not have transuranic or high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives. Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences.

[b] Maximum and minimum alternatives for truck and rail transport are the same unless otherwise indicated by the presence of two sets of codes separated by a diagonal line.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

11.4.2 CUMULATIVE IMPACTS

Aside from continuation of existing operations, the waste management activities considered in this PEIS, and environmental restoration activities, DOE has no other actions planned at BNL. No other DOE or non-DOE actions are planned in the BNL region that would contribute to the cumulative impacts of waste management alternatives.

The environmental restoration program at BNL will address cleanup of an estimated 139,800 m^3 of contaminated media and facilities (19,000 m^3 and 120,800 m^3 of LLMW and LLW, respectively; see Appendix B). Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, no major changes are anticipated from ongoing environmental restoration activities, and any future impacts should be similar to those occurring under existing operations. Project-specific environmental evaluations that consider cumulative effects will be conducted prior to implementation of all future environmental restoration activities.

Table 11.4–2 identifies the range of cumulative impacts that could result from the combined waste management alternatives and current operations and activities at BNL. As identified in Table 11.4–1, the maximum annual radioactive releases to the atmosphere from waste management activities (including transportation) would result in some increase in dose to the offsite population; however, BNL atmospheric releases would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

BNL is in a nonattainment region for ozone. While the expected atmospheric emissions of ozone-producing contaminants under the alternatives would increase the levels of ozone, the increases would be below the regulated levels in the nonattainment region. The maximum combined alternatives could result in exceedance of the air quality standard for NO_2. Mitigation would be required to maintain compliance should these alternatives be chosen. The combined preferred alternatives are not expected to result in an exceedance of the NO_2 standard. Disposal of LLMW or LLW at BNL under any alternative is not expected to result in any exceedances of drinking water standards in groundwater.

The combined actions would affect a maximum of 4 acres of land. This area is less than 1% of the total suitable acreage at BNL and less than 1% of the area available for waste management facilities. Onsite infrastructure demands for water and power and the generation of wastewater would not measurably

Table 11.4–2. Brookhaven National Laboratory Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	2.7E+01	1.2E-04	2.6E-01	4.8E-03	--	2.7E+01	2.7E+01	2.7E+01
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	--	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.1E-01	1.7E-07	3.1E-04	6.3E-06	--	1.1E-01	1.1E-01	1.1E-01
Worker Population									
Collective dose, 10 years (person-rem)	(4)	NA	9.9E+01	1.9E+02	9.9E+01	--	9.9E+01	1.9E+02	9.9E+01
Number of cancer fatalities from collective dose	(1)	NA	~0	~0	~0	--	~0	~0	~0
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	80	0	1,380	1,370	--	80	1,460	1,370
Number of rail shipments (10 yr)		0	0	540	530	--	0	540	530
Annual dose (mrem) from truck transport		3.2E-02	0.0E+00	2.2E-03	2.23E-03	--	3.2E-02	3.4E-02	2.2E-03
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	8.6E-04	8.52E-04	--	0.0E+00	8.6E-04	8.5E-04
Resources and Infrastructure									
Land requirement (% of suitable area)		36%	0.03%	0.10%	0.03%	--	36%	36%	36%
Water use (% of total capacity)	(6)	75%	0.02%	0.17%	0.02%	--	75%	75%	75%
Wastewater production (% of treatment capacity)		43%	0.02%	0.05%	0.02%	--	44%	44%	44%
Power demand (% current load)		74%	0.38%	2.83%	0.38%	--	75%	77%	75%
Employment									
Number of site workers	(7)	3,557	41	105	41	--	3,598	3,744	3,598
Air Quality Exceedances	(8)	Ozone	None	NO_2	None	--	Ozone	Ozone, NO_2	Ozone
Groundwater Quality Exceedances	(9)	8 parameters exceeded	None	None	None	--	8 parameters exceeded	8 parameters exceeded	8 parameters exceeded

[a] Aside from continuation of existing operations, waste management activities, and environmental restoration actions, no other future actions are planned by DOE at BNL.
[b] Sum of impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5E-04 cancer fatalities per person-rem. Calculated values less than 1E-01 are reported as approximately zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both waste management and noninvolved workers. Assumes 4E-04 cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers for existing operations.
(8) Existing air quality exceedance is for the region in which the site is located and is not an exceedance of existing site emission requirements. Waste management impacts presented indicate whether emissions would result in or be a substantial contributor to nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

increase as a result of the combined alternatives. The combined alternatives could add up to 105 jobs at BNL, or an approximately 3% increase at the maximum, which would not affect offsite community infrastructures or institutions.

11.5 Fernald Environmental Management Project

The Fernald Environmental Management Project (FEMP) will continue in the future to conduct site cleanup and support waste management and base service activities. The existing environmental conditions at FEMP resulting from these ongoing activities are described in Chapter 4.

11.5.1 Combined Waste Management Impacts

DOE considered the management of LLMW and LLW at FEMP. Table 11.5–1 lists the minimum and maximum impacts of the alternatives for FEMP. The most adverse impacts at FEMP and in the FEMP region would occur as a result of Regionalized Alternatives for which treatment and disposal facilities would be constructed for FEMP to manage its own waste, as well as the treatment of LLMW from other sites.

Other Regionalized or Centralized Alternatives for which FEMP would only prepare and package waste for offsite treatment and disposal would result in the least adverse impacts. For most impact categories, the combined impacts of the preferred alternatives at FEMP are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

11.5.2 Cumulative Impacts

Aside from continuation of existing operations, the waste management activities considered in this PEIS, and future environmental restoration activities, DOE has no other actions planned at FEMP. No other DOE or non-DOE actions are planned in the FEMP region that would contribute to the cumulative impacts of waste management alternatives. The environmental impacts of environmental restoration activities have been presented in various CERCLA documents (DOE 1994j, k; 1995g, h; 1996l).

Table 11.5–1. Fernald Environmental Management Project Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	2.9E–04	R1	1.4E+00	R2-C	1.4E–07	R1	7.0E–04	R2-C	9.2E–08	N	3.3E–05
Low Level[a]	--	--	R2	4.6E+02	--	--	R2	2.3E–01	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2.9E–04**		**4.6E+02**		**1.4E–07**		**2.3E–01**		**9.2E–08**		**3.3E–05**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	5.4E–09	R1	2.6E–05	R2-C	2.7E–12	R1	1.3E–08	R2-C	2.9E–12	N	1.1E–09
Low Level[a]	--	--	R2	8.8E–03	--	--	R2	4.4E–06	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**5.4E–09**		**8.8E–03**		**2.7E–12**		**4.4E–06**		**2.9E–12**		**1.1E–09**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,D	0 / 0	R1	1,060 / 410	N,D	0.0E+00	R1	1.70E–05	N,D	0.0E+00	R1	6.60E–06
Low Level[a]	--	--	R2	910 / 400	--	--	R2	1.50E–05	--	--	R2	6.40E–06
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**1,970 / 810**		**0.0E+00**		**3.25E–05**		**0.0E+00**		**1.3E–05**

Table 11.5-1. Fernald Environmental Management Project Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	2.1E-06	R1	9.4E-03	R2-C	1.1E-09	R1	4.7E-06	R2-C	6.4E-09	N	2.3E-06
Low Level[a]	--	--	R2	1.0E+00	--	--	R2	5.2E-04	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2.1E-06**		**1.0E+00**		**1.1E-09**		**5.2E-04**		**6.4E-09**		**2.3E-06**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	--	--	D, R1	U-238	R2-C	1.4	R1	12.3
Low Level[a]	R2/None	R2/None	--	--	--	--	N,D,R1, R3-C5	0.0	R2	3.9
Transuranic[a]	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[c]**	**None**		**None**				**1.4**		**16.2**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	2,104	R1	23,556	N	1,013	R1	4,630	R2-C	0.76	N	2.65
Low Level[a]	--	--	R2	5,254	--	--	R2	2,403	--	--	R2	0.50
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2,104**		**28,810**		**1,013**		**7,033**		**0.76**		**3.15**

Table 11.5–1. Fernald Environmental Management Project Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.01	R1	0.07	N,R2-C	0.01	R1	0.04	N	107	R1	584
Low Level[a]	--	--	R2	0.04	--	--	R2	0.02	N,D,R1, R3-C5	0	R2	312
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.01**		**0.11**		**0.01**		**0.06**		**107**		**896**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] The Fernald Environmental Management Project does not have transuranic or high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives. Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.5-2 identifies the range of cumulative impacts that could result from the combined waste management alternatives, current activities, and future actions at FEMP. However, the radiological effects of environmental restoration activities at FEMP are not included in this analysis because of differences in analytical approaches. As identified in Table 11.5-1, the maximum annual radioactive releases to the atmosphere from combined waste management activities (including transportation) would result in some increase in dose to the offsite population; however, atmospheric radioactive releases from existing operations and waste management activities would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite. FEMP is in a nonattainment region for ozone. While the expected atmospheric emissions of ozone-producing contaminants under the combined alternatives would increase the levels of ozone, the increases would be below the regulated levels in the nonattainment region.

The combined actions could affect a maximum of 16 acres of land. This area is less than 2% of the total suitable acreage at FEMP and 6% of the area available for waste management facilities. Other actions could affect 208 acres of the FEMP site. Onsite cumulative demands for water, wastewater treatment, and power could exceed existing capacities. The combined alternatives could add up to 328 jobs at FEMP, or a maximum increase of about 15% over existing employment. The maximum increase in employment is not expected to affect offsite community infrastructures or institutions because of the current population and employment base in the FEMP region.

Disposal of LLMW at FEMP under the Decentralized Alternative and Regionalized Alternative 1 could result in exceedances of drinking water standards in groundwater for U-238. Mitigation could be required to maintain compliance with drinking water standards should either of these alternatives be selected. No disposal of LLMW at FEMP would occur under the preferred alternative.

11.6 Hanford Site

The Hanford Site would continue in the future to conduct programs for waste disposal technologies and cleanup of site contamination. The existing environmental conditions at the Hanford Site resulting from these ongoing activities are described in Chapter 4.

Table 11.5–2. Fernald Environmental Management Project Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.3E+01	2.90E–04	4.60E+02	5.20E–02	Not available	1.30E+01	4.73E+02	1.31E+01
Number of cancer fatalities from collective dose	(2)	~0	~0	2.30E–01	~0	Not available	~0	2.37E–01	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	2.10E–03	5.40E–07	8.80E–01	9.70E–05	Not available	2.10E–03	8.82E–01	2.20E–03
Worker Population									
Collective dose, 10 years (person-rem)	(4)	6.75E+02	6.30E–01	8.47E+01	7.30E–01	Not available	6.76E+02	7.60E+02	6.76E+02
Number of cancer fatalities from collective dose	(1)	2.70E–01	~0	~0	~0	Not available	2.70E–01	3.04E–01	2.70E–01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	4,460	0	1,970	110	Not available	4,460	6,430	4,570
Number of rail shipments (10 yr)		0	0	810	50	Not available	0	810	50
Annual dose (mrem) from truck transport		1.8E+00	0.0E+00	3.2E–03	1.80E–04	Not available	1.8E+00	1.8E+00	1.8E+00
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	1.3E–03	8.10E–05	Not available	0.0E+00	1.3E–03	8.1E–05
Resources and Infrastructure									
Land requirement (% of suitable area)		32%	0.16%	1.89%	0.99%	24.33%	57%	58%	57%
Water use (% of total capacity)		25%	0.13%	1.80%	1.10%	2,550%	2,575%	2,577%	2,576%
Wastewater production (% of treatment capacity)		96%	0.04%	0.31%	0.12%	9.52%	106%	106%	106%
Power demand (% current load)		91%	2.30%	9.55%	6.55%	6.00%	99%	106%	103%
Employment									
Number of site workers	(7)	2,124	38	328	134	0	2,162	2,452	2,258
Air Quality Exceedances	(8)	Ozone	None	None	None	None	Ozone	Ozone	Ozone
Groundwater Quality Exceedances	(9)	11 parameters exceeded	None	U-238	None	None	11 parameters exceeded	11 parameters exceeded	11 parameters exceeded

[a] Aside from waste management and environmental restoration activities, no other future actions are planned by DOE at FEMP. The impacts of environmental restoration activities have been presented in DOE 1994j, 1994k, 1995g, 1995h, 1996. In some cases, impacts were not presented in a manner that allowed addition to this table.
[b] Sum of impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based in DOE (1994a), which contains releases for the year 1992. Excludes radon-220, which is not subject to National Emission Standards for Hazardous Air Pollutants (NESHAP) limits. Exposure from existing operations at FEMP including radon-220 = 51 mrem.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Existing air quality exceedance is for the region in which the site is located and does not indicate an exceedance of existing site emission requirements.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

11.6.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, TRUW, HLW, and HW at the Hanford Site. Table 11.6–1 lists the minimum and maximum combined impacts of the waste management alternatives considered for the Hanford Site. The most adverse impacts at the Hanford Site and in the Hanford Site region would occur as a result of some Regionalized and Centralized Alternatives for which treatment and disposal facilities would be constructed for the Hanford Site to manage its own waste and accept offsite LLMW and LLW for treatment and disposal, offsite TRUW for treatment, and offsite HLW canisters for storage. The least adverse impacts at Hanford and in the Hanford region generally would result from the No Action, Decentralized, and some Regionalized Alternatives for which the Hanford Site would be primarily responsible for its own waste, would package and ship its wastes for offsite treatment and disposal, or would only receive small quantities of waste from other sites for treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at Hanford are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

11.6.2 Cumulative Impacts

Aside from continuation of existing operations and the waste management activities considered in this PEIS, there are a number of other actions planned or being undertaken by DOE at the Hanford Site that have been the subject of various recent EISs. These include the (1) development of a tank waste remediation system (DOE, 1996d); (2) management of spent nuclear fuel from K Basin (DOE, 1996a); (3) disposal of decommissioned, defueled Cruiser, Ohio Class, and Los Angeles Class Naval nuclear plants (Navy, 1996); (4) storage and disposition of weapons-usable fissile materials (DOE, 1996b); (5) plutonium finishing plant stabilization (DOE, 1996e); and (6) DOE spent nuclear fuel management (DOE, 1995d). The findings presented in these EISs are included in the cumulative impacts analysis presented here.

Future environmental restoration activities at the Hanford Site include the decontamination and decommissioning of facilities (including eight surplus reactors) and groundwater remediation. Environmental contamination is present in some areas of the Hanford Site, and major efforts will be required to achieve the current cleanup scenario. The current cleanup scenario for the Hanford Site is considered in the *Draft Hanford Remedial Action EIS and Comprehensive Land Use Plan* (DOE, 1996j). This document analyzes the potential environmental impacts associated with establishing future land-use objectives for the site. Impact analysis was performed by examining the consequences (primarily from

Table 11.6–1. Hanford Site Range of Combined Waste Management Alternative Impacts

Effects on Offsite Population from Atmospheric Releases

Waste Type	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1	2.7E+00	C	5.0E+01	R1	1.4E–03	C	2.5E–02	D,R1	1.1E–06	N,C	1.2E–05
Low Level[a]	N	8.3E–04	C5	1.5E+02	N	4.2E–07	C5	7.5E–02	--	--	--	--
Transuranic	N	1.5E–02	R2,3	3.3E+02	N	5.3E–06	R2,3	1.7E–01	N	2.6E–11	R1-R3	1.3E–10
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	R1	4.3E–03
Total		**2.7E+00**		**5.3E+02**		**1.4E–03**		**2.7E–01**		**1.1E–06**		**4.3E–03**

Effects on Offsite Maximum Exposed Individual from Atmospheric Releases

Waste Type	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1	5.6E–05	C	1.0E–03	R1	2.8E–08	C	5.2E–07	R1	3.6E–11	N,C	4.1E–10
Low Level[a]	N	1.7E–08	C5	3.1E–03	N	8.6E–12	C5	1.5E–06	--	--	--	--
Transuranic	N	3.0E–07	R2,3	6.8E–03	N	1.5E–10	R2,3	3.4E–06	All	<9.9E–14	All	<9.9E–14
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	R1	1.4E–07
Total		**5.6E–05**		**1.1E–02**		**2.8E–08**		**5.4E–06**		**3.6E–11**		**1.4E–07**

Effects of Transportation on Offsite Maximum Exposed Individual

Waste Type	Number of Truck / Rail Shipments[b] (10 yr)				Radiation Doses from Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	C	7,520 / 3,340	N	0.0E+00	C	1.2E–04	N	0.0E+00	C	5.4E–05
Low Level	D, R1-3	0 / 0	C1	242,730 / 91,440	D, R1-R3	0.0E+00	C1	3.9E–03	D, R1-R3	0.0E+00	C1	1.5E–03
Transuranic	N	0 / 0	R2-3	11,830 / 5,930	N	0.0E+00	R2-R3	1.8E–03	N	0.0E+00	R2-R3	1.8E–03
High Level	N, D, R1	15,000 / 3,000	C2	28,224 / 5,646	N, D, R1	6.0E–03	C2	1.1E–02	N, D, R1	1.2E–03	C2	2.3E–03
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**15,000 / 3,000**		**290,304 / 106,356**		**6.0E–03**		**1.7E–02**		**1.2E–03**		**5.7E–03**

Noninvolved Worker Health Risks

Waste Type	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D,R1	1.0E–01	C	6.6E–01	R1	5.2E–05	C	3.3E–04	R1	6.5E–07	N,C	7.3E–06
Low Level[a]	N	3.0E–05	C5	1.9E+00	N	1.5E–08	C5	9.7E–04	--	--	--	--
Transuranic	N	7.0E–04	R2,R3	1.6E+01	N	3.5E–07	R2,R3	8.2E–03	N	1.6E–11	R1	7.9E–11
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,D,R2	0.0E+00	R1	2.6E–03
Total		**1.0E–01**		**1.8E+01**		**5.2E–05**		**9.5E–03**		**6.5E–07**		**2.6E–03**

Table 11.6–1. Hanford Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	C/PM_{10}	--	--	D, R1, R2, R4, C	U-238, 4 hazardous chemicals[c]	N	1.8	C	50.2
Low Level	All/None	All/None	--	--	N, D, R1-R6, C1, C3, C5	U-238	R7,C2	3.7	C5	86.4
Transuranic	All/None	All/None	--	--	--	--	N	0	R2,3	24.7
High Level	All/None	All/None	--	--	--	--	N	1	C	16.0
Hazardous	All/None	All/None	--	--	--	--	--	--	R1	1
Total	**None[d]**	**NO_2, PM_{10}**		**None**		**U-238, 4 hazardous chemicals[e]**		**6.5**		**178.3**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	3,038	C	87,637	N	2,573	C	43,085	N	1.14	C	8.33
Low Level	R7,C2	6,887	C5	199,473	R7,C2	1,615	C5	101,650	R7,C2	0.83	C3	34.62
Transuranic	N	2,796	R2,3	64,729	N	2,796	R2,R3	15,519	N	0.30	R2, 3	3.60
High Level	N	3,200	D-C	8,000	N	3,200	D-C	8,000	N	0.06	C	0.10
Hazardous	--	--	R1	1,366	--	--	R1	933	--	--	R1	0.28
Total		**15,921**		**361,205**		**10,184**		**169,187**		**2.33**		**46.93**

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.09	C	1.66	N	0.05	C	0.76	N	260	C	3,968
Low Level	R7,C2	0.10	C5	3.34	R7,C2	0.04	C5	1.50	R7,C2	238	C5	7,961
Transuranic	N	0.10	R2,3	1.05	N	0.14	R2,3	0.39	N	287	R2,3	2,491
High Level	N	0.06	R2,C	0.14	N	0.04	D-C	0.08	N	826	C	1,734
Hazardous	--	--	R1	0.03	N,D,R2	0.00	R1	0.01	N,D	0	R1	70
Total		**0.35**		**6.22**		**0.27**		**2.74**		**1,611**		**16,224**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; NO_2 = nitrogen dioxide; PM_{10} = particulate matter measuring less than 10 microns in diameter; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. Routine high-level waste storage does not result in releases of radioactive or chemical substances. Hazardous waste does not contain radioactive materials and therefore does not cause radiation doses or fatalities.

[b] Number of truck and rail shipments of radioactive waste types. Does not include hazardous waste shipments.

[c] Maximum and minimum alternatives for truck and rail transport are the same.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

[e] Hazardous chemicals that could exceed drinking water standards include benzene, carbon tetrachloride, 1,2-dichloroethane, and methylene chloride.

remediation activities) of the actions determined necessary to achieve desired future land-use objectives. Site-specific decisions regarding remediation technologies and remediation activities would not be made based on the Draft Hanford Remedial Action EIS, but rather by a process specified in the Comprehensive Environmental Response Compensation and Liability Act of 1980 and the Resource Conservation and Recovery Act of 1976.

To facilitate the establishment of future land-use objectives, the Hanford Site was divided into four geographic areas: (1) Columbia River, (2) Reactors on the River, (3) Central Plateau, and (4) All Other Areas. The future land-use alternatives considered in detail in the Hanford Remedial Action Draft EIS and for each of the geographic areas are as follows:

- Columbia River—Unrestricted and Restricted
- Reactors on the River—Unrestricted and Restricted
- Central Plateau—Exclusive
- All Other Areas—Restricted

The impacts of remediation in these areas at Hanford are included as reasonably foreseeable impacts in this section.

In addition to these programs being conducted at the Hanford Site, other non-DOE nuclear facilities at or near the Hanford Site contribute to radioactive releases and potentially to cumulative impact. These facilities include the commercial radioactive burial ground at the Hanford Site, the commercial nuclear generating station at the Hanford Site, a nuclear fuel production plant, a commercial low-activity radioactive waste compacting facility, and a commercial decontamination facility.

Table 11.6–2 identifies the range of cumulative impacts resulting from these other actions, the waste management alternatives, and current activities. To calculate the cumulative impacts of the alternatives for the Hanford Site, DOE used the impacts of the preferred alternative contained in the EISs mentioned above.

As identified in Table 11.6–2, the maximum annual radioactive releases to the atmosphere from the combined waste management activities (including transportation) would result in an increase in the dose to the offsite population. The maximum increase in radioactive releases under the combined alternatives primarily results from the Hanford Site being considered as the single candidate site for the treatment and disposal of all contact-handled LLMW and LLW under the Centralized Alternatives. Cumulative radioactive

Table 11.6–2. Hanford Site Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	6.00E+00	2.70E+00	5.30E+02	2.75E+00	2.74E+02	2.83E+02	8.10E+02	2.83+02
Number of cancer fatalities from collective dose	(2)	~0	~0	2.65E–01	~0	1.37E–01	1.41E–01	4.05E–01	1.41E–01
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	3.70E–03	5.60E–03	1.10E+00	5.71E–03	1.91E+00	1.92E+00	3.01E+00	1.92E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	2.10E+03	3.53E+03	1.59E+04	1.31E+04	1.26E+04	1.82E+04	3.06E+04	2.78E+04
Number of cancer fatalities from collective dose	(1)	8.40E–01	1.41E+00	6.37E+00	5.23E+00	5.03E+00	7.29E+00	1.22E+01	1.11E+01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	1,310	15,000	290,304	275,510	830	17,140	292,444	277,650
Number of rail shipments (10 yr)		0	3,000	106,356	102,920	0	3,000	106,356	102,920
Annual dose (mrem) from truck transport		5.2E–01	6.0E–01	1.68E+00	1.12E+00	3.3E–02	1.16E+00	2.2E+00	1.68E+00
Annual dose (mrem) from rail transport		0.0E+00	1.2E–01	5.65E–01	3.95E–01	0.0E+00	1.2E–01	5.7E–01	3.95E–01
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	11%	0.00%	0.09%	0.06%	0.98%	12%	12%	12%
Water use (% of total capacity)		12%	0.02%	0.46%	0.29%	0.94%	13%	13%	13%
Wastewater production (% of treatment capacity)		79%	5.09%	84.59%	39.68%	4.35%	88%	168%	123%
Power demand (% current load)		17%	0.66%	13.34%	12.52%	22.74%	40%	53%	52%
Employment									
Number of site workers	(7)	14,613	609	5,343	3,659	10,260	25,482	30,216	28,532
Air Quality Exceedances	(8)	None	None	NO_2, PM_{10}	None	PM_{10}, NO_2, SO_2, U-238, Pu-239, Pu-240	PM_{10}, NO_2, SO_2, U-238, Pu-239, Pu-240	PM_{10}, NO_2, SO_2, U-238, Pu-239, Pu-240	PM_{10}, NO_2, SO_2, U-238, Pu-239, Pu-240
Groundwater Quality Exceedances	(9)	14 parameters exceeded	None	U-238, 4 hazardous chemicals[e]	U-238, 4 hazardous chemicals[e]	U-238	15 parameters exceeded	18 parameters exceeded	18 parameters exceeded

[a] Other reasonably foreseeable future actions include actions addressed in EISs related to spent nuclear fuel management (including spent nuclear fuel from foreign research reactors) (DOE, 1995d), tank waste remediation system (DOE, 1996d), management of spent nuclear fuel from the K Basin (DOE, 1996a), disposal of decommissioned Naval nuclear plants (Navy, 1996), storage and disposition of weapons-grade fissile materials (DOE, 1996c), plutonium finishing plant stabilization (DOE, 1996e), and remedial actions (DOE 1996j).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.
[e] Hazardous chemicals that could exceed drinking water standards in groundwater include benzene, carbon tetrachloride, 1,2-dichloroethane, and methylene chloride.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based in DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Truck and rail shipments of radioactive waste types; does not include hazardous waste shipments. Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment. PM_{10} = particulate matter measuring less than or equal to 10 microns in diameter.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

releases, including the maximum releases associated with the combined WM PEIS alternatives and contributions estimated at 0.05 millirems per year from commercial nuclear facilities at or near the Hanford Site, would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

The Hanford Site is in an attainment region where criteria air pollutants do not exceed standards. In the alternatives that result in maximum atmospheric emissions, the standards for NO_2 and particulate (PM_{10}) emissions could be exceeded; mitigation measures would be necessary to reduce these emissions if these alternatives are chosen. The combined preferred alternatives are not expected to result in exceedance of any air quality standards. Remedial action at Hanford could result in temporary exceedances of standards for several additional compounds.

The combined alternatives would affect between 7 and 178 acres of land at the Hanford Site. This area is less than 1% of the total suitable acreage at Hanford and 3% of the area available for waste management facilities. Other actions could affect another 1,949 acres. Although the combined alternatives and other actions would only cumulatively affect a maximum of about 1% of the suitable acreage at the Hanford Site, the land affected may require detailed characterization studies and evaluations to ensure protection of wildlife habitats and cultural artifacts prior to disturbance.

Although the cumulative demand for water and power would not be greatly affected by the combined alternatives, a maximum cumulative increase of 169% in wastewater generation could require new or upgraded wastewater treatment facilities at the Hanford Site. The combined alternatives could add up to 5,343 jobs at the Hanford Site, while other actions could increase the number of jobs at the Hanford Site by 10,260. Cumulatively, the number of jobs at Hanford could increase by up to 107% over current employment levels, which could impact existing offsite community infrastructures and institutions. Mitigation measures could be necessary to reduce any adverse impacts resulting from this increase in employment.

Disposal of LLMW at the Hanford Site under the Decentralized Alternative; Regionalized Alternatives 1, 2, and 4; and the Centralized Alternative could result in exceedances of drinking water standards in groundwater for benzene, carbon tetrachloride, 1,2-dichloroethane, methylene chloride, and U-238. Disposal of LLW at Hanford could result in concentrations of U-238 that exceed drinking water standards under the Decentralized Alternative; Regionalized Alternatives 1 through 6; and Centralized Alternatives 1,

3, and 5. Disposal under the combined preferred alternatives for LLMW and LLW would result in these same groundwater quality exceedances. To meet drinking water standards, performance-based waste acceptance criteria may be needed for onsite disposal of LLMW and LLW.

11.7 Idaho National Engineering Laboratory

Idaho National Engineering Laboratory (INEL) would continue in the future to conduct programs that include building, testing, and operating various types of nuclear facilities, and focusing on environmental restoration, waste management, and technology development. The existing environmental conditions at INEL resulting from these ongoing activities are described in Chapter 4.

11.7.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, TRUW, HLW, and HW at INEL. Table 11.7–1 lists the minimum and maximum combined impacts of the waste management alternatives considered for INEL. The most adverse impacts at INEL and in the INEL region would occur as a result of some Regionalized and Centralized Alternatives for which treatment and disposal facilities would be constructed for INEL to manage its own waste, in addition to accepting offsite LLMW and LLW for treatment and disposal and offsite TRUW for treatment. The least adverse impacts at INEL and in the INEL region generally would result from Decentralized and other Regionalized Alternatives for which INEL would primarily be responsible for its own waste or would prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at INEL are expected to be less than the impacts of the maximum combined waste management alternatives at the site.

1.7.2 Cumulative Impacts

Aside from continuation of existing operations and the waste management activities presented in this PEIS, several additional actions are planned or being undertaken by DOE at INEL and are included as reasonably foreseeable future actions in this analysis. These actions are considered in several EISs and include continued management of spent nuclear fuel (including spent nuclear fuel from naval reactors and foreign

Table 11.7–1. Idaho National Engineering Laboratory Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	9.9E–03	R2-4	1.3E+00	C	4.9E–06	R4	6.7E–04	C	4.9E–09	N	1.9E–06
Low-Level[a]	D,R1,3, C5	1.6E–03	R5	8.2E–01	D,R1,3, C5	8.0E–07	R5	4.1E–04	--	--	--	--
Transuranic	N	1.3E–05	R3	8.2E+01	N	6.7E–09	R3	4.1E–02	N	1.7E–12	C	6.6E–09
High-Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	D	--	R2	9.7E–04
Total		**1.2E–02**		**8.4E+01**		**5.7E–06**		**4.2E–02**		**4.9E–09**		**9.7E–04**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	1.2E–06	R4	1.7E–04	C	6.1E–10	R4	8.4E–08	C	6.7E–13	R2	2.6E–07
Low-Level[a]	D,R1,3, C5	2.0E–07	R5	1.0E–04	D,R1,3, C5	9.9E–11	R5	5.1E–08	--	--	--	--
Transuranic	N	1.7E–09	R3	1.0E–02	N	8.4E–13	R3	5.1E–06	N	<9.9E–14	C	9.1E–13
High-Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	D	0.0E+00	R2	1.3E–07
Total		**1.4E–06**		**1.0E–02**		**7.1E–10**		**5.2E–06**		**6.7E–13**		**3.9E–07**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments[b] (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R4	1,740 / 760	N	0.0E+00	R4	2.80E–05	N	0.0E+00	R4	1.20E–05
Low-Level	N,D,R1-R4	0 / 0	R5	25,620 / 10,020	N,D,R1-R4	0.0E+00	R5	4.10E–04	N,D,R1-R4	0	R5	1.60E–04
Transuranic	N	0 / 0	R3	7,610 / 3,820	N	0.0E+00	R3	1.10E–03	N	0.0E+00	R3	1.10E–03
High-Level	N	0 / 0	D,R1,R2, C1,C2	1,700 / 340	N	0	D,R1,R2, C1,C2	6.80E–04	N	0	D,R1,R2, C1,C2	1.40E–04
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**36,670 / 14,940**		**0.0E+00**		**2.2E–03**		**0.0E+00**		**1.4E–03**

Table 11.7–1. Idaho National Engineering Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	6.9E–04	N	3.0E–01	C	3.5E–07	N	1.5E–04	C	6.4E–09	N	2.6E–06
Low-Level[a]	D,R1,3, C5	4.8E–04	R5	2.3E–01	D,R1,3, C5	2.4E–07	R5	1.2E–04	--	--	--	--
Transuranic	N	3.4E–06	R3	2.5E+01	N	1.7E–09	R3	1.2E–02	N	2.3E–12	C	8.7E–09
High-Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	D	--	R2	1.3E–03
Total		**1.2E–04**		**2.5E+01**		**5.9E–07**		**1.2E–02**		**6.4E–09**		**1.3E–03**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	C	12.2	D,R1	55.6
Low Level	All/None	All/None	All	None	All	None	N	7.5	R5	26.5
Transuranic	All/None	All/None	--	--	--	--	N	0.0	R2-C	28.2
High Level	All/None	All/None	--	--	--	--	N	0	D-C	2.0
Hazardous	All/None	All/None	--	--	--	--	N	0.0	R2	3.0
Total	**None[d]**	**PM_{10}**		**None**		**None**		**19.7**		**115.3**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	21,517	D,R1	110,206	C	1,258	R4	13,239	C	0.32	N	10.34
Low Level	N	4,458	R5	63,961	N	4,458	R5	28,247	R6-C2,5	1.26	R5	7.30
Transuranic	N	3,206	R3	77,743	N	3,206	R3	16,872	N	0.53	R2-C	2.78
High Level	N	0	D-C	820	N	0	D-C	820	N	0.00	D-C	0.03
Hazardous	D	--	R2	1,823	D	--	R2	1,108	D	--	R2	0.42
Total		**29,181**		**254,553**		**8,922**		**60,286**		**2.11**		**20.87**

Table 11.7–1. Idaho National Engineering Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.62	R4	2.04	C	0.07	R1-2	0.48	C	836	R4	2,377
Low Level	R6-C2,5	0.60	R5	2.99	R6-C2,5	0.26	R5	3.20	R6-C2,5	693	R5	3,484
Transuranic	N	0.17	R3	2.13	N	0.22	R3	0.91	N	246	R3	2,485
High Level	N	0.00	D-C	0.03	N	0.00	D-C	0.07	N	0	D-C	368
Hazardous	D	0.00	R2	0.13	N,D	0.00	R2	0.02	D	4	R2	137
Total		**1.39**		**7.32**		**0.55**		**4.68**		**1,779**		**8,851**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; PM_{10} = particulate matter measuring less than 10 microns in diameter; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. Routine high-level waste storage does not result in releases of radioactive or chemical substances. Hazardous waste does not contain radioactive materials and therefore does not cause radiation doses or fatalities.

[b] Number of truck and rail shipments of radioactive waste types. Does not include hazardous waste shipments.

[c] Maximum and minimum alternatives for truck and rail transport are the same.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

research reactors; DOE, 1995d); other site projects such as processing and treatment of HLW, environmental restoration, and infrastructure improvements (DOE, 1995d); and storage and disposition of weapons-usable fissile materials (DOE, 1996b). Table 11.7–2 identifies the range of cumulative impacts resulting from these other actions, the WM PEIS alternatives, and existing activities. To calculate the cumulative impacts at INEL, DOE used the impacts of the preferred alternatives contained in the aforementioned EISs. While there are no other nuclear facilities in the vicinity of INEL, two commercial facilities in Pocatello, Idaho, release naturally occurring radionuclides from phosphate processing. Lack of inclusion of the impacts of these facilities would not affect the relative impacts of alternatives, and the current analysis is thought to be sufficient to make programmatic decisions.

The environmental restoration program at INEL will address cleanup of an estimated 849,700 m^3 of contaminated media and facilities (200,000 m^3, 640,000 m^3, and 9,700 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). The cumulative impacts analysis includes a number of environmental remediation and decontamination projects that have been evaluated in DOE (1995d), including remediation of groundwater, Pit 9 retrieval, and decontamination and decommissioning of facilities at the Chemical Processing Plant and reactor areas. Environmental analyses of future environmental restoration activities conducted at INEL under the authority of CERCLA will be incorporated into CERCLA documentation and will include NEPA values. These reports will be available for public review and comment through the CERCLA process.

As identified in Table 11.7–2, the cumulative radioactive releases from the combined alternatives and other actions would result in an increase in the radiation dose to the offsite population. The maximum cumulative increase in radioactive releases would primarily result from environmental restoration activities at the site. However, maximum cumulative radioactive releases would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

INEL is in an attainment region where criteria air pollutants do not exceed standards. The emissions from the combined alternatives would not result in air quality standard exceedances, except for particulates. Maximum combined waste management alternatives are expected to result in exceedance of air quality standards for particulates (PM_{10}). Mitigation measures could be necessary to reduce these emissions if the maximum combined alternatives were chosen. The preferred alternatives are not expected to result in exceedance of the PM_{10} standard. No exceedances of drinking water standards in groundwater are expected for disposal of any waste type.

Table 11.7–2. Idaho National Engineering Laboratory Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	3.00E–01	1.20E–02	8.40E+01	8.33E+01	2.70E+01	2.73E+01	1.11E+02	1.11E+02
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	~0	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.50E–03	1.40E–04	1.00E+00	1.00E+00	5.80E–01	5.82E–01	1.58E+00	1.58E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	7.50E+02	1.79E+03	5.07E+03	3.94E+03	4.20E+02	2.96E+03	6.24E+03	5.11E+03
Number of cancer fatalities from collective dose	(1)	3.00E–01	7.16E–01	2.03E+00	1.58E+00	1.68E–01	1.18E+00	2.50E+00	2.04E+00
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	580	0	36,670	23,670	15,332	15,912	52,582	39,582
Number of rail shipments (10 yr)		0	0	14,940	9,770	5,932	5,932	20,872	15,702
Annual dose (mrem) from truck transport		2.3E–01	0.0E+00	2.2E–01	2.01E–01	6.1E–01	8.5E–01	1.1E+00	1.05E+00
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	1.4E–01	1.32E–01	2.4E–01	2.4E–01	3.8–01	3.69E–01
Resources and Infrastructure									
Land requirement (% of suitable area)		2%	0.00%	0.02%	0.01%	0.19%	2%	2%	2%
Water use (% of total capacity)	(6)	17%	0.09%	0.82%	0.49%	0.90%	18%	19%	18%
Wastewater production (% of treatment capacity)		25%	0.89%	6.03%	3.94%	0.62%	27%	32%	30%
Power demand (% current load)		76%	3.84%	37.95%	14.20%	38.45%	118%	152%	129%
Employment									
Number of site workers	(7)	12,422	513	4,687	1,913	1,452	14,387	18,561	15,787
Air Quality Exceedances	(8)	None	None	PM_{10}	None	PM_{10}	PM_{10}	PM_{10}	PM_{10}
Groundwater Quality Exceedances	(9)	1 parameter exceeded	None	None	None	None	1 parameter exceeded	1 parameter exceeded	1 parameter exceeded

[a] Other reasonably foreseeable future actions include actions addressed in EISs related to storage and disposition of weapons-usable fissile materials (DOE, 1996b), spent nuclear fuel management (including spent nuclear fuel from naval reactors and foreign research reactors), and INEL environmental restoration and waste management (DOE, 1995d).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as approximately zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and non-involved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Truck and rail shipments of radioactive waste types; does not include hazardous waste shipments. Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment. PM_{10} = particulate matter measuring less than or equal to 10 microns in diameter.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The combined alternatives would affect between 20 and 117 acres of land at INEL. This area is less than 1% of the total suitable acreage at INEL and less than 1% of the area available for waste management facilities. Other actions could affect another 1,059 acres. Although existing operations, the combined alternatives, and other actions would only cumulatively affect a maximum of about 2% of the suitable acreage at INEL, any land to be disturbed may require detailed characterization studies and evaluations to ensure protection of wildlife habitats and cultural artifacts.

Although the demand for water, wastewater, and power would not be greatly affected by the combined alternatives, the capacities for these services at the INEL could require improvements (expansions or upgrades) as a result of the demands of other actions. The combined alternatives could add up to 4,687 jobs at INEL, while other actions could increase the number of jobs at INEL by 1,452. Cumulatively, the number of jobs at INEL could increase by up to 49% over current employment, which could impact existing offsite community infrastructures and institutions. Mitigation measures could be necessary to reduce any adverse impacts.

11.8 Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory (LLNL) would continue in the future to conduct defense and related programs that include laser research, biomedical and environmental research, and environmental restoration and waste management activities. The existing environmental conditions at LLNL resulting from these ongoing activities are described in Chapter 4.

11.8.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, and TRUW at LLNL. Table 11.8–1 lists the minimum and maximum combined impacts of the waste management alternatives for LLNL. The most adverse impacts at LLNL and in the LLNL region would occur as a result of the Regionalized Alternatives for which treatment and disposal facilities would be constructed for LLNL to manage its own waste and accept LLMW and LLW from offsite facilities for treatment and disposal. The least adverse impacts at LLNL and in the LLNL region generally would result from those alternatives for which LLNL would either manage only its own waste or prepare, package, and ship its waste for offsite treatment and disposal. For most

Table 11.8–1. Lawrence Livermore National Laboratory Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	8.8E–04	D,R1	3.1E+02	R2-C	4.4E–07	R1	1.6E–01	R2-C	4.5E–07	N	9.1E–05
Low Level[a]	N	7.1E–04	R2	7.7E+02	N	3.5E–07	R2	3.9E–01	--	--	--	--
Transuranic	N	2.2E–03	R1-C	7.3E–03	N	1.1E–06	R1-C	3.6E–06	N	1.4E–08	R1-C	2.2E–07
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.8E–03**		**1.1E+03**		**1.9E–06**		**5.5E–01**		**4.6E–07**		**9.1E–05**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	1.4E–08	R1	5.1E–03	R2-C	7.2E–12	R1	2.6E–06	R2-C	1.0E–11	N	2.0E–09
Low Level[a]	N	1.2E–08	R2	1.3E–02	N	6.0E–12	R2	6.3E–06	--	--	--	--
Transuranic	N	3.6E–08	R1-C	1.2E–07	N	1.8E–11	R1-C	5.9E–11	N	3.1E–13	R1-C	4.8E–12
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**6.2E–08**		**1.8E–02**		**3.1E–11**		**8.9E–06**		**1.0E–11**		**2.0E–09**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses from Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R1	310 / 180	N	0.0E+00	R1	5.00E–06	N	0.0E+00	R1	2.9E–06
Low Level	N	320 / 120	D,R1,R4, R5,C4 / D,R1-R2	570 / 230	N	5.20E–06	D,R1,R4, R5,C4	9.20E–06	N	1.9E–06	D,R1-R2	3.7E–06
Transuranic	N	0 / 0	D	260 / 130	N	0.0E+00	D	3.9E–05	N	0.0E+00	D	3.9E–05
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**320 / 120**		**1,140 / 540**		**5.2E–06**		**5.3E–05**		**1.9E–06**		**4.6E–05**

Table 11.8–1. Lawrence Livermore National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	4.1E–05	R1	4.3E+00	R2-C	2.0E–08	R1	2.2E–03	R2-C	1.1E–07	N	2.2E–05
Low Level[a]	N	3.2E–05	R2	1.1E+01	N	1.6E–08	R2	5.3E–03	--	--	--	--
Transuranic	N	1.1E–04	R1-C	3.6E–04	N	5.3E–08	R1-C	1.8E–07	N	3.4E–09	R1-C	5.2E–08
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.8E–04**		**1.5E+01**		**8.9E–08**		**7.5E–03**		**1.1E–07**		**2.2E–05**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	R2-C	1.1	N	21.7
Low Level	All/None	All/None	All	None	All	None	N	1.0	R2	10.0
Transuranic	All/None	All/None	--	--	--	--	N	0.0	D-C	1.6
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[c]**	**None**		**None**		**None**		**2.1**		**33.3**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	1,277	N	70,507	R2-C	652	R1	7,769	R2-C	0.71	N	10.10
Low Level	N	1,224	R2	19,972	N	683	R2	4,025	N	0.12	R2	1.05
Transuranic	N	898	D-C	2,455	R1-C	809	D	1,345	N	0.1	D-C	0.21
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3,399**		**92,934**		**2,144**		**13,139**		**0.93**		**11.36**

Table 11.8-1. Lawrence Livermore National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	0.01	R1	0.08	R2-C	0.00	R1	0.02	R2-C	77	R1	846
Low Level	N	0.01	R2	0.04	N	0.00	R2	0.02	R3-C5	214	R2	593
Transuranic	N,R3-C5	0.09	R2-C	0.36	N,R1	0.00	D, R2-C	0.01	N	87	R2-C	291
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.11**		**0.48**		**0.00**		**0.05**		**378**		**1,730**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. Lawrence Livermore National Laboratory does not have high-level waste, and no new hazardous waste facilities are considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same unless otherwise indicated by the presence of two sets of codes separated by a diagonal line.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

impact categories, the combined impacts of the preferred alternatives at LLNL are well below the impacts of the maximum combined waste management alternatives at the site.

11.8.2 Cumulative Impacts

Aside from continuation of existing operations, the waste management activities addressed in this PEIS, and environmental restoration activities, reasonably foreseeable future actions at LLNL include projects that have been evaluated in a previous sitewide EIS (DOE, 1992b) and in the stockpile stewardship and management EIS (DOE, 1996f). Table 11.8–2 identifies the range of cumulative impacts that could result from the combined waste management alternatives, additional planned actions, and current activities. In addition to these DOE actions, closures and realignment of military bases in the LLNL region could contribute to the cumulative impacts of waste management alternatives.

The environmental restoration program at LLNL will address soil and groundwater contamination; and while some cleanup actions will generate hazardous wastes, no LLW, LLMW, or TRUW is projected to be generated as a result of cleanup actions. Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities at LLNL have had no significant adverse environmental impacts based on the reviews completed to data under CERCLA, RCRA, and NEPA. Project-specific environmental evaluations that incorporate cumulative effects will be conducted prior to implementation of all future environmental restoration activities.

As identified in Table 11.8–2, the annual radioactive releases that would result from the combined alternatives would result in an increase the current radiation dose to the offsite population. However, the maximum cumulative radioactive release would not exceed the EPA standard of 10 millirems per year to the maximally exposed individual offsite. LLNL is in an attainment region for all criteria air pollutants. Emissions from the combined alternatives would not exceed air quality standards, although other actions are expected to result in exceedance of the nitrogen dioxide standard. Disposal of LLMW or LLW at LLNL is not expected to result in exceedance of drinking water standards in groundwater under any of the alternatives. No disposal of LLMW or LLW would occur at LLNL under the preferred alternatives.

Table 11.8–2. Lawrence Livermore National Laboratory Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.70E+01	3.80E–03	1.10E+03	3.30E+02	5.20E+00	2.22E+01	1.12E+03	3.52E+02
Number of cancer fatalities from collective dose	(2)	~0	~0	5.50E–01	1.65E–01	~0	~0	5.61E–01	1.76E–01
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	6.90E–01	6.20E–06	1.80E+00	5.33E–01	1.45E–01	8.35E–01	2.64E+00	1.37E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	2.85E+02	4.42E+00	6.09E+02	2.77E+01	8.75E+01	3.77E+02	9.82E+02	4.00E+02
Number of cancer fatalities from collective dose	(1)	1.14E–01	~0	2.44E–01	~0	~0	1.51E–01	3.93E–01	1.60E–01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	140	320	1,140	1,090	2,755	3,215	4,035	3,985
Number of rail shipments (10 yr)		0	120	540	470	0	120	540	470
Annual dose (mrem) from truck transport		5.6E–02	5.2E–04	5.3E–03	5.24E–03	1.1E–01	1.7E–01	1.7E–01	1.7E–01
Annual dose (mrem) from rail transport		0.0E+00	1.9E–04	4.5E–03	4.44E–03	0.0E+00	1.9E–04	4.6E–03	4.4E–03
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	4%	0.03%	0.41%	0.22%	0.45%	4%	5%	5%
Water use (% of total capacity)		28%	0.13%	3.69%	0.96%	9.14%	38%	41%	39%
Wastewater production (% of treatment capacity)		24%	0.13%	0.78%	0.58%	3.02%	27%	28%	27%
Power demand (% current load)		61%	0.93%	11.36%	1.82%	26.00%	88%	98%	89%
Employment									
Number of site workers	(7)	8,964	141	530	387	2,495	11,600	11,989	11,709
Air Quality Exceedance	(8)	None	None	None	None	NO_2	NO_2	NO_2	NO_2
Groundwater Quality Exceedance	(9)	4 parameters exceeded	None	None	None	None	4 parameters exceeded	4 parameters exceeded	4 parameters exceeded

[a] Other reasonably foreseeable future actions include actions described in Continued Operations EIS (DOE, 1992b) and Stockpile Stewardship and Management EIS (DOE, 1996f).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development and that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The combined alternatives would affect a maximum of about 33 acres of land, or a maximum of less than 1% of the suitable acreage at LLNL. This area is less than 1% of the area available for waste management facilities; other actions would affect an additional 37 acres (0.5%). Onsite infrastructure demands for water, wastewater treatment, and power would increase by a maximum of approximately 11% as a result of the combined alternatives but by as much as 26% as a result of future actions at the site. These infrastructure demands are all within the existing capacities of the site, and no upgrades should be required.

The combined alternatives could add up to 530 jobs at LLNL, while other actions could increase the number of jobs by 2,495. Cumulatively, the number of jobs could increase by up to 38% over existing employment, potentially offsetting approximately 2,220 jobs that will be lost within the region as a result of closures and the realignments of military bases (DBCRC, 1995). The maximum cumulative increase in employment is not expected to affect offsite community infrastructures or institutions.

11.9 Los Alamos National Laboratory

Los Alamos National Laboratory (LANL) would continue in the future to conduct programs in nuclear weapons research and development and related projects. The existing environmental conditions at LANL resulting from these ongoing activities are described in Chapter 4.

11.9.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, TRUW, and HW at LANL. Table 11.9–1 lists the minimum and maximum combined impacts of the waste management alternatives for LANL. The most adverse impacts at LANL and in the LANL region would occur as a result of the Regionalized and Centralized Alternatives for which treatment and disposal facilities would be constructed for LANL to manage its own waste in addition to accepting offsite LLMW, LLW, and TRUW for treatment and LLMW and LLW for disposal. The least adverse impacts generally would result from the No Action Decentralized, and Centralized Alternatives for which LANL would either only manage its own waste or would prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at LANL are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

Table 11.9–1. Los Alamos National Laboratory Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	7.6E–02	R2,3	1.7E+00	R4,C	3.8E–05	R2,3	8.6E–04	C	1.6E–08	R2	6.9E–06
Low Level[a]	N	3.9E–01	R2,4,C3, 4	1.6E+01	N	1.9E–04	R2,4,C3, 4	7.8E–03	--	--	--	--
Transuranic	N	8.3E–03	R2	1.3E+03	N	4.1E–06	R2	6.4E–01	N	2.3E–11	R3,C	1.9E–09
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	--	R1	1.9E–02
Total		**4.7E–01**		**1.3E+03**		**2.3E–04**		**6.5E–01**		**1.6E–08**		**1.9E–02**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	8.0E–06	R2,3	1.8E–04	R4,C	4.0E–09	R2,3	9.1E–08	C	2.0E–12	R2	8.5E–10
Low Level[a]	N	4.1E–05	R2,4,C3, 4	1.6E–03	N	2.0E–08	R2,4,C3, 4	8.2E–07	--	--	--	--
Transuranic	N	8.7E–07	R2	1.3E–01	N	4.4E–10	R2	6.7E–05	D	8.3E–14	R3,C	2.3E–13
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	--	R1	2.4E–06
Total		**5.0E–05**		**1.3E–01**		**2.4E–08**		**6.8E–05**		**2.0E–12**		**2.4E–06**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments[b] (10 yr)				Radiation Doses from Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,D	0 / 0	R2	2,610 / 1,020	N,D	0.0E+00	R2	4.20E–05	N,D	0.0E+00	R2	1.6E–05
Low Level	N,D	0 / 0	C3,C4	36,640 / 14,400	N,D	0.0E+00	C3,C4	5.90E–04	N,D	0.0E+00	C3,C4	2.3E–04
Transuranic	N	0 / 0	D	1,590 / 800	N	0.0E+00	D	2.4E–04	N	0.0E+00	D	2.4E–04
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**40,840 / 16,220**		**0.0E+00**		**8.7E–04**		**0.0E+00**		**4.9E–04**

Table 11.9–1. Los Alamos National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	1.5E–03	R2,3	3.5E–02	R4,C	7.5E–07	R2,3	1.7E–05	C	8.1E–09	R2	3.4E–06
Low Level[a]	N	2.6E–02	R2,4,C3, 4	1.4E+00	N	1.3E–05	R2,4,C3, 4	7.0E–04	--	--	--	--
Transuranic	N	7.6E–04	R2	1.2E+02	N	3.8E–07	R2	5.8E–02	N	1.1E–11	R3,C	9.4E–10
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	0.0E+00	R1	9.5E–03
Total		**2.8E–02**		**1.2E+02**		**1.4E–05**		**5.9E–02**		**8.1E–09**		**9.5E–03**

Waste Type	Air Quality Exceedances		Groundwater Quality Exceedances				Resource Requirements			
	Construction	Operation					Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	R2, 4	None	D, R1	Methylene chloride	R4,C	4.8	N	20.8
Low Level	All/None	All/None	All	None	All	None	R6-C2,5	3.3	R4	18.5
Transuranic	All/None	R2/Radiation	--	--	--	--	N	0	D	15.4
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous	All/None	R1/Vinyl Chloride	--	--	--	--	N,R2	--	D, R1	1.0
Total	**None[d]**	**Radiation and Vinyl Chloride**		**None**		**Methylene chloride**		**8.1**		**55.7**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	2,149	N	69,589	R4,C	597	R2	5,078	R4,C	0.61	N	10.00
Low Level	R6-C2,5	5,714	R4	35,601	R6-C2,5	1,739	R4	15,828	R5-C2	1.49	R4	3.89
Transuranic	N	1,850	R1	34,966	N	1,850	R2	6,974	N	0.25	R3,C	1.94
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous	N,R2	--	R1	1,777	N,R2	--	R1	907	N,R2	--	R1	0.26
Total		**9,713**		**141,933**		**4,186**		**28,787**		**2.35**		**16.09**

Table 11.9–1. Los Alamos National Laboratory Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,R4,C	0.01	R2	0.05	C	0.05	R2	0.48	C	109	R2	869
Low Level	R6-C2,5	0.30	R4	2.36	R6-C2,5	0.14	R4	1.42	R6-C2,5	287	R4	2,270
Transuranic	N	0.09	R2	1.07	N	0.14	R2	0.49	N	110	R2	1,030
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous	N,R2	--	R1	0.07	N,R2	--	R1	0.03	N, R2	--	R1	66
Total		**0.40**		**3.55**		**0.33**		**2.42**		**506**		**4,235**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. The Los Alamos National Laboratory does not have high-level waste. Hazardous waste does not contain radioactive materials and, therefore, does not cause radiation doses or fatalities.

[b] Number of truck and rail shipments of radioactive waste types. Does not include hazardous waste shipments.

[c] Maximum and minimum alternatives for truck and rail transport are the same.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

11.9.2 CUMULATIVE IMPACTS

Aside from the continuation of existing operations and the waste management activities addressed in this PEIS, reasonably foreseeable future actions at LANL include construction and operation of the dual-axis hydrodynamic test facility (DOE, 1995e), medical isotope production project (DOE, 1996c), stockpile stewardship and management (DOE, 1996f), the transfer of non-nuclear functions (DOE, 1993), and environmental restoration activities. No other DOE or non-DOE actions are planned in the LANL region that would contribute to the cumulative impacts of waste management alternatives.

The environmental restoration program at LANL will address cleanup of an estimated 9,804,400 m^3 of contaminated media and facilities (500,000 m^3, 9,300,000 m^3, and 4,400 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities have had no significant adverse environmental impacts based on the NEPA reviews completed to date. Project-specific environmental evaluations that incorporate cumulative effects will be conducted prior to implementation of all future environmental restoration activities.

Table 11.9–2 identifies the range of cumulative impacts at LANL resulting from the combined waste management alternatives, existing waste management activities, and planned actions described in the aforementioned EISs. The impacts of other projects being considered for LANL as part of a planned sitewide EIS currently in preparation (DOE, 1994a) are not yet available.

As identified in Table 11.9–2, the annual radioactive releases that would result from the combined waste management alternatives (including transportation) would result in an increase in the radiation dose to the offsite population. Without mitigation, the cumulative radioactive releases for the maximum combined waste management alternatives would exceed the EPA standard of 10 millirems per year to the maximally exposed individual offsite, almost entirely as a result of the treatment of TRUW. This exceedance would require mitigation should the maximum combined alternatives be chosen. The combined impacts of the preferred alternatives would not result in the exceedance of this standard.

LANL is in an attainment region where criteria air pollutants do not exceed standards. While minimum cumulative emissions and the cumulative emissions under the preferred alternatives would not exceed air quality standards, maximum cumulative emissions would result in vinyl chloride emissions above regulation

Table 11.9–2. Los Alamos National Laboratory Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.40E+01	4.70E–01	1.30E+03	1.73E+00	5.70E+00	2.02E+01	1.32E+03	2.14E+01
Number of cancer fatalities from collective dose	(2)	~0	~0	6.50E–01	~0	~0	~0	6.60E–01	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	7.90E+00	5.00E–03	1.30E+01	1.75E–02	2.00E–02	7.93E+00	2.09E+01	7.94E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	1.94E+03	3.53E+02	2.93E+03	2.64E+03	6.96E+02	2.99E+03	5.6E+03	5.28E+03
Number of cancer fatalities from collective dose	(1)	7.76E–01	1.41E–01	1.17E+00	1.06E+00	2.78E–01	1.20E+00	2.2E+00	2.11E+00
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	270	0	40,840	22,600	720	990	41,830	23,590
Number of rail shipments (10 yr)		0	0	16,220	8,730	0	0	16,220	8,730
Annual dose (mrem) from truck transport		1.1E–01	0.0E+00	8.7E–02	5.72E–02	2.1E–02	1.3E–01	2.2E–01	1.86E–01
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	4.9E–02	3.66E–02	0.0E+00	0.0E+00	4.9E–02	3.66E–02
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	41%	0.03%	0.20%	0.16%	0.04%	41%	41%	41%
Water use (% of total capacity)		41%	0.10%	1.42%	0.86%	0.31%	41%	43%	42%
Wastewater production (% of treatment capacity)		Not available	0.42%	2.88%	1.88%	0.16%	1%	3%	2%
Power demand (% current load)		57%	1.96%	13.41%	4.68%	11.58%	70%	82%	73%
Employment									
Numbers of site workers	(7)	6,546	243	1,742	1,017	559	7,348	8,847	8,122
Air Quality Exceedance	(8)	None	None	Vinyl chloride, radiation	None	None	None	Vinyl chloride, radiation	None
Groundwater Quality Exceedance	(9)	13 parameters exceeded	None	Methylene chloride	None	None	13 parameters exceeded	14 parameters exceeded	13 parameters exceeded

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to dual-axis radiographic hydrodynamic test facility (DOE, 1995e), medical isotope production (DOE, 1996c), transfer of non-nuclear functions (DOE, 1993), and stockpile stewardship and management (DOE, 1996f).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Truck and rail shipments of radioactive waste types; does not include hazardous waste shipments. Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

limits as a result of the treatment of hazardous waste under HW Regionalized Alternative 2. Mitigation would be needed to reduce vinyl chloride emissions to acceptable levels if this alternative is chosen.

The combined alternatives would affect a maximum of 56 acres of land. This area is less than 1% of the suitable acreage at LANL and less than 1% of the area available for waste management facilities. An additional 10 acres (0.04%) of land would be affected by other actions. Onsite infrastructure demands for water, wastewater treatment, and power would increase little as a result of the combined alternatives, and cumulative demands would be within existing capacities. The combined alternatives could add up to 1,742 jobs at LANL, or a maximum increase of approximately 27% over existing employment, while other actions would add another 559 jobs. The maximum increase in employment could affect offsite community infrastructures or institutions. Mitigation measures could be needed to reduce any adverse impacts resulting from these increases in employment.

Disposal of LLMW at LANL under the Decentralized Alternative and Regionalized Alternative 1 could result in exceedances of standards for groundwater used as drinking water for methylene chloride. Mitigation could be required to maintain compliance with drinking water standards should either of these alternatives be selected. No other alternatives for LLMW are expected to result in exceedances for any contaminants at LANL, nor are there any expected exceedances for other waste types. Disposal of LLMW and LLW under the preferred alternatives is not expected to result in any groundwater quality exceedances.

11.10 Nevada Test Site

Nevada Test Site (NTS) has been the nation's primary location for testing nuclear explosive devices, although current U.S. policy prohibits underground testing of nuclear weapons. NTS is a LLW disposal site. The existing environmental conditions at NTS resulting from these ongoing activities are described in Chapter 4.

11.10.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, and TRUW at NTS. Table 11.10–1 lists the minimum and maximum combined impacts of the waste management alternatives considered for NTS. The most

Table 11.10–1. Nevada Test Site Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.3E–05	N	1.2E–02	R1-C	6.4E–09	N	5.8E–06	R1-C	1.5E–11	N	4.7E–08
Low Level[a]	N	2.6E–09	R2,4,5, 6,C1,3, 4,5	3.2E–09	N	1.3E–12	R2,4,5, 6,C1,3, 4,5	1.6E–12	--	--	--	--
Transuranic	N	0.0E+00	R1-C	3.0E–07	--	0.0E+00	R1-C	1.5E–10	N	0.0E+00	R1-C	1.1E–12
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.3E–05**		**1.2E–02**		**6.4E–09**		**5.8E–06**		**1.5E–11**		**4.7E–08**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	3.2E–09	N	3.0E–06	R1-C	1.6E–12	N	1.5E–09	R1-C	<9.9E–14	N	1.2E–11
Low Level[a]	N	6.7E–13	R2,4,5, 6,C1,3, 4,5	8.1E–13	All	<9.9E–14	All	<9.9E–14	--	--	--	--
Transuranic	N	0.0E+00	R1-C	7.8E–11	N	0.0E+00	R1-C	3.9E–14	All	<9.9E–14	All	<9.9E–14
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.2E–09**		**3.0E–06**		**1.6E–12**		**1.5E–09**		**0.0E+00**		**1.2E–11**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R3	9,640 / 3,690	N	0.0E+00	R3	1.50E–04	N	0.0E+00	R3	5.9E–05
Low Level	D,R1,R2, C3	0 / 0	C2	257,270 / 96,880	D,R1, R2,C3	0	C2	4.10E–03	D,R1,R2, C3	0.0E+00	C2	1.6E–03
Transuranic	N	0 / 0	D	90 / 90	N	0.0E+00	D	1.40E–05	N	--	D	1.5E–05
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**267,000 / 100,620**		**0.0E+00**		**4.3E–03**		**0.0E+00**		**1.7E–03**

Table 11.10–1. Nevada Test Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.7E–05	N	3.1E–02	R1-C	8.7E–09	N	1.5E–05	R1-C	2.1E–10	N	6.2E–07
Low Level[a]	N	6.0E–09	R2,4,5, 6,C1,3, 4,5	7.2E–09	N	3.0E–12	R2,4,5, 6,C1,3, 4,5	3.6E–12	--	--	--	--
Transuranic	N	0.0E+00	R1-C	8.4E–07	--	0.0E+00	R1-C	4.2E–10	N	0.0E+00	R1-C	1.5E–11
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.7E–05**		**3.1E–02**		**8.7E–09**		**1.5E–05**		**2.1E–10**		**6.2E–07**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	R2, R4	None	R3	3 hazardous chemicals[c]	R2,4,C	5.7	D	25.2
Low Level	C2,4/CO	C2-5/CO	All	None	--	--	R6,C1,3,5	0.5	C4	15.2
Transuranic	All/None	All/None	All	None	--	--	N,R1-C	0.0	D	1.2
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**CO[d]**	**CO**		**None**		**3 hazardous chemicals[c]**		**6.2**		**40.4**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2,4,C	6,593	D	52,725	R2,4,C	936	D	9,352	R1,2,4,C	0.46	D	6.52
Low Level	R6,C1,3,5	553	C2	54,787	R6,C1,5	251	C2	22,196	R6,C1,3,5	0.5	C4	15.2
Transuranic	R1-C	38	D	1,465	R1-C	38	D	609	N,R1-C	0.02	D	0.12
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**7,184**		**107,512**		**1,225**		**32,157**		**0.98**		**21.84**

Table 11.10–1. Nevada Test Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.02	R3	0.13	N	0.01	R3	0.07	N	120	R3	702
Low Level	R2,6,C1, 3,5	0.01	C2	0.57	R2,6, C1,3,5	<0.01	C2	0.25	R6,C1,3,5	55	C2	2,986
Transuranic	R1-C	0.00	D	0.02	R1-C	0.00	N,D	0.01	R1-C	7	D	96
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.03**		**0.72**		**0.01**		**0.33**		**182**		**3,784**

Notes: Alt. = alternative; C = Centralized Alternative; CO = carbon monoxide; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. The Nevada Test Site does not have high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Hazardous chemicals include 1,2-dichloroethane, methylene chloride, and benzene. The NTS EIS (DOE 1996g) did not indicate groundwater quality exceedances. Waste management values overestimate groundwater exceedances for NTS since travel time through the vadose zone to the aquifer has been estimated from field-measured properties to be over 2 million years.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

adverse impacts at NTS and in the NTS region generally would occur as a result of the No Action and Regionalized 3 Alternatives for LLMW, Regionalized and Centralized Alternatives for LLW, and Regionalized and Centralized Alternatives for TRUW. The least adverse impacts at NTS and in the NTS region generally would result from the Centralized Alternative for LLMW; the No Action Alternative for LLW; and the No Action Alternative for TRUW. For most impact categories, the combined impacts of the preferred alternatives at NTS are expected to be less than the impacts of the maximum combined waste management alternatives at the site.

11.10.2 CUMULATIVE IMPACTS

Aside from the continuation of existing operations and the waste management activities addressed in this PEIS, reasonably foreseeable future actions at NTS include stockpile stewardship and management (DOE, 1996f); storage and disposition of weapons-usable fissile materials (DOE, 1996b); and environmental restoration activities and a number of other actions evaluated in a draft sitewide EIS (DOE, 1996g). In addition, the Yucca Mountain Site (located on a portion of NTS) is the candidate site for the nation's geological repository for spent nuclear fuel and HLW under the Nuclear Waste Policy Act (42 USC 10101–10270). No other DOE or non-DOE actions are planned in the NTS region that would contribute to the cumulative impact of waste management alternatives.

Table 11.10–2 identifies the range of cumulative impacts at NTS resulting from the combined waste management alternatives (including transportation), current activities, and planned actions described in the aforementioned EISs. The impacts of a geologic repository for spent nuclear fuel and HLW are not included in this cumulative impact analysis because that information is not yet available.

As identified in Table 11.10–2, the maximum radioactive releases from the combined waste management alternatives would not measurably increase the existing radiological releases from NTS to the offsite population. Maximum cumulative radioactive releases would be below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

The NTS is adjacent to a nonattainment region in Clark County for breathable particulates and carbon monoxide. Maximum cumulative emissions are predicted to exceed applicable air emissions standards for carbon monoxide as a result of the maximum combined alternatives and preferred alternatives, and, as a

Table 11.10–2. Nevada Site Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	2.90E–01	1.30E–05	1.20E–02	3.60E–05	4.30E–05	2.90E–01	3.02E–01	2.90E–01
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	~0	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.20E–02	3.20E–07	3.00E–04	3.26E–07	9.10E–06	1.20E–02	1.23E–02	1.20E–02
Worker Population									
Collective dose, 10 years (person-rem)	(4)	2.00E+01	7.94E+00	6.49E+03	6.49E+03	6.60E+02	6.88E+02	7.17E+03	7.17E+03
Number of cancer fatalities from collective dose	(1)	~0	~0	2.60E+00	2.60E+00	2.64E–01	2.75E–01	2.87E+00	2.87E+00
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	4,540	0	267,000	267,000	35,134	39,674	306,674	306,674
Number of rail shipments (10 yr)		0	0	100,620	100,620	0	0	100,620	100,620
Annual dose (mrem) from truck transport		1.8E+00	0.0E+00	4.3E–01	4.26E–01	1.4E+00	3.2E+00	3.6E+00	3.65E+00
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	1.7E–01	1.67E–01	0.0E+00	0.0E+00	1.7E–01	1.67E–01
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	26%	0.00%	0.00%	0.00%	2%	28%	28%	28%
Water use (% of total capacity)		49%	0.26%	3.87%	3.18%	300%	349%	353%	352%
Wastewater production (% of treatment capacity)		41%	0.36%	9.51%	9.32%	59%	101%	110%	110%
Power demand (% current load)		67%	2.18%	48.53%	17.76%	44%	113%	160%	129%
Employment									
Number of site workers	(7)	7,086	53	1,544	1,535	8,561	15,700	17,191	17,182
Air Quality Exceedance	(8)	PM_{10}, CO	None	CO	CO	None	PM_{10}, CO	PM_{10}, CO	PM_{10}, CO
Groundwater Quality Exceedance	(9)	8 parameters exceeded	None	3 hazardous chemicals[e]	3 hazardous chemicals[e]	None	8 parameters exceeded	11 parameters exceeded[e]	11 parameters exceeded[e]

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to stockpile stewardship and management (DOE, 1996d), storage and disposition of weapons-usable fissile materials (DOE, 1996b), and the NTS sitewide EIS, which incorporates the impacts of environmental restoration activities (DOE 1996g). Shipment numbers and shipment MEI values do not include those related to stockpile stewardship and management because these were not presented in that EIS.
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.
[e] Hazardous chemicals include 1,2-dichloroethane, methylene chloride, and benzene. The NTS EIS did not indicate groundwater quality exceedances. Waste management values overestimate groundwater exceedances for NTS since travel time through the vadose zone to the aquifer has been estimated from field-measured properties to be over 2 million years.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Existing air quality exceedance is for the region in which the site is located and does not indicate an exceedance of existing site emission requirements. Waste management impacts presented indicate whether emissions would result in nonattainment. PM_{10} = particulate matter measuring less than or equal to 10 microns in diameter.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

consequence, mitigation measures may be necessary to reduce these emissions. Note that the NTS sitewide EIS (DOE, 1996g) predicted no exceedances of air quality standards.

The NTS EIS found that maximum cumulative emissions in the Clark County nonattainment region (primarily from the Las Vegas Valley) exceed standards for carbon monoxide; however, this is not a direct result of NTS activities. Under the NTS EIS combined alternatives, the incremental contribution of carbon monoxide from NTS-related activities would not present a significant addition to the nonattainment status of the adjacent region. In addition, the NTS EIS found that breathable particulates and total suspended particulates, which also exceed standards in the region, are not and would not be directly attributed to NTS activities under the combined alternatives. Therefore, mitigation measures may not be necessary to reduce these emissions due to the insignificance of the contribution from NTS-related activities to the existing pollutant burden.

The combined alternatives would affect up to 40 acres of land at NTS. This area is less than 1% of the total suitable acreage and less than 1% of the area available for waste management facilities. Other actions could affect another 14,481 acres. Although the combined alternatives and other actions would cumulatively affect a maximum of about 2% of the suitable acreage at NTS, the land affected may have to be subjected to detailed characterization studies and evaluations to ensure protection of wildlife habitats and cultural artifacts.

The cumulative demand for water, wastewater treatment capacity, and power is expected to increase substantially at NTS. Infrastructure improvements (expansion or upgrades) will likely be required to meet these increased demands, and wastewater capacity could require expansion as a result of demands of other planned actions at NTS.

The combined alternatives could add up to of 1,544 jobs at NTS, while other actions could also increase the number of jobs by 8,561. Cumulatively, the number of jobs at the NTS could more than double, which could affect existing offsite community infrastructures and institutions. Mitigation measures could be necessary to reduce any adverse offsite infrastructure and institutional impacts.

Disposal of LLMW at NTS under Regionalized Alternative 3 and under the preferred alternative could result in exceedances of drinking water standards in groundwater for benzene, 1,2-dichloroethane, and methylene chloride. The Decentralized Alternative and Regionalized Alternative 1 are not expected to result

in an exceedance for benzene but could result in exceedances for 1,2-dichloroethane and methylene chloride. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. No other alternatives for LLMW are expected to result in exceedances for any contaminants at NTS, nor are there any expected exceedances for disposal of LLW. Note that the NTS EIS (DOE, 1996g) predicted no exceedances of drinking water standards in the groundwater from disposal of LLMW or LLW at NTS, and the waste management values are thought to overestimate groundwater exceedances for NTS. Travel time through the vadose zone to the aquifer has been estimated from field-measured properties to be over 2 million years.

11.11 Oak Ridge Reservation

Oak Ridge Reservation (ORR) would continue in the future to conduct environmental restoration activities and programs that include applied research and development in support of conservation and energy technologies, environmental management activities, and defense programs. The existing environmental conditions at ORR resulting from these ongoing activities are described in Chapter 4.

11.11.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, TRUW, and HW at ORR. Table 11.11–1 lists the minimum and maximum combined impacts of the waste management alternatives considered. The most adverse impacts at ORR and in the ORR region would occur as a result of the No Action Alternative for LLMW and Regionalized Alternatives for which treatment and disposal facilities would be constructed for ORR to manage its own waste, in addition to accepting offsite LLMW and LLW for treatment and disposal, and offsite TRUW and HW for treatment. The least adverse impacts at ORR and in the ORR region generally would result from those alternatives for which ORR would only be responsible for its own waste or would prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at ORR are expected to be less than the impacts of the maximum combined waste management alternatives at the site.

Table 11.11-1. Oak Ridge Reservation Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	1.4E-02	N	2.3E+02	C	6.8E-06	N	1.1E-01	C	1.1E-06	N	4.1E-05
Low Level[a]	N	9.2E-03	R5	6.0E+02	N	4.6E-06	R5	3.0E-01	--	--	--	--
Transuranic	N	1.3E-04	R2-C	9.2E+01	N	6.6E-08	R2-C	4.6E-02	N	7.8E-09	D,R1	1.6E-07
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N	7.4E-03	R2	9.5E-02
Total		**2.3E-02**		**9.2E+02**		**1.1E-05**		**4.6E-01**		**7.4E-03**		**9.5E-02**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	4.2E-07	N	7.0E-03	C	2.1E-10	N	3.5E-06	C	5.8E-11	N	2.1E-09
Low Level[a]	N	2.9E-07	R5	1.9E-02	N	1.4E-10	R5	9.3E-06	--	--	--	--
Transuranic	N	4.1E-09	R2-C	2.8E-03	N	2.1E-12	R2-C	1.4E-06	N	4.0E-13	D,R1	8.1E-12
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N	3.9E-07	R2	5.0E-06
Total		**7.1E-07**		**2.9E-02**		**3.5E-10**		**1.4E-07**		**3.9E-07**		**5.0E-06**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments[b] (10 yr)				Radiation Doses from Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,D,R1	0 / 0	R3	2,100 / 790	N,D,R1	0	R3	3.40E-05	N,D,R1	0	R3	1.3E-05
Low Level	N / N, D,R1,R2	20 / 20	R3	64,590 / 24,470	N	3.20E-07	R3	1.00E-03	N,D,R1, R2	3.2E-07	R3	3.9E-05
Transuranic	N	0 / 0	R1	2,440 / 1,230	N	0.0E+00	R1	3.60E-04	N	0.0E+00	R1	3.7E-04
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous	--	--	--	--	--	--	--	--	--	--	--	--
Total		**20 / 20**		**69,130 / 26,490**		**3.2E-07**		**1.4E-03**		**3.2E-07**		**7.7E-04**

Table 11.11–1. Oak Ridge Reservation Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	4.5E–04	N	9.6E+00	C	2.3E–07	N	4.8E–03	C	3.7E–07	N	1.4E–05
Low Level[a]	N	3.1E–04	R5	8.7E+00	N	1.5E–07	R5	4.3E–03	--	--	--	--
Transuranic	N	4.6E–06	R2-C	3.1E+00	N	2.3E–09	R2-C	1.6E–03	N	2.6E–09	D,R1	5.2E–08
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N	2.5E–03	R2	3.2E–02
Total		**7.6E–04**		**2.1E+01**		**3.8E–07**		**1.1E–02**		**2.5E–03**		**3.2E–02**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	R3, C	4 radionuclides	D,R1-C	2 hazardous chemicals, 4 radionuclides[c]	C	5.3	R4	19.1
Low Level	All/None	All/None	All	None	All	None	R6-C2,5	11.6	R3	137.6
Transuranic	All/None	All/None	--	--	--	--	N	0.0	D	6.6
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous	All/None	R1,2/Vinyl Chloride	--	--	--	--	N	0.0	R2	2.0
Total	**None[d]**	**NO_2, PM_{10}, Vinyl Chloride**		**4 radionuclides**		**2 hazardous chemicals, 4 radionuclides[e]**		**22.8**		**165.3**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	7,888	R4	32,846	C	4,686	R4	20,085	C	0.74	R4	6.65
Low Level	N	13,701	R3	539,756	R6-C2,5	7,328	R5	47,608	R6-C2,5	2.86	R3	80.69
Transuranic	N	1,425	R2-C	14,448	N	1,425	D	3,929	N	0.14	D	0.69
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous	N	168	R2	2,438	N	168	R2	2,101	N	0.13	R2	0.58
Total		**23,014**		**589,488**		**13,439**		**73,723**		**3.9**		**88.61**

Table 11.11–1. Oak Ridge Reservation Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts—Continued								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.25	R4	0.76	C	0.15	R4	0.38	N	934	R4	2,233
Low Level	R6-C2,5	0.34	R5	1.82	R6-C2,5	0.16	R5	0.96	R6-C2,5	1,001	R5	5,331
Transuranic	N	0.07	R2-C	0.23	N	0.05	R1-C	0.09	N	243	R2-C	677
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous	N	0.01	R2	0.04	N,D	0.00	R1, R2	0.01	N	18	R2	135
Total		**0.67**		**2.85**		**0.36**		**1.44**		**2,196**		**8,376**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; NO_2 = nitrogen dioxide; PM_{10} = particulate matter measuring less than 10 microns in diameter; R = Regionalized Alternative; -- = not applicable; scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. High-level waste is not present at the Oak Ridge Reservation. Hazardous waste does not contain radioactive materials and therefore does not cause radiation doses or fatalities.

[b] Number of truck and rail shipments of radioactive waste types. Does not include hazardous waste shipments.

[c] Maximum and minimum alternatives for truck and rail transport are the same unless otherwise indicated by the presence of two sets of codes separated by a diagonal line.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

[e] Hazardous chemicals that could exceed drinking water standards include 1,2-dichloroethane and methylene chloride; radionuclides that could exceed standards include Pu-239, Pu-240, Tc-99, and U-238.

11.11.2 CUMULATIVE IMPACTS

Aside from the continuation of existing operations and the waste management activities addressed in this PEIS, reasonably foreseeable future actions at ORR include stockpile stewardship and management activities (DOE, 1996f), storage and disposition of weapons-usable fissile materials (DOE, 1996b), the disposition of highly enriched uranium (DOE, 1995f), interim storage of enriched uranium (DOE, 1994i), the transfer of non-nuclear functions (DOE, 1993), and environmental restoration activities. No other DOE or non-DOE actions are planned in the ORR region that would contribute to the cumulative impact of waste management activities.

The environmental restoration program at ORR will address cleanup of an estimated 1,402,400 m^3 of contaminated media and facilities (460,000 m^3, 940,800 m^3, and 1,600 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). Future cleanup actions include remediation of contaminated groundwater and soil and decontamination and decommissioning of facilities. Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities have had no significant adverse environmental impacts based on the CERCLA and NEPA reviews completed to date. Project-specific environmental evaluations under CERCLA will be performed prior to implementation of all future environmental restoration activities.

Table 11.11–2 identifies the range of cumulative impacts resulting from the waste management alternatives (including transportation), existing activities, and planned actions described in the aforementioned EISs.

As identified in Table 11.11–2, the maximum annual radioactive releases would increase as a result of maximum radiological releases from the combined alternatives and radioactive releases from other possible actions. Maximum cumulative radioactive releases, however, would not exceed the EPA standard of 10 millirems per year to the maximally exposed individual.

ORR is in an attainment region where criteria air pollutants do not exceed standards. The maximum emissions from the combined waste management alternatives could exceed air quality standards for nitrogen dioxide, breathable particulates, and vinyl chloride. Mitigation measures would be necessary to reduce these emissions to acceptable levels should these alternatives be chosen. No exceedances of air quality standards are anticipated for the preferred alternatives at ORR.

Table 11.11–2. Oak Ridge Reservation Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	4.30E+02	2.50E-02	9.20E+02	2.41E+00	1.90E+01	4.49E+02	1.37E+03	4.51E+02
Number of cancer fatalities from collective dose	(2)	2.15E-01	~0	4.60E-01	~0	~0	2.25E-01	6.85E-01	2.26E-01
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.40E+00	7.00E-05	2.90E+00	7.34E-03	5.00E-01	1.90E+00	4.80E+00	1.91E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	6.80E+02	2.40E+02	3.37E+03	2.09E+03	1.11E+03	2.03E+03	5.16E+03	3.88E+03
Number of cancer fatalities from collective dose	(1)	3.40E-01	~0	1.35E+00	8.35E-01	4.44E-01	8.12E-01	2.06E+00	1.55E+00
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	10,400	20	69,130	69,180	1,704	12,124	81,234	81,284
Number of rail shipments (10 yr)		80	20	26,490	26,510	0	100	26,570	26,590
Annual dose (mrem) from truck transport		4.2E+00	3.2E-05	1.30E-01	1.30E-01	6.8E-02	4.2E+00	4.4E+00	4.4E+00
Annual dose (mrem) from rail transport		3.22E-02	3.2E-05	6.83E-02	6.83E-02	0.0E+00	3.2E-02	1.1E-01	1.0E-01
Resources and Infrastructure									
Land requirement (% of suitable area)	(6)	67%	0.13%	0.97%	0.91%	0.8%	68%	69%	69%
Water use (% of total capacity)		46%	0.06%	1.47%	1.43%	-0.9%	45%	46%	46%
Wastewater production (% of treatment capacity)		70%	1.46%	8.01%	4.25%	13%	84%	91%	87%
Power demand (% current load)		18%	0.59%	13.43%	13.02%	8.8%	27%	40%	39%
Employment									
Number of site workers	(7)	23,597	621	3,453	1,658	754	24,972	26,009	26,009
Air Quality Exceedance	(8)	None	None	NO_2, PM_{10}, vinyl chloride	None	None	None	NO_2, PM_{10}, vinyl chloride	None
Groundwater Quality Exceedance	(9)	17 parameters exceeded	None	2 hazardous chemicals, 4 radionuclides[e]	2 hazardous chemicals, 4 radionuclides[e]	None	17 parameters exceeded	22 parameters exceeded	22 parameters exceeded

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to stockpile stewardship and management (DOE, 1996f), storage and disposition of weapons-usable fissile materials (DOE, 1996b), transfer of non-nuclear functions (DOE, 1993), interim storage of enriched uranium (DOE, 1994i), and disposition of surplus highly enriched uranium (DOE, 1995f).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts
[e] Hazardous chemicals that could exceed drinking water standards include 1,2-dichloroethane and methylene chloride; radionuclides that could exceed standards include Pu-239, Pu-240, Tc-99, and U-238.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Truck and rail shipments of radioactive waste types; does not include hazardous waste shipments. Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment. PM_{10} = particulate matter less than or equal to 10 microns in diameter.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The combined waste management alternatives would affect between 23 and 165 acres of land at ORR. This area is about 1% of the total suitable acreage and 3% of the area available for waste management facilities. Other actions could affect another 144 acres. Together, the combined alternatives and other actions would affect a maximum of 1.8% of the suitable acreage at ORR and could result in impacts to sensitive land. Detailed characterization studies and evaluations to ensure protection of wildlife habitats and cultural artifacts may be required prior to any new land disturbance.

The demand for water, wastewater, and power at ORR would not be greatly affected by the combined alternatives. Cumulatively, water, wastewater, and power capacities at ORR would probably not require major improvements (expansions or upgrades) as a result of the construction and operation of planned facilities.

The combined waste management alternatives could add up to 2,453 jobs at ORR, while other actions could also increase the number of jobs at ORR by 754. Cumulatively, the number of jobs at ORR could increase by up to 18%, which could affect existing offsite community infrastructures and institutions. Mitigation measures could be necessary to reduce any adverse offsite infrastructure and institutional impacts.

Disposal of LLMW at ORR under the Decentralized Alternative and Regionalized Alternatives 1, 2 (the preferred alternative), and 4 could result in exceedances of drinking water standards in groundwater for 1,2-dichloroethane, methylene chloride, Pu-239, Pu-240, Tc-99, and U-238. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. No other alternatives for LLMW are expected to result in exceedances for any contaminants at ORR, nor are there any expected exceedances for other waste types.

11.12 Paducah Gaseous Diffusion Plant

Paducah Gaseous Diffusion Plant (PGDP) would continue in the future to produce enriched uranium. The existing environmental conditions at PGDP resulting from these ongoing activities are described in Chapter 4.

11.12.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, and TRUW at the PGDP. Table 11.12–1 lists the minimum and maximum combined impacts of the waste management alternatives for PGDP. The most adverse impacts at PGDP and in the PGDP region would occur as a result of the No Action Alternative for LLMW and Regionalized and Centralized Alternatives for LLW and TRUW. The least adverse impacts at PGDP and in the region generally would result from the Regionalized and Centralized Alternatives for LLMW for which PGDP would only prepare, package, and ship waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at PGDP are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

11.12.2 Cumulative Impacts

Aside from the continuation of existing operations, the waste management activities addressed in this PEIS, and environmental restoration actions, DOE has no other actions planned at PGDP. No other DOE or non-DOE actions are planned in the PGDP region that would contribute to the cumulative impact of the waste management alternatives.

The environmental restoration program at PGDP will address cleanup of an estimated 1,220,000 m^3 of contaminated media and facilities (450,000 m^3, 770,000 m^3, and 7 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). Future cleanup actions include remediation of contaminated groundwater and eventual decontamination and decommissioning of uranium enrichment facilities. Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities at PGDP have had no significant adverse environmental impacts based on the CERCLA, NEPA, and RCRA reviews completed to date. Project-specific environmental evaluations under CERCLA, RCRA, or NEPA will be performed prior to implementation of all future environmental restoration activities.

Table 11.12–1. Paducah Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	1.6E–03	N	3.6E+00	R2-C	8.1E–07	N	1.8E–03	R2-C	9.7E–09	N	1.1E–06
Low Level[a]	N	4.0E–05	R2	3.8E–03	N	2.0E–08	R2	1.9E–06	--	--	--	--
Transuranic	N	--	R1-C	1.1E–05	N	--	R1-C	5.3E–09	N	--	R1-C	9.5E–13
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.6E–03**		**3.6E+00**		**8.3E–07**		**1.8E–03**		**9.7E–09**		**1.1E–06**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	1.8E–07	N	4.0E–04	R2-C	9.0E–11	N	2.0E–07	R2-C	1.3E–12	N	1.5E–10
Low Level[a]	N	4.5E–09	R2	4.2E–07	N	2.3E–12	R2	2.1E–10	--	--	--	--
Transuranic	N	--	R1-C	1.2E–09	N	--	R1-C	5.9E–13	All	<9.9E–14	All	<9.9E–14
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.8E–07**		**4.0E–04**		**9.3E–11**		**2.0E–07**		**1.3E–12**		**1.5E–10**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R2-R4,C	50 / 30	N	0.0E+00	R2-R4,C	8.1E–07	N	0.0E+00	R2-	4.8E–07
Low Level	D,R1,R2	10 / 10	N	6,420 / 2,400	D,R1,R2	1.6E–07	N	1.0E–04	D,R1,R2	1.6E–07	R4,C	3.9E–05
Transuranic	N	0 / 0	D-C	10 / 10	N	0.0E+00	D-C	1.5E–06	N	0.0E+00	N	3.0E–06
High Level[a]	--	--	--	--	--	--	--	--	--	--	D-C	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**10 / 10**		**6,480 / 2,440**		**1.6E–07**		**1.0E–04**		**1.6E–07**		**4.2E–05**

Table 11.12–1. Paducah Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Workers from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	1.3E–04	N	2.8E–01	R2-C	6.4E–08	N	1.4E–04	R2-C	5.1E–09	N	5.9E–07
Low Level[a]	N	3.2E–06	R2	3.0E–04	N	1.6E–09	R2	1.5E–07	--	--	--	--
Transuranic	N	--	R1-C	8.2E–07	N	--	R1-C	4.1E–10	N	--	R1-C	5.0E–13
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.3E–04**		**1.9E–02**		**6.6E–08**		**9.7E–06**		**5.1E–09**		**3.4E–08**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Min.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	R2-C	0.3	D,R1	2.3
Low Level	All/None	All/None	All	None	D,R1,2	Np-237	N	2.9	D,R1	11.2
Transuranic	All/None	All/None	--	--	--	--	N	0	D-C	0.6
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[b]**	**None**		**None**		**Np-237**		**3.8**		**14.1**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	116	D,R1	2,963	R2-C	176	D,R1	1,541	R2-C	0.25	D,R1	0.45
Low Level	N	2,968	R2	67,852	N	1,682	R2	5,847	N	0.38	D,R1	11.31
Transuranic	N	171	R2-C	880	N	171	D-C	200	N	0.17	R1	0.26
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3,613**		**71,695**		**2,058**		**7,588**		**0.81**		**12.02**

Table 11.12–1. Paducah Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.04	D,R1	0.24	N,R2-C	0.02	D,R1	0.11	N	41	D,R1	221
Low Level	N	0.27	R2	0.88	N	0.14	R2	0.44	R3-C5	276	R2	797
Transuranic	N	0.03	R2-C	0.07	N	0.01	R2-C	0.03	N	32	R2-C	59
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.38**		**1.19**		**0.18**		**0.58**		**349**		**1,077**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. The Paducah Gaseous Diffusion Plant does not have high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.12–2 identifies the range of cumulative impacts that would result from the combined waste management alternatives (including transportation) and current activities at PGDP. As identified in Table 11.12–2, the maximum annual radioactive releases that would result from the waste management alternatives would result in a slight increase in the dose to the offsite population; however, PGDP cumulative radioactive releases would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

PGDP is in a nonattainment region for ozone. While the expected atmospheric emissions of ozone-producing contaminants under various alternatives could increase the levels of these emissions, the increases would be below the regulated levels in the nonattainment region. Disposal of LLW at PGDP under the Decentralized and Regionalized Alternatives 1 and 2 could result in exceedance of drinking water standards in groundwater for Np-237. No disposal of LLW would occur at PGDP under the preferred alternative.

The combined alternatives could affect between 4 and 14 acres of land at PGDP. This area is less than 1% of the total suitable acreage and less than 1% of the area available for waste management facilities. Onsite infrastructure demands for water, wastewater treatment, and power would not measurably increase from the combined alternatives. The combined alternatives could add up to 378 jobs at PGDP, or a maximum increase of approximately 20% over existing employment. The maximum increase in employment is not expected to affect offsite community infrastructures or institutions because of the current population and employment base in the PGDP region.

11.13 Pantex Plant

The Pantex Plant would continue in the future to disassemble, assemble, and conduct quality evaluation and maintenance of the nation's nuclear weapons stockpile. The existing environmental conditions at the Pantex Plant resulting from these ongoing activities are described in Chapter 4.

Table 11.12–2. Paducah Gaseous Diffusion Plant Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.70E–01	1.60E–03	3.60E+00	1.65E–03	--	1.72E–01	3.77E+00	1.72E–01
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	--	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	4.50E–03	1.80E–05	4.00E–02	1.85E–05	--	4.52E–03	4.45E–02	4.52E–03
Worker Population									
Collective dose, 10 years (person-rem)	(4)	5.19E+01	4.07E+00	1.26E+01	4.07E+00	--	5.60E+01	6.45E+01	5.60E+01
Number of cancer fatalities from collective dose	(1)	~0	~0	~0	~0	--	~0	~0	~0
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	9,960	10	6,480	6,330	--	9,970	16,440	16,290
Number of rail shipments (10 yr)		0	10	2,440	2,410	--	10	2,440	2,410
Annual dose (mrem) from truck transport		4.0E+00	1.6E–05	1.0E–02	1.02E–02	--	4.0E+00	4.0E+00	4.0E+00
Annual dose (mrem) from rail transport		0.0E+00	1.6E–05	4.2E–03	4.15E–03	--	1.6E–05	4.2E–03	4.2E–03
Resources and Infrastructure									
Land area (% of available area)	(6)	79%	0.40%	1.48%	0.53%	--	79%	80%	79%
Water use (% capacity)		50%	0.01%	0.24%	0.02%	--	50%	50%	50%
Wastewater treatment (% capacity)		23%	0.12%	0.43%	0.13%	--	23%	23%	23%
Power demand (% current load)		51%	0.03%	0.40%	0.03%	--	51%	52%	51%
Employment									
Number of site workers	(7)	1,869	115	378	125	--	1,984	2,247	1,994
Air Quality Exceedance	(8)	Ozone	None	None	None	--	Ozone	Ozone	Ozone
Groundwater Quality Exceedance	(9)	15 parameters exceeded	None	Np-237	None	--	15 parameters exceeded	16 parameters exceeded	15 parameters exceeded

[a] Aside from continuation of existing operations, waste management, and environmental restoration activities, no other actions are planned by DOE at the Paducah Gas Diffusion Plant.
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Existing air quality exceedance is for the region in which the site is located and does not indicate an exceedance of site emission requirements. Waste management impacts presented indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

11.13.1 Combined Waste Management Impacts

DOE considered the management of LLMW and LLW at the Pantex Plant. Table 11.13–1 lists the minimum and maximum combined impacts of the waste management alternatives considered for the Pantex Plant. The most adverse impacts at the Pantex Plant and in the Pantex Plant region would occur as a result of the Decentralized and Regionalized Alternatives for which treatment and disposal facilities would be constructed for LLMW and LLW. The least adverse impacts at the Pantex Plant and in the Pantex Plant region generally would result from the No Action Alternative and other Regionalized and Centralized Alternatives for which the Pantex Plant would prepare, package, and ship waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at Pantex are expected to be lower than the impacts of the maximum combined waste management alternatives at the site.

11.13.2 Cumulative Impacts

Aside from the continuation of existing operations and the waste management activities addressed in this PEIS, reasonably foreseeable future actions at the Pantex Plant are described in separate EISs and include the storage and disposition of weapons-usable fissile materials (DOE, 1996b), stockpile stewardship and management (DOE, 1996f), and continued operations (including environmental restoration activities) as described in a sitewide EIS (DOE, 1996i). In addition to these DOE actions, closures and realignment of military bases in the region could contribute to the cumulative impact of waste management alternatives. Table 11.13–2 identifies the range of cumulative impacts resulting from other actions described in the aforementioned EISs, the combined waste management alternatives, and existing activities.

As identified in Table 11.13–2, the maximum annual radioactive releases from the combined waste management alternatives (including transportation) would result in a slight increase in the dose to the offsite population from the Pantex Plant. However, maximum cumulative radioactive releases would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

Table 11.13–1. Pantex Plant Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population Health from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	2.2E–03	D,R1	6.9E–02	N	1.1E–06	D,R1	3.5E–05	R2-C	3.6E–10	N	7.0E–08
Low Level[a]	D-C5	8.8E–04	N	1.8E–03	D-C5	4.4E–07	N	8.8E–07	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.1E–03**		**7.1E–02**		**1.5E–06**		**3.5E–05**		**3.6E–10**		**7.0E–08**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	1.8E–07	D,R1	5.9E–06	N	9.2E–11	D,R1	2.9E–09	R2-C	3.0E–14	N	5.8E–12
Low Level[a]	D-C5	7.5E–08	N	1.5E–07	D-C5	3.7E–11	N	7.5E–11	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2.6E–07**		**6.1E–06**		**1.3E–10**		**2.9E–09**		**3.0E–14**		**5.8E–12**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses from Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,D1,R1	0 / 0	R2-R4,C	40 / 30	N,D,R1	0.0E+00	R2-R4,C	6.4E–07	N,D,R1	0.0E+00	R2-R4,C	4.8E–07
Low Level	D,R1,R2	0 / 0	R5,C3,C4	430 / 170	D,R1,R2	0.0E+00	R5,C3,C4	6.9E–06	D,R1,R2	0.0E+00	R5,C3,C4	2.7E–06
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**470 / 200**		**0.0E+00**		**7. 5–06**		**0.0E+00**		**3.2E–06**

Table 11.13-1. Pantex Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Workers from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	4.7E-04	D,R1	6.9E-03	R2-C	2.3E-07	D,R1	3.5E-06	R2-C	4.1E-10	N	8.0E-08
Low Level[a]	D-C5	8.7E-05	N	1.7E-04	D-C5	4.4E-08	N	8.7E-08	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**5.6E-04**		**7.1E-03**		**2.8E-07**		**3.5E-06**		**4.1E-10**		**8.0E-08**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Min.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	All	None	All	None	R2-C	0.3	D.R1	3.7
Low Level	All/None	All/None	All	None	All	None	N,R3-C5	1.7	R2	4.5
Transuranic[a]	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[c]**	**None**		**None**		**None**		**2.0**		**8.2**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R2-C	387	D,R1	4,499	N	305	D,R1	1,457	R2-C	0.16	D,R1	0.45
Low Level	N,R3-C5	1,977	R2	4,599	N,R3-C5	671	R2	3,691	N,R3-C5	0.19	R2	0.79
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2,364**		**9,098**		**976**		**5,148**		**0.35**		**1.24**

Table 11.13–1. Pantex Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.03	D,R1	0.17	N,R2-C	0.02	D,R1	0.07	N	38	D,R1	192
Low Level	N,R3-C5	0.12	R2	0.20	All	0.09	All	0.09	N,R3-C5	135	R2	222
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.15**		**0.37**		**0.11**		**0.16**		**173**		**414**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and, therefore, is assumed not to cause chemical cancer incidences. The Pantex Plant does not have transuranic and high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.13–2. Pantex Plant Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	0	3.10E-03	7.10E-02	6.99E-02	5.80E-03	8.90E-03	7.68E-02	7.57E-02
Number of cancer fatalities from collective dose	(2)	0	~0	~0	~0	~0	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.00E-04	2.60E-05	6.10E-04	5.98E-04	5.00E-05	1.76E-04	7.60E-04	7.48E-04
Worker Population									
Collective dose, 10 years (person-rem)	(4)	3.00E+02	2.32E+00	5.00E+00	2.74E+00	4.93E+02	7.95E+02	7.98E+02	7.96E+02
Number of cancer fatalities from collective dose	(1)	1.50E-01	~0	~0	~0	2.47E-01	3.18E-01	3.19E-01	3.18E-01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	2,350	0	470	460	830	3,180	3,650	3,640
Number of rail shipments (10 yr)		0	0	200	190	0	0	200	190
Annual dose (mrem) from truck transport		9.4E-01	0.0E+00	7.5E-04	7.34E-04	3.3E-02	9.7E-01	9.7E-01	9.74E-01
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	3.2E-04	3.08E-04	00E+00	0.0E+00	3.2E-04	3.08E-04
Resources and Infrastructure									
Land area (% of available area)	(6)	21%	0.02%	0.08%	0.06%	2%	23%	23%	23%
Water use (% capacity)		33%	0.16%	0.61%	0.43%	13%	46%	47%	47%
Wastewater treatment (% capacity)		50%	0.18%	0.94%	0.39%	24%	75%	75%	75%
Power demand (% current load)		0.8%	0.02%	0.08%	0.04%	0.77%	2%	2%	2%
Employment									
Number of site workers	(7)	3,011	77	125	107	968	4,056	4,104	4,086
Air Quality Exceedance	(8)	None	None	None	None	Alcohols	Alcohols	Alcohols	Alcohols
Groundwater Quality Exceedance	(9)	10 parameters exceeded	None	None	None	None	10 parameters exceeded	10 parameters exceeded	10 parameters exceeded

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to storage and disposition of weapons-usable fissile materials (DOE, 1996b), stockpile stewardship and management (DOE, 1996f), and continuation of sitewide operations (including the impacts of environmental restoration activities) (DOE, 1996i). Shipment numbers and shipment MEI values do not include those related to stockpile stewardship and management and continuation of sitewide operations because these were not presented in those EISs.
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The Pantex Plant is in an attainment region where criteria air pollutants do not exceed standards. Although no air quality exceedances are expected for combined waste management activities, cumulative emissions for all activities at the site could result in the exceedance of the air quality standard for alcohols. Disposal of LLMW and LLW at Pantex are not expected to result in exceedance of standards for groundwater used as drinking water under any of the alternatives. No disposal of LLMW or LLW would occur at Pantex under the preferred alternatives.

The combined alternatives would affect between 2 and 8 acres of land at the Pantex Plant. This area is less than 1% of the total suitable acreage at Pantex and less than 1% of the area available for waste management facilities. Other actions could affect another 222 acres. Although the combined alternatives and other actions would only cumulatively affect a maximum of 2% of the suitable acreage at the Pantex Plant, detailed characterization studies and evaluations of the land may be required to ensure protection of wildlife habitats and cultural artifacts prior to development.

The demand for water and wastewater treatment would not be greatly affected nor would it exceed existing capacities because of the combined alternatives or the cumulative effects of other planned actions. Although cumulative power demand would increase as a result of other planned actions at the Pantex Plant, this increase would be well within current capacity, and no expansions or upgrades would be needed.

The combined alternatives could add up to 125 jobs at the Pantex Plant, while other actions could increase the number of jobs by 968. Cumulatively, the maximum number of jobs at the Pantex Plant would increase about 36%. Within the Pantex Plant region, about 2,080 jobs will be lost as a result of military base closures and realignments (DBCRC, 1995), and the potential employment increases at the Pantex Plant could offset some of these job losses. Mitigation measures may be required to reduce any adverse impacts to offsite community infrastructures and institutions.

11.14 Portsmouth Gaseous Diffusion Plant

Portsmouth Gaseous Diffusion Plant (PORTS) would continue in the future to produce enriched uranium. The existing environmental conditions at PORTS resulting from these ongoing activities are described Chapter 4.

11.14.1 Combined Waste Management Impacts

DOE considered the management of LLMW and LLW at PORTS. Table 11.14–1 lists the minimum and maximum combined impacts of the waste management alternatives for PORTS. The most adverse impacts at PORTS and in the PORTS region would occur as a result of Regionalized Alternatives for which treatment and disposal facilities would be constructed for PORTS to manage its own waste, as well as accept offsite LLMW and LLW for treatment and disposal. The least adverse impacts at PORTS and in the PORTS region generally would result from other Regionalized and Centralized Alternatives for which PORTS would only prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at PORTS are expected to be well below the impacts of the maximum combined waste management alternatives at the site.

11.14.2 Cumulative Impacts

Aside from the continuation of existing operations, the waste management activities addressed in this PEIS, and environmental restoration actions, DOE has no other actions planned at PORTS. No other DOE or non-DOE actions are planned in the PORTS region that would contribute to the cumulative impact of the waste management alternatives.

The environmental restoration program at PORTS will address cleanup of an estimated 1,000,000 m^3 of contaminated media and facilities (270,000 m^3, 730,000 m^3 of LLMW and LLW, respectively; see Appendix B). Future cleanup actions include remediation of contaminated groundwater and soils and eventual decontamination and decommissioning of uranium enrichment facilities. Although the impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, past environmental restoration activities at PORTS have had no significant adverse environmental impacts based on the NEPA and RCRA reviews completed to date. Future environmental evaluations will continue to be performed on a project-specific basis under RCRA and NEPA.

Table 11.14–2 identifies the range of cumulative impacts that would result from the combined waste management alternatives (including transportation) and current activities at PORTS. As identified in Table 11.14–2, the maximum annual radioactive releases that would result from the waste management alternatives would result in a very slight increase in the radiation dose to the offsite population; however,

Table 11.14–1. Portsmouth Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	3.6E–05	R2,3	2.1E–01	R4,C	1.8E–08	R2,3	1.1E–04	R4,C	4.9E–08	N	5.9E–05
Low Level[a]	D,R1	4.9E–07	R4, C3,4	3.8E+01	D,R1	2.4E–10	R4,C3,4	1.9E–02	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.6E–05**		**3.8E+01**		**1.8E–08**		**1.9E–02**		**4.9E–08**		**5.9E–05**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	4.5E–09	R2,3	2.6E–05	R4,C	2.2E–12	R2,3	1.3E–08	R4,C	8.2E–12	N	9.8E–09
Low Level[a]	D, R1	6.2E–11	R4,C3,4	4.6E–03	D,R1	3.1E–14	R4,C3,4	2.3E–06	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**4.9E–09**		**4.6E–03**		**2.E–12**		**2.3E–06**		**8.2E–12**		**9.8E–09**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R2,R3	2,260 / 960	N	0.0E+00	R2-R3	3.6E–05	N	0.0E+00	R2-R3	1.5E–05
Low Level	D	23,320 / 4,770	R4	47,610 / 18,410	D	3.7E–04	R4	7.7E–04	D	1.4E–04	R4	3.0E–04
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**23,320 / 4,770**		**49,870 / 19,370**		**3.7E–04**		**8.1E–04**		**1.4E–04**		**3.2E–04**

Table 11.14-1. Portsmouth Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	3.7E-06	R2,3	1.6E-02	R4,C	1.9E-09	R2,3	8.0E-06	R4,C	2.8E-08	N	3.3E-05
Low Level[a]	D,R1	5.1E-08	R4,C3,4	1.2E+00	D,R1	2.6E-11	R4,C3,4	5.9E-04	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.8E-06**		**1.2E+00**		**1.9E-09**		**6.0E-04**		**2.8E-08**		**3.3E-05**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	R2-4,C	None	R1	2 hazardous chemicals[c]	N	1.3	R1	12.2
Low Level	All/None	All/None	All	None	All	None	R3,5-C2,5	2.0	R2	44.7
Transuranic[a]	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[d]**	**None**		**None**		**2 hazardous chemicals[c]**		**3.3**		**56.9**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	2,190	R1	19,863	R4,C	1,888	R1	6,787	R4,C	0.37	R1	1.84
Low Level	R3,5-C2,5	3,997	R1	178,908	R3,5-C2,5	1,094	N	22,144	R3,5-C2,5	0.44	R1	26.84
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**6,187**		**198,771**		**2,982**		**28,931**		**0.81**		**28.68**

Table 11.14–1. Portsmouth Gaseous Diffusion Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0.20	R1	0.98	N,R4,C	0.09	R1	0.36	N	210	R1	838
Low Level	R3,5-C2,5	0.20	R2	1.69	R3,5-C2,5	0.08	R2	0.62	R3,5-C2,5	169	R2	1,436
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.40**		**2.67**		**0.17**		**0.98**		**379**		**2,274**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. Portsmouth does not have transuranic or high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Hazardous chemicals that could exceed standards for groundwater used as drinking water include 1,2-dichloroethane and methylene chloride.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.14–2. Portsmouth Gaseous Diffusion Plant Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	3.00E–01	3.60E–05	3.80E+01	5.40E–03	--	3.00E+01	6.80E+01	3.00E+01
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	--	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	2.60E–01	4.90E–07	4.60E–01	6.80E–05	--	2.60E–01	7.20E–01	2.60E–01
Worker Population									
Collective dose, 10 years (person-rem)	(4)	1.71E+03	1.31E+01	4.35E+02	1.46E+01	--	1.72E+03	2.15E+03	1.72E+03
Number of cancer fatalities from collective dose	(1)	6.84E–01	~0	1.74E–01	~0	--	6.89E–01	8.58E–01	6.90E–01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	2,600	23,320	49,870	34,090	--	25,920	52,470	36,690
Number of rail shipments (10 yr)		2,150	4,770	19,370	13,000	--	6,920	21,520	15,150
Annual dose (mrem) from truck transport		1.0E+00	3.7E–02	8.1E–02	5.50E–02	--	1.1E+00	1.1E+00	1.1E+00
Annual dose (mrem) from rail transport		8.6E–01	1.4E–02	3.2E–02	2.14E–02	--	8.7E–01	8.9E–01	8.8E–01
Resources and Infrastructure									
Land area (% of available area)	(6)	20%	0.08%	1.42%	0.31%	--	21%	21%	20%
Water use (% capacity)		38%	0.02%	0.54%	0.06%	--	38%	38%	38%
Wastewater treatment (% capacity)		29%	0.25%	2.41%	0.65%	--	29%	32%	30%
Power demand (% current load)		80%	0.04%	1.49%	0.11%	--	80%	81%	80%
Employment									
Number of site workers	(7)	2,582	153	927	400	--	2,582	3,509	2,982
Air Quality Exceedance	(8)	None	None	None	None	--	None	None	None
Groundwater Quality Exceedance	(9)	8 parameters exceeded	None	2 hazardous chemicals[e]	None	--	8 parameters exceeded	9 parameters exceeded	8 parameters exceeded

[a] Aside from the continuation of existing operations, waste management, and environmental restoration activities, no other actions are planned by DOE at the PORTS site.
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.
[e] Hazardous chemicals that could exceed standards for groundwater used as drinking water include 1,2-dichloroethane and methylene chloride.

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

cumulative radioactive releases would still be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

PORTS is in an attainment region where criteria air pollutants do not exceed standards, and cumulative emissions are not expected to result in air quality standard exceedances. The combined alternatives would affect between 3 and 57 acres of land at PORTS. This area is about 1% of the total suitable acreage at PORTS and 2% of the area available for waste management facilities. Onsite infrastructure demands for water, wastewater treatment, and power would not greatly increase from the combined waste management alternatives and would remain within existing capacities. The combined alternatives could add up to 927 jobs, or a maximum employment increase of approximately 36%. The maximum increase in employment is not expected to affect offsite community infrastructures or institutions because of the current population and employment base in the region.

Disposal of LLMW at PORTS under Regionalized Alternative 1 could result in exceedances of standards for groundwater used as drinking water for 1,2-dichloroethane and methylene chloride. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. No other alternatives for LLMW are expected to result in exceedances for any contaminants at PORTS, nor are there any expected exceedances for other waste types. No disposal of LLMW would occur at PORTS under the preferred alternative.

11.15 Rocky Flats Environmental Technology Site

Rocky Flats Environmental Technology Site (RFETS) would continue in the future to conduct decontamination and decommissioning and cleanup. The existing environmental conditions at RFETS resulting from these ongoing activities are described in Chapter 4.

11.15.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, and TRUW at RFETS. Table 11.15–1 lists the minimum and maximum combined impacts of the waste management alternatives for RFETS. The most adverse impacts at RFETS and in the RFETS region would occur as a result of the No Action Alternative for LLMW and Regionalized Alternatives for which LLW treatment and disposal facilities would be

Table 11.15–1. Rocky Flats Environmental Technology Site Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	1.3E–02	N	2.6E+01	R4,C	6.3E–06	N	1.3E–02	R4,C	2.4E–06	N	1.0E–03
Low Level[a]	N	2.4E–04	R2,4,C3,4	3.7E–01	N	1.2E–07	R2,4,C3,4	1.9E–04	--	--	--	--
Transuranic	N	6.0E–03	R2	2.2E+02	N	3.0E–06	R2	1.1E–01	N	1.0E–10	R3,C	1.1E–09
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.9E–02**		**2.5E+02**		**9.4E–06**		**1.2E–01**		**2.4E–06**		**1.0E–03**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	1.7E–07	N	3.6E–04	R4,C	8.5E–11	N	1.8E–07	R4,C	1.9E–11	N	8.0E–09
Low Level[a]	N	3.3E–09	R2,4,C3,4	5.1E–06	N	1.6E–12	R2,4,C3,4	2.5E–09	--	--	--	--
Transuranic	N	8.2E–08	R2	3.0E–03	N	4.1E–11	R2	1.5E–06	All	<9.9E–14	All	<9.9E–14
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2.5E–07**		**3.4E–03**		**1.3E–10**		**1.7E–06**		**1.9E–11**		**8.0E–09**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R2,R3	2,560 / 980	N	0.0E+00	R2,R3	4.1E–05	N	0.0E+00	R2,R3	1.6E–05
Low Level	D,R1, R2	0 / 0	R3,R6,R7, C1,C2 / R3, R5-R7 C1, C2	3,570 / 1,330	D,R1,R2	0.0E+00	R3,R6,R7, C1,C2	5.7E–05	D,R1,R2	0.0E+00	R3,R5-R7, C1,C2	2.1E–05
Transuranic	N	0 / 0	D	830 / 420	N	0.0E+00	D	1.2E–04	N	0.0E+00	D	1.3E–04
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**6,960 / 2,730**		**0.0E+00**		**2.2E–04**		**0.0E+00**		**1.7E–04**

Table 11.15–1. Rocky Flats Environmental Technology Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	6.4E–04	N	7.3E+00	R4,C	3.2E–07	N	6.7E–04	R4,C	4.8E–07	N	2.0E–04
Low Level	N	1.2E–05	R2,4,C3,4	1.9E–02	N	6.2E–09	R2,4,C3,4	9.5E–06	--	--	--	--
Transuranic	N	3.1E–04	R2	1.1E+01	N	1.5E–07	R2	5.6E–03	N	2.1E–11	R3,C	2.3E–10
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.6–03**		**1.1E+01**		**8.0E–07**		**5.6E–03**		**4.8E–07**		**1.0E–05**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D-R3/CO;D-R1/NO_2	All/None	N,R2-4,C	None	D,R1	3 hazardous chemicals[c]	R4,C	6.2	D.R1	32.9
Low Level	All/None	All/None	All	None	All	None	N	1.1	R2	11.4
Transuranic	All/None	All/None	--	--	--	--	N	0	R2	2.8
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**CO, NO_2[d]**	**CO**		**None**		**3 hazardous chemicals[c]**		**8.5**		**47.1**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	7,271	D,R1	89,025	R4,C	3,478	D,R1	11,099	R4,C	0.86	D,R1	11.49
Low Level	N	2,490	R2	17,980	N	914	R2	11,997	N	0.20	D,R2	1.67
Transuranic	R3,C	2,173	R2	8,223	R3,C	708	R2	4,866	N	0.12	R2	0.87
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**11,934**		**115,228**		**5,100**		**27,962**		**1.51**		**14.03**

Table 11.15–1. Rocky Flats Environmental Technology Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R4,C	0.05	D,R1	0.14	R4,C	0.02	D,R1	0.07	R4,C	627	D,R1	1,826
Low Level	N,R3,5-C2,5	0.02	R2	0.08	N,R3,5-C2,5	0.01	R2	0.05	R3,5-	228	R2	1,044
Transuranic	R3,C	0.01	R2	0.04	R3,C	0.00	R1,2	0.02	C2,5	127	R2	531
High Level[a]	--	--	--	--	--	--	--	--	R3,C	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
									--			
Total		**0.08**		**0.26**		**0.03**		**0.14**		**982**		**3,401**

Notes: Alt. = alternative; C = Centralized Alternative; CO = carbon monoxide; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; NO_2 = nitrogen dioxide; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. The Rocky Flats Environmental Technology Site does not have high-level waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same unless otherwise indicated by the presence of two sets of codes separated by a diagonal line.

[c] Hazardous chemicals that could exceed drinking water standards include carbon tetrachloride, 1,2-dichloroethane, and methylene chloride.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

constructed to allow RFETS to manage its own waste. The least adverse impacts at RFETS and in the RFETS region generally would result from the Regionalized and Centralized Alternatives for which RFETS would only prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at RFETS are expected to be well below the impact of the maximum waste management alternatives at the site.

11.15.2 CUMULATIVE IMPACTS

Aside from the continuation of existing operation and waste management activities addressed in this PEIS, reasonably foreseeable future actions at RFETS include the transfer of certain Nuclear Weapons Complex nonnuclear functions from RFETS to other sites (DOE, 1993); the operation of a supercompactor and TRUW shredder (DOE, 1990a); and environmental restoration activities. The impacts of the supercompactor and TRUW shredder are not included as future activities in the table because the operation of the supercompactor is considered part of the TRUW alternatives. In addition to these DOE actions, closure and realignment of military bases in the RFETS region could contribute to the cumulative impact of waste management alternatives. Table 11.15–2 identifies the range of cumulative impacts resulting from the combined waste management alternatives (including transportation), other actions, and current activities.

The environmental restoration program at RFETS will address cleanup of an estimated 480,900 m^3 of contaminated media and facilities (380,000 m^3, 96,000 m^3, and 4,900 m^3 of LLMW, LLW, and TRUW, respectively; see Appendix B). Future and ongoing cleanup actions include remediation of contaminated groundwater, solidification and disposition of solar pond sludge, and decontamination and decommissioning of facilities. The impacts of these activities are not sufficiently well known to allow full incorporation into the cumulative impact analysis, but project-specific environmental evaluations will be performed prior to implementation.

As identified in Table 11.15–2, the annual radioactive releases that would result from the combined waste management alternatives (including transportation) would increase the radiation dose to the offsite population. However, the maximum cumulative radioactive release would be below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

Table 11.15–2. Rocky Flats Environmental Technology Site Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.40E+00	1.90–02	2.50E+02	2.00E–01	--	1.42E+00	2.51E+02	1.60E+00
Number of cancer fatalities from collective dose	(2)	~0	~0	1.25E–01	~0	--	~0	1.26E–01	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	2.00E–04	2.50E–05	3.40E–01	2.66E–04	--	2.25E–04	3.40E–01	4.66E–04
Worker Population									
Collective dose, 10 years (person-rem)	(4)	Not available	5.61E+00	9.23E+01	2.44E+01	--	5.61E+00	9.20E+01	2.44E+01
Number of cancer fatalities from collective dose	(1)		~0	~0	~0	--	~0	~0	~0
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	210	0	6,960	6,920	--	210	7,170	7,130
Number of rail shipments (10 yr)		0	0	2,730	2,690	--	0	2,730	2,690
Annual dose (mrem) from truck transport		8.4E–02	0.0E+00	2.2E–02	2.17E–02	--	8.4E–02	1.1E–01	1.1E–01
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	1.7E–02	1.66E–02	--	0.0E+00	1.7E–02	1.7E–02
Resources and Infrastructure									
Land area (% of available area)	(6)	15%	0.13%	0.69%	0.56%	--	15%	16%	16%
Water use (% capacity)		27%	1.19%	11.52%	9.89%	--	28%	39%	37%
Wastewater treatment (% capacity)		30%	1.02%	5.59%	3.16%	--	31%	36%	33%
Power demand (% current load)		53%	4.38%	40.67%	36.00%	--	57%	94%	89%
Employment									
Number of site workers	(8)	7,962	272	1,369	774	-715	7,519	8,616	8,736
Air Quality Exceedance	(9)	PM_{10}, CO, ozone	None	CO, NO_2	CO, NO_2	--	PM_{10}, CO, ozone	PM_{10}, CO, NO_2, ozone	PM_{10}, CO, NO_2, ozone
Groundwater Quality Exceedance	(6)	12 parameters exceeded	None	3 hazardous chemicals[e]	None	--	13 parameters exceeded	14 parameters exceeded	13 parameters exceeded

[a] Other reasonably foreseeable future actions include the transfer of non-nuclear functions from RFETS to other sites (DOE, 1993). Impacts of proposed TRUW supercompactor are included within waste management alternatives for TRUW.
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.
[e] Hazardous chemicals that could exceed standards for groundwater used as drinking water include carbon tetrachloride, 1,2-dichloroethane, and methylene chloride,

Notes
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Existing air quality exceedance is for the region in which the site is located and does not indicate an exceedance of existing site emission requirements. Waste management impacts presented indicate whether emissions would result in nonattainment. PM_{10} = particulate matter measuring less than or equal to 10 microns in diameter.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

RFETS is in a nonattainment region where criteria air pollutants are exceeded for particulates, carbon monoxide, and ozone. While minimum cumulative emissions would not exceed air quality standards, cumulative emissions with maximum combined alternatives or the preferred alternatives are expected to result in exceedances of both carbon monoxide and nitrogen dioxide emission limits as a result of the construction of LLMW facilities and for carbon monoxide alone for operation of facilities. Measures to mitigate these emissions would be necessary if these alternatives were chosen.

The combined alternatives would affect between 9 and 47 acres of land. This area is less than 1% of the total suitable acreage at RFETS and less than 1% of the area available for waste management facilities. Although the combined alternatives would result in increases in the demands for water, wastewater treatment, and power, the existing capacities for these utilities are expected to be sufficient.

The combined alternatives could add up to 1,369 jobs at RFETS, while the transfer of nonnuclear functions from RFETS would reduce employment by 715 jobs. Within the RFETS region, about 2,900 jobs will be lost as a result of military base closures and realignments (DBCRC, 1995). The potential employment increase at RFETS would offset some of the job losses, and no mitigation is expected to be necessary to reduce adverse impacts to offsite infrastructures and institutions.

Disposal of LLMW at RFETS under the Decentralized Alternative and Regionalized Alternative 1 could result in exceedances of drinking water standards in groundwater for carbon tetrachloride, 1,2-dichloroethane, and methylene chloride. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. No other alternatives for LLMW are expected to result in exceedances for any contaminants at RFETS, nor are there any expected exceedances for other waste types. No disposal of LLMW would occur at RFETS under the preferred alternatives.

11.16 Sandia National Laboratories

Sandia National Laboratories in New Mexico (SNL-NM) would continue in the future to develop, engineer, and test nonnuclear components of nuclear weapons. The existing environmental conditions at SNL-NM resulting from these ongoing activities are described in Chapter 4.

11.6.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, and TRUW at SNL-NM. Table 11.16–1 lists the minimum and maximum combined impacts of the waste management alternatives for SNL-NM. As noted in Table 11.16–1, SNL-NM has a very small quantity of TRUW, and impacts are expected to be minimal for all TRUW alternatives affecting SNL-NM. The most adverse impacts at SNL-NM and in the SNL-NM region would occur as a result of the Decentralized Alternatives for which treatment and disposal facilities would be constructed to allow SNL-NM to manage its own waste. The least adverse impacts would result from the Regionalized and Centralized Alternatives for which SNL-NM would prepare, package, and ship its waste for offsite treatment and disposal. For most impact categories, the combined impacts of the preferred alternatives at SNL-NM are expected to be less than the impacts of the maximum combined waste management alternatives at the site.

11.16.2 Cumulative Impacts

Aside from the continuation of existing operations and the waste management activities addressed in this PEIS, reasonably foreseeable future actions at SNL-NM include the transfer of certain Nuclear Weapons Complex nonnuclear functions to SNL-NM (DOE, 1993), stockpile stewardship and management (DOE 1996f), medical isotope production (DOE, 1996c), and environmental restoration activities (DOE, 1996k). Table 11.16–2 identifies the range of cumulative impacts resulting from the combined alternatives, the confirmed transfer of nonnuclear functions to SNL-NM, and current activities.

As identified in Table 11.16–2, the annual radioactive releases that would result from the combined waste management alternatives would result in a slight increase in the current radiation dose to the offsite population. However, the maximum cumulative radioactive release would remain well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

SNL-NM is in a nonattainment region for carbon monoxide; however, both minimum and maximum combined emissions would not exceed air quality standards. The combined alternatives would affect between 1 and 5 acres of land. This area is approximately 1% of the total suitable acreage at SNL-NM and about 2% of the area available for waste management facilities. Other future actions could affect another 1,123 acres. Onsite infrastructure demands for water, wastewater treatment, and power would not

Table 11.16-1. Sandia National Laboratories-New Mexico Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	3.6E-05	D	2.8E-01	R1-C	1.8E-08	D	1.4E-04	R1-C	5.4E-10	N	7.3E-07
Low Level[a]	N	3.4E-03	D-C5	3.6E-03	N	1.7E-06	D-C5	1.8E-06	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.4E-03**		**2.8E-01**		**1.7E-06**		**1.4E-04**		**5.4E-10**		**7.3E-07**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	1.4E-09	D	1.1E-05	R1-C	7.1E-13	D	5.4E-09	R1-C	2.3E-14	N	3.1E-11
Low Level[a]	All	1.4E-07	All	1.4E-07	N	6.8E-11	R1-C5	7.2E-11	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1.4E-07**		**1.1E-05**		**6.9E-11**		**5.5E-09**		**2.3E-14**		**3.1E-11**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses from Rail Transport in Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,D	0 / 0	R1-R4, C	20 / 20	N,D	0.0E+00	R1-R4,C	3.20E-07	N,D	0.0E+00	R1-R4,C	3.2E-07
Low Level	D	0 / 0	N,R5,C3, C4 / N	240 / 120	D	0.0E+00	N,R5,C3, C4	3.90E-06	D	0.0E+00	N	1.9E-06
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**260 / 140**		**0.0E+00**		**4.2E-06**		**0.0E+00**		**2.2E-06**

Table 11.16–1. Sandia National Laboratories (New Mexico) Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Workers from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	6.9E–07	D	1.6E–03	R1-C	3.5E–10	D	7.8E–07	R1-C	6.0E–11	N	8.1E–08
Low Level[a]	N	5.8E–05	D-C5	6.1E–05	N	2.9E–08	D-C5	3.0E–08	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**5.9E–05**		**1.7E–03**		**2.9E–08**		**8.1E–07**		**6.0E–11**		**8.1E–08**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Min.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	N,R1-C	None	D	Pu-240	N,R1-C	0.0	D	1.7
Low Level	All/None	All/None	N,R1-C5	None	D	5 radionuclides[c]	N	0.9	D	3.0
Transuranic[a]	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[d]**	**None**		**None**		**5 radionuclides[c]**		**0.9**		**4.7**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N,R1-C	18	D	2,079	N,R1-C	18	D	289	N,R1-C	0.01	D	0.15
Low Level	N	1,077	D	3,675	N	622	D	1,146	N	0.12	D	0.39
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**1,095**		**5,754**		**640**		**1,435**		**0.13**		**0.54**

Table 11.16–1. Sandia National Laboratories (New Mexico) Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	0.00	D	0.02	N,R1-C	0.00	D	0.07	R1-C	6	D	73
Low Level	N	0.02	D	0.06	N,R1-C	0.01	D	0.03	R1-C5	108	D	243
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.02**		**0.08**		**0.01**		**0.10**		**114**		**316**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. Sandia National Laboratories, which includes the Inhalation Toxicology Research Institute, has a de minimis quantity of transuranic waste and does not have high-level waste. No new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same unless otherwise indicated by the presence of two sets of codes separated by a diagonal line.

[c] Radionuclides that could exceed drinking water standards in groundwater include Pu-239, Pu-240, Tc-99, U-234, and U-238.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.16–2. Sandia National Laboratories-New Mexico Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	2.00E–01	3.44E–03	2.84E–01	2.84E–01	1.30E+02	1.30E+02	1.30E+02	1.30E+02
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	~0	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	3.40E–03	1.40E–05	1.11E–03	1.11E–03	1.75E–01	1.78E–01	1.80E–01	1.80E–01
Worker Population									
Collective dose, 10 years (person-rem)	(4)	3.50E+01	1.04E+00	2.15E+02	1.82E+00	2.50E+02	2.86E+02	5.00E+02	2.87E+02
Number of cancer fatalities from collective dose	(1)	~0	~0	~0	~0	1.00E–01	1.14E–01	2.00E–01	1.15E–01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	60	0	380	370	16,100	16,160	16,540	16,530
Number of rail shipments (10 yr)		0	0	200	180	0	0	200	180
Annual dose (mrem) from truck transport		2.4E–02	0.0E+00	7.5E–04	7.28E–04	6.1E–01	6.3E–01	6.3E–01	6.3E–01
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	6.0E–04	5.72E–04	0.0E+00	0.0E+00	6.0E–04	5.7E–04
Resources and Infrastructure									
Land area (% of available area)	(6)	6%	0.04%	0.18%	0.13%	40%	46%	46%	46%
Water use (% capacity)		25%	0.03%	0.14%	0.11%	17%	42%	42%	42%
Wastewater treatment (% capacity)		95%	0.11%	0.25%	0.16%	36%	131%	131%	131%
Power demand (% current load)		69%	0.26%	1.08%	0.78%	18%	87%	88%	88%
Employment									
Number of site workers	(7)	8,596	23	107	46	1,726	10,345	10,429	10,368
Air Quality Exceedances	(8)	CO	None	None	None	None	CO	CO	CO
Water Quality Exceedances	(9)	5 parameters exceeded	None	5 radionuclides[e]	None	None	5 parameters exceeded	10 parameters exceeded	5 parameters exceeded

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to stockpile stewardship and management (DOE, 1996f), transfer of non-nuclear functions (DOE, 1993), medical isotope production (DOE, 1996c) and environmental restoration activities (DOE, 1996k).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts including maximum combined waste management impacts.
[e] Radionuclides that could exceed drinking water standards in groundwater include Pu-239, Pu-240, Tc-99, U-234, and U-238.

Notes:
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or land that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Existing air quality exceedance is for the region in which the site is located and does not indicate an exceedance of existing site emission requirements.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

measurably increase from the combined waste management alternatives, but wastewater treatment capacity would be exceeded as a result of other actions planned at SNL-NM and would require upgrades.

The combined waste management alternatives could add up to 107 jobs at SNL-NM, while other actions would add an additional 1,726 jobs. The cumulative increase would be about 21% over existing employment at SNL-NM, which is not expected to affect offsite community infrastructures and institutions.

Disposal of LLW at SNL-NM under the Decentralized Alternative could result in exceedances of standards for groundwater used as drinking water for Pu-239, Pu-240, Tc-99, U-234, and U-238. For disposal of LLMW, the Decentralized Alternative could also result in an exceedance for Pu-240. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. No other alternatives for LLW or LLMW are expected to result in exceedances for any contaminant at SNL-NM, nor are there any expected exceedances for other waste types. No disposal of LLMW or LLW would occur at SNL-NM under the preferred alternatives.

11.17 Savannah River Site

Savannah River Site (SRS) would continue in the future to conduct defense program missions, including those for tritium and special nuclear materials. The existing environmental conditions at SRS resulting from these ongoing activities are described in Chapter 4.

11.17.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, TRUW, HLW, and HW at SRS. Table 11.17–1 lists the minimum and maximum combined impacts of the waste management alternatives considered for SRS. The most adverse impacts at SRS and in the SRS region would occur as a result of some Centralized and Regionalized Alternatives for which treatment and disposal facilities would be constructed for SRS to manage its own LLW and LLMW, in addition to accepting offsite LLMW and LLW for treatment and disposal, offsite TRUW for treatment, and offsite HLW canisters for storage. The least adverse impacts generally would result from other Regionalized and Centralized Alternatives for which SRS would only prepare, package, and ship waste for offsite treatment and disposal. For most impact categories, the

Table 11.17–1. Savannah River Site Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	2.7E–03	D-R4	3.5E+00	C	1.3E–06	R1-R4	1.8E–03	C	6.1E–08	N	2.9E–06
Low Level[a]	C5	2.5E–02	N,R2,4,5, C3,4	1.2E+00	C5	1.2E–05	R2,4,5, C3,4	6.1E–04	--	--	--	--
Transuranic	N	4.3E–02	R2,3	4.5E+00	N	2.2E–05	R2,3	2.3E–03	N	7.2E–13	R1	3.1E–11
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	--	D	1.3E–03
Total		**7.1E–02**		**9.2E+00**		**3.5E–05**		**4.7E–03**		**6.1E–08**		**1.3E–03**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	2.5E–08	D-R4	3.3E–05	C	1.3E–11	D-R4	1.7E–08	C	7.9E–13	N	3.7E–11
Low Level[a]	C5	2.3E–07	N,R2,4,5	1.1E–05	C5	1.2E–10	R2,4,5, C3,4	5.7E–09	--	--	--	--
Transuranic	N	4.1E–07	R2,3	4.2E–05	N	2.0E–10	R2,3	2.1E–08	All	<9.9E–14	All	<9.9E–14
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	--	D	1.7E–08
Total		**6.7E–07**		**8.6E–05**		**3.3E–10**		**4.4E–08**		**7.9E–13**		**1.7E–08**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments[b] (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.[c]	Min.	Alt.[c]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	R3	710 / 330	N	0.0E+00	R3	1.1E–05	N	0.0E+00	R3	5.3E–06
Low Level	D,R1-R5	20 / 10	R6,R7	130,030 / 49,340	D,R1-R5	3.2E–07	R6,R7	2.1E–03	D,R1-R5	1.6E–07	R6,R7	7.9E–04
Transuranic	N	0 / 0	D	2,370 / 1,190	N	0.0E+00	D	3.5E–04	N	0.0E+00	D	3.6E–04
High Level	N,D,R2,C 1,C2	4,572 / 915	R1	5,252 / 1,051	N,D,R2, C1,C2	1.8E–03	R1	2.1E–03	N,D,R2, C1,C2	3.7E–04	R1	4.2E–04
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**4,592 / 925**		**138,362 / 51,911**		**1.8E–03**		**4.6E–03**		**3.7E–04**		**1.6E–03**

Table 11.17–1. Savannah River Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Workers from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	1.3E–04	N	1.3E–01	C	6.5E–08	N	6.5E–05	C	3.1E–08	N	1.4E–06
Low Level[a]	C5	2.2E–03	C3,4	6.7E–02	C5	1.1E–06	R2,4,5, C3,4	3.3E–05	--	--	--	--
Transuranic	N	4.7E–03	R2,3	4.8E–01	N	2.3E–06	R2,3	2.4E–04	N	3.6E–13	R1-3	1.5E–11
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	N,R2	0.0E+00	D	6.5E–04
Total		**6.9E–03**		**6.8E–01**		**4.1E–06**		**3.4E–04**		**3.1E–08**		**6.5E–04**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	R3,C	None	D,R1,2,4	4 hazardous chemicals[c]	R3,C	12.8	N	24.9
Low Level	All/None	All/None	C1-C5	--	N,D,R1-7	U-238	C1,2,5	12.5	R6,7	82.5
Transuranic	All/None	All/None	--	--	--	--	N	0	R2,3	8.2
High Level	All/None	All/None	--	--	--	--	N,D,R2,C	2.0	R1	4.0
Hazardous	All/None	All/None	--	--	--	--	N,R2	--	R1	1.0
Total	**None[d]**	**None**		**None**		**4 hazardous chemicals,[e] U-238**		**27.3**		**120.6**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	2,832	N	74,593	C	1,053	R1,2	8,980	R3,C	1.41	N	10.46
Low Level	N	13,690	R6,7	174,220	C1,2,5	7,911	R6,7	40,247	N	5.31	R6,7	9.77
Transuranic	N	1,973	R2,3	22,118	C	847	R2,3	7,366	N	0.07	R2,3	1.17
High Level	N,C	1,900	D-R2	1,930	N,C	1,900	D-R2	1,930	All	0.05	All	0.05
Hazardous	N,R2	--	R1	593	N,R2	--	R1	371	N,R2	--	D,R1	0.13
Total		**20,395**		**273,454**		**11,711**		**58,894**		**6.84**		**21.58**

Table 11.17–1. Savannah River Site Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	C	0.09	R1,2,4	0.46	C	0.04	R1,2,4	0.32	C	253	R1,2,4	1,245
Low Level	C1,2,5	0.40	R6,7	2.48	C1,2,5	0.19	R6,7	1.33	C1,2,5	1,066	R6,7	6,630
Transuranic	N	0.05	R2,3	0.38	N	0.02	R2,3	0.16	N	161	R2,3	1,024
High Level	C	0.06	D-R2	0.13	All	0.03	All	0.03	C	283	R1	594
Hazardous	N,R2	--	R1	0.01	N,R2	--	R1	0.00	R2	--	R1	32
Total		**0.60**		**3.46**		**0.25**		**1.84**		**1,763**		**9,525**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. Routine high-level waste storage does not result in releases of radioactive or chemical substances. Hazardous waste does not contain radioactive materials and therefore does not cause radiation doses or fatalities.

[b] Number of truck and rail shipments of radioactive waste types. Does not include hazardous waste shipments.

[c] Maximum and minimum alternatives for truck and rail transport are the same.

[d] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

[e] Hazardous chemicals that could exceed drinking water standards in groundwater include benzene, carbon tetrachloride, 1,2-dichloroethane, and methylene chloride.

combined impacts of the preferred alternatives at SRS are expected to be lower than the impacts of the maximum combined management alternatives at the site.

11.17.2 CUMULATIVE IMPACTS

Aside from the waste management activities addressed in this PEIS, reasonably foreseeable future actions at SRS include continued management of spent nuclear fuels (DOE, 1995d), tritium supply and recycling (DOE, 1995a), transfer of Nuclear Weapons complex nonnuclear functions to SRS (DOE, 1993), processing of F-Canyon plutonium solutions to plutonium metal (DOE, 1994g), interim management of nuclear materials (DOE, 1995b), operation of the Defense Waste Processing Facility (DOE, 1994h), other site projects for the management of waste (including environmental restoration activities) (DOE, 1995c), storage and disposition of weapons-usable fissile materials (DOE, 1996b), stockpile stewardship and management (DOE, 1996f), and disposition of surplus highly enriched uranium (DOE, 1995f).

Table 11.17–2 identifies the range of cumulative impacts resulting from these other actions, the combined waste management alternatives, and current activities that include atmospheric radiological releases from the Vogtle Nuclear Power Plant, located near SRS. Table 11.17–2 does not include, under the category of Other Actions, the impacts of waste management projects considered in the SRS Waste Management EIS (DOE, 1995c) because these are also included in the alternatives in this WM PEIS. Table 11.17–2 includes the impacts of SRS managing aluminum-clad spent nuclear fuel, as recently decided by DOE and evaluated in DOE (1995d).

As identified in Table 11.17–2, the maximum annual cumulative radioactive releases would result in an increase in the radiation dose to the offsite population. The maximum cumulative increase in radioactive releases would primarily result from the treatment of TRUW and releases associated with tritium production and recycling. Maximum cumulative radioactive releases would continue to be below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

SRS is in an attainment region where criteria air pollutants do not exceed standards. The cumulative emissions resulting from the existing operations, combined waste management alternatives, and other future actions are not expected to result in air quality standard exceedances.

Table 11.17–2. Savannah River Site Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	6.40E+01	7.10E–02	9.20E+00	3.81E+00	2.90E+03	2.96E+03	2.97E+03	2.96E+03
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	1.45E+00	1.48E+00	1.48E+00	1.48E+00
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	1.40E–01	6.70E–05	8.60E–03	3.59E–03	3.76E+00	3.90E+00	3.91E+00	3.90E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	3.50E+03	2.65E+03	5.76E+03	4.93E+03	1.16E+04	1.77E+04	2.08E+04	2.00E+04
Number of cancer fatalities from collective dose	(1)	1.40E+00	1.06E+00	2.30E+00	1.97E+00	4.63E+00	7.09E+00	8.33E+00	8.00E+00
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	580	4,592	138,362	74,862	1,349	6,521	140,291	76,791
Number of rail shipments (10 yr)		0	925	51,911	27,275	422	1,347	52,333	27,697
Annual dose (mrem) from truck transport		2.3E–01	1.8E–01	4.6E–01	3.10E–01	5.2E–02	4.6E–01	7.4E–01	5.9E–01
Annual dose (mrem) from rail transport		0.0E+00	3.7E–02	1.6E–01	9.75E–02	1.6E–02	5.3E–02	1.7E–01	1.1E–01
Resources and Infrastructure									
Land area (% of available area)		10%	0.02%	0.07%	0.05%	0.31%	10%	10%	10%
Water use (% capacity)	(6)	32%	0.41%	5.47%	3.23%	103%	136%	141%	139%
Wastewater treatment (% capacity)		67%	1.56%	7.85%	5.79%	50%	119%	125%	123%
Power demand (% current load)		74%	3.91%	12.33%	5.69%	213%	291%	300%	293%
Employment									
Number of site workers	(7)	19,201	483	3,216	2,406	3,499	23,183	25,916	25,106
Air Quality Exceedances	(8)	None	None	None	None	None	None	None	None
Water Quality Exceedances	(9)	42 parameters exceeded	None	4 hazardous chemicals,[e] U-238	4 hazardous chemicals,[e] U-238	None	42 parameters exceeded	43 parameters exceeded	43 parameters exceeded

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to defense waste processing (DOE, 1994h), tritium supply and recycle (DOE, 1995a), spent nuclear fuel management (including spent nuclear fuel form foreign research reactors) (DOE, 1995d), other site-specific waste management actions (including environmental restoration activities) (DOE, 1994c), F-Canyon (DOE, 1994g), interim management of nuclear materials (DOE, 1995b), storage and disposition of weapons-usable fissile materials (DOE, 1996b), stockpile stewardship and management (DOE, 1996f), transfer of non-nuclear functions (DOE, 1993), and disposition of highly enriched uranium (DOE 1995f).

[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.

[c] Cumulative impacts, including minimum combined waste management impacts.

[d] Cumulative impacts, including maximum combined waste management impacts.

[e] Hazardous chemicals that could exceed drinking water standards in groundwater include benzene, carbon tetrachloride, 1,2-dichloroethane, and methylene chloride.

Notes:

(1) Assumes all facilities operate concurrently for the same 10-year period.

(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).

(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.

(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.

(5) Truck and rail shipments of radioactive waste types; does not include hazardous waste shipments. Maximum exposed individuals to truck and rail shipments are assumed to be different.

(6) Suitable land includes land that is available for development or that is currently developed.

(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.

(8) Impacts indicate whether emissions would result in nonattainment.

(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

The combined waste management alternatives would affect between 25 and 119 acres of land at SRS. This area is less than 1% of the total suitable acreage at SRS and less than 1% of the area available for waste management facilities. Other actions could affect another 500 acres. Although the combined alternatives and other actions would only cumulatively affect a maximum of less than 1% of the suitable acreage at SRS, detailed characterization studies and evaluations of that land may be required to ensure protection of wildlife habitats and cultural artifacts.

The maximum demand for water, wastewater treatment, and power resulting from the combined alternatives would not exceed 13% of existing capacities and would not require upgrades or expansion of existing capacities. Cumulatively, water, wastewater, and power capacities at SRS would require improvements (expansions or upgrades) from the increased demands resulting from other actions planned at SRS.

The combined alternatives could add up to 3,216 jobs at SRS, while other actions could also increase the number of jobs at SRS by up to 3,499. Cumulatively, the number of jobs at SRS could increase by 35%, which could affect existing offsite community infrastructures and institutions. Such an increase could require mitigation to reduce any adverse offsite infrastructure and institutional impacts.

Disposal of LLMW at SRS under the Decentralized Alternative and Regionalized Alternatives 1, 2, and 4 (including the preferred alternative for LLMW) could result in exceedances of drinking water standards for groundwater for U-238, benzene, carbon tetrachloride, 1,2-dichloroethane, and methylene chloride. The No Action Alternative, Decentralized Alternative, and Regionalized Alternatives 1 through 7 (including the preferred alternative for LLW) could, in addition, result in exceedances in U-238 for disposal of LLW. Mitigation could be required to maintain compliance with drinking water standards should any of these alternatives be selected. Other alternatives for LLMW or LLW are not expected to result in exceedances for any contaminants at SRS.

11.18 Waste Isolation Pilot Plant

The only alternative being considered for the Waste Isolation Pilot Plant (WIPP) is the possible treatment of all contact-handled TRUW under the TRUW Centralized Alternative. Table 11.18–1 lists the impacts of this alternative for WIPP. The preferred alternative for WIPP would have treatment of TRUW occurring elsewhere.

Table 11.18–1. Waste Isolation Pilot Plant Range of Combined Waste Management Alternative Impacts

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N,D-R3	--	C	5.2E+02	N,D-R3	--	C	2.6E-01	N,D-R3	--	C	5.5E-10
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0**		**5.2E+02**		**0**		**2.6E-01**		**0**		**5.5E-10**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N,D-R3	--	C	1.4E-01	N,D-R3	--	C	6.9E-05	N,D-R3	--	C	2.1E-13
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0**		**1.4E-01**		**0**		**6.9E-05**		**0**		**2.1E-13**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses in Person-Rem (10 yr)			
	Alt.[b]	Min.	Alt.[b]	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N	0 / 0	D	23,860 / 11,970	N	0.0E+00	D	3.1E-03	N	0.0E+00	D	3.1E-03
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0 / 0**		**23,860 / 11,970**		**0.0E+00**		**3.1E-03**		**0.0E+00**		**3.1E-03**

Table 11.18–1. Waste Isolation Pilot Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Worker											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N,D-R3	--	C	4.2E+01	N,D-R3	--	C	2.1E–02	N,D-R3	--	C	2.8E–10
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0**		**4.2E+01**		**0**		**2.1E–02**		**0**		**2.8E–10**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--
Transuranic	All/None	All/None	--	--	--	--	N,D-R3	--	C	8.8
High Level[a]	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--
Total	**None[c]**	**None**		**None**		**None**		**0**		**8.8**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N,D-R3	--	C	41,429	N,D-R3	--	C	15,204	N,D-R3	--	C	3.5
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0**		**41,429**		**0**		**15,204**		**0**		**3.5**

Table 11.18-1. Waste Isolation Pilot Plant Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed[a]	--	--	--	--	--	--	--	--	--	--	--	--
Low Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Transuranic	N,D-R3	--	C	2.05	N,D-R3	--	C	0.64	N,D-R3	--	C	2,346
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0**		**2.05**		**0**		**0.64**		**0**		**2,346**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E-05 = 0.00001

[a] The Waste Isolation Pilot Plant does not have low-level mixed, low-level, or high-level waste, and no hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

WIPP is the candidate location for a geologic repository for DOE TRUW. The potential impacts of TRUW disposal at WIPP have been assessed in previous EISs (DOE, 1980; DOE, 1990b) and in the supplemental EIS that is currently being prepared by DOE (DOE, 1996m). Table 11.18–2 identifies the range of cumulative impacts resulting from the possible treatment and disposal of TRUW at WIPP. No other DOE or non-DOE actions are planned at WIPP or in the WIPP vicinity that would contribute to the cumulative impact of waste management alternatives.

As identified in Table 11.18–2, the annual cumulative radioactive releases could result in an increase in radiation dose to the offsite population and, without mitigation, the maximum increase in radioactive releases could exceed the EPA standard of 10 millirems per year to the maximally exposed individual offsite. The preferred alternative would not result in such an exceedance.

WIPP is located an attainment region where criteria air pollutants do not exceed standards. The maximum air emissions, other than radioactive emissions, are not expected to result in air quality standard exceedances.

Treatment of contact-handled TRUW at WIPP would affect 9 acres of land. This area is less than 1% of the total suitable acreage at WIPP and less than 1% of the area available for waste management facilities. Facilities for disposal could affect 150 acres. These actions cumulatively would affect about 2% of the suitable acreage at WIPP, and detailed characterization studies and evaluations of this land may be required to ensure protection of wildlife habitats and cultural resources.

The maximum cumulative demand for water would not measurably affect existing usage or capacity. The treatment and disposal of TRUW would individually and cumulatively require increases in wastewater treatment capacity, however. In addition, treatment of TRUW could add up to 459 jobs at WIPP and could impact existing offsite community infrastructures and institutions. Such an increase could require mitigation to reduce any adverse offsite infrastructure and institutional impacts.

Table 11.18–2. Waste Isolation Pilot Plant Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	0.0E+00	0.0E+00	5.20E+02	0.00E+00	2.00E-01	2.00E-01	5.20E+02	2.00E-01
Number of cancer fatalities from collective dose	(2)	0	0	2.60E-01	0.00E+00	~0	~0	2.60E-01	1.00E-04
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	0.0E+00	0.0E+00	1.40E+01	0.00E+00	2.00E-02	2.00E-02	1.4E+01	2.00E-02
Worker Population									
Collective dose, 10 years (person-rem)	(4)	0.0E+00	0.0E+00	4.10E+01	0.00E+00	3.00E+02	3.00E+02	3.41E+02	3.00E+02
Number of cancer fatalities from collective dose	(1)	0	0	~0	0.00+00	1.20E-01	1.20E-01	1.36E-01	1.20E-01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	0	0	23,860	23,860	0	0	23,860	23,860
Number of rail shipments (10 yr)		0	0	11,970	11,970	0	0	11,970	11,970
Annual dose (mrem) from truck transport		0.0E+00	0.0E+00	3.1E-01	3.10E-01	0.0E+00	0.0E+00	3.1E-01	3.10E-01
Annual dose (mrem) from rail transport		0.0E+00	0.0E+00	3.1E-01	3.10E-01	0.0E+00	0.0E+00	3.1E-01	3.10E-01
Resources and Infrastructure									
Land area (% of available area)	(6)	0.34%	0.00%	0.09%	0.00%	1.46%	1.81%	1.89%	1.81%
Water use (% capacity)		0.87%	0.00%	0.48%	0.00%	0.0%	0.87%	1.35%	0.87%
Wastewater treatment (% capacity)		65%	0.00%	82.20%	0.00%	0.0%	65%	147%	65%
Power demand (% current load)		49%	0.00%	37.02%	0.00%	0.0%	49%	86%	49%
Employment									
Number of site workers	(7)	932	22	459	22	163	1,117	1,554	1,117
Air Quality Exceedances	(8)	None	None	Radiation	None	None	None	Radiation	None
Groundwater Quality Exceedances	(9)	6 parameters exceeded	None	None	None	None	6 parameters exceeded	6 parameters exceeded	6 parameters exceeded

[a] Other reasonably foreseeable future actions include startup of disposal operations as described in the draft WIPP Supplemental EIS (DOE, 1996m).
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts including maximum combined waste management impacts.

Notes:
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts item assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers.
(5) Maximum exposed individual to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. For the WIPP site, all six constituents are naturally high and do not result from any activities at the site. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

11.19 West Valley Demonstration Project

The West Valley Demonstration Project (WVDP) began operations as a nuclear fuel reprocessing plant in 1966 and was shut down in the late 1970s. DOE plans to decommission WVDP in the near future. The existing environmental conditions at WVDP resulting from past activities are described in Chapter 4.

11.19.1 Combined Waste Management Impacts

DOE considered the management of LLMW, LLW, TRUW, and HLW at WVDP. Table 11.19–1 lists the minimum and maximum combined impacts of the waste management alternatives considered for WVDP. WVDP has very small quantities of both LLW and TRUW, and impacts associated with these two waste types are expected to be minimal. The most adverse impacts at WVDP and in the WVDP region would occur as a result of the No Action and Decentralized Alternatives for which treatment and disposal facilities would be located at WVDP to manage its own waste. The least adverse impacts at WVDP and in the WVDP region generally would result from the Regionalized and Centralized Alternatives for which WVDP would only prepare, package, and ship its waste for offsite treatment and disposal.

11.19.2 Cumulative Impacts

Additional actions to occur at WVDP include the vitrification of HLW, which was previously assessed in an EIS (DOE, 1982a), and completion and closure activities that have been assessed in a separate EIS (DOE, 1996h). No other DOE or non-DOE actions are planned at WVDP or in the WVDP region. Table 11.19–2 identifies the range of cumulative impacts at WVDP.

As identified in Table 11.19–2, the maximum annual cumulative radioactive releases would result in an increase in radiation dose to the offsite population. The maximum cumulative increase in radioactive releases would continue to be well below the EPA standard of 10 millirems per year to the maximally exposed individual offsite.

Table 11.19–1. West Valley Demonstration Project Range of Combined Waste Management Alternative Impacts[a]

Waste Type	Effects on Offsite Population from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1,2,3	3.4E–04	N	2.7E–01	R1,2,3	1.7E–07	N	1.4E–04	R1-C	4.5E–09	N	1.5E–07
Low Level[a]	D	2.5E–03	N	7.1E–03	D	1.2E–06	N	3.5E–06	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**2.8E–03**		**2.8E–01**		**1.4E–06**		**1.4E–04**		**4.5E–09**		**1.5E–07**

Waste Type	Effects on Offsite Maximum Exposed Individual from Atmospheric Releases											
	Radiation Doses in Rem (10 yr)				Risk of Radiation Cancer Fatality (10 yr)				Risk of Chemical Cancer Incidence (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1-C	5.2E–09	N	4.1E–06	R1-C	2.6E–12	N	2.1E–09	R1-C	1.5E–13	N	5.0E–12
Low Level[a]	D	3.7E–08	N	1.1E–07	D	1.9E–11	N	5.3E–11	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**4.2E–08**		**4.2E–06**		**2.2E–12**		**2.1E–09**		**1.5E–13**		**5.0E–12**

Waste Type	Effects of Transportation on Offsite Maximum Exposed Individual											
	Number of Truck/Rail Shipments (10 yr)				Radiation Doses From Truck Transport in Rem (10 yr)				Radiation Doses From Rail Transport in Rem (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	0 / 0	D	100 / 100	N	0.0E+00	D	1.60E–06	N	0.0E+00	D	1.6E–06
Low Level	D	0 / 0	R1,R3,R6, R7,C1,C2	6,620 / 2,480	D	0.0E+00	R1,R3,R6, R7,C1,C2	1.10E–04	D	0	R1,R3,R6, R7,C1,C2	4.0E–05
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	All	340 / 68	All	340 / 68	All	1.40E–04	All	1.40E–04	All	2.7E–05	All	2.7E–05
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**340 / 68**		**7,060 / 2,648**		**1.40E–04**		**2.5E–04**		**2.7E–05**		**6.9E–05**

Table 11.19–1. West Valley Demonstration Project Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Effects on Noninvolved Workers from Atmospheric Releases											
	Radiation Doses in Person-Rem (10 yr)				Number of Radiation Fatalities (10 yr)				Number of Chemical Cancer Incidences (10 yr)			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	R1,2,3	4.4E–07	N	6.7E–04	R1,2,3	2.2E–10	N	3.4E–07	R1,2,3	8.9E–11	N	3.0E–09
Low Level[a]	D	5.1E–06	N	1.5E–05	D	1.5E–11	N	7.5E–09	--	--	--	--
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level[a]	--	--	--	--	--	--	--	--	--	--	--	--
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**5.6E–06**		**6.9E–04**		**2.4E–10**		**3.5E–07**		**8.9E–11**		**3.0E–09**

Waste Type	Air Quality Exceedances		Groundwater Quality Impacts				Resource Requirements			
	Construction	Operation	Number and Type of Exceedances				Acres Required			
	Alt./Pollutants	Alt./Pollutants	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All/None	All/None	--	--	--	--	N	0.4	D	1.5
Low Level	--	--	--	--	--	--	N,R1-C5	4.0	D	18
Transuranic[a]	--	--	--	--	--	--	--	--	--	--
High Level	All/None	All/None	--	--	--	--	All	--	All	--
Hazardous[a]	--	--	--	--	--	--	--	--	-	--
Total	**None[c]**	**None**		**None**		**None**		**4.4**		**19.5**

Waste Type	Resource Requirements—Continued											
	Gallons of Water Use Per Day				Gallons of Wastewater Per Day				Megawatts of Power			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	N	229	D	1,925	N	18	D	240	N	0.02	D	0.26
Low Level	N,R1-C5	6,447	D	58,800	N,R1-C5	2,588	D	5,618	N,R1-C5	0.70	D	8.49
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level	N,C	1,000	D-R2	1,010	N,C	1,000	D-R2	1,010	All	0.04	All	0.04
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**7,676**		**61,735**		**3,606**		**6,868**		**0.76**		**8.79**

Table 11.19–1. West Valley Demonstration Project Range of Combined Waste Management Alternative Impacts—Continued

Waste Type	Socioeconomic Impacts								Total Costs			
	Percent Change in Regional Employment				Percent Change in Regional Population				1994 Millions of Dollars			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	All	0.00	All	0.00	All	0.00	All	0.00	R1-C	7	N	26
Low Level	N,R1-C5	0.06	D	0.11	N,R1-C5	0.02	D	0.05	N,R1-C5	330	D	614
Transuranic[a]	--	--	--	--	--	--	--	--	--	--	--	--
High Level	N,D	0.00	R1-C	0.01	All	0.00	All	0.00	D-C	29	N	30
Hazardous[a]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**0.06**		**0.11**		**0.02**		**0.05**		**366**		**670**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; N = No Action Alternative; R = Regionalized Alternative; -- = not applicable, see footnote (b); scientific notation such as 1.0E–05 = 0.00001.

[a] Low-level waste does not contain RCRA-regulated hazardous chemicals and therefore is assumed not to cause chemical cancer incidences. Routine high-level waste storage does not result in releases of radioactive or chemical substances. West Valley has de minimis quantities of transuranic waste, and no new hazardous waste facilities were considered under the hazardous waste alternatives.

[b] Maximum and minimum alternatives for truck and rail transport are the same.

[c] Combined construction air quality assumes that construction of different waste type facilities does not occur simultaneously.

Table 11.19–2. West Valley Demonstration Project Range of Cumulative Impacts

Impact Category	Notes	Impacts of Existing Operations	Combined Waste Management Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Minimum	Maximum	Preferred Alternative		Minimum[c]	Maximum[d]	Preferred Alternative
Offsite Population									
Collective dose, 10 years (person-rem)	(1)	1.10E–01	2.80E–03	2.80E–01	4.44E–03	9.10E+01	9.11E+01	9.14E+01	9.11E+01
Number of cancer fatalities from collective dose	(2)	~0	~0	~0	~0	~0	~0	~0	~0
Offsite Maximum Exposed Individual									
Annual dose, atmospheric releases (mrem)	(3)	3.00E–04	4.20E–06	4.20E–04	6.62E–06	2.50E+00	2.50E+00	2.50E+00	2.50E+00
Worker Population									
Collective dose, 10 years (person-rem)	(4)	1.40E–01	1.52E+02	3.00E+02	2.22E+02	1.50E+03	1.65E+03	1.80E+03	1.72E+03
Number of cancer fatalities from collective dose	(1)	~0	~0	1.20E–01	~0	6.00E–01	6.61E–01	7.20E–01	6.89E–01
Transportation Effects on Offsite Maximum Exposed Individual									
Number of truck shipments (10 yr)	(5)	0	340	7,060	6,990	21,000	21,340	28,060	27,990
Number of rail shipments (10 yr)		0	68	2,648	2,578	13,300	13,368	15,948	15,878
Annual dose (mrem) from truck transport		0.0E+00	1.4E–02	2.5E–02	2.50E–02	8.4E–01	8.5E–01	8.7E–01	8.7E–01
Annual dose (mrem) from rail transport		0.0E+00	2.7E–03	6.9E–03	6.75E–03	5.3E–01	5.4E–01	5.4E–01	5.4E–01
Resources and Infrastructure									
Land area (% of available area)		25%	2.00%	8.86%	2.11%	0%	27%	34%	27%
Water use (% capacity)		64%	6.98%	56.12%	7.11%	0%	71%	120%	71%
Wastewater treatment (% capacity)		100%	5.15%	9.81%	5.39%	0%	105%	110%	105%
Power demand (% current load)		45%	11.69%	135.23%	11.85%	61%	117%	241%	117%
Employment									
Number of site workers	(7)	1,100	123	276	142	1,368	2,591	2,744	2,610
Air Quality Exceedances	(5)	None	None	None	None	None	None	None	None
Groundwater Quality Exceedances	(6)	2 parameters exceeded	None	None	None	None	2 parameters exceeded	2 parameters exceeded	2 parameters exceeded

[a] Includes impacts of HLW vitrification (as identified in DOE, 1982a) and completion and closure of the WVDP (as identified in DOE, 1996f). The alternatives analyzed in the WVDP completion and closure EIS include WVDP waste volumes analyzed in the WM PEIS.
[b] Impacts of existing operations, combined waste management impacts, and impacts of other reasonably foreseeable future actions.
[c] Cumulative impacts, including minimum combined waste management impacts.
[d] Cumulative impacts, including maximum combined waste management impacts.

Notes:
(1) Assumes all facilities operate concurrently for the same 10-year period.
(2) Assumes 5×10^{-4} cancer fatalities per person-rem. Calculated values less than 1×10^{-1} are reported as zero (~0).
(3) Based on DOE (1994a), which contains releases for the year 1992. Cumulative impacts assumes all facilities operate simultaneously and are located at the same point.
(4) Includes both facility and noninvolved workers. Assumes 4×10^{-4} cancer fatalities per person-rem.
(5) Maximum exposed individuals to truck and rail shipments are assumed to be different.
(6) Suitable land includes land that is available for development or that is currently developed.
(7) Average annual employment for operations. Number of site workers reported for waste management activities may include some workers reported for existing operations.
(8) Impacts indicate whether emissions would result in nonattainment.
(9) Existing groundwater quality exceedance is for the groundwater over which the site is located. Waste management impacts presented indicate whether disposal would result in exceedance of drinking water standards. Drinking water standards are described in Section C.4.3.5 of Appendix C (Volume III).

WVDP is in an attainment region where criteria air pollutants do not exceed standards. The cumulative emissions are not expected to result in air quality standard exceedances. Disposal is considered at WVDP only under the Decentralized Alternative (not the preferred alternative) for LLMW; no drinking water standards are expected to be exceeded in groundwater for this alternative.

The combined alternatives would affect between 4 and 20 acres of land. This area is about 9% of the total suitable acreage at WVDP and 12% of the area available for waste management facilities. The maximum cumulative demand for wastewater treatment and power are expected to exceed existing capacities and will require expansion or upgrading. The combined waste management alternatives could add up to 276 jobs at WVDP, which would not affect existing offsite community infrastructures and institutions. Completion and closure activities could result in an additional 1,368 jobs at WVDP.

11.20 Transportation

In addition to the combined and cumulative impacts of the alternatives at and in the region of each of the major sites, combined and cumulative impacts could also occur regionally and nationally from the transportation of waste. Tables 11.20–1 and 11.20–2 summarize the range of combined impacts that could occur from the routine transport of waste by truck and rail for the alternatives.

For the combination of alternatives that would involve the fewest shipments of waste, the transport of HLW would have the highest number of shipments and shipment miles, while the transport of HLW and TRUW would result in the highest radiological consequences and risks to transport crew members and the population along transportation routes. For the combination of alternatives that would involve the largest number of shipments, the transport of LLW would result in the highest number of shipments, shipment miles, and radiological consequences and risks to transport crew members and the population along transportation routes.

The transport of waste by truck is expected to result in a combined total of between 12 and 69 fatalities for the shipment of LLMW, LLW, TRUW, HLW, and HW. The majority of these fatalities would result from physical trauma directly related to potential accidents and truck fuel emissions. The transport of LLMW,

Table 11.20–1. Combined Waste Management Alternative Truck Transportation Impacts[a]

Waste Type	Waste Transport Shipments and Mileage										
	Number of Waste Shipments				Millions of Miles of Shipments				Maximum Shipments To or From a Site		
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Site	Shipments
Low-Level Mixed	D	480	R3	10,990	D	0.3	R3	14.9	R3	Nevada Test Site	9,650
Low Level	D	24,420	C4	264,060	D	8.6	C1	563.0	C2	Nevada Test Site	257,270
Transuranic	R2	18,640	D	23,900	R2	34.0	D	42.4	D	Waste Isolation Pilot Plant	23,680
High Level	D	19,912	C	28,224	D	29.4	C	39.5	C	Hanford Site	28,224
Hazardous	R2	1,685	R1	2,483	R2	30.0	R1	55.7	R1	Hanford Site	423
Total		**65,137**		**329,657**		**102.3**		**715.5**			**b**

Waste Type	Radiological Doses from Waste Transport								Waste Transport Fatalities			
	Routine Occupational Dose in Person-Rem				Routine Population Dose in Person-Rem				Vehicle Emission Fatalities			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D	8.2E+00	R3	4.3E+02	D	4.7E+00	R3	5.1E+02	D	4.6E–03	R3	1.0E–01
Low Level	D	3.2E+02	C1	1.6E+04	D	3.4E+02	C1,5	1.9E+04	D	8.8E–02	C2	2.9E+00
Transuranic	R2	2.9E+03	D	3.7E+03	R2	2.9E+03	D	3.9E+03	R2	1.8E–01	D	2.2E–01
High Level	D	2.6E+03	C	3.5E+03	D	3.5E+03	C	4.7E+03	D	2.1E–01	C	2.7E–01
Hazardous[c]	--	--	--	--	--	--	--	--	D,R2	1.0E–01	R1	1.8E–01
Total		**5.8E+03**		**2.4E+04**		**6.7E+03**		**2.8E+04**		**5.8E–01**		**3.7E+00**

Waste Type	Waste Transport Fatalities—Continued											
	Number of Occupational Radiation Fatalities				Number of Population Radiation Fatalities				Vehicle-Related Accident Fatalities			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D	3.3E–03	R3	1.7E–01	D	5.5E–03	C	2.9E–01	D	1.8E–02	R3	1.0E+00
Low Level	D-R2	1.0E–01	C1	6.3E+00	D	1.7E–01	C1	9.7E+00	D	4.3E–01	C2	3.5E+01
Transuranic	R2	1.2E+00	D	1.5E+00	R2	1.5E+00	D	1.9E+00	R2	2.4E+00	D	3.0E+00
High Level	D	1.0E+00	C	1.4E+00	D	1.8E+00	C	2.3E+00	D-R2	1.8E+00	C	2.3E+00
Hazardous[c]	--	--	--	--	--	--	--	--	D	2.7E–01	R1	5.3E–01
Total		**2.3E+00**		**9.4E+00**		**3.5E+00**		**1.4E+01**		**4.9E+00**		**4.2E+01**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; R = Regionalized Alternative; -- = not applicable, see footnote (c); scientific notation such as 7.7E+00 = 7.7 and 2.3E+02 = 230.

[a] Range of impacts does not include the impacts of the No Action Alternatives for low-level mixed waste, transuranic waste, and high-level waste. Transport impacts listed are those that would occur over a 20-year period except for HLW, which would occur over about 40 years.

[b] No combined total indicated as different sites involved.

[c] Shipments of hazardous waste do not result in external exposure to radiation and latent cancer fatalities from exposure to radiation.

Table 11.20–2. Combined Waste Management Alternative Rail Transportation Impacts[a]

Waste Type	Waste Transport Shipments and Mileage										
	Number of Waste Shipments				Millions of Miles of Shipments				Maximum Shipments To or From a Site		
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Site	Shipments
Low-Level Mixed	D	350	R3	4,540	D	0.2	R3	6.8	R3	Nevada Test Site	3,700
Low Level	D	9,210	C2	96,880	D	3.5	C2	219.0	C2	Nevada Test Site	96,880
Transuranic	R2	9,360	D	12,010	R2	15.8	D	20.3	D	Waste Isolation Pilot Plant	11,970
High Level	D	3,983	C	5,646	D	6.7	C	8.7	C	Hanford Site	5,646
Hazardous[c]	--	--	--	--	--	--	--	--	--	--	--
Total		**22,903**		**119,076**		**26.2**		**254.8**			**b**

Waste Type	Radiological Doses from Waste Transport								Waste Transport Fatalities			
	Routine Occupational Dose in Person-Rem				Routine Population Dose in Person-Rem				Vehicle Emission Fatalities			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D	2.0E+00	R3	4.1E+01	D	5.8E+00	R3	7.6E+01	D	5.7E–03	R3	5.5E–02
Low Level	D	4.1E+01	C1-3,5	1.2E+03	D	1.3E+02	C1,2	2.3E+03	D	1.2E–01	C1,2,4,5	1.8E+00
Transuranic	R2	6.6E+02	D	8.4E+02	R2	8.2E+02	D	1.1E+03	R2,3	8.0E–02	D,R1,C	1.0E–01
High Level	D	1.5E+02	C	2.1E+02	D	1.7E+02	C	2.2E+02	D	4.1E–02	C	5.0E–02
Hazardous[c]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**8.5E+02**		**2.3E+03**		**1.1E+03**		**3.7E+03**		**2.5E–01**		**2.0E+00**

Waste Type	Waste Transport Fatalities—Continued											
	Number of Occupational Radiation Fatalities[d]				Number of Population Radiation Fatalities				Vehicle-Related Accident Fatalities			
	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.	Alt.	Min.	Alt.	Max.
Low-Level Mixed	D	8.1E–04	R3	1.7E–01	D	3.1E–03	R3	3.8E–02	D	5.0E–04	R3,C	1.4E–02
Low Level	D	1.6E–02	C1,3	4.8E–01	D	6.4E–02	C1,2,4,5	1.2E+00	D	7.3E–03	C1,5	4.7E–01
Transuranic	R2	2.6E–01	D	3.3E–01	R2	4.1E–01	D	5.7E–01	R2	3.3E–02	D	4.3E–02
High Level	D	6.1E–02	C	8.2E–02	D	8.4E–02	C	1.1E–01	D	1.4E–02	C	1.8E–02
Hazardous[c]	--	--	--	--	--	--	--	--	--	--	--	--
Total		**3.4E–01**		**1.1E+00**		**5.6E–01**		**1.9E+00**		**5.5E–02**		**5.5E–01**

Notes: Alt. = alternative; C = Centralized Alternative; D = Decentralized Alternative; Max. = maximum; Min. = minimum; R = Regionalized Alternative; -- = not applicable, see footnote (c); scientific notation such as 7.7E+00 = 7.7 and 2.3E+02 = 230.

[a] Range of impacts does not include the impacts of the No Action Alternatives for low-level mixed waste, transuranic waste, and high-level waste. Transport impacts listed are those that would occur over a 20-year period except for HLW, which would occur over about 40 years.

[b] No combined total indicated as different sites involved.

[c] All shipments of hazardous waste were analyzed on the basis of transport by truck.

[d] Rail crew values are expected to range from impacts listed in this table (for dedicated shipments) to slightly higher than the truck crew impacts identified in the previous table. See Section 5.4.1.1 for a more detailed explanation.

LLW, TRUW, and HLW by rail would result in approximately the same number of fatalities from radiological causes as from vehicle-related causes. HW transportation by truck does not contribute to the potential radiological fatalities but does contribute to physical trauma fatalities. A major difference between truck and rail transport is the number of potential fatalities from physical trauma. All truck transport could potentially result in 5 to 42 physical trauma fatalities, while all rail transport could potentially result in up to one physical trauma fatality. These fatalities from physical trauma for both truck and rail accidents are independent of the shipment contents. Comparatively, from 1971 through 1993, over one million persons were killed in vehicular accidents in the United States (DOE, 1995d). A discussion of the uncertainties involved when comparing the truck and rail transportation impacts is presented in Appendix E, Section E.8.5.

The largest number of shipments to or from a single site could occur at the Nevada Test Site as a result of shipments LLMW and LLW, and the shipments of HLW if Yucca Mountain is found to be suitable for the emplacement of defense HLW. A combined total of more than 295,000 truck shipments or more than 106,000 rail shipments of waste could occur at the Nevada Test Site, or about 118 truck shipments or 42 rail shipments per day (assuming receipt of shipments during 250 days per year).

The transport of each of the waste types under the alternatives is only one source of potential risk associated with the shipment of radioactive materials. Other sources of risk include the shipments of DOE and commercial spent nuclear fuel, other DOE nuclear materials, radioisotopes used in medicine and other activities, and commercial waste. Table 11.20–3 summarizes existing and reasonably foreseeable shipments of radioactive materials that have been included in the assessment of cumulative transportation impacts but that are not a part of the alternatives. A discussion of these other shipments is contained in DOE (1995d).

Table 11.20–4 summarizes the potential cumulative transportation-related radiological collective doses and latent cancer fatalities. Over the 93-year period from 1943 through about 2035, the total number of radiation-related cancer fatalities is estimated at 315, or about three latent cancer fatalities per year on average. Cumulatively, the non-DOE transport of radioactive material accounts for approximately 80% of the collective dose to workers and the public and therefore radiation-related latent cancer fatalities. The total number of potential radiation-related latent cancer fatalities associated with the alternatives in this WM PEIS are about 7% of the cumulative radiation-related latent cancer fatalities.

Table 11.20–3. Other Activities Considered in the Cumulative Transportation Assessment

Activity	Description
Existing activities	
Historical spent nuclear fuel	Historical shipments of DOE spent nuclear fuel to Hanford Site, Idaho National Engineering Laboratory, Savannah River Site, Oak Ridge Reservation, and Nevada Test Site
General transportation	Nationwide transport of radioactive materials for medical, industrial, fuel cycle, and disposal purposes
Reasonably foreseeable activities	
Interim spent nuclear fuel Management	Shipments to and between locations for the storage and interim management of DOE spent nuclear fuel
Geologic repository	Shipments of commercial spent nuclear fuel to the candidate geologic repository at Yucca Mountain, Nevada[a]
Naval reactor components	Shipments of reactor compartments from Puget Sound Naval Shipyard to Hanford
Return of isotope capsules	Shipments of cesium-137 isotope capsules to the Hanford Site
Uranium billets	Shipment of low-enriched uranium billets from the Hanford Site to the United Kingdom

[a] Transportation of TRUW to WIPP is incorporated in the waste management alternatives presented in Section 11.18.

Table 11.20–4. Cumulative Transportation-Related Radiological Collective Doses and Latent Cancer Fatalities[a]

Category	Collective Occupational Dose in Person-Rem	Collective General Population Dose in Person-Rem
Historical DOE spent nuclear fuel shipments (1943-1993)	265.4	106.3
Interim management of DOE spent nuclear fuel shipments		
Naval (truck and train)	1.5 to 15	0.34 to 12
DOE (100% truck 1995 to 2035)	0.0 to 1,000	0.0 to 2,300
DOE (100% train 1995 to 2035)	0.0 to 130	0.0 to 170
Reasonably foreseeable shipments		
Commercial spent nuclear fuel and defense high-level waste to geologic repository[b]	8,600	48,000
Submarine reactor component disposal	--	0.053
Return of cesium-137 isotope capsules	0.42	5.7
Uranium billets	0.50	0.014
Non-DOE shipments of radioactive materials		
1943 to 1982	220,000	170,000
1983 to 2035	89,000	98,000
Waste management alternatives		
Low-level mixed waste	7.7 to 430	9.2 to 510
Low-level waste	230 to 16,000	240 to 19,000
Transuranic waste[c]	2,900 to 3,700	2,900 to 3,900
High-level waste[b]	3,200 to 3,500	4,300 to 4,800
Hazardous waste	--	--
Total collective dose	342,510	346,630
Total latent cancer fatalities	140	175

[a] Estimated occupational and general population doses for all categories except waste management alternatives are based on DOE (1995d).
[b] Shipments to geologic repository and HLW alternatives both include the shipment of HLW from DOE sites to the candidate geologic repository at Yucca Mountain.
[c] TRUW alternatives include the shipment of TRUW to the Waste Isolation Pilot Plant.

Chapter 11
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CHAPTER 12
Mitigation Measures and Unavoidable Adverse Impacts and Irreversible and Irretrievable Commitments of Resources

This chapter discusses possible programmatic and other mitigation measures that could be implemented to reduce or eliminate some adverse environmental impacts. The chapter also addresses unavoidable adverse impacts, the relationship between short-term uses of the environment and the maintenance of long-term productivity, and any irreversible and irretrievable commitments of resources that would occur because of waste management activities.

The regulations promulgated by the Council on Environmental Quality to implement the procedural provisions of the National Environmental Policy Act (42 USC 4321 *et seq.*) (NEPA) require that an environmental impact statement (EIS) include a discussion of appropriate mitigation measures (see 40 CFR 1502.14(f); 40 CFR 1502.16(h)). The term "mitigation" includes the following:

- Avoiding an impact by not taking an action
- Minimizing impacts by limiting the degree or magnitude of an action
- Rectifying an impact by repairing, rehabilitating, or restoring the affected environment
- Reducing or eliminating the impact over time
- Compensating for the impact by replacing or providing substitute resources or environments (40 CFR 1508.20)

In addition, NEPA mandates that an EIS address any adverse environmental effects that cannot be avoided should the proposal be implemented, the relationship between short-term uses of the environment and maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented (NEPA, 102(2)(C)). This chapter describes possible mitigation measures, unavoidable impacts, and irreversible and irretrievable commitments of resources that could result from waste management activities.

12.1 Programmatic Mitigation Measures

The potential human health risks, environmental impacts, and costs associated with the waste management alternatives could be reduced or mitigated through the implementation of programmatic and other mitigation measures. Such programmatic measures to reduce or eliminate potential risks, impacts, and costs are described below. Other mitigation measures are described in Section 12.2.

Pollution Prevention: DOE has a pollution prevention policy that requires DOE sites to employ pollution prevention strategies. To implement these requirements, DOE issued the *1994 Waste Minimization/Pollution Prevention Crosscut Plan* (DOE, 1994) that establishes a DOE-wide goal to meet pollution reduction targets (Executive Order 12856): a 50% reduction in total releases and offsite shipments of toxic chemicals and pollutants by December 31, 1999. The 1994 Crosscut Plan calls for each DOE site to establish site-specific reduction goals for hazardous, radioactive, radioactive mixed, and sanitary wastes and pollutants. Currently, site-specific goals are being prepared. Future implementation of pollution prevention may result in the reduction of future quantities of wastes that require storage, treatment, and disposal, thereby reducing the impacts associated with the construction and operation of these facilities.

Implementing Waste Acceptance Criteria and/or Performance Assessments at low-level mixed waste (LLMW) and low-level waste (LLW) disposal sites: Under DOE Order 5820.2a (DOE, 1988), DOE sites must establish performance objectives for the management of LLW to protect human health and the environment. Each site is responsible to implement and maintain performance assessment documentation. Waste Acceptance Criteria for LLW are imposed to ensure that the dose limitations are not exceeded. The Waste Management Programmatic Environmental Impact Statement (WM PEIS) did not factor the LLW Waste Acceptance Criteria into the analysis, but rather made the general assumption that all waste slated to be transported to a particular site could be accepted by the receiving site. In reality, this may not be the case. Application of LLW Waste Acceptance Criteria could potentially reduce estimated risk and impacts at a given site. It is anticipated that appropriate LLMW Waste Acceptance Criteria will be developed.

Selecting treatment and disposal facility locations within the fenceline based upon site-specific geology and demographics: The analysis required that a specific location be identified to conduct the human health risk and air quality and ecological impact assessments at each site. DOE chose the location of existing facilities to conduct these analyses; however, when no facilities existed onsite, a central location was selected for the placement of the waste management facility. The estimates of human health risk and air quality and ecological impacts may be reduced or mitigated if alternative locations are selected based on site-specific data and considerations. The potential for natural hazards such as floods, erosion, tornadoes, earthquakes, and volcanoes will be considered in selecting the exact locations of facilities.

Changing treatment and disposal technologies based upon site-specific waste criteria, or applying emerging technologies not considered during this study: A base technology was selected for all alternatives. The various processes, identified in the process flow diagrams, reflect only currently existing, proven

technologies. They are also generic in the sense that the same technologies have been applied at all sites. Risk and impacts may be reduced or mitigated in the future by applying technologies that may not have been developed prior to this study, or by implementing tailored technologies based on site-specific and waste-specific needs.

Modifying the engineering facility design to reduce or eliminate risk or impacts: For consistency, the design parameters for each treatment process were the same, regardless of the site or specific waste characteristics (although alpha and remote-handled wastes were treated in engineered facilities designed specifically to meet their special treatment and handling needs). The generic models were developed to meet DOE's General Design Criteria. However, the actual design would be refined to reflect unique, site-specific environmental parameters and operational parameters (e.g., differences in waste loads, chemical and radionuclide composition, and facility age). Tailored designs could reduce anticipated impacts.

Transporting waste based on treatment need rather than geographic proximity, similar to and in close coordination with arrangements specified in the Federal Facility Compliance Act (FFCAct) Site Treatment Plans (STPs): Geographic proximity was used to assign shipping routes for LLMW between DOE sites. This assumption eliminated subjective judgments on where to ship and handle waste and minimized transportation miles. However, the FFCAct (42 USC 6961 *et seq.*) site treatment plan process has established site-specific treatment and shipping arrangements in which DOE's LLMW is transported based upon mutual agreement by the shipping and receiving sites. In addition, the STPs usually consolidate waste for treatment based upon treatment needs of specific waste streams, rather than on geographic proximity. This would reduce total construction requirements and result in fewer impacts and costs at the sites, although impacts from transporting waste between sites may increase.

Using a mix of truck and rail transport based on shipment location, size, and availability: Both truck and rail transport of wastes were analyzed on a DOE-wide basis. However, a more appropriate mix of truck and rail could be chosen to minimize potential risk and impacts at both the receiving and shipping locations, and along the transportation route. Selection of transportation means will be based on human health risks, environmental impacts, and costs.

Combining facilities for various waste types and waste streams, such as the collocation of LLW and LLMW treatment: Although the DOE analyzed the risks, impacts, and costs associated with facilities dedicated to a specific waste type, combining facilities to take advantage of similar processing technologies and units,

infrastructure requirements, and skilled labor could reduce adverse impacts. Combining or locating more than one treatment facility at a site may reduce the risks, impacts, and costs associated with the construction of multiple, new facilities across DOE sites.

Adjusting timing and scheduling of both the analytical time frame of 20 years and the construction and work-off periods for all waste types except HLW: DOE used uniform assumptions for scheduling the construction and treatment periods for inventoried and annually generated wastes (called work-off periods) for all waste types except HLW. This assumption was required to compare impacts and waste loads for a given time period. However, adjustment of the timing and work-off schedules could result in reduced risk and impacts. For example for LLW, LLMW, TRUW and HW under all alternatives except No Action, all facilities were sized according to an averaged throughput over a 10-year period, after assuming a 10-year construction period when wastes were accumulated in a storage facility awaiting treatment. If, however, construction could be completed in a shorter time frame, less waste would accumulate, providing the opportunity for a decreased annual throughput. Additionally, if the work-off period were longer (e.g., 20 years, as opposed to 10), the annual throughput and emissions rates would be reduced.

Implementing strict and mandatory safety programs for all facility and transportation workers: Most of the worker risk associated with treatment and transportation of waste results from industrial type accidents, which were based on actual industrial accident and transportation statistics. The implementation of an intensive and comprehensive training program has reduced the industrial accidents experienced at DOE facilities, resulting in less risk and a more highly skilled, experienced workforce.

Providing retraining opportunities for experienced, skilled DOE workers to move between facilities and jobs within DOE: Good training and experienced workers will likely result in fewer work-related injuries. The WM PEIS assumes the in-migration of workers for each new treatment and disposal facility; however, arrangements might be made to utilize special teams of experienced DOE workers thereby creating a dedicated workforce, redistributing and optimizing employment demands at any given location and potentially reducing risk caused by inexperience.

Future Technology Development: The waste management technologies analyzed in the WM PEIS are those technologies that have been approved by regulators. Other, emerging technologies, however, have not been widely accepted by regulators or are not yet demonstrated and available. Such technologies, while believed

to be sound in theory, may require significant development prior to becoming proven, demonstrated, and acceptable to regulators.

Technology is a major factor in DOE's waste management decisions. The availability, or the projected availability, of appropriate technologies will govern what can be effectively managed with the least risk to health, safety, and the environment. While the selection of technologies is most appropriate to project-specific implementation decisions, technology selection could mitigate the environmental impacts and the economic costs of future waste management activities.

DOE manages an aggressive national program of applied research, development, demonstration, testing, and evaluation for environmental cleanup, waste management, and related technologies. The primary objective of this effort is to achieve compliance with applicable regulations, while lowering human health risks, environmental impacts, and costs. In many cases, the development of new technology presents a greater hope for ensuring a substantial reduction in risk to the environment and improved worker and public safety within realistic financial constraints. DOE is currently pursuing three emerging technologies that could mitigate the potential impacts and costs of implementing the alternatives. These technologies are: treatment of organic contaminants (e.g., nonthermal destruction), monitoring of emissions from treatment (e.g., real-time, continuous emission monitoring), and current transportation development activities (e.g., hazardous materials packagings).

12.2 Other Mitigation Measures

Potential mitigation measures that DOE could implement to reduce human health risks and environmental impacts at each site are summarized in Table 12–1. These measures may be considered in greater detail in sitewide or project-specific NEPA reviews conducted prior to decisions to construct waste management facilities at particular locations at DOE sites. The extent to which risks and impacts may be reduced or eliminated depends on conditions at individual DOE sites.

12.3 Unavoidable Adverse Environmental Effects

Regardless of the alternatives selected by DOE, and despite implementation of the mitigation measures described above, there would be some adverse environmental impacts caused by treating, storing,

Table 12–1. Potential Mitigation Measures

Impact Area	Mitigation Measures
Air Quality—Construction	
Fugitive Dust	• Use of water or chemicals for dust control during road grading or site clearing • Application of asphalt, water, grass seed, or suitable chemical treatments on dirt roads, fill stockpiles, and other surfaces that can give rise to airborne dust • Covering of open bed trucks
Equipment Exhaust	• No unnecessary idling of equipment
Air Quality—Operation	
Thermal Treatment Unit (Incinerator)	• Implementing a potentially cleaner alternative organic treatment technology • Changing incinerator design (e.g., using additional filters to remove particulates, building taller stack to provide greater dispersion, using higher operating temperature to attain more complete destruction of organic contaminants) • Changing composition of waste incinerated (e.g., change waste acceptance criteria to limit amount of certain materials in waste such as radionuclides) • Selecting cleaner burning fuels (e.g., natural gas and low sulfur fuel oils) • Limiting rate of waste introduced into the incinerator (known as the charging rate) • Compensating emissions from new facilities with reduced emissions from existing facilities
Transportation	• Implementing transportation control programs that reduce work-related and vehicle miles traveled such as: • Ridesharing, transit programs, parking management, compressed work weeks, flextime, telecommuting
Water Resources—Construction	
Availability	• Reducing amount of water used for dust suppression and design changes to reduce concrete requirements • Use of alternate water source to minimize impacts to onsite water resources, such as alternatives to water for use in dust suppression and concrete mixing, or mixing concrete offsite and transporting to the site in mixing trucks
Water Resources—Operation	
Availability	• Changing engineering design to increase recycle and reuse of water within facility such as zero discharge facility design • Switching surface water use to groundwater or municipal water supply and vice versa depending upon which resource is more limited • Returning water to source if adequate quality is maintained • Compensating water use requirements for new facilities with reduced water use from existing facilities
Water Resources—Disposal	
Groundwater Quality	• Limiting disposal of problem isotopes or storing waste containing problem isotopes until radioactive decay lessened their concentration • Changing waste form (e.g., vitrification or encasement of waste in polymer resin) • Changing disposal facility design to provide greater isolation (e.g., change shallow land burial to greater confinement disposal) • Increase the institutional control period and the environmental monitoring period to reduce the chance of an undetected release

Table 12–1. Potential Mitigation Measures—Continued

Impact Area	Mitigation Measures
Ecological Resources	
Habitat	• Minimize land area requirements and maintain flexible site design and facility placement to help avoid sensitive habitats • Use engineering control practices during construction to minimize direct discharges to aquatic resource habitats • Consider use of native species for mitigation and/or restoration of habitat impacts • Compensate wetland loss or other habitat loss with creation of new habitat
Economic and Population	• Maintain consistent level of funding throughout the life of the project to provide stable economic environment • Assist community to compensate for situations where existing resources may fall short of demand (e.g., return of land suitable for development to local community) • Close coordination with appropriate agencies (public and private) in local community to anticipate future demand and plan necessary facilities • Staggering start and shut-down dates to extend the period over which the complex employs waste management workers • Job training and retraining (to help reduce demand for new employees who would in-migrate into regions and place additional demands on local infrastructure) • Cooperation and communication with existing industries to identify and take advantage of opportunities for diversification
Infrastructure	• Expansion of water supply, wastewater treatment, and power supply capacity or allotment to meet new demand and anticipated long term regional growth; consideration of burden payments may be necessary, depending upon severity of impacts • Implementation of or strengthening of site resource conservation measures (e.g., reducing landscaping irrigation, using reclaimed greywater for irrigation and other uses where possible, installing energy-efficient fluorescent lights) • Implementation of or strengthening of community resource conservation measures and education (e.g., rating homes and businesses for energy-efficiency and providing incentives for improvements) • Working with local and regional planners to prepare for additional road traffic, water, wastewater treatment, and power supply requirements to enhance ability of affected jurisdictions to plan effectively • Compensate infrastructure requirements for new facilities with reduced infrastructure requirements from existing facilities
Cultural Resources	• Use of surveys to ensure adherence with the National Historic Preservation Act and associated regulations • Involvement of stakeholders concerned about cultural resources in decision making

Table 12–1. Potential Mitigation Measures—Continued

Impact Area	Mitigation Measures
Public and Worker Safety	• Use of safety analyses to establish safety limits within which a facility can operate while limiting risks and adequately protecting the environment • Review and modification, as appropriate, of existing emergency action plans at DOE sites to ensure appropriate response to accidents and other emergencies that might arise from operation of new waste management facilities • Planning of specific transportation routes to minimize risk using DOT routing guidelines • Training to ensure that emergency response personnel are knowledgeable of emergency response procedures

disposing, and transporting wastes. The location and severity of these impacts will depend on which of the alternatives is implemented for a given waste type. In general, more sites will experience unavoidable impacts under the Decentralized Alternative for any of the waste types than under the Regionalized or Centralized alternatives. Aggregate transportation impacts, in contrast, will increase under the Regionalized and Centralized alternatives because more shipments would be required to treat and dispose the total aggregate waste load. This section includes discussion of adverse effects that potential mitigation measures could not reduce or avoid.

Health Risk to Workers and the Public. Some health risks to workers and the public will be unavoidable at the time selected management strategies are implemented. Workers at facility construction sites, operating waste management facilities, and involved in truck or rail shipments are subject to the same types and frequencies of injuries and accidental deaths that workers experience across the industrial sector of the nation. Workers would also be exposed to the specific health risks of exposures to radiation and hazardous chemicals. The public would generally be at a lower risk than any of the workers involved in waste management activities. Risks would be higher at those sites where waste management activities are concentrated; where the largest waste loads are treated and disposed of under the Regionalized and Centralized alternatives. The Decentralized alternatives would tend to spread the public health risks more evenly across the sites. Although more individuals are likely to be at risk, their exposure levels are likely to be lower. Transportation risks too would tend to be lower under the Decentralized alternatives because the bulk of the wastes would remain at their site of origin.

Air Quality. Construction activities at each site would result in short term, elevated levels of particulate matter in localized areas. During the operational phases of facilities, air quality would be affected unavoidably through the introduction of criteria and hazardous and toxic air pollutant emissions at the sites and from worker vehicles and truck or rail waste shipment vehicles. In general, these impacts would be greater under those alternatives where activities are concentrated at a single site (Centralized) or group of sites (Regionalized). Criteria air pollutants in particular would increase where worker vehicle traffic, waste shipments by truck or rail, and fuel burning by waste management facilities all are at their highest levels at the Centralized sites. Effects at any single site would reflect the specific attainment status of the site's air quality control region for each criteria air pollutant. These effects would increase if one site is chosen as the Centralized location for management of two or more waste types.

Habitats. Portions of nonsensitive terrestrial habitats would be lost when waste management facilities are constructed. A greater amount of habitat acreage will be lost in aggregate under the Decentralized Alternative because each site must build facilities to manage its own wastes. At any single site, however, the greatest habitat loss would be in the Centralized Alternative where facilities to treat and dispose of all the waste of a particular type would be built at one site. Based on the WM PEIS analyses, none of these habitat losses is expected to constitute a significant impact to the resident plant and animal species because these species have broad ranges and the amount of lost habitat would comprise only a small fraction of these communities. Impacts to sensitive species and their habitats may be avoidable because decisions on specific facility locations at a site are yet to be made.

Economic Effects. The economic effects of the waste management alternatives would generally be considered beneficial, adding jobs and infusing monies to the regional economy at each site. The major sites would benefit more under the Centralized alternatives. However, at those sites where waste may be shipped offsite for treatment or disposal, there could be economic impacts, due to the relocation of jobs or reduced expenditures in the region of influence. These effects are partially offset by the increased potential for economic diversification that may result from alternate economic uses of the land.

Infrastructure Impacts. Infrastructure impacts are unavoidable at sites where existing systems are currently nearing capacity. At sites where DOE's decisions to implement waste management activities require construction of additional water supply, electrical power supply, waste water treatment, or transportation infrastructure, the environmental impacts of such construction projects would be unavoidable. Also, use of energy and water resources to support operation would be unavoidable.

Cultural Resource Impacts. In most instances, project requirements for available land at sites are sufficiently small to allow DOE to avoid impacts to cultural resources. As was the case with sensitive species and environmental justice concerns, decisions on specific facility locations are yet to be made. However, the cultural resource surveys and impacts analysis that would be part of the NEPA reviews at the site and project level should provide sufficient data to enable DOE to site required facilities with minimal or no effect on existing cultural resources.

12.4 Relationship Between Short-Term Use of the Environment and the Maintenance and Enhancement of Long-Term Productivity

Short-term impacts are those that would occur during waste management facility construction and operation. Impacts that extend beyond the period of waste management facility operations are considered to be long-term.

The implementation of each of the waste management alternatives would require short-term use of the environment and a variety of resources such as land, fuel, construction materials, and labor. Development of new waste management treatment and storage facilities would commit lands to those uses from the beginning of the construction period through the duration of the operation period and until such facility is fully decommissioned. Depending upon the specific locations at sites selected for treatment and storage facilities, some terrestrial habitat may be lost when the area is cleared for construction. Disturbance of this acreage would eliminate the natural productivity of the land. At the end of the operational period, these waste management facilities could be converted to other industrial uses or decontaminated and decommissioned and the land returned to its original use or a condition compatible with future uses.

Since certain DOE wastes contain long-lived radionuclides, disposal actions are expected to commit resources for an indefinite period of time, resulting in the potential long-term loss of resources and productivity. The loss of land for disposal may be especially important at sites with small land areas. Proper disposal of wastes, however, has the benefit or providing long-term isolation of wastes from the environment while not incurring the use of additional land areas, costs, and labor resources for indefinite storage of wastes.

Wetlands, threatened or endangered species habitats, wildlife preserves, parklands, rare habitats, and other specially designated sites are considered to be ecologically sensitive areas. The analysis of ecological

resource impacts assumes that significant impacts to ecologically sensitive areas as a result of new treatment, storage and disposal facility construction can generally be avoided because DOE will have flexibility in locating waste management facilities at particular sites.

Ecological resources would be affected mainly through disturbance or loss of habitat resulting from site clearing and construction. Terrestrial resources would be directly affected by land clearing, which would adversely affect the habitat of terrestrial animals. These changes may be significant for individual animals of certain species with limited home ranges, such as small mammals and songbirds, and lead to direct mortality and higher susceptibility to predation. Given the amount of land area required for waste management facilities and the expected availability of locally similar habitat, the overall effect should be displacement of individual organisms with limited impact on local populations.

Aquatic resources may be indirectly affected through increased runoff and sedimentation in surface waters from disturbed land areas. However, the use of various mitigation techniques could minimize potential waste management facility construction impacts to aquatic ecological resources. Direct discharges of contaminants to surface waters from the routine operation of waste management facilities are expected to be limited by engineering control practices. Therefore, long-term impacts to aquatic organisms are expected to be minimal.

12.5 Irreversible and Irretrievable Commitments of Resources

This section describes the major irreversible and irretrievable commitments of resources that can be identified at this programmatic level of analysis. A commitment of resources is irreversible when primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources neither renewable nor recoverable for future use.

The programmatic decisions resulting from this PEIS will select waste management strategies that could lead to the commitment of resources to new construction and renovation of treatment, storage, and disposal facilities at identified sites. This section discusses three major resource categories that could be committed irreversibly or irretrievably to the proposed action at the time strategy is implemented: land, materials, and energy.

Land Use. The land that is currently occupied by treatment and storage facilities could ultimately be returned to open space uses if buildings, roads, and other structures were removed, areas cleaned up, and the land revegetated. Alternatively, the facilities could be modified for use in other DOE programs. Therefore, the commitment of such land is not necessarily irreversible.

However, land rendered unfit for other purposes, such as that set aside for disposal facilities, represents an irreversible commitment of resources. The land could not be restored to its original condition, nor could the site feasibly be used for any other purposes following closure of the disposal facility. This land would be perpetually unusable because it would not be available for other potential intrusive uses such as mining, utilities, or foundations for other buildings.

The value of any land set aside for waste management operations, whether calculated in market terms or as the value of other social or economic land uses that may be forgone, is a site-specific consideration. Because the actual locations of WM facilities on sites will not be determined by this PEIS, it is not possible to discuss the potential for lost value of any land designated for WM use nor the potential change in value of any adjacent land. These will be more appropriately addressed in tiered, sitewide or project-specific NEPA analyses where the importance of specific land areas and uses to stakeholder groups in the region can be considered.

In the environmental impact statement for FEMP, for instance, it was stated that DOE expected to irreversibly commit some 220 acres of the approximately 1,000-acre site for long-term disposal. Under current law, such commitments documented in an environmental impact statement or comparable environment analysis are immunized from natural resource damage liability. Similar commitments could occur in siting facilities based on decisions that result from this PEIS. In addition, DOE will attempt to identify sensitive resources prior to siting in order to minimize the impact that long-term disposal may have on natural resources of value to humans and the environment.

Material. The irreversible and irretrievable commitment of material resources during the life-cycle of treatment, storage, and disposal facilities includes construction materials that cannot be recovered or recycled, materials that are rendered radioactive and cannot be decontaminated, and materials consumed or reduced to unrecoverable forms of waste. Where construction is necessary, materials required include wood, concrete, sand, gravel, plastics, steel, aluminum, and other metals. These construction resources, except for those that can be recovered and recycled with present technology, would be irretrievably lost.

However, none of those identified construction resources is in short supply, and all are readily available in the vicinity of locations being considered for new waste management facilities.

The commitment of materials in new equipment that cannot be recycled at the end of the project's useful lifetime is irretrievable. Consumption of operating supplies, chemicals, and gases, while irretrievable, is not expected to involve any material in critically short supply in the United States.

Materials reduced to unrecoverable forms of waste, such as uranium, are also irretrievably lost. However, strategic and critical materials, or resources having small natural reserves, are of such value that economics promotes recycling. Plans to recover and recycle as much of these valuable, depletable resources as is practical depend on need, and each item would be considered individually at the time a recovery decision is required.

Energy. The irretrievable commitment of resources during construction and operations of facilities would include the consumption of fossil fuels used to generate heat and electricity. Energy would also be expended in the form of diesel fuel, gasoline, and oil for construction equipment and transportation vehicles. The amount of energy required to operate treatment, storage and disposal facilities, and construction equipment and transportation vehicles would be irretrievable.

Chapter 12
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CHAPTER 13
List of Preparers

Those who filled primary roles in the preparation of this Department of Energy (DOE) Waste Management Programmatic Environmental Impact Statement (WM PEIS) are noted in this chapter.

The WM PEIS project manager is David Hoel of DOE's Office of Environmental Management.

For preparation of the WM PEIS, primary assistance was provided to DOE by Argonne National Laboratory (ANL), and its subcontractors, Maria Elena Toraño Associates, Inc. (META), Louis Berger and Associates, Inc. (Berger), Lamb Associates, Inc. (Lamb) and Brown and Root Environmental (BRE). The DOE WM PEIS Team provided direction to the WM PEIS contractors through ANL. ANL and its subcontractors were responsible for developing analytical methodology and alternatives, and for work coordination, impact analysis, and production of the WM PEIS. DOE was responsible for data quality, for the scope and content of the WM PEIS, and for providing issue resolution and direction to ANL and its subcontractors.

Several of the national laboratories assisted in preparing supporting information and documentation. These included Argonne National Laboratory-East (ANL); Oak Ridge National Laboratory (ORNL); Battelle Pacific Northwest National Laboratory (PNNL); Los Alamos National Laboratory (LANL); and Idaho National Engineering Laboratory (INEL). These laboratories worked closely throughout the WM PEIS development process. Their interrelationships and contributions are illustrated in Figure 13-1. The supporting information and documentation prepared by the national laboratories were evaluated by DOE. The DOE was responsible for determining the appropriateness and adequacy of incorporating into the WM PEIS any data, analyses, and results of other work performed by the national laboratories before incorporating the information into this PEIS.

Argonne National Laboratory was responsible for integrating the effort of all required contractors and national laboratories, and was the primary responsible organization for producing the Final WM PEIS for DOE.

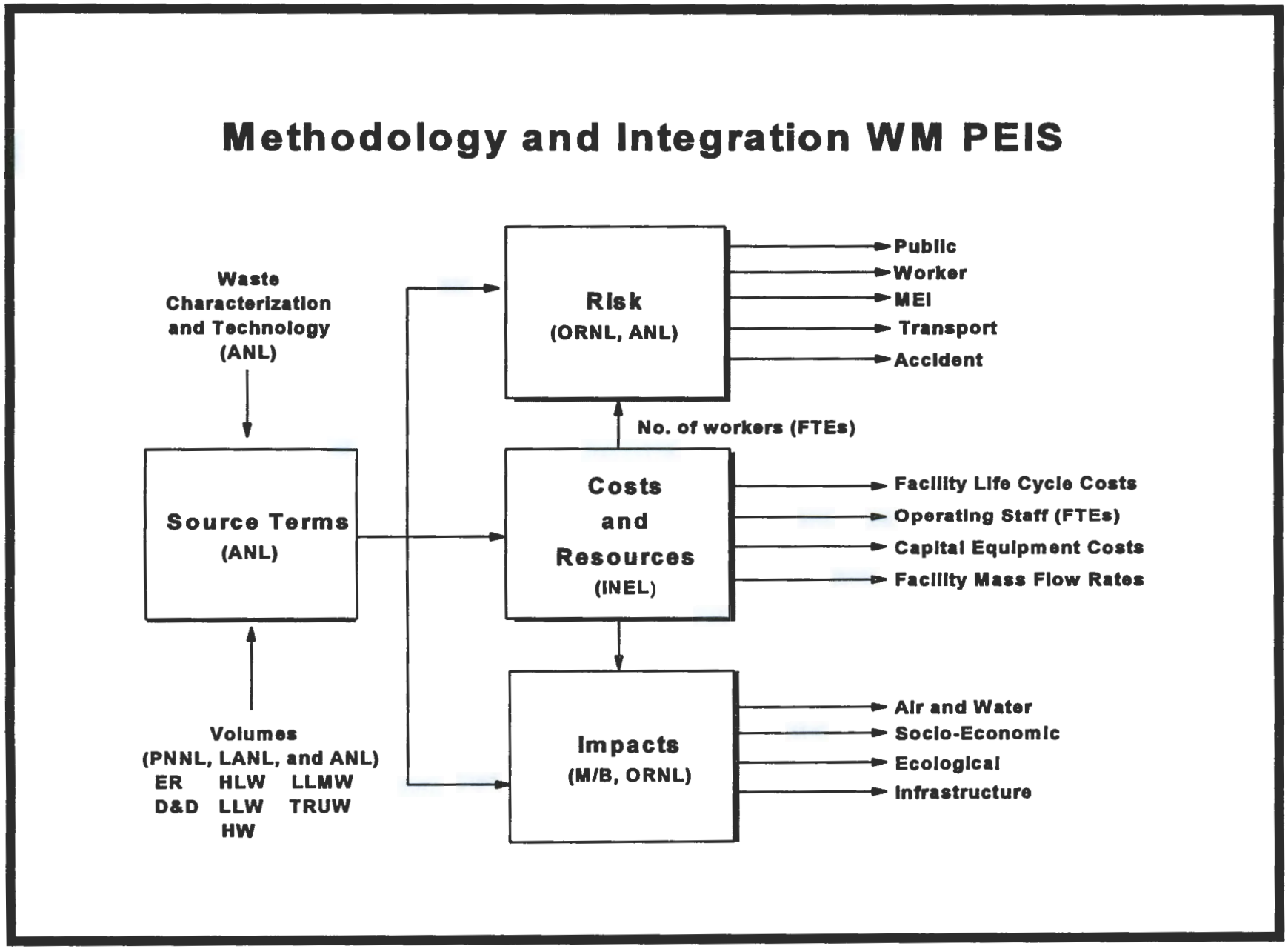

Figure 13–1. WM PEIS Analytical Relationships

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CHAPTER 14
Glossary

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

500-Year Flood. A flood event of such magnitude it occurs, on average, every 500 years (equates to a 0.2% probability of occurring in any given year).

Absorbed Dose. The energy imparted to matter (such as tissue) by ionizing radiation per unit mass or irradiated material at the place of interest in that material (such as a specific internal organ). The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray).

Accident, Transportation. In a mobile environment, the harmful effects of an unplanned event on the human environment with respect to both safety and health.

Accident, Treatment, Storage and Disposal [TSD] Facility. Within a stationary environment, the harmful effects of an unplanned event on the human environment (effects on buildings and equipment are relevant only to the degree that human safety and/or health are affected). TSD facility accidents are concerned with safety and health effects arising from both radiological and hazardous sources (contamination, inhalation, or radiation) and from physical phenomena (fire, flood, earthquake, or other mechanical or thermal forces).

Adsorption. The adhesion of a substance to the surface of a solid or solid particles.

Affected Environment. As used in the preparation of an Environmental Impact Statement (EIS), a description of the existing environment (e.g., site descriptions) covering information that directly relates to the scope of the proposed actions and alternatives whose impacts are to be analyzed; i.e., the information necessary to assess or understand the impacts. Often referred to as the baseline for the EIS concerned. Must be in sufficient detail to support the impact analysis including cumulative impact analysis (see "Cumulative Impact"). This 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.

Air Pollutant. Any substance, including but not limited to dust fume, gas, mist, odor, smoke, vapor, pollen, soot, carbon, or particulate matter, that is regulated.

Air Quality. The specific measurement in the ambient air of a particular air pollutant at any given time.

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

Air Quality Criteria. The varying amounts of pollution and lengths of exposure at which specific adverse effects to health and welfare take place.

ALARA. *See* **As Low as Reasonably Achievable**.

Alluvia/Alluvium. Material deposited by running water, such as clay, silt, sand, and gravel.

Alpha-Low-Level Waste. This waste is not a different waste type per se, but rather, low-level radioactive waste materials contaminated with alpha-emitting (helium nuclei) radionuclides not listed under uranium/thorium or low levels (< 100 nanocuries per gram) of transuranic isotopes. Special handling and additional levels of containment are required to protect workers from ingesting this waste into the respiratory system. It is normally disposed similar to low-level waste, except for the precautionary measures for the workers involved (see "Radiation, Alpha Particle").

Alpha Particle. A positively charged subatomic particle emitted from a nucleus during radioactive decay. It is made up of two neutrons and two protons bound together, and hence is identical with the nucleus of a helium atom. It is the least penetrating of the three common types of radiation emitted by radioactive material, and can be stopped by a sheet of paper. It is not dangerous to plants, animals, or humans unless the emitting substance has entered the body.

Alternative. As used in the preparation of an Environmental Impact Statement (EIS), one of the range of reasonable alternatives to the proposed action (see "Action"). For a Programmatic EIS, one of the range of reasonable alternatives for achieving the program's goal or meeting a legislative requirement (i.e., a

specific proposed action (project) is not necessarily specified). Reasonable alternatives are those that are practical or feasible from a common sense, technical, *and* economic standpoint.

Alternative, No Action. The No Action Alternative must be considered in a U.S. Department of Energy Environmental Impact Statement. It need not be a reasonable alternative. "No Action" can mean doing nothing or it can mean continuing with an existing course of action. It also can mean discontinuing the present course of action by phasing out operations in the near term. The No Action Alternative is meant to provide an environmental baseline against which impacts of the proposed action (and its alternatives) can be compared (see "Affected Environment").

Alternative, Preferred. The alternative that the U.S. Department of Energy believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical, and other factors.

Alternatives, Centralized. Alternatives that would result in transporting wastes to one or two sites for treatment, storage, or disposal. As with the Regionalized Alternatives, those sites that have the largest volumes of a given waste type were generally considered as sites for Centralized treatment, storage, or disposal.

Alternatives, Decentralized. Alternatives that would result in managing waste where it is or where it will be generated, treated, or disposed of in the future. Unlike the No Action Alternative, the Decentralized Alternatives may require the siting, construction, and operation of new facilities or the modification of existing facilities. Under the Decentralized Alternatives, the waste management facilities would be located at a larger number of sites than under the Regionalized or Centralized Alternatives.

Alternatives, Regionalized. Alternatives that would result in transporting wastes to various numbers of sites (fewer than the number of sites considered for the Decentralized Alternatives but greater than the number of sites considered for the Centralized Alternatives). In general, those sites that now have the largest volumes of a given waste type are considered as regional sites for treatment, storage, or disposal. More than one Regionalized Alternative is considered for all waste types.

Ambient Air Quality Standard. The prescribed level of a pollutant in the outside air that cannot be exceeded during a specified time in a specified geographical area. Established by both Federal and state governments (see "Air Pollutants, Hazardous").

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

Anticline. A convex upward fold of rock.

Applicable or Relevant and Appropriate Requirements (ARARs). Requirements, including cleanup standards, standards of control, and other substantive environmental protection requirements and criteria for hazardous substances as specified under Federal and state law and regulations, that must be met when complying with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980.

Aquifer. A body of rock or sediment sufficiently permeable to conduct groundwater and to yield significant quantities of water to wells and springs.

Aquitard. A less-permeable geologic unit in a stratigraphic sequence. The unit is not permeable enough to transmit significant quantities of water. Aquitards separate aquifers.

Arroyo. A gully or channel cut by an intermittent stream.

As Low As Reasonably Achievable (ALARA). An approach to control or manage radiation exposures (both individual and collective to the workforce and the public) and releases of radioactive material to the environment as low as social, technical, economic, practical, and public policy considerations permit. ALARA is not a dose limit. It is a process that has as its objective the attainment of dose levels as far below applicable limits as possible.

Atomic Energy Act of 1954. A Federal statute that, along with other related legislation (including the Energy Reorganization Act of 1974 and the Department of Energy Organization Act of 1977), provides

U.S. Department of Energy with the authority for developing generally applicable standards for protecting the environment from radioactive materials.

Atomic Energy Commission (AEC). A five-member commission, established by the Atomic Energy Act of 1946, to supervise nuclear weapons design, development, manufacturing, maintenance, modification, and dismantlement. In 1974, the Atomic Energy Commission was abolished and all functions were transferred to the U.S. Nuclear Regulatory Commission and the Administrator of the Energy Research and Development Administration (ERDA). ERDA was later terminated and its functions vested by law in the Administrator were transferred to the Secretary of Energy.

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

Background Level. The value assigned to the quantity of particulate or gaseous material in ambient air that originates from natural sources uninfluenced by the activity of man.

Background Radiation. Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material), and global fallout as it exists in the environment from the testing of nuclear explosive devices.

Baseline. *See* **Affected Environment**. *See* **Alternative, No Action**.

Basement Rocks. The undifferentiated complex of rocks that underlies the rocks of interest in an area. In many places the rocks of the complex are igneous and metamorphic and of Precambrian Age.

Best Available Technology (BAT). The preferred technology for treating a particular process liquid waste containing radioactive material so that the final waste stream will contain radionuclide concentrations no greater than the Derived Concentration Guide reference values at the point of discharge to a surface waterway.

Best Demonstrated Available Technology (BDAT). Earlier demonstrations have shown that incineration, vitrification, and aqueous treatment are effective in reducing the concentration of hazardous materials in

waste shipments to levels acceptable for land disposal technologies. Concentration levels are set by the Land Disposal Restrictions standards stipulated in the Hazardous and Solid Waste Disposal Act of 1984. The U.S. Environmental Protection Agency established the Land Disposal Restrictions standards on the basis of BDATs rather than risk-based or health-based standards.

Beta Particle. An elementary subatomic particle emitted from a nucleus during radioactive decay, with a single electrical charge and a mass equal to 1/1,837 that of a proton. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron. Beta particle radiation may cause skin burns, and beta particle emitters are harmful if they enter the body. Beta particles are easily stopped by a thin sheet of metal or plastic.

Bounding. In the context of accident analysis, bounding is a term used to identify conservative assumptions that will likely overestimate actual risks or consequences.

Calcination. An inorganic material is heated in a calciner to high temperatures but without fusing in order to drive off volatile matter (to remove organic material) or to effect changes (as oxidation or pulverization or to convert it to nodular form). Calciners and nodulizing kilns are considered to be similar units.

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

Candidate Species. Plant or animal species that are not yet officially listed as threatened or endangered but are undergoing status review by the U.S. Fish and Wildlife Service. They are candidates for possible addition to the list of threatened and endangered species.

Canister. A metal receptacle surrounding the waste form that facilitates handling, storage, transportation, and/or disposal.

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

Case. With respect to an Environmental Impact Statement, a case is analogous to an alternative (see "Alternative"). The term "case" is used when several alternatives are predominantly similar; e.g., construction of a given plant at one site, at two sites, at three sites, etc.

Cask (Radioactive Materials). As defined by the U.S. Environmental Protection Agency, a cask is a thick-walled container (usually lead) that meets all applicable regulatory requirements for transporting radioactive materials.

CERCLA. *See* **Comprehensive Environmental Response, Compensation, and Liability Act**.

Characterization. The determination of waste composition and properties, whether by review of process knowledge, nondestructive examination or assay, or sampling and analysis, generally done for the purpose of determining appropriate storage, treatment, handling, transportation, and disposal requirements.

Class I Area. Under the Clean Air Act, any Federal land that is classified or reclassified "Class I." The designation applies to pristine areas, such as national parks and wilderness areas, where substantial growth is effectively precluded in order to avoid any degradation of the air quality.

Classified Waste. Waste materials, including weapons components and assemblies, designated by the U.S. Government, pursuant to Executive Order, statute, or regulation, that require protection against unauthorized information or material disclosure for reasons of national security. Additional security and safeguards management activities are required in the handling of these materials.

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

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

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

Collective Dose. The sum of the total effective dose equivalent values for all individuals in a specified population. Collective dose is expressed in units of person-rem.

Collocated Workers. Workers in a fixed population outside the day-to-day safety management controls of a given facility area. In practice, this fixed population is normally the workers at an independent facility area located some distance from the reference facility area. Also, an individual assumed to be located 100 meters (328 feet) from where an accidental release occurs.

Combined Impact. Depending on the scope of the program concerned, a Programmatic Environmental Impact Statement may address more than one "Purpose and Need," each with its own set of alternatives. These several actions, however, may have common environments (e.g., two or more nuclear waste types being managed at the same site). The sum of these impacts with respect to the site concerned are combined impacts, as opposed to cumulative impacts (see "Cumulative Impacts"), which incorporate the site-specific impacts of activities not otherwise related to the action(s) and alternatives in question.

Commercialization. In this PEIS, commercialization refers to the use of a waste management facility that is owned and operated by a private entity (or State) that treats, stores, or disposes of waste from a variety of sources for a fee.

Committed Dose Equivalent (CDE). The calculated dose equivalent projected to be received by a tissue or organ over a 50-year period after an intake of radionuclide into the body. It does not include contributions from external dose. Committed dose equivalent is expressed in units of rem.

Committed Effective Dose Equivalent (CEDE). The sum of the committed dose equivalents to various tissues in the body, each multiplied by its weighting factor. It does not include contributions from external dose. Committed effective dose equivalent is expressed in units of rem.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). A Federal law (also known as "Superfund") that provides a comprehensive framework to deal with past or abandoned hazardous materials. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 provides for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment that could endanger public health, welfare, or the environment, as well as the cleanup of inactive hazardous waste disposal sites. CERCLA has jurisdiction over any release

or threatened release of any "hazardous substance" to the environment. Under CERCLA, the definition of "hazardous" is much broader than under the Resource Conservation and Recovery Act, and the hazardous substance need not be a waste. If a site meets the CERCLA requirements for designation, it is ranked along with other "Superfund" sites and listed on the National Priorities List. This ranking and listing is the U.S. Environmental Protection Agency's way of determining which sites have the highest priority for cleanup.

Contact-Handled Waste. Waste with a surface dose rate that does not exceed 200 millirems/hour.

Contamination. The deposition of unwanted radioactive or hazardous material on the surfaces of structures, areas, objects, or personnel.

Cradle-to-Grave. In the context of waste management, cradle-to-grave means from the time of generation through permanent disposal.

Criteria Air Pollutant. One of six air pollutants for which National Ambient Air Quality Standards are established by the U.S. Environmental Protection Agency under Title I of the Federal Clean Air Act. The six pollutants are sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, particulate matter (equal to or smaller than 10 microns in diameter), and lead.

Cultural Resources. Archaeological sites, architectural features, traditional-use areas, and Native American sacred sites or special-use areas.

Cumulative Impact. In an Environmental Impact Statement, the impact on the environment that results from incremental impacts of an 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. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR Part 1508.7) (see "Combined Impact").

Curie (Ci). The basic unit used to describe the intensity of radioactivity in a sample of material. The curie is equal to 37 billion disintegrations/second, which is approximately the rate of decay of 1 gram of radium. A curie is also a quantity of any radionuclide that decays at a rate of 37 billion disintegrations/second.

Daughter Products. Nuclides formed by the radioactive disintegration of a radionuclide (parent).

Deactivation. A technology applied to a hazardous substance to mitigate its hazardous characteristics, such as ignitability, corrosivity, or reactivity.

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

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

Depleted Uranium. Uranium whose content of the isotope uranium-235 is less than 0.7%, which is the uranium-235 content of naturally occurring uranium.

Derived Concentration Guide (DCG). The concentration of a radionuclide in air or water that, under conditions of continuous exposure by ingestion of water, submersion in air, or irradiation, would result in an effective dose equivalent of 100 millirem for 1 year of exposure. DCG values are listed in DOE Order 5400.5. DOE drinking water standards are 4% of the DCG values for ingestion, and thus meet the criterion of 4 millirem/year.

Disposal. Emplacement of waste in a manner that ensures protection of human health and the environment within prescribed limits for the foreseeable future with no intent of retrieval and that requires deliberate action to regain access to the waste.

Disposal Facility. A facility or part of a facility at which hazardous, radioactive, or solid waste is intentionally placed into or on any land or water, and at which waste is intended to permanently remain after closure.

Disposition, Final. The ultimate solution to disposition of nuclear or hazardous waste: it will never again require handling and/or movement. For a given volume of waste, the final disposition may be represented by recycling, reprocessing, incineration, or burial (see "Storage" and "Storage, Long-Term").

Disproportionate. Neither DOE nor the Federal Working Group on Environmental Justice has yet issued final guidance on interpreting the provisions of the Executive Order on Environmental Justice, nor has there been a judicial interpretation of the term "disproportionate" within the context of environmental justice. In general use, disproportionate refers to a condition of disparity, or a lack of symmetry in the relation of one part of an entity to another part or to the whole with respect to magnitude, quantity, or degree. For purposes of the environmental justice analysis in the WM PEIS, the use of the term refers to any distribution of impacts across minority, low-income, or Native American populations that may be substantially greater in magnitude or quantity than that experienced by the general population. A high or adverse impact (or risk or rate of impact) is disproportionate when it significantly exceeds, for a low-income, minority, or Native American community, the same type of impacts in the larger community (for environmental impacts) or the risk or rate to the general population and, where available, to another appropriate comparison group (for health impacts).

Dose (or Radiation Dose). The amount of energy deposited in body tissue as a result of radiation exposure. Various technical terms, such as absorbed dose, collective dose, dose equivalent, and effective dose equivalent, are used to evaluate the amount of radiation an exposed person receives. Each of these terms is defined in this glossary.

Dose Equivalent. (a) That number (corrected for background) zero (minimal or negligible) and above, that is recorded as representing an individual's dose from external radiation sources or internally deposited radioactive materials determined in accordance with DOE Order 5480.1B, Chapter XI, Requirements. (b) The product of absorbed dose in rads in tissue and a quality factor. Dose equivalent is expressed in units of rem. (c) The product of the absorbed dose, the quality factor, and any other modifying factors. The dose equivalent is a quantity for comparing the biological effectiveness of different kinds of radiation (based on the quality of radiation and its spacial distribution in the body) on a common scale. The unit of dose equivalent is the rem. A millirem (mrem) is one thousandth (0.001) of a rem.

Ecological Impact. The effect that a manmade or natural activity has on living organisms and their nonliving (abiotic) environment.

Ecotoxicity. A measure of the ecological effects of chemicals.

Effective Dose Equivalent (EDE). The summation of the products of the dose equivalent received by specified tissues (or organs) of the body and a tissue-specific weighing factor. This sum is a risk-equivalent value and can be used to estimate the health-effects risk of the exposed individual. The tissue-specific weighing factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent due to penetrating radiation from sources external to the body. Weighing factors are: 0.25 for gonads, 0.15 for breast, 0.12 for red bone marrow, 0.12 for lungs, 0.03 for thyroid, 0.03 for bone surface, and 0.06 for each of the other five organs receiving the highest dose equivalent. Effective dose equivalent is expressed in units of rem.

Effects (40 CFR Part 1508.8). "Effects" include: (a) direct effects, which are caused by the action and occur at the same time and place; (b) indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems. Effects and impacts as used in the Council on Environmental Quality regulations are synonymous. Effects include ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Effects may also include those resulting from actions that may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial (see "Human Environment").

Effluent. A gas or fluid discharged into the environment.

EIS. *See* **Environmental Impact Statement**.

Emission Standard. A permit or regulatory requirement contained in 40 CFR Part 60 or 40 CFR Part 61 (that sets forth the National Emission Standards for Hazardous Air Pollutants), that limits the quantity, rate, or concentration of emissions on a continuous basis, including any requirements that limit opacity, prescribe equipment, set fuel specifications, or prescribe operation or maintenance procedures to ensure continuous emission control.

Endangered Species. Any species or subspecies of animal or plant whose survival is threatened with extinction throughout all or a significant portion of its range.

Endpoints. The types of potential adverse health effects evaluated in the health risk analysis. These effects include cancer incidence, cancer fatality, genetic effects, physical trauma injury and fatality, and noncancer effects (e.g., headaches, dermal irritation, liver or kidney toxicity, neurotoxicity, immunotoxicity, and reproductive and development toxicity).

Engineered Barriers. Manmade components in a disposal system designed to prevent the release of radionuclides into the geologic medium involved. This term includes the radioactive waste form, radioactive waste containers, and other materials placed over and around such containers. A manmade structure or device that is intended to improve the land disposal facility's ability to meet performance objectives.

Enriched Uranium. Uranium that has greater amounts of the fissionable isotope uranium-235 than occurs naturally. Naturally occurring uranium is 0.72% uranium-235.

Environment. The sum of all external conditions affecting the life, development, and survival of an organism.

Environmental Impact Statement (EIS). A report by Federal agencies, prepared in accordance with the National Environmental Policy Act, that documents the information required to evaluate the environmental impact (both positive and negative effects) of a proposed project ("action"). Such a report informs decision makers and the public of the reasonable alternatives that would avoid or minimize adverse impacts or enhance the quality of the environment. The draft EIS (DEIS) is circulated for public comment before the final EIS (FEIS) is prepared.

Environmental Justice. The fair treatment of people of all races, cultures, and income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (U.S. Environmental Protection Agency Office of Environmental Justice Small Grants Programs, Pre-Application Kit for Assistance, FY 1995).

Environmental Monitoring. The process of sampling and analyzing environmental media in and around a facility being monitored to (a) confirm compliance with performance objectives and (b) detect any contamination entering the environment early enough to facilitate timely remedial action.

Environmental Restoration. Cleanup and restoration of sites, and decontamination and decommissioning of facilities contaminated with radioactive and/or hazardous substances during past production, accidental releases, or disposal activities.

Environmental Restoration Program. A U.S. Department of Energy (DOE) subprogram concerned with all aspects of assessment and cleanup of both contaminated (radioactive and/or hazardous substances) DOE-owned facilities in use and of DOE sites that are no longer a part of active operations. Remedial actions, most often concerned with contaminated soil and groundwater and decontamination and decommissioning are responsibilities of this program.

Epidemiology. Study of the distribution of disease or other health-related states and events in human populations, as related to age, sex, occupation, ethnic, and economic status in order to identify and alleviate health problems and promote better health.

Exceedance. A value that goes over a prescribed limit.

Exposure Index. The sum of all ratios that compare the estimated exposure concentration of a particular noncarcinogenic chemical to an appropriate occupational exposure limit for that chemical.

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

External Dose Rate. The radiation dose from a shipping package delivered per unit time (e.g., rem per year).

Facility. (a) Any equipment, structure, system, process, or activity that fulfills a specific purpose. Examples include accelerators, storage areas, research devices, nuclear reactors, production or processing plants, conversion plants, windmills, radioactive waste disposal systems and burial grounds, testing laboratories, research laboratories, transportation activities, and accommodations for analytical examinations of irradiated and nonirradiated components. (b) Buildings and other structures; their functional systems and equipment, including site development features such as landscaping, roads, walks, and parking areas; outside lighting and communications systems; central utility plants; utilities supply and distribution systems; and other physical plant features. (c)(1) Any building, structure, installation, equipment, pipe, or pipeline (including any pipe into a sewer or publicly owned treatment works), well, pit, pond, lagoon, impoundment, ditch, landfill, storage container, motor vehicle, rolling stock, or aircraft, or (2) any site or area where a hazardous substance has been deposited, stored, disposed of, or placed, or otherwise come to be located; but does not include any consumer product in consumer use or any vessel (see "Site").

Fault. A fracture in the earth's crust accompanied by displacement of one side of the fracture with respect to the other and in a direction parallel to the fracture.

Federal Facility Compliance Act (FFCAct). Federal law signed in October 1992 amending the Resource Conservation and Recovery Act. The objective of the FFCAct is to bring all Federal facilities into compliance with applicable Federal and state hazardous waste laws, to waive Federal sovereign immunity under those laws, and to allow the imposition of fines and penalties. The law also requires the U.S. Department of Energy to submit an inventory of all its mixed waste and to develop a treatment plan for mixed wastes.

Federal Land Management Policy Act of 1976. Act that provides for the periodic and systematic inventory of public lands and their resources and for projecting their present and future use through a land use planning process coordinated with Federal and state planning efforts. Among other things, it encourages management on the basis of multiple uses and protection of the quality of scenic, historical, ecological, environmental, air and atmospheric, water resources, and archaeological values.

Federally Listed Species. *See* **Threatened Species**, **Endangered Species**, and **Candidate Species**.

Fines. Finely crushed or powdered material; i.e., very small particles in a mixture of various sizes.

Fission. The splitting of a heavy atomic nucleus into two nuclei of lighter elements, accompanied by the release of energy and generally one or more neutrons. Fission can occur spontaneously or be induced by neutron bombardment.

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

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

Gamma Ray. High-energy, short-wavelength electromagnetic radiation of nuclear origin (radioactive decay) similar to x-rays. Gamma rays are true rays of energy, in contrast to alpha and beta radiation, and they are the highest penetrating of the three common types of radioactive decay. They are best stopped or shielded against by dense materials, such as lead or depleted uranium.

Gaussian Plume. The distribution of material (a plume) in the atmosphere resulting from the release of pollutants from a stack or other source. The distribution of concentrations about the centerline of the plume, which is assumed to decrease as a function of its distance from the source and centerline (Gaussian distribution), depends on the mean wind speed and atmospheric stability.

General Conformity Rule. U.S. Environmental Protection Agency rule that establishes minimal levels for criteria air pollutant emissions, in tons per year, based on the air quality control region's nonattainment designation.

Genetic Effects. The outcome resulting from exposure to mutagenic chemicals or radiation that results in genetic changes in germ line or somatic cells. Effects on genetic material in germ line (sex cells) cause trait modifications that can be passed from parents to offspring. Effects on genetic material in somatic cells result in tissue or organ modifications (e.g., liver tumors) that do not pass from parents to offspring.

Geologic Repository. A system intended to be used for, or may be used for, the disposal of radioactive waste or spent nuclear fuel in excavated geologic media. A geologic repository includes (a) a geologic repository operating area, and (b) the portion of the geologic setting that provides isolation. A near-surface disposal area is not a geologic repository.

Greater-Than-Class-C Waste (GTCC). Low-level radioactive waste that is generated by the commercial sector and 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 Greater-Than-Class-C wastes from U.S. Department of Energy nondefense programs.

Groundwater. In general, all water contained in the ground. Water held below the water table available to freely enter wells.

Habitat. Area where a plant or animal lives.

Half-Life (Radiological). The time in which half the atoms of a radioactive substance disintegrate to another nuclear form; this varies for specific radioisotopes from millionths of a second to billions of years.

Hazard Index. The sum of ratios that compare the estimated concentration of a noncarcinogenic chemical to which an individual may be exposed to a criterion presumed to be protective of human health against noncancer toxicity.

Hazard Quotient. The ratio of the exposure concentration (or dose) of a single substance to the reference concentration (or reference dose) for that substance; hazard quotients are used by the U.S. Environmental Protection Agency to measure the risk of noncancer health effects and are independent of cancer risk, which is calculated only for those chemicals identified as carcinogens.

Hazardous Air Pollutants (HAPs). U.S. Environmental Protection Agency definition: Air pollutants that are not covered by ambient air quality standards but that, as defined in the Clean Air Act, may reasonably be expected to cause or contribute to irreversible illness or death. Such pollutants include asbestos, beryllium, mercury, benzene, coke oven emissions, radionuclides, and vinyl chloride. Office of Environmental Safety and Health definition: Air contaminants to which no ambient air quality standard is applicable and that causes, or contributes to, air pollution that may reasonably be anticipated to result in

an increase in mortality or an increase in serious irreversible or incapacitating reversible, illness. Hazardous air pollutants are regulated by 40 CFR 61 (Regulations on National Emission Standards for Hazardous Air Pollutants).

Hazardous Materials Transportation Act of 1975, as Amended. Act that provides the U.S. Department of Transportation the authority to establish standards on any safety aspect of the transport of hazardous (including radioactive) materials by any mode in interstate and foreign commerce.

Hazardous Substance. Any substance that, when released to the environment in an uncontrolled or unpermitted fashion, becomes subject to the reporting and possible response provisions of the Clean Water Act and the Comprehensive Environmental Response, Compensation, and Liability Act.

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

Heavy Metals. Metallic or semimetallic elements of high molecular weight, such as mercury, chromium, cadmium, lead, and arsenic, that are toxic to plants and animals at known concentrations.

High-Efficiency Particulate Air (HEPA) Filter. A filter with an efficiency of at least 99.95% used to separate particles from air exhaust streams prior to releasing that air into the atmosphere.

High-Level Waste (HLW). The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly from reprocessing and any solid waste derived from the liquid that contains a combination of transuranic and fission product nuclides in quantities that require permanent isolation. High-level waste may include other highly radioactive material that the U.S. Nuclear Regulatory Commission, consistent with existing law, determines by rule requires permanent isolation.

Human Environment (40 CFR Part 1508.14). "Human environment" shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment. This means that economic or social effects are not intended by themselves to require preparation of an Environmental Impact Statement (EIS). When an EIS is prepared and economic or social and natural or physical environmental effects are interrelated, then the EIS will discuss all of these effects on the human environment.

Human Health Risk. A measure of the probability that adverse effects, or impacts, on human health will occur as a result of a given hazard.

Hypothetical Farm Family. An imaginary family assumed to live 300 meters downgradient of the center of a waste disposal unit. The family farms, grows, and consumes its own crops and livestock and uses groundwater for watering crops and animals—an estimated maximum exposure scenario taking place in the future at a time when institutional controls no longer exist. The scenario is analyzed to determine potential upper-bound exposures by ingestion of contaminated groundwater.

Hypothetical Intruder. An imaginary adult who drills a well directly through a disposal unit to the groundwater. As a result of the drilling, contaminated soil from within the unit is brought to the surface where it mixes with the top layers of the surface soil. The individual farms the land and eats the crops. The intruder scenario occurs after the failure of institutional control. This is consistent with the analysis required for disposal facilities under DOE Order 5820.2A.

Impact. In an Environmental Impact Statement, the positive or negative effect of an action (past, present, or future) on the environment. Environmental impacts are usually categorized as (a) natural environment (land use, air quality, water resources, geological resources, ecological resources, and aesthetic and scenic resources), or (b) human environment (infrastructure, economics, social, and cultural). Within an Environmental Impact Statement, cost; health risks; transportation and transportation accidents; and treatment, storage, and disposal facility accidents are treated separately from environmental impacts.

Impact Attribute. Environmental impacts are broadly defined as those affecting the "natural and physical environment and the relationship of people thereto." If natural and physical attributes are involved, economic and social impacts may be brought into play as appropriate. More specifically, these attributes include geology and soils, water resources, air quality, ecological resources, socioeconomic and land uses,

infrastructure, cultural resources, the local transportation network, and the level of radionuclide and radiation exposure.

Incineration. The efficient burning of combustible solid and liquid wastes to destroy organic constituents and reduce the volume of the waste. Incinerators are designed to burn with extremely high efficiency. The greater the burning efficiency, the cleaner the air emission. Incineration of radioactive materials does not destroy the radionuclides but does significantly reduce the volume of the waste matrix. High-efficiency particulate air filters are used to prevent radionuclides and heavy metals from escaping from the stack into the atmosphere.

Increased Cancer Incidence Effects. An air concentration of hazardous waste containing carcinogens above which an exposed person has an increased carcinogenic risk of 1 in 1 million (1E–06) or higher.

Individual Health Risk Impacts. Impacts focusing on the probability that the maximally exposed individual within each receptor population would experience an adverse health impact. These impacts include the probability of a cancer fatality, the probability of cancer incidence, and the probability of genetic effects.

Inventory Waste. The accumulated waste remaining from the development and production of U.S. nuclear weapons, i.e., waste that is currently in warehouse storage, retrievable storage on bermed pads, or disposed of in trenches.

Isotope. A variation of an element that has the same number of protons, but a different weight because the number of neutrons differs from that of its other isotope(s). A given element may have many isotopes. For example, uranium occurs naturally in three forms: uranium-234 (142 neutrons), uranium-235 (143 neutrons), and uranium-238 (146 neutrons); each of these isotopes has 92 protons. Various isotopes of the same element may have different radioactive behaviors—some are highly unstable (i.e., they decay spontaneously and/or emit radiation) (see "Radioisotope" and "Radiation").

Land Disposal Restrictions (LDRs). Restrictions on the disposal of waste that is hazardous under the Resource Conservation and Recovery Act. LDRs include technology-based or performance-based treatment standards that must be met before hazardous waste can be land disposed. The regulations in 40 CFR Part 268 address LDRs.

Land-Use Planning. A decision-making process to determine the future or end use of a parcel of land, considering such factors as current land use, public expectations, cultural considerations, local ecological factors, legal rights and obligations, technical capabilities, and costs.

Life Cycle. The entire time period from generation to permanent disposal or elimination of waste.

Low-Income Population. A census tract within the 80-kilometer (50-mile) zone of impact at each of the 17 U.S. Department of Energy sites that has a low-income population proportion greater than the national average of 13.1%.

Low-Income Status. Based on U.S. Census Bureau data definitions of individuals below the poverty line. The poverty line is defined by a statistical threshold that considers family size and income. For 1990, the poverty threshold for a family unit consisting of four individuals, based on 1989 income, was $12,674. Other poverty thresholds are provided by the U.S. Census Bureau for larger and smaller family sizes.

Low-Level Waste (LLW). Waste that contains radioactivity and is not classified as high-level waste, transuranic waste, or spent nuclear fuel, or byproduct tailings containing uranium or thorium from processed ore (as defined in Section 11(e)(2) of the Atomic Energy Act). Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided that the concentration of transuranic is less than 100 nCi/g.

Low-Level Mixed Waste (LLMW). Waste that contains both hazardous waste under the Resource Conservation and Recovery Act and source, special nuclear, or by-product material subject to the Atomic Energy Act of 1954 (42 USC 2011, *et seq.*).

Maximally Exposed Individual (MEI). A hypothetical individual whose location and habits maximize the highest total radiation dose and/or chemical intake for all exposure routes (e.g., inhalation, ingestion, direct exposure) over the individual's lifetime. Two types of MEIs are considered in this PEIS. One is the offsite MEI, a member of the general population located within 80 kilometers (50 miles) of an onsite facility. The other is the MEI of the noninvolved worker population, that is, the population of onsite employees not directly involved in waste handling activities.

Millirem. One thousandth of a rem (see "Rem").

Minimum Treatment. The least amount of treatment required to meet waste acceptance criteria for disposal and, if shipped to another site, packaging requirements for transportation. Minimum treatment includes solidification of liquids and fines, and packaging.

Minority Population. Includes individuals who report themselves as belonging to any of the following racial groups: Black (reported their race as "Black or Negro," or reported entries such as "African American, Afro-American, Black Puerto Rican, Jamaican, Nigerian, West Indian, or Haitian"); American Indian, Eskimo, or Aleut; Asian or Pacific Islander, or "Other Race." Individuals identifying themselves as of Hispanic origin are also included in the minority category. Hispanics can be of any race, however. To avoid double-counting minority Hispanic individuals, only white Hispanics were included in the number of racially based minorities in a tabulation, since nonwhite Hispanics had already been counted under their minority racial classification. For this analysis, minority populations consist of any census tract within the 80-kilometer (50-mile) zone of impact at each of the 17 U.S. Department of Energy sites that has a minority population proportion greater than the national average of 24.4%.

Mitigation (40 CFR Part 1508.20). "Mitigation" includes: (a) avoiding the impact altogether by not taking a certain action or parts of an action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; or (e) compensating for the impact by replacing or providing substitute resources or environments.

Mixed Waste. Waste that contains both (a) hazardous waste under the Resource Conservation and Recovery Act, and (b) source, special nuclear, or byproduct material subject to the Atomic Energy Act of 1954 (see "Low-Level Mixed Waste").

Most Exposed Lifetime (MEL). The 70-year lifetime out of the 143 lifetimes evaluated during which the highest exposures are estimated to occur for the hypothetical farm family.

Multimedia Environmental Pollutant Assessment System (MEPAS). For the groundwater pathway, various computer models, including MEPAS, are used to simulate environmental transport of contaminants

from the source (waste disposal location) to groundwater to potential receptors. Contaminant-specific unit rate of transfer (flux) rates out of the engineered disposal facility are used by MEPAS to simulate the transport of contaminants through the vadose zone (the area above the permanent groundwater level) and into the groundwater. The MEPAS model then predicts the environmental concentration of contaminants at various receptor locations as a function of time.

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

National Emission Standards for Hazardous Air Pollutants (NESHAPS). A set of national emission standards for listed hazardous pollutants emitted from specific classes or categories of new and existing sources. These were implemented in the Clean Air Act Amendments of 1977.

National Environmental Policy Act (NEPA) (10 CFR Part 1021.1). This 1969 legislation (42 U.S.C. 4321 *et seq.*) establishes national policies and goals for protecting the environment. Section 102(2) of NEPA contains certain procedural requirements directed toward attaining such goals. In particular, all Federal agencies are required to give appropriate consideration to the environmental effects of their proposed actions in their decision making and to prepare detailed environmental statements on recommendations or reports on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment. Executive Order 11991 of May 24, 1977, directed the Council on Environmental Quality to issue regulations to implement the procedural provisions of NEPA.

National Historic Preservation Act of 1966, as Amended. This Act directs Federal agencies to consider the effects of their programs and projects on properties listed or eligible for the National Register of Historic Places. It does not require any permits, but pursuant to Federal code, if a proposed action could impact an archaeological, historic, or architectural resource, it mandates consultation with the proper agencies.

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

National Priorities List (NPL). A formal listing of the Nation's most hazardous waste sites, as established under the Comprehensive Environmental Response, Compensation, and Liability Act, that have been identified for remediation.

National Register of Historic Places (NRHP). The official list of historic properties (districts, sites, buildings, structures, and objects) maintained by the Secretary of the Interior deserving preservation because of their local, state, or national significance in American history, architecture, archaeology, engineering, and culture. Properties listed or eligible for the National Register are protected by the National Historic Preservation Act of 1966, as amended.

Native American Grave Protection and Repatriation Act of 1990. Act requiring Federal agencies and Federally funded museums to repatriate human remains, sacred objects, and objects of cultural patrimony to the culturally affiliated Native American groups. This includes repatriation of cultural items in collections, proof of consultation with appropriate Native American groups for excavation on Federal or tribal lands, and notification of the Federal Land Manager and appropriate Native American group when an inadvertent discovery is made on Federal or tribal land. Any cultural items excavated after November 16, 1990, pertaining to this Act, are owned by lineal descendants.

NEPA. *See* **National Environmental Policy Act**.

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

Nitrogen Oxides (NO_x). Gases formed in great part from atmospheric nitrogen and oxygen when combustion takes place under conditions of high temperature and high pressure; considered a major air pollutant. Two major nitrogen oxides, nitric oxide (NO), and nitrogen dioxide (NO_2), are important airborne contaminants. In the presence of sunlight, nitric oxide combines with atmospheric oxygen to produce nitrogen dioxide, which in high enough concentrations can cause lung damage.

Nonattainment Area. An air quality control region (or portion thereof) in which the U.S. Environmental Protection Agency has determined that ambient air concentrations exceed National Ambient Air Quality Standards for one or more criteria pollutants.

NPDES. *See* **National Pollutant Discharge Elimination System.**

Nuclear Waste Policy Act of 1982, as Amended. This Act authorizes Federal agencies to develop a geologic repository for the permanent disposal of spent nuclear fuel and high-level radioactive waste. The Act specifies the process for selecting a repository site and constructing, operating, closing, and decommissioning the repository. The Act also establishes programmatic guidance for these activities.

Nuclide. A general term referring to all known isotopes, both stable (279) and unstable (about 5,000), of the chemical elements (see "Isotope" and "Radioisotope").

Offsite Population. For facility accident analyses, the collective sum of individuals located within an 80-kilometer (50-mile) radius of a facility and within the path of the plume with the wind blowing in the most populous direction.

Onsite. The same or geographically contiguous property that may be divided by public or private right-of-way, provided the entrance and exit between the properties is at a crossroads intersection, and access is by crossing as opposed to going along the right-of-way. Noncontiguous properties owned by the same person but connected by a right-of-way that he/she controls and to which the public does not have access is also considered onsite property.

Ozone (O_3). The triatomic form of oxygen; in the stratosphere, ozone protects the Earth from the sun's ultraviolet rays, but in lower levels of the atmosphere ozone is considered an air pollutant.

Paleontology. The study of fossils.

Paleozoic Era. Geologic time dating from 570 million to 245 million years ago when seed-bearing plants and vertebrates first appeared.

Particulate Matter. Any material, except uncombined water, that exists in a finely divided form as a liquid or solid.

Particulates. Particles in an aerosol stream, the larger of which usually can be removed by filtration.

PEIS. *See* **Programmatic Environmental Impact Statement**.

Playa. A dry lake bed in a desert basin or a closed depression that contains water on a seasonal basis.

Pleistocene Epoch. Geologic time that occurred approximately 1.8 to 10,000 years ago. Generally equated with the "Ice Age."

Plume. The three-dimensional area (usually in air or groundwater) containing measurable concentrations of a compound or element that has migrated from its source point.

Plutonium (Pu). A heavy, radioactive, metallic element with the atomic number 94. It is produced artificially in a reactor by bombardment of uranium with neutrons and is used in the production of nuclear weapons.

PM_{10}. All particulate matter in the ambient air with an aerodynamic diameter less than or equal to a nominal 10 micrometers (10 microns). Particles less than this diameter are small enough to be breathable and could be deposited in lungs.

Pollution Prevention. The use of materials, processes, and practices that reduce or eliminate the generation and release of pollutants, contaminants, hazardous substances, and wastes into land, water, and air. Pollution prevention includes practices that reduce the use of hazardous materials, energy, water, and other resources along with practices that protect natural resources through conservation or more efficient use.

Polychlorinated Biphenyls (PCBs). A class of chemical substances formerly manufactured as an insulating fluid in electrical equipment that is highly toxic to aquatic life. In the environment, PCBs exhibit many of the characteristics of dichloro diphenyl trichloroethane (DDT); they persist in the environment for a long time and accumulate in animals.

Population Dose. The overall dose to the offsite population.

Population Health Risk Impacts. Impacts focusing on the total number of persons in each population who may experience adverse health impacts if a particular alternative were implemented. These impacts include fatalities from physical hazards, cancer fatalities, cancer incidences, and genetic effects.

Potential Life-Threatening Concentration (PLC). An air concentration of hazardous waste above which exposed persons are at risk of potentially life-threatening health effects when exposed for the associated exposure period.

Potentially Adverse Effects Concentration (PAEC). An air concentration of hazardous waste above which exposed persons are at risk of any adverse effect, which may include mild transient effects such as headaches.

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

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

Privatization. In this PEIS, privatization refers to the use of a DOE facility on a DOE site that is operated, maintained, and eventually decontaminated and decommissioned by a private entity who operates that waste management facility for the exclusive use of DOE and is reimbursed by DOE on a competitive, fixed-price basis. Privatization also includes the construction and subsequent operation of a new waste management facility by a private entity on a DOE site.

Programmatic Environmental Impact Statement (PEIS). A broad-scope Environmental Impact Statement that identifies and assesses the environmental impacts of a U.S. Department of Energy program. A PEIS may have several purposes (see "Purpose and Need") with distinct proposed actions and alternatives for each (see "Combined Impacts").

Proposed Action. The activity proposed to accomplish an agency's purpose and need (see "Purpose and Need"). An Environmental Impact Statement analyzes the environmental impacts of the proposed action and of reasonable alternatives to that action (see the various entries under "Alternatives"). A proposed action is described as a project and its related support operations to include preconstruction, construction, and operational activities, and postoperational requirements.

PSD. *See* **Prevention of Significant Deterioration.**

Public. Anyone outside the U.S. Department of Energy site boundary at the time of an accident or during normal operation. With respect to accidents analyzed in this Environmental Impact Statement, anyone outside the site boundary at the time of an accident.

Purpose and Need. In the context of an Environmental Impact Statement, the broad requirement to be met or goal to be achieved (with respect to a specific statutory authority) by the Federal agency concerned. The proposed action and its alternatives are means of accomplishing the purpose and need (see "Action" and "Alternative").

Quality Assurance. All those planned and systematic actions necessary to provide adequate confidence that a facility, structure, system, or components will perform satisfactorily and safely in service. Quality assurance includes quality control, which is all those actions necessary to control and verify the features and characteristics of material, process, product, or service to specified requirements.

Quaternary. The period of geologic time since the end of the Pliocene, consisting of the Pleistocene and Holocene, from about 1.8 million years ago to the present.

Radiation. The release of energy in the form of particles and/or electromagnetic radiation resulting from the spontaneous nuclear decay of an unstable atomic nucleus.

Radioactive Waste. Waste managed for its radioactive content.

Radioactivity. The property or characteristic of material to spontaneously "disintegrate" with the corresponding release of energy in the form of particles and/or electromagnetic radiation (see "Radiation"). The unit of radioactivity is the curie.

Radioisotope. An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation. Approximately 5,000 natural and artificial radioisotopes have been identified (see"Isotope").

Radionuclide. *See* **Radioisotope**.

Radon. Gaseous, radioactive element with the atomic number 86 resulting from the radioactive decay of radium. Radon occurs naturally in the environment, and can collect in unventilated enclosed areas, such as basements. Large concentrations of radon can cause lung cancer in humans.

RCRA. *See* **Resource Conservation and Recovery Act**.

Record of Decision (ROD). A public document that records the final decision(s) on a proposed action. The Record of Decision is based in whole or in part on information and technical analysis generated either during the Comprehensive Environmental Response, Compensation, and Liability Act process or the National Environmental Policy Act process, both of which take into consideration public comments and community concerns. 40 CFR Part 1505.2 states, in part: "At the time of its decision or, if appropriate, its recommendation to Congress, each agency shall prepare a concise public record of decision. The record shall:

- State what the decision was.
- Identify all alternatives considered by the agency in reaching its decision, specifying the alternative or alternatives that were considered to be environmentally preferable. An agency may discuss preferences among alternatives based on relevant factors including economic and technical considerations and agency statutory missions. An agency shall identify and discuss all such factors including any essential considerations of national policy which were balanced by the agency in making its decision and state how those considerations entered into its decision.
- State whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted, and if not, why they were not."

Recycling. Recycling techniques are characterized as use, reuse, and reclamation techniques (resource recovery). Use or reuse involves the return of a potential waste material either to the originating process as a substitute for an input material or to another process as an input material. Reclamation is the recovery of a useful or valuable material from a waste stream. Recycling allows potential waste materials to be put to a beneficial use rather than going to treatment, storage, or disposal.

Region of Influence (ROI). The physical area that bounds the environmental, sociological, economic, or cultural feature of interest for the purpose of analysis.

Regional Input-Output Modeling System (RIMS). The economic multipliers (for disposable income, output, and job years) used by the Programmatic Environmental Impact Statement team to assess the economic impact of waste management activities were derived from an 80-sector (80 industries) model based on the RIMS approach developed by the U.S. Department of Commerce.

Rem (Roentgen Equivalent Man). A unit of individual dose of absorbed ionizing radiation used to measure the effect on human tissue. The dosage of an ionizing radiation that will cause the same biological effect as one roentgen of x-ray or gamma-ray exposure.

Remediation. Process of remedying a site where a hazardous substance release has occurred.

Remote-Handled Waste. Wastes whose external dose rate exceeds 200 millirem per hour.

Repository. A permanent deep geologic disposal facility for high-level or transuranic wastes and spent nuclear fuel.

Reprocessing. A recycling procedure in which the useful material is removed from spent nuclear fuel and reused, and the remaining material is disposed of as waste.

Resource Conservation and Recovery Act (RCRA). A Federal law addressing the management of waste. Subtitle C of the law addresses hazardous waste under which a waste must either be "listed" on one of the U.S. Environmental Protection Agency's (EPA's) hazardous waste lists or meet one of EPA's four hazardous characteristics of ignitability, corrosivity, reactivity, or toxicity, as measured using the toxicity characterization leaching procedure. Cradle-to-grave management of wastes classified as Resource Conservation and Recovery Act (RCRA) hazardous wastes must meet stringent guidelines for environmental protection as required by law. These guidelines include regulation of transportation, treatment, storage, and disposal of RCRA-defined hazardous waste. Subtitle D of the law addresses the management of nonhazardous, nonradioactive solid waste, such as municipal wastes.

Risk. Usually quantitative, sometimes qualitative expression of possible loss that considers both the probability that a hazard/event causes harm and the consequences (damage to life, health, property) of the event/hazard. It is usually described in terms of loss or injury over a given period of time.

Saltcake. Concentrated waste in the form of crystallized salts resulting from the evaporation of liquid high-level waste.

Scrubber. An air pollution control device that uses a spray of water or reactant or a dry process to trap pollutants in emissions.

Seismicity. The tendency for the occurrence of earthquakes.

Shielding. A material interposed between a source of radiation and persons, equipment, or other objects in order to absorb radiation and thereby reduce radiation exposure. Depending on the type of radiation being shielded, typical materials include lead, steel, depleted uranium, concrete, and water.

Site. (1) A U.S. Government-owned property, including land, facilities, structures, and equipment, that usually is operated for DOE by a prime contractor that administratively reports to a U.S. Department of Energy (DOE) Operations Office; e.g., the Oak Ridge National Laboratory is operated by Martin Marietta and reports administratively to DOE's Oak Ridge Operations Office; the Los Alamos National Laboratory is operated by the University of California and reports administratively to DOE's Albuquerque Operations Office. (2) When qualified (for example, *release site*), an area of contaminated ground (see "Facility").

Socially Sensitive Action. One that includes a question(s) of environmental justice (see "Action" and "Environmental Justice").

Socioeconomics. The measure of an economy's (community's) ability to support its infrastructure (e.g., schools, roads, police) and standard of living (e.g., parks, cultural facilities). Usually used with respect to changes in this measure effected by significant changes in the local economy, such as shutdown of an established industry; opening of a new industry.

Sole Source Aquifer. An aquifer that supplies 50% or more of the drinking water of an area. As defined by the Safe Drinking Water Act, an aquifer that is the only source or potential source of drinking water in an area.

Solid Waste. Any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained

gaseous material resulting from industrial, commercial, mining, or agricultural operations or from community activities. It does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges that are point sources subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended, or source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954, as amended (Public Law 94-580, 1004[27] [Resource Conservation and Recovery Act]).

Solidification. Treatment process that produces a monolithic block of waste with high structural integrity from excavated solid particulates, liquids, or sludge wastes.

Source Term. The type and quantity of pollutants released to the environment (e.g., air, water) from a specific source or group of sources.

Special-Case Waste. Waste generated by the U.S. Department of Energy that does not fit into any typical low-level waste management and is usually not suitable for near-surface disposal.

Spent Nuclear Fuel. Fuel that has been withdrawn from a nuclear reactor after irradiation, the constituent elements of which have not been separated.

Special Nuclear Material. As defined in Section 11 of the Atomic Energy Act of 1954, special nuclear material means (a) plutonium, uranium enriched in the isotope 233 or in the isotope 235, and any other material that the U.S. Nuclear Regulatory Commission determines to be special nuclear material or (b) any material artificially enriched by any of the foregoing.

Stakeholder. Any person or organization with an interest in or affected by U.S. Department of Energy activities. Stakeholders may include representatives from Federal agencies, state agencies, Congress, Native American Tribes, unions, educational groups, industry, environmental groups, other groups, and members of the general public.

State-Listed Species. Any species listed by a state government as threatened or endangered (see "Threatened Species," "Endangered Species," and "Candidate Species").

Storage. The collection and containment of waste or spent nuclear fuel (in such a manner as not to constitute disposal of the waste or spent nuclear fuel) for the purposes of awaiting treatment or disposal capacity (i.e., not short-term accumulation) (see "Storage, Long-Term," and "Disposition, Final").

Storage, Long-Term. The containment of waste (usually after undergoing treatment) for a period of years, possibly decades, until ultimate permanent disposal.

Targets. Refers to a variety of nonfuel components that are placed within a nuclear reactor or particle accelerator in order to produce a desired material.

Terrestrial. Pertaining to plants or animals living on land rather than in the water.

Tertiary Period. The first geologic period of the Cenozoic Era, dating from 66 million to about 5.5 million years ago. During this time, mammals became the dominant life form.

Thermal Treatment. Thermal destruction is the efficient burning of combustible solid and liquid wastes to destroy organic constituents and reduce the volume of the waste. The greater the destruction efficiency, the cleaner the air emissions. The thermal destruction technology assumed in the WM PEIS is incineration.

Threatened Species. Any species or subspecies of plant or animal that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Total Effective Dose Equivalent (TEDE). The sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

Toxic Air Pollutants (TAPs). Other toxic compounds regulated by the U.S. Environmental Protection Agency and state or local governments.

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

Transuranic Waste (TRUW). Transuranic waste is waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes, per gram of waste, with half-lives greater than 20 years, except for (a) high-level radioactive waste, (b) waste that the Secretary has determined, with concurrence of the Administrator, does not need the degree of isolation required by the disposal regulations; or (c) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.

Treatment. Any method, technique, or process designed to change the physical or chemical character of the waste to render it less hazardous; safer to transport, store, or dispose of; or reduced in volume.

Treatment Facility. Land area, structures, and/or equipment used for treating waste or spent nuclear fuel.

Treatment Group. Refers to the grouping together of waste streams that receive treatment through the same sequence of treatment steps.

Type B Package. A Type B packaging together with its radioactive contents. An NRC-certified container that must be used for the transport of highly radioactive materials. Type B packaging must be able to withstand both normal and accident transport conditions without releasing its radioactive contents. These containers are tested under severe, hypothetical accident conditions that demonstrate resistance to impact, puncture, fire, and submersion in water.

Type B Shipping Cask. An NRC-certified cask with a protective covering that contains and shields radioactive materials, dissipates heat, prevents damage to the contents, and prevents criticality during normal shipment and accident conditions. It is used for transport of highly radioactive materials, and is tested under severe, hypothetical accident conditions that demonstrate resistance to impact, puncture, fire, and submersion in water.

Vadose Zone. The zone between the land surface and the water table. Saturated bodies, such as perched groundwater, may exist in the vadose zone. Also called the zone of aeration and the unsaturated zone.

Vitrification. (a) A waste treatment process in which calcined or another decomposed form of waste is mixed with glass and fused into a solid mass. The resultant mass is expected to remain a stable and insoluble form for long time periods, and thus will be a leading candidate for the most benign waste form for disposal. (Vitrification with borosilicate glass is the Best Demonstrated Available Technology for high-level

waste and certain mixed waste streams.) (b) The conversion of high-level waste materials into a glassy or noncrystalline solid for subsequent disposal. (c) The process of immobilizing waste that produces a glasslike solid that permanently captures the radioactive materials.

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

Volume Reduction. Reduces the overall disposal volume of low-level waste by using a variety of treatment techniques. Volume reduction uses several different available technologies, including thermal destruction, compaction/supercompaction, size reduction, and evaporation/concentration. For low-level waste disposal, DOE evaluated the impacts associated with both shallow land burial and engineered disposal facilities.

Waste Acceptance Criteria (WAC). The requirements specifying the characteristics of waste and waste packaging acceptable to a waste receiving facility and the documents and processes the generator needs to certify that waste meets applicable requirements.

Waste Characterization. *See* **Characterization**.

Waste Generation. Any waste produced during a particular calendar year. This does not include waste produced in previous years that is being repacked, treated, or disposed of in the current calendar year. It does include any secondary waste (e.g., clothing, gloves, waste from maintenance operations) generated by treatment, storage, or disposal activities of previously generated wastes.

Waste Isolation Pilot Plant (WIPP). A facility in southeastern New Mexico being developed as the disposal site for transuranic and transuranic mixed waste, not yet in operation.

Waste Isolation Pilot Plant Land Withdrawal Act. A Federal statute (Public Law 102-579) that addresses issues associated with the Waste Isolation Pilot Plant (WIPP) as a disposal site for transuranic waste. Among other things, it withdraws the land comprising WIPP from usual public land laws and reserves it to the U.S. Department of Energy for uses associated with its being a disposal site for transuranic waste.

Waste Load. Inventory defined by waste type, current or to-be-generated, and/or physical or radiological characteristics, as the case may be. Expressed in a variety of units of weight, mass, volume, and/or activity, and sometimes specifying a treatment group.

Waste Management. The planning, coordination, and direction of those functions related to generation, handling, treatment, storage, transportation, and disposal of waste, as well as associated pollution prevention and surveillance and maintenance activities.

Waste Management Program. A U.S. Department of Energy (DOE) subprogram concerned with all aspects of waste management associated with radioactive and/or hazardous substances generated by DOE-owned facilities.

Waste Minimization. An action that economically avoids or reduces the generation of waste by source reduction, by reducing the toxicity of hazardous waste, by improving energy usage, or by recycling. These actions will be consistent with the general goal of minimizing present and future threats to human health, safety, and the environment.

Waste Package. The waste, waste container, and any absorbent that are intended for disposal as a unit.

Waste Stream. A flow of waste materials with specific definable characteristics that remain the same throughout the life of the process generating the waste stream. A waste stream is produced by a single process or subprocess; however, that process or subprocess may be one that combines two or more input waste streams together to produce a single output waste stream.

Waste Type. The waste types being considered in this Programmatic Environmental Impact Statement are high-level waste, transuranic waste, low-level mixed waste, low-level waste, and hazardous waste (see specific waste type definitions).

Wastewater. Water that typically contains less than a 1% concentration of organic hazardous waste materials.

Wetland. Lands or areas exhibiting hydric soils, saturated, or inundated soil during some portion of the plant growing season, and plant species tolerant of such conditions (includes swamps, marshes, and bogs).

Worker, Facility. Any worker whose day-to-day activities are controlled by process safety management programs and a common emergency response plan associated with a facility or facility area. This definition includes any individual within a facility/facility area or its 0.6-kilometer (0.4-mile) exclusion zone. This definition can also include those transient individuals or small populations outside the exclusion zone but inside the radius defined by the maximally exposed collocated worker, if reasonable efforts to account for such people have been made in the facility or facility area emergency plan. For facility accident analyses, the facility worker is defined as an individual located 100 meters (328 feet) downwind of the facility location where an accidental release occurs.

Worker, Noninvolved. Workers on DOE sites who are not involved directly in waste management. In accident studies, these workers are assumed to be located some prescribed distance from the point of release.

Worker, Waste Management. Onsite employees working in a site's waste management facilities (e.g., treatment, storage, and disposal), including workers involved in the waste management process, construction workers who build the waste management facilities, and those operating the trucks and trains that transport the waste.

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

CHAPTER 15
List of Appendices and Technical Reports

15.1 Appendices

The Waste Management Programmatic Environmental Impact Statement (WM PEIS) includes nine appendices. The following paragraphs include the letter designation and title of each of these appendices and provide a brief abstract of each.

Appendix A Public Comments to DOE's Proposed Revisions to the Scope of the WM PEIS

This appendix reproduces the Department's *Federal Register* notice of January 24, 1995 (in which the Department announced proposed modifications to the title and scope of the "Environmental Restoration and Waste Management PEIS"), and addresses the public's response to the notice. In summary, the Department proposed to eliminate the analysis of environmental restoration alternatives, focus primarily on the evaluation and analysis of waste management issues confronting the Department, and rename the analysis the "Waste Management PEIS."

Appendix B Environmental Restoration Wastes

This appendix provides an estimate of waste to be generated by environmental restoration activities throughout the DOE complex and discusses whether managing those potential waste loads would cause DOE management to make a different decision than would be made by the analysis of waste management wastes alone. The discussion focuses on the subset of environmental restoration wastes that will be transferred to the waste management program. The environmental restoration program generates low-level mixed, low-level, and transuranic wastes, all of which may affect the respective components of the waste management program. The environmental restoration program is not responsible for the management of high-level waste.

Appendix C Environmental Impacts Analysis Methods

This appendix describes the methods used to estimate costs and environmental impacts. It presents the methods in the context of the three-phase approach to the PEIS analysis. The appendix describes Phase-I of the analysis in which waste volumes and treatability groups are identified; treatment, storage, and disposal technologies and the engineering modules used to model those technologies are selected; and alternative-specific waste transportation requirements and waste loads are identified at each site, for each waste type. The appendix summarizes the outputs of the module-based engineering analysis produced in Phase II, which include discharges to the environment from treatment, storage, and disposal facilities; resource use and labor requirements; and facility and transportation costs. The appendix then describes in detail the impacts analysis methods that use the Phase II outputs to evaluate air quality, water resources, and ecological resources impacts, economic and social impacts, environmental justice concerns, and land use, infrastructure, and cultural resources impacts.

In accordance with the requirements of Executive Order 12898, DOE evaluated the potential for the WM PEIS program alternatives to cause disproportionately high and adverse human health or environmental effects to minority and low-income populations at the 17 major waste management sites and then reviewed the human health effects and environmental impacts associated with alternatives for the five waste types at those sites. This appendix provides the full details of the methods used to evaluate environmental justice impacts and presents maps showing the distribution of minority and low-income populations at the 17 sites. The maps are based on an analysis of 1990 U.S. Bureau of the Census files, which contain political boundaries, geographical features, and demographic information. Two sets of maps are provided, one for minority population distribution, and the other for low-income population distribution. Data were resolved to the census tract group level. Native American tribal lands located within 50 miles of each site also were identified and mapped. They are included where applicable with the minority population distribution maps.

Appendix D Waste Management Facility Human Health Risk Estimates

This appendix summarizes the human health impacts posed by stationary sources of waste at DOE waste management facilities. The purpose of this human health risk evaluation is to provide projections of the health risks posed by the waste consolidation options being considered for DOE waste management facilities in this WM PEIS. This information, in conjunction with other WM PEIS impacts (e.g., transportation risks,

ecological risks, air, water, and socioeconomic impacts) and costs, is intended to aid in determining the advantages and disadvantages of the various waste consolidation options.

Appendix E Radioactive and Hazardous Waste Transportation Risk Assessment

This appendix presents a summary of the transportation-related human-health risk assessment conducted for the WM PEIS and provides supplementary references to more detailed sources of information for all types of waste. The assessment of the risks associated with the transportation of radioactive waste is described in Part I. The risk assessment for the transportation of hazardous waste (HW) is described in Part II.

Transportation is an integral component of the alternatives being considered for each type of radioactive waste in the WM PEIS. For some alternatives, radioactive waste would be shipped among the DOE sites at various stages of the treatment, storage, and disposal process. The magnitude of the transportation-related activities varies with each alternative, ranging from minimal transportation for Decentralized approaches to significant transportation for some Centralized approaches. The human health risks associated with transporting various waste materials were assessed to ensure a complete appraisal of the impacts of each WM PEIS alternative being considered.

The transportation of radioactive waste and HW involves a risk to both crew members and members of the public. Part of this risk results from the nature of transportation itself, independent of the radioactive or hazardous characteristics of the cargo. These risks can be viewed as "vehicle-related" risks. On the other hand, the transportation of radioactive waste and HW may pose an additional risk because of the characteristics and potential hazards of the material itself. These risks are considered to be "cargo-related" risks. In this appendix, the risks to human health from both vehicle- and cargo-related causes are assessed.

Appendix F Treatment and Storage Facility Accidents

This appendix documents the methodology and computational framework for facility accident analyses performed for the WM PEIS. The output of the facility accident analyses is a specification for each waste type of the accidents potentially important to human health risk, an assessment of the frequencies of these accidents, and an evaluation of the radiological and chemical source terms resulting from these accidents.

A radiological source term is defined by specifying the amount (in curies) of each radionuclide released during an accident, where release is conservatively assumed to be instantaneous. A chemical source term is defined by specifying the rate and duration of release for each toxic chemical released during an accident. The frequencies of the accidents and the results of the source term evaluation are provided as input to the WM PEIS for calculations of the human health and risk impacts.

The methodology considers the spectrum of accident sequences that could occur in activities covered by the WM PEIS and uses a graded approach emphasizing the risk-dominant scenarios to facilitate discrimination among the various WM PEIS alternatives. Although it allows reasonable estimates of the risk impacts associated with each alternative, the main goal of the accident analysis methodology is to allow reliable estimates of the relative risks among the alternatives. Rather than developing all accident sequences in detail, the accident models are systematically applied to approximate the key source term parameters as a function of (1) the phenomenology and severity of the accident, (2) the process parameters, (3) the characteristics of the facility, and (4) the properties of the waste types. This allows many of the uncertainties in the data that are reflected in estimates of absolute risk to be canceled in estimates of relative risk providing a sufficient and scrutable basis for discriminating among alternatives.

Appendix G Pollution Prevention

DOE has a waste reduction policy that requires DOE sites to engage in waste minimization and pollution prevention and to have an established program for implementing this policy. The DOE Office of Waste Management (WM) is responsible for coordinating and consolidating this waste reduction policy. The purpose of this appendix is to discuss how DOE's associated programs and practices may affect the waste loads that WM facilities receive and, consequently, the need for the facilities. It contains estimates of reductions in waste loads, risks associated with WM activities, and WM costs resulting from these waste minimization practices.

Within DOE, the activities concerned are those that involve source reduction and recycling of all waste and pollutants, and include those practices that reduce or eliminate pollutants through increased efficiency in the use of raw materials, energy, water, or other resources, or the protection of natural resources by conservation. Source reduction means any practice that reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment before

recycling, treatment, or disposal; and any practice that reduces the hazards to public health and the environment associated with the release of such substance, pollutants or contaminants.

Appendix H Technology Development

This appendix addresses the potential impact of technology development on the alternatives being considered in the WM PEIS. The availability, and the projected availability, of appropriate technologies govern what can be cleaned up, how, and how soon. DOE's objective is to manage its waste with the greatest effectiveness, efficiency, and lowest tolerable risks to people (health, safety, jobs), as well as to the environment. In many cases, the development of new technologies presents the best hope for ensuring a substantial reduction in risk to the environment and improved safety for workers and the public within realistic financial constraints. This appendix outlines the developmental approach taken by DOE's Office of Environmental Management through its Office of Technology Development and discusses selected examples of emerging technologies that may influence the WM PEIS alternatives and/or mitigate the impact of associated activities.

The Office of Technology Development is responsible for managing an aggressive national program of applied research, development, demonstration, testing, and evaluation for environmental cleanup, waste management, and related technologies. This Technology Development (TD) Program undertakes a focused problem-oriented approach to have technologies available for use to support DOE's environmental management needs. The TD Program is designed to resolve major technical issues, to rapidly advance beyond current technologies for environmental restoration and waste management operations, and to expedite compliance with applicable environmental laws and regulations.

Appendix I Update of Site-Specific Waste Volumes for LLW, LLMW, and TRUW

DOE is characterizing the many types of waste at its facilities. Because information about the waste streams is continually being updated, DOE documents prepared at different times may contain different information on waste inventories and waste disposition. Since the initial preparation of the WM PEIS, DOE has issued updated information on several types of waste. This appendix addresses newly available data on LLW,

LLMW, and TRUW; potential impacts on the analyses of alternatives in the WM PEIS; and recommendations for reanalysis where critical to programmatic decision making.

15.2 Technical Reports

Technical reports provide detailed data and other background information developed in support of the WM PEIS and its appendices. These documents were produced as noted below by DOE's National Laboratories or by the contractor (META/Berger) that supported DOE in the development of the WM PEIS. The available documents are listed here, organized into major categories pertinent to the WM PEIS.

Waste Types, Technologies, and Source Terms

Argonne National Laboratory. 1996. *High-Level Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by S.M. Folga, G. Conzelmann, J.L. Gillette, P.H. Kier, and L.A. Poch. ANL/EAD/TM-17. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Low-Level Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by M.L. Goyette and D.A. Dolak. ANL/EAD/TM-20. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Transuranic Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by K.J. Hong, T.J. Kotek, S.M. Folga, B.L. Koebnick, Y. Wang, and C.M. Kaicher. ANL/EAD/TM-22. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Hazardous Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by M.A. Lazaro, A.A. Antonopoulos, M.P. Esposito, and A.J. Policastro. ANL/EAD/TM-25. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *WASTE_MGMT: A Computer Model for Calculation of Waste Loads, Profiles, and Emissions* by T.J. Kotek, H.I. Avci, and B.L. Koebnick. ANL/EAD/TM-30. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Information Related to Low-Level Mixed Waste Inventory, Characteristics, Generation, and Facility Assessment for Treatment, Storage, and Disposal Alternatives Considered in the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by B.D. Wilkins, D.A. Dolak, Y.Y. Wang, and N.K. Meshkov. ANL/EAD/TM-32. Aug. Argonne, IL.

Los Alamos National Laboratory. 1996. *Mixed-Waste Treatment Model: Basis and Analysis* by Bryon Palmer. LA-13041-M5. Sept. Los Alamos, NM.

Musgrave, B.C. 1995. *Analysis of Waste Treatment Requirements for DOE Mixed Waste - Technical Basis.* Feb. Livermore, CA: BC Musgrave, Inc.

Pacific Northwest Laboratory. 1995. *Description of Source Term Data on Contaminated Sites and Buildings Compiled for the Waste Management Programmatic Environmental Impact Statement (WM PEIS)* by S.M. Short, D.E. Smith, J.G. Hill, and M.E. Lerchen. PNL-10450, AD-940. Sept. Richland, WA.

Treatment, Storage, and Disposal Facility Accidents

Argonne National Laboratory. 1996. *Analysis of Accident Sequences and Source Terms at Waste Treatment and Storage Facilities for Waste Generated by U.S. Department of Energy Waste Management Operations* by C. Mueller, B. Nabelssi, J. Roglans-Ribas, S.M. Folga, and A. Policastro (ANL); W. Freeman, University of Illinois at Chicago; and R. Jackson, S. Turner, and J. Mishima (Science Applications International Corporation). ANL/EAD/TM-29. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Waste_ACC: A Computer Model for Analysis of Waste Management Accidents* by B.K. Nabelssi, S. Folga, E.J. Kohout, C.J. Mueller, and J. Roglans-Ribas. ANL/EAD/TM-52. Aug. Argonne, IL.

Argonne National Laboratory. 1996. *Supplemental Analysis of Accident Sequences and Source Terms for Waste Treatment and Storage Operations and Related Facilities for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by S. Folga, C. Mueller, B. Nabelssi, E. Kohout, and J. Mishima. ANL/EAD/TM-53. Aug. Argonne, IL.

Transportation Risk

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Argonne National Laboratory. 1996. *Risk Assessment for the Off-Site Transportation of High-Level Waste for the U.S. Department of Energy Waste Management Programmatic Environmental Impact Statement* by F.A. Monette, B.M. Biwer, and S.Y. Chen. ANL/EAD/TM-21. Aug. Argonne, IL.

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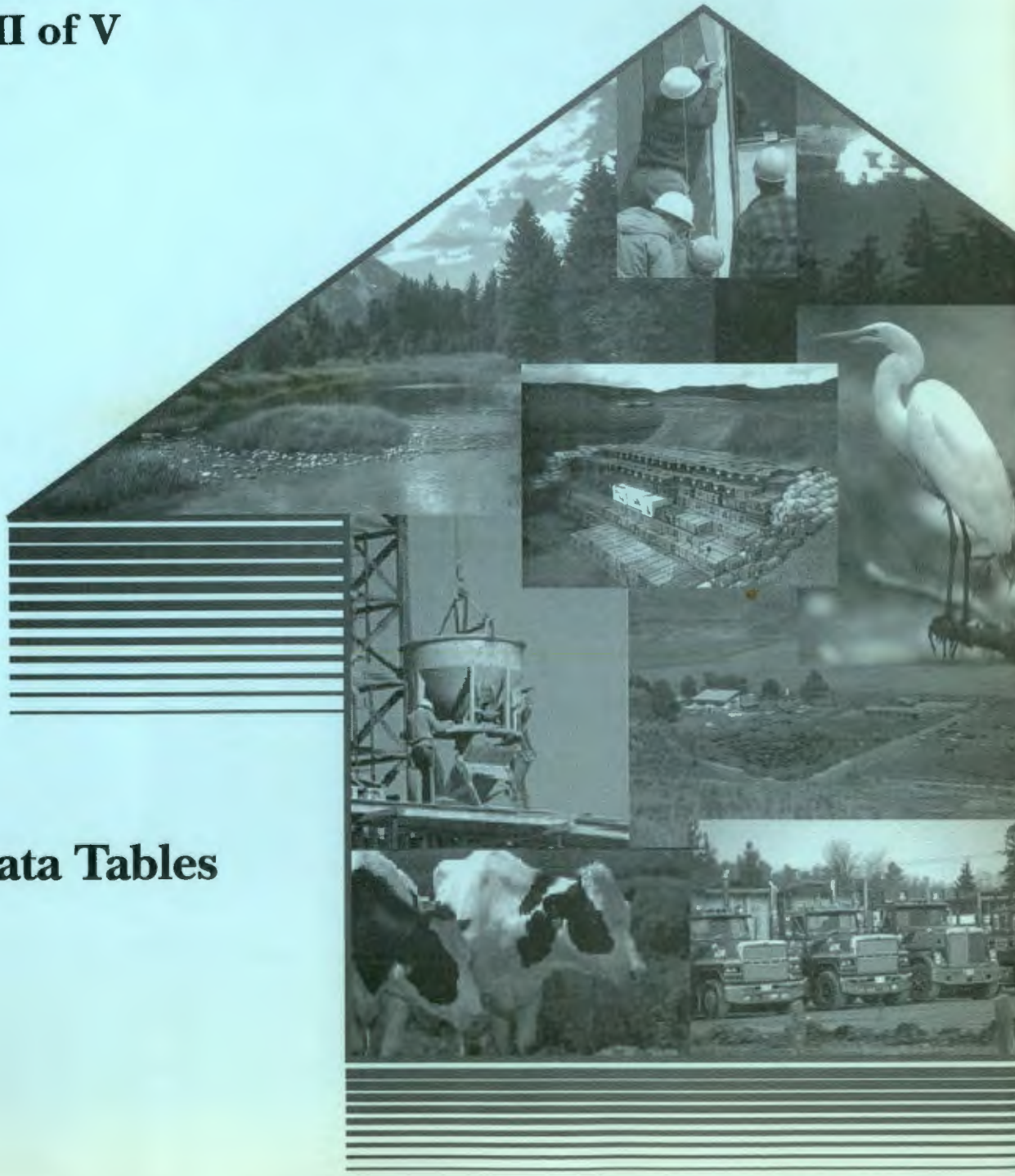
U.S. Department of Energy
Office of Environmental Management

Final Waste Management Programmatic Environmental Impact Statement

For Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste

Volume II of V

DOE/EIS-0200-F



Site Data Tables

DOE/EIS-0200-F

FINAL
WASTE MANAGEMENT
PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT
for
Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste

Volume II of V

Site Data Tables

U.S. Department of Energy
Office of Environmental Management
1000 Independence Ave.
Washington, DC 20585

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SITE DATA TABLES

II.1.0 Introduction

Volume II is an integral part of the Office of Environmental Management's (EM's) Waste Management Programmatic Environmental Impact Statement (WM PEIS), which portrays the impacts of EM's waste management activities at each of the 17 major DOE sites evaluated in the WM PEIS.

II.1.1 Scope

Impacts are displayed for each of the 17 major sites in tabular form as a complement to the impact discussions in waste-type Chapters 6 through 10 (see Table II.1.1). The chapters present background information on each waste type, volume data, existing capacities for managing the wastes, and assumptions used in the waste-type analysis. Readers should refer to these chapters and to Chapter 5, "Impact Analysis Methodologies," for a more thorough discussion of the methodologies, assumptions and definitions associated with these impacts. A synopsis of key definitions and assumptions is also presented at the rear of this introductory section.

Table II.1-1. Waste-Type Chapters

Chapter 6	Impacts of the Management of Low-Level Mixed Waste
Chapter 7	Impacts of the Management of Low-Level Waste
Chapter 8	Impacts of the Management of Transuranic Waste
Chapter 9	Impacts of the Management of High-Level Waste
Chapter 10	Impacts of the Management of Hazardous Waste

Sites were evaluated only when the sites were considered as potential treatment, storage, and/or disposal locations for a given waste type. Not all sites were involved in the alternatives for all waste types. Table II.1-2 presents waste types considered for treatment, storage and/or disposal at the 17 major sites.

Table II.1–2. Waste Types Considered for Treatment, Storage and/or Disposal at Major DOE Sites

SITES	LLMW	LLW	TRUW	HW	HLW
1. ANL-E	x	x	x		
2. BNL	x	x			
3. FEMP	x	x			
4. HS	x	x	x	x	x
5. INEL	x	x	x	x	x
6. LANL	x	x	x	x	
7. LLNL	x	x	x		
8. NTS	x	x	x		
9. ORR	x	x	x	x	
10. PGDP	x	x	x		
11. Pantex	x	x			
12. PORTS	x	x			
13. RFETS	x	x	x		
14. SNL-NM	x	x	x		
15. SRS	x	x	x	x	x
16. WIPP			x		
17. WVDP	x	x			x

1. Argonne National Laboratory-East (Illinois)
2. Brookhaven National Laboratory (New York)
3. Fernald Environmental Management Project (Ohio)
4. Hanford Site (Washington)
5. Idaho National Engineering Laboratory (Idaho)
6. Los Alamos National Laboratory (New Mexico)
7. Lawrence Livermore National Laboratory (California)
8. Nevada Test Site (Nevada)
9. Oak Ridge Reservation (Tennessee)
10. Paducah Gaseous Diffusion Plant (Kentucky)
11. Pantex Plant (Texas)
12. Portsmouth Gaseous Diffusion Plant (Ohio)
13. Rocky Flats Plant (Colorado)
14. Sandia National Laboratory- Albuquerque (New Mexico)
15. Savannah River Site (South Carolina)
16. Waste Isolation Pilot Plant (New Mexico)
17. West Valley Demonstration Plant (New York)

Fifteen impact categories were analyzed; however, they do not apply to all wastes types, as shown in Table II.1–3 below.

Table II.1–3. Impact Categories Associated With the Waste Types

	Impact Category	LLMW	LLW	TRUW	HW	HLW
1.	Treatment and Disposal (LLMW & LLW), Treatment (TRUW, HW), or Storage (HLW): Estimated Number of Fatalities	x	x	x	x	x
2.	Treatment (LLMW, LLW, TRUW, HW) or Storage (HLW): Estimated Number of Cancer Incidences and Genetic Effects	x	x	x	x*	x
3.	Disposal: Estimated Number of Cancer Incidences and Genetic Effects	x	x			
4.	Treatment and Disposal (LLMW & LLW) or Treatment (TRUW): MEI Probability of Cancer Fatality	x	x	x		
5.	Treatment and Disposal (LLMW & LLW) or Treatment (TRUW): MEI Probability of Cancer Incidences and Genetic Effects	x	x	x		
6.	Treatment and Disposal (LLMW) or Treatment (TRUW, HW): Noncancer Health Risk from Chemical Exposure	x		x	x	
7.	Emissions in tons per year of criteria pollutants	x	x	x	x	x
8.	Percent standard/guide of criteria pollutants	x	x	x	x	x
9.	Percent standard/guideline for hazardous air pollutants and toxic air pollutants	x	x	x	x	x
10.	Impacts on Water Resources Due to Increased Water Use	x	x	x	x	x
11.	Radionuclide Concentration in Ground Water (Percent of Comparison Criteria) for Disposal (Contact and Remote Handled)	x	x			
12.	Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact and Remote Handled)	x				
13.	Socioeconomics Impacts	x	x	x	x	x
14.	Infrastructure Impacts	x	x	x	x	x
15.	Cost	x	x	x	x	x

* Cancer incidences only.

II.1.2 General Description of Table Formats

Sections II.2 through II.18 present the impacts of managing radioactive and hazardous wastes at each of the 17 major sites. Typical sections are subdivided by waste type, then by impact category. Impacts are presented in the form of tables for applicable impact categories and sites. Each of these tables provides a comparative analysis: displaying the magnitude of a given impact for each of the alternatives analyzed by this PEIS. [These alternatives are described in detail in Chapter 3 as well as in the specific waste-type chapters (see Table II.1-1)].

When reviewing the impacts and costs identified for the No Action Alternative for LLMW and TRUW, it is important to realize that the results for indefinite storage of those waste types are based on the initial 20 years of that indefinite period. This is consistent with the period of analysis for the other alternatives; however, not shown are the impacts from storage expected beyond this 20-year time frame. The longer term storage impacts and costs are likely to exceed those for the first 20 years, not only as a result of routine indefinite storage operations, but also from degradation of facilities and containers. This differs from the effects predicted for the action alternatives for management of the 20-year forecast of LLMW and TRUW, where risks to workers and the offsite population, and other impacts and costs, are reduced following disposal. The No Action Alternative does not reduce or avoid impacts and costs; rather it causes impacts and costs to be experienced every year for an indefinite period of time. A discussion of the longer term impacts expected for indefinite storage of LLMW can be found in Section 6.16 of Chapter 6, Volume I. A brief discussion of the longer term effects of storage of TRUW can be found in Section 8.3.1 of Chapter 8, Volume I, with a more detailed assessment in the *Waste Isolation Pilot Plant Disposal Phase Draft Supplemental II Environmental Impact Statement* (DOE/EIS-0026-S-2).

It should also be noted that the No Action Alternative for HLW does not provide enough canister storage capacity for all of the canisters that would be produced after treatment of HLW. Provision of adequate storage would lead to costs and impacts as great as shown for the other HLW alternatives. A discussion of the assumptions made to address this shortage of storage capacity in the HLW analyses is contained in Section 9.3.1 of Chapter 9, Volume I.

Impact tables are often further subdivided to present impacts associated with the treatment of waste versus those associated with the disposal of waste. A glossary is provided in Volume I for acronyms and selected terms appearing under these two major headings in the tables. Also in Volume I, Chapter 5 provides a detailed explanation of each of the 14 impact categories.

The site tables that present information for LLMW and LLW include two columns, one labeled with a T for Treatment and the other labeled with a D for Disposal. The information in these two columns represents, for the alternative concerned, the number of sites that are treating LLMW or LLW, and the number of sites disposing LLMW or LLW.

The site tables that present information for TRUW include three columns, one labeled CH Treat, the next labeled RH Treat, and the third labeled Treat STD (treatment standard). The information in these three columns represents, for the alternative concerned, the number of sites treating contact-handled TRUW, the number of sites treating remote-handled TRUW, and the treatment standard that the sites are using (i.e., to meet current waste acceptance criteria at WIPP (WIPP WAC), or to reduce the potential for gas generation after disposal, or to meet land disposal restrictions (LDRs) under the Resource Conservation and Recovery Act).

The site tables that present information for HLW include a column that is labeled with an S for Storage. The information in this column represents, for the alternative concerned, the number of sites storing HLW.

The site tables that present information for HW include a column that is labeled with a T for Treatment. The information in this column represents, for the alternative concerned, the number of sites treating HW.

II.1.3 Description of Health Risk Data Tables

Background

Health risk impacts can result from exposure to radiation and chemicals and from physical trauma associated with constructing and operating treatment, storage and/or disposal facilities or transporting waste. Health effects resulting from radiation exposure, whether from sources external or internal to the body, can affect either the exposed individual (known as "somatic" effects, such as cancer) or descendants of the exposed individual (known as "genetic" effects). Chapter 5 of Volume I provides additional information about the methodologies and assumptions used in the health risk analysis.

The WM PEIS evaluated potential health risks to a number of receptor populations and individuals including:

- The offsite population—those individuals living within an 80 km (50-mile) radius of the site, as well as along transportation routes
- Noninvolved workers population—the workers on DOE sites who are not involved directly in waste management activities
- Waste management workers population (or "waste management workers")—onsite employees working in an installation's waste management facilities, including workers involved in the waste management process, construction workers who build the waste management facilities, and those operating the trucks and trains that transport the waste
- Maximally exposed individual (MEI) for the offsite population—hypothetical individual in the offsite population who would receive the highest total lifetime multimedia dose
- MEI for the noninvolved worker population—hypothetical individual in the noninvolved worker population who would receive the highest total lifetime multimedia dose
- Hypothetical farm family most exposed lifetime MEI—hypothetical individual in the most exposed lifetime of the farm family who would receive the highest dose from groundwater contamination following disposal of LLW and LLMW

- A hypothetical intruder—an individual who would experience maximum potential risks from direct contact with disposed LLW and LLMW upon the loss of institutional control. The hypothetical intruder risks are not reported in Volume II Site Data Tables; see Chapters 6 and 7 of Volume I for this information.

- A waste management worker—an individual who would experience potential noncancer effects, as estimated using the Exposure Index, following exposure to the hazardous chemical constituents of LLMW, TRUW, and HW.

Population impacts focus on the *total number* of people in each population who would experience adverse health impacts if a particular alternative is implemented. Individual impacts focus on the *probability* (e.g., one-in-one million) that the individual would experience an adverse health impact over his or her lifetime.

The types of potential health impacts evaluated include:

- Fatalities from physical hazards

- Latent cancer fatalities from radiation exposure

- Cancer incidences from radiation or chemical exposure

- Genetic effects from radiation exposure

- Noncancer effects from chemical exposure (e.g., headaches, nasal irritation, liver or kidney toxicity, neurotoxicity, immunotoxicity, and reproductive and developmental toxicity)

The WM PEIS did not estimate the incidence of nonfatal cancers from exposure to radionuclides. However, the number of nonfatal cancers can be derived from the total cancer incidence estimates by subtracting the estimated number of fatal cancer cases. Note that both the total cancer incidence and the nonfatal cancer incidence values are overestimated by factor of about two because the estimates contain a relatively large component of skin cancers. The International Commission on Radiological Protection (ICRP) dose conversion factor (see "Interpreting the Health Risk Tables") used in the WM PEIS to estimate total cancer incidence includes incidences of skin cancer. However, the internal exposure pathways evaluated in the WM PEIS (i.e., inhalation or ingestion of radionuclides) are not likely to induce large numbers of skin cancer cases.

Data in the risk tables are presented in scientific notation; see Table II.1–4 for an explanation of this format.

Table II.1–4. Scientific Notation and "E" Notation

Scientific notation is used in the WM PEIS to express numbers that are so large or so small that they can be difficult to read or write. Scientific notation is based on the use of positive and negative powers (or exponents) of 10. A number written in scientific notation is expressed as the product of a number between 1 and 10 times a positive or negative power of 10. Some positive and negative powers of 10 include:

Positive Powers of 10	*Negative Powers of 10*
$10^1 = 10 \times 1 = 10$	$10^1 = 1/10 = 0.1$
$10^2 = 10 \times 10 = 100$	$10^2 = 1/100 = 0.01$
and so on, therefore,	*and so on, therefore,*
$10^6 = 1{,}000{,}000$ *(or 1 million)*	$10^6 = 0.000001$ *(or 1 in 1 million)*

A power of 10 is also commonly expressed as "E," where "E" means "x 10." For example, 3×10^5 *can also be written as 3E+05, and* 3×10^{-5} *is equivalent to 3E-05. Therefore, 3E+05=300,000 and 3E-05=0.00003.*

The health risk data in this volume use "E" notation with negative exponents. An important value for relative comparison of health risk probability estimates is the number "1 in 1 million." This value appears in the data tables as "1E-06." It can also be expressed as 1×10^{-6}*, and is equivalent to 0.000001, or 1/1,000,000.*

Tables II.1–5 and II.1–6 provide indices for the health risk information contained in the Volume II Site Data Tables. Interpreting the results of the health risk analyses involves consideration of both uncertainties and appropriate standards. See Chapter 5 of Volume I for a further discussion of these issues.

The Volume II Site Data Tables are organized by waste type. Table II.1–5 indicates the health risk endpoint/population receptor combinations that were evaluated for each waste type. Table II.1–6 presents similar information for individual receptors.

Table II.1–5. Crosswalk of Health Risk Information for Receptor Populations Contained in Volume II Site Data Tables

Receptors	Health Risk Endpoints				
	Number of Radiation Cancer Fatalities	**Number of Physical Trauma Fatalities**	**Number of Radiation Cancer Incidences**	**Number of Chemical Cancer Incidences**	**Number of Radiation Genetic Effects**
Offsite Population	LLMW, LLW, TRUW	NA	LLMW, LLW, TRUW	LLMW, TRUW, HW	LLMW, LLW, TRUW
Noninvolved Workers	LLMW, LLW, TRUW	NA	LLMW, LLW, TRUW	LLMW, TRUW, HW	LLMW, LLW, TRUW
WM Workers	LLMW, LLW, TRUW, HLW	LLMW, LLW, TRUW, HLW, HW	LLMW, LLW, TRUW, HLW	LLMW, TRUW, HW	LLMW, LLW, TRUW, HLW

NA = not applicable.

Table II.1–6. Crosswalk of Health Risk Information for Receptor Individuals Contained in Volume II Site Data Tables

Receptors*	Health Risk Endpoints				
	Radiation Cancer Fatality Probability	**Radiation Cancer Incidence Probability**	**Chemical Cancer Incidence Probability**	**Radiation Genetic Effects Probability**	**Noncancer Effects (Hazard Index/ Exposure Index)**
Offsite MEI	LLMW, LLW, TRUW	LLMW, LLW, TRUW	LLMW, TRUW, HW	LLMW, LLW, TRUW	LLMW, TRUW, HW
Noninvolved Worker MEI	LLMW, LLW, TRUW	LLMW, LLW, TRUW	LLMW, TRUW, HW	LLMW, LLW, TRUW	LLMW, TRUW, HW
WM Worker	NA	NA	NA	NA	LLMW, TRUW, HW
Hypothetical Farm Family MEI (most exposed lifetime)	LLMW, LLW	LLMW, LLW	LLMW	LLMW, LLW	LLMW

*Volume II risk tables do not contain results for the Hypothetical Intruder. See Chapters 6 and 7 of Volume I and Appendix D in Volume II for results for this receptor (LLMW and LLW only).
NA = not applicable.

Table II.1–7 provides a summary of the exposure pathways evaluated for treatment, storage and disposal activities.

Table II.1–7. Exposure Pathways for Treatment, Storage, Transportation, and Disposal Activities

Waste Processing Phase	Pathway	Potentially Exposed Populations and Individuals
Treatment • Routine emissions	Atmospheric • Inhalation • Ingestion of crops and animals Direct Radiation	• Public within 50-mile radius • Onsite employees, evenly distributed within site borders (atmospheric only) • Onsite MEI (atmospheric only) • Offsite MEI (atmospheric only) • Waste management worker (inhalation and direct radiation only)
Storage • Routine emissions	Atmospheric • Inhalation • Ingestion of crops and animals Direct Radiation	• Public within 50-mile radius • Onsite employees, evenly distributed within site borders (atmospheric only) • Onsite MEI (atmospheric only) • Offsite MEI (atmospheric only) • Waste management worker (inhalation and direct radiation only)
Disposal • Routine emissions	Atmospheric • Inhalation Groundwater • Ingestion of drinking water • Irrigation of crops • Watering of livestock • Bathing Direct Radiation	• Waste management worker (atmospheric and direct radiation during disposal operations only) • Hypothetical farm family (ingestion of groundwater and food) • Hypothetical intruder (ingestion of crops and soil, inhalation of soil particulates, direct radiation)

Interpreting the Health Risk Tables

This section provides some examples of the types of health risk tables found in this volume and describes how the data should be interpreted using the following series of tables for management of LLMW. Table II.1–8 presents information on the estimated number of fatalities resulting from treatment and disposal of LLMW for several receptor groups (i.e., Waste Management Workers, Offsite Population, Noninvolved Workers). Since each of these receptor groups contains multiple individuals, the estimated health risks are presented as the number of potential adverse health effects in each population. For example, under the "Treatment" heading, "Waste Management Workers" are the first receptor group listed. Under the "Waste Management Workers" heading, the column entitled "Radiation Exposure" contains the estimated number of latent cancer fatalities resulting from radiation exposure of waste management workers.

Table II.1–8. LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population Radiation Exposure	Noninvolved Workers Radiation Exposure	WM Worker	
	T	D	Radiation Exposure	Physical Hazards			Radiation Exposure	Physical Hazards
No Action	3	--	4.4E–02	9.1E–02	2.6E–02	1.2E–04	NA	NA
Decentralized	37	16	1.9E–02	2.1E–01	1.3E–03	6.1E–06	1.24E–02	3.91E–02
Regionalized-1	11	12	1.0E–02	4.7E–02	6.0E–06	2.8E–08	NA	NA
Regionalized-2	7	6	1.0E–02	4.7E–02	6.0E–06	2.8E–08	NA	NA
Regionalized-3	7	1	1.0E–02	4.7E–02	6.0E–06	2.8E–08	NA	NA
Regionalized-4	4	6	1.0E–02	4.7E–02	6.0E–06	2.8E–08	NA	NA
Centralized	1	1	1.0E–02	4.7E–02	6.0E–06	2.8E–08	NA	NA

Notes: T = treatment; D = disposal; -- = disposal of LLMW is not considered for this alternative; NA = not applicable.

Waste management workers are assumed to be exposed to direct radiation during the 10-year operational lifetime of the treatment facility. However, radiation-induced latent cancer fatalities are estimated over the entire 70-year lifetime of the workers since a fatal cancer could occur throughout the lifetime of exposed workers. The numbers in this column are all less than one, ranging from 0.01 to 0.044. These values mean that less than one worker cancer fatality is estimated to result from direct radiation exposure received during treatment of LLMW under each of the waste management alternatives at this site. The data listed under the column headings "Offsite Population Radiation Exposure" and "Noninvolved Workers Radiation Exposure", as well as the column labeled "Waste Management Workers Radiation Exposure" under the "Disposal" heading can be interpreted in a similar manner.

The columns labeled "Physical Hazards" for waste management workers list the estimated numbers of worker fatalities resulting from physical trauma encountered during construction and operation of the treatment and disposal facilities. These values were estimated using an assumed 10-year period for facility construction followed by a 10-year period of operation.

Similar types of population level impact tables present estimates of the number of cancer and genetic effects in various receptor groups, as shown in Table II.1-9 below.

Table II.1-9. LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	--	5.2E+01	8.8E-02	3.8E-04	5.2E-03	2.5E-01	4.2E-04	7.9E-06	2.5E-05	1.1E+02	1.6E-01	2.2E-06	6.7E-03
Decentralized	37	16	2.6E+00	4.5E-03	1.8E-05	2.6E-04	1.2E-02	2.1E-05	3.7E-07	1.2E-06	4.8E+01	6.7E-02	2.2E-04	2.9E-03
Regionalized-1	11	12	1.2E-02	2.0E-05	1.4E-07	1.2E-06	5.6E-05	9.6E-08	3.0E-09	5.6E-09	2.6E+01	3.6E-02	1.1E-06	1.6E-03
Regionalized-2	7	6	1.2E-02	2.0E-05	1.4E-07	1.2E-06	5.6E-05	9.6E-08	3.0E-09	5.6E-09	2.6E+01	3.6E-02	1.1E-06	1.6E-03
Regionalized-3	7	1	1.2E-02	2.0E-05	1.4E-07	1.2E-06	5.6E-05	9.6E-08	3.0E-09	5.6E-09	2.6E+01	3.6E-02	1.1E-06	1.6E-03
Regionalized-4	4	6	1.2E-02	2.0E-05	1.4E-07	1.2E-06	5.6E-05	9.6E-08	3.0E-09	5.6E-09	2.6E+01	3.6E-02	1.1E-06	1.6E-03
Centralized	1	1	1.2E-02	2.0E-05	1.4E-07	1.2E-06	5.6E-05	9.6E-08	3.0E-09	5.6E-09	2.6E+01	3.6E-02	1.1E-06	1.6E-03

Notes: T = treatment; D = disposal; -- = disposal of LLMW is not considered for this alternative.

This table represents estimates of the radiation doses received by the receptor groups as well as the number of cancer incidences and genetic effects. Note that radiation dose estimates for populations are presented in the tables in units of "person-rem," which is the sum of the radiation dose, measured in units of rems, received by each individual in the receptor group. Numbers of adverse health effects are estimated based on the application of risk factors to the dose estimates produced by the models used in the analysis. The risk factors used, listed below, are from the International Commission on Radiological Protection (ICRP) published in 1990:

Endpoint	Risk Factors for Public Receptors	Risk Factors for Workers
Cancer incidence	0.0017/rem-lifetime	0.0014/rem-lifetime
Cancer fatality	0.0005/rem-lifetime	0.0004/rem-lifetime
Genetic effects	0.0001/rem-lifetime	0.00006/rem-lifetime

For example, for the "Offsite Population," under the No Action Alternative, the estimated dose is 52 person-rem. Multiplying this value by the cancer incidence risk factor for public receptors of 0.0017 cancer/rem-lifetime listed above produces the estimate of 0.088 cancers listed in the table. For "Waste Management Workers," under the Decentralized Alternative, the estimated dose is 48 person-rem. Multiplying this dose by the genetic effects risks factor for workers of 0.00006 genetic effects/rem-lifetime listed above produces the estimate of 2.9E-03 listed in the table. Similar calculations can be made using the dose estimates and the appropriate cancer fatality risk factor to obtain the radiation fatality values listed in Table II.1–8. Note that slight differences in values are due to rounding and that the risk factors for public receptors were used to calculate risks for the "Noninvolved Workers". Also note that the risk factors presented above are used only in converting radiation doses to estimates of adverse health effects; the chemical cancer incidence values listed in the table are calculated in a different manner (see Chapter 5 of Volume I and Appendix D for additional information).

The WM PEIS also evaluated health risk impacts to hypothetical individuals estimated to experience the maximum exposure (i.e., the maximally exposed individual, or MEI) within the offsite population and noninvolved worker receptor groups (for treatment) and the most exposed lifetime of the farm family (for disposal). Table II.1–10 is an example of an MEI table that presents data on cancer fatality probabilities resulting from treatment and disposal. Since the MEI receptors are by definition single individuals, the risk estimates are *probabilities* that the MEI within each receptor population would experience an adverse health impact. Chapter 5 of Volume II contains a discussion of risk benchmarks that may be helpful in interpreting the risk probability estimates. Note that the MEI radiation exposure estimates are presented in units of "rem." Similar tables present information on probabilities of cancer incidence and genetic effects.

Table II.1-10 is an example of an MEI table that presents data on cancer fatality probabilities resulting from treatment an disposal.

Table II.1-10. LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	--	1.4E-07	1.2E-07	NA
Decentralized	37	16	7.2E-09	6.1E-09	8.5E-05
Regionalized-1	11	12	3.3E-11	2.8E-11	NA
Regionalized-2	7	6	3.3E-11	2.8E-11	NA
Regionalized-3	7	1	3.3E-11	2.8E-11	NA
Regionalized-4	4	6	3.3E-11	2.8E-11	NA
Centralized	1	1	3.3E-11	2.8E-11	NA

Notes: T = treatment; D = disposal; MEI = maximally exposed individual; -- = disposal of LLMW is not considered for this Alternative; NA = not applicable.

Table II.1-11 is an example of a table that presents noncancer health risk data. Noncancer health risk estimates are for single individuals and result from exposure to chemicals that are not believed to cause cancer. The data presented in the table are index values rather than probabilities. Both the Hazard Index (for the Offsite population MEI, Noninvolved Worker MEI, and the Hypothetical Farm Family Most Exposed Lifetime MEI) and the Exposure Index (for the WM Worker) are ratios of concentrations. They compare the estimated exposure concentrations of chemicals to concentrations thought to be protective of health (i.e., concentrations that should not produce adverse health effects upon prolonged exposure). If the index or ratio values exceed 1, there is a potential for adverse noncancer health effects. Values below 1 indicate that adverse noncancer health effects are not of concern. Since the values in Table II.1-11 are less than 1, these receptors are not at risk for adverse noncancer health effects under the waste management alternatives evaluated at this site.

Table II.1-11. LLMW—Noncancer Health Risk for Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	--	2.7E-06	8.1E-06	4.7E-06	NA
Decentralized	37	16	1.8E-07	5.4E-07	6.0E-04	5.5E-01
Regionalized-1	11	12	1.2E-09	3.5E-09	4.7E-06	NA
Regionalized-2	7	6	1.2E-09	3.5E-09	4.7E-06	NA
Regionalized-3	7	1	1.2E-09	3.5E-09	4.7E-06	NA
Regionalized-4	4	6	1.2E-09	3.5E-09	4.7E-06	NA
Centralized	1	1	1.2E-09	3.5E-09	4.7E-06	NA

Notes: T = treatment; D = disposal; MEI = maximally exposed individual; -- = Disposal of LLMW is not considered for this alternative; NA = not applicable.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

II.1.4 Description of Air Quality Data Tables

DOE evaluated air quality impacts at each proposed waste management site on the basis of estimated increases in emissions of the six criteria air pollutants, hazardous air pollutants (which include radionuclides), and toxic air pollutants. Pollutant emission estimates were made for the construction, and operations and maintenance (O&M) activities of waste management facilities.

The Clean Air Act (42 USC 7401 *et seq.*) regulates emissions of air pollutants. In those areas where criteria air pollution standards are not met (known as "nonattainment areas"), activities that introduce new sources of emissions from both "stationary" (e.g., treatment, storage, and/or disposal facilities) and mobile (e.g., vehicles and construction equipment) sources are regulated under the "General Conformity Rule." In this rule, EPA has established limits for each criteria pollutant for nonattainment areas. A Federal entity that seeks to engage in an activity that will result in emissions equal to or greater than those limits in a nonattainment area, in addition to obtaining a New Source Review permit, must also conduct a formal conformity determination.

In "attainment areas" (where criteria air pollution standards are met), new and existing sources of emissions from stationary sources are regulated. In these areas, regulations for the Prevention of Significant Deterioration (PSD) of ambient air quality apply. Allowable emission increases are known as PSD increments. A PSD permit is required for a new stationary source that equals or exceeds the allowable increase. A PSD permit is not required for criteria pollutant emissions from mobile sources.

Major Types of Air Pollutants

Criteria Air Pollutants: *carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), ozone (O_3), and particulate matter less than or equal to 10 microns in diameter (PM_{10})*

Hazardous Air Pollutants: *189 hazardous substances (including radionuclides) whose emissions are regulated by the Clean Air Act*

Toxic Air Pollutants: *Other toxic compounds regulated by EPA and state or local governments*

Criteria air pollutants can be emitted from construction equipment and from vehicles that workers use to drive to the construction site. Both are considered to be "mobile sources." Criteria air pollutants are also emitted during the O&M of waste management facilities (stationary sources) and by vehicles that are driven by workers to the facility or used to transport waste (mobile sources). DOE evaluated air quality impacts for these pollutants at each site by comparing estimated increases in tons per year to the allowable emission limits (General Conformity Rules in nonattainment areas or PSD increments in attainment areas). Estimated concentrations resulting from criteria air pollutant emissions from facilities were also compared with the National Ambient Air Quality Standards (NAAQS) (40 CFR 50).

Thermal treatment of waste will also result in emission of small quantities of hazardous and toxic air pollutants. Hazardous air pollutants, other than radionuclides, and toxic air pollutants were evaluated by comparing estimated ambient concentrations to EPA guidelines and State Ambient Allowable Limits. Radionuclides from air emissions were evaluated by comparing the annual radiation dose to a maximally exposed individual (MEI) with the National Emissions Standards for Hazardous Air Pollutants—10 millirems per year (mrem/yr) (40 CFR 61).

Volume II contains three air quality tables for each site, for each waste type. The first is similar to example Table II.1–12 provided below, and shows the emissions of criteria air pollutants in tons per year for construction and operations. For construction, the table includes total emissions, and in parenthesis, emissions from construction equipment exhaust and worker vehicles. For operations, the table includes total emissions, and in parenthesis, emissions from stationary-sources (waste management facilities), and mobile-sources (worker and waste shipment vehicles).

Table II.1–12. Emissions in Tons per Year of Criteria Air Pollutants

	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
Alternatives	**T**	**D**	**CO**	**NO_2**	**Pb**	**PM_{10}**	**SO_2**	**VOC**	**CO**	**NO_2**	**Pb**	**PM_{10}**	**SO_2**	**VOC**
No Action	3	--	12(1/11)	5(3/2)	0	0	0	2(1/1)	9(1/8)	4(2/2)	0	0	0	1((0/1)
Decentralized	37	16	58(5/53)	24(13/11)	0	1(1/0)	1(1/0)	7(1/6)	50(0/50)	15(5/10)	0	3(3/0)	0	6(0/6)
Regionalized	11	12	70(5/65)	25(12/13)	0	1(1/0)	1(1/0)	9(1/8)	52(1/51)	15(5/10)	0	4(4/0)	0	6(0/6)
Centralized	1	1	93(25/68)	99(44/54)	0	6(5/1)	6(6/0)	38(6/32)	93(3/90)	75(33/42)	0	23(22/1)	2(2/0)	25(0/25)

Notes: T = treatment; D = disposal; -- = disposal is not considered for this alternative. VOC = volatile organic compounds; CO = carbon monoxide; NO_2 = nitrogen dioxide; Pb = lead; PM_{10} = particulate matter less than 10 microns in diameter; SO_2 = sulfur dioxide. Emissions <1 ton per year are shown as zeros.
(1) Values = total emissions (equipments emissions / worker vehicles emission)
(2) Values = total emissions (stationary-source emissions / mobile-source emissions).

The second table is similar to example Table II.1-13 provided below, and shows the percentage of applicable tons per year standards for emissions listed in the first table. The second table also shows the percentage of applicable National Ambient Air Quality Standards (NAAQSs) for criteria air pollutant concentrations due to releases from incineration. Double dashes are used to show where information is not applicable or not available.

Table II.1-13. Percent of Standard/Guidelines for Criteria Air Pollutants

	Number of Sites		Construction						Operations & Maintenance											
			Percent of Tons/Year General Conformity Rule (1)						Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
Alternatives	**T**	**D**	**CO**	**NO_2**	**Pb**	**PM_{10}**	**SO_2**	**VOC**	**CO(4)**	**NO_2(4)**	**Pb(4)**	**PM_{10}(5)**	**SO_2(4)**	**VOC(4)**	**CO**	**NO_2**	**Pb**	**PM_{10}**	**SO_2**	**VOC**
No Action	3	--	NA	NA	NA	0	NA	NA	1	4	0	5(1/4)	0	0	NA	NA	NA	NA	NA	NA
Decentralized	37	16	NA	NA	NA	3(2/1)	NA	NA	1	12	0	4(1/3)	1	0	0	0	0	0	0	0
Regionalized	11	12	NA	NA	NA	3(2/1)	NA	NA	1	13	0	10(2/8)	1	0	0	0	0	0	0	0
Centralized	1	1	NA	NA	NA	12(11/7)	NA	NA	3	82	1	25(5/20)	5	1	0	0	0	0	2	0

Notes: T = treatment; D = disposal; -- = disposal is not considered for this alternative; NA = not applicable; PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule. CO = carbon monoxide. NO_2 = nitrogen dioxide. Pb = lead. PM_{10} = particulate matter less than 10 microns in diameter. SO_2 = sulfur dioxide. VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard. Percentages <1% are shown as zeros.
(1) GCR de minimis levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicle emissions).
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for the No Action and minimum treatment (no incineration) alternatives are assumed to be negligible.
(4) Attainment area for this pollutant; therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for this pollutant; therefore GCR de minimis levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).

The final table is similar to example Table II.1-14 provided below, and shows the percentages of the applicable concentration standards for hazardous and toxic air pollutants. The percentages of the 10 mrem per year total dose standard for the air pathway under the National Emissions Standards for Hazardous Air Pollutants (NESHAP) are also included in this table.

Table II.1-14. Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

Alternatives	Number of Sites		Operations & Maintenance						
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form
No Action	3	--	0	0	0	NA	NA	0	NA
Decentralized	37	16	0	0	0	NA	NA	0	NA
Regionalized	11	12	0	0	0	NA	NA	0	NA
Centralized	1	1	1	0	0	NA	NA	0	NA

Notes: T = treatment; D = disposal;
-- = disposal is not considered for this alternative; NA = not applicable.
Percentages <1% are shown as zeros.

II.1.5 Description of Water Resources Data Tables

DOE evaluated the effects on water availability from building and operating treatment, storage and disposal facilities. Impacts on surface water and groundwater availability were assessed by comparing current water use rates from municipal, surface water, or groundwater sources to projected requirements for construction or operation of waste management facilities. In addition, impacts on surface water were further assessed by examining the effect of potential withdrawals from and discharges to the major offsite water body at a given site. Volume II tables identify projected water usage under any alternative.

In addition, DOE evaluated the impacts to groundwater quality caused by the migration of radionuclides and chemicals that leach from LLMW and LLW disposal facilities over time. DOE calculated concentrations of radionuclides and hazardous components at a hypothetical well located 300 meters from the center of the disposal facility, and compared these to DOE or EPA drinking water standards. For radionuclides, most of the allowable drinking water concentrations equate to a 4 mrem per year effective dose equivalent.

The drinking water standards are used as comparison criteria for groundwater quality. Although they are not enforceable standards, they are often used as goals for contaminated site cleanup actions under the Comprehensive Environmental Response, Compensation and Liability Act. DOE and EPA established these criteria to protect human health, therefore groundwater concentrations of radionuclides and chemicals at or below these levels present a low risk.

The concentrations of hazardous constituents in the groundwater from disposal of LLMW are largely due to assumptions on the routing of wastes through the treatment system. As shown in the LLMW flow diagram in Chapter 6 (Figure 6.2-1), some wastes containing solvents were assumed to bypass the thermal treatment processes. The solvents in these wastes were not destroyed, but instead, ended up in the disposal facility. Some of these wastes contain solvents in large enough concentrations to cause drinking water standards to be exceeded when the wastes are disposed. In practice, LLMW to be disposed would meet EPA standards for treatment and disposal, and therefore should not produce major impacts to groundwater quality. Therefore, although the absolute values of the results for hazardous constituent contamination in groundwater are higher than would result from wastes treated to EPA standards, the results are still useful in showing the relative suitability of the sites. Even with the conservative assumptions used in the WM PEIS, drinking water standards were not exceeded at some sites. This may indicate that these sites are better for LLMW disposal than other sites.

The performance of disposal facilities at a specific site would be evaluated in greater detail in DOE's Performance Assessment process under DOE Order 5820.2A. This process would help to ensure that all regulatory requirements are met and significant contamination of groundwater would not occur.

Volume II contains two types of water resources tables for each site. The first type of table (Table II.1–15) presents the water use in gallons per day for construction and operations, along with the percent of current use and percent of streamflow for the water use. This table also provides the percent of streamflow for wastewater discharges, assuming all water used by the facility during operations is discharged. The first type of table is provided for all five waste types. The second type of table (Table II.1–16) provides results of the analysis of impacts to groundwater quality from the disposal of LLMW and LLW. Concentrations of radionuclides are shown as a percentage of drinking water standards. In addition, tables that show the percent of drinking water standards for hazardous constituents are provided for LLMW.

Table II.1-15. Impacts on Water Resources due to Increased Water Use

Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	--	9,920	0.1	0.00	11,491	0.1	0.00	0.00
Decentralized	37	16	24,085	0.1	0.00	14,992	0.1	0.00	0.00
Regionalized	11	12	24,085	0.1	0.00	14,992	0.1	0.00	0.00
Centralized	1	1	7,888	0.0	0.00	4,686	0.0	0.00	0.00

Notes: T = treatment; D = disposal; -- = disposal is not considered for this alternative.
Water is supplied by surface water from the river. Current water use = 18,300,000 gallons/day. Wastewater is discharged to the River. Average flow rate of the River = 3,003,000,000 gallons/day.

Table II.1-16. Radionuclide Concentrations in Groundwater (Percent of Drinking Water Standard) for Disposal

Alternatives	Number of Sites		Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
	T	D*																					
No Action	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	1,000	600	0
Regionalized	11	12	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	1,000	600	0
Centralized	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	1,000	600	0

Notes: T = treatment; D = disposal; — = no disposal for this alternative.

II.1.6 Description of Socioeconomic Impacts Data Tables

DOE estimated the effects of expenditures for waste management on the regional economies at the 17 major sites and on the national economy. Regional economic effects were based on direct expenditures at each site for construction, operations and maintenance, and decontamination of treatment and disposal facilities. The region-of-influence (ROI), where these effects were evaluated, consists essentially of the counties of residence of site employees. The economy at each site was represented by employment, personal income, and industry output (revenue) data for the ROI counties. Transportation expenditures were not considered in the regional level analysis.

Regional economic effects were estimated on an annual basis. The impacts resulting from the construction and operation phase expenditures were combined to estimate total project effects at each site. For all alternatives, the construction phase at any site was assumed to take 4 years; the operations phase was assumed to follow the construction phase immediately and to take 15 years (a 10-year operations and maintenance period and a 5-year decontamination period). Five years was added to the operations phase to account for the continued effects on employment and income after this last phase ends. Job and personal income increases only are shown for each site in the Volume II site tables. Industry effects are listed in the impacts technical report.

In addition to the economic effects, proposed waste management activities could affect the social environment by increasing population. Potential population changes in the ROI were estimated using the direct labor requirement to calculate potential worker in-migration. These estimates were used to evaluate the likelihood that population changes would cause social effects, such as changes in community size and diversity, and effects on the provision of necessary social services.

Volume II contains one socioeconomic impacts table for each site, for each waste type. The table is similar to example Table II.1-17 below which presents information used to assess the impacts of the waste management alternatives on the regional economies and population. The cost required for the waste management alternatives is listed since this is the factor that drives the socioeconomic impacts. To be consistent with the socioeconomic baseline data (1990 census) on the regional economies, the costs listed here have been corrected to 1990 dollars from the costs in 1994 dollars appearing in the cost tables. The annual number of jobs and the percent annual change in the number of jobs in the ROI are supplied as an indicator of impacts to employment in the region. The annual income attributable to the waste management action, and the percent change in the annual income in the ROI are presented as a measure of economic effects. The percent change in the local population is provided as a measure of the potential for changes in community size and diversity that may produce adverse social effects.

Table II.1-17. Socioeconomic Impacts for Treatment and Disposal Alternatives

Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	--	230	187	0.09	2.0	0.03	0.05
Decentralized	37	16	759	772	0.36	8.2	0.13	0.17
Regionalized	11	12	828	842	0.39	9.0	0.14	0.19
Centralized	1	1	3507	3567	1.66	38.1	0.58	0.76

Notes: T = treatment; D = disposal; ROI = region of influence; -- = disposal is not considered for this alternative.
(1) In 1990 dollars.
(2) Compared with 1990 baseline.

Land Use and Infrastructure Impacts

DOE examined the impacts of the waste management alternatives on land use by comparing the acreage required for construction of new treatment and disposal facilities to the acreage either designated for waste operations or suitable for development. Suitable land is the total site acreage, minus the acreage of existing structures, known cultural resource areas, sensitive habitats (including wetlands and wildlife management areas), prohibitive topographic features, surface waters, and any other features that would preclude development.

DOE evaluated the impacts on site infrastructure by comparing existing onsite capacities to new WM requirements for water, wastewater treatment, and power. Water and power were evaluated for both construction and operations; wastewater treatment was evaluated only for operations because wastewater from construction activities was assumed to be negligible. Where onsite maximum capacity information was unavailable, the proposed requirement was evaluated as a percentage of current use. Increased site employment was used as an indicator of increased demand on the community infrastructure.

Volume II contains one land use and infrastructure table for each site, for each waste type. Table II.1-18 provides an example of this table. The table provides information on land use, water supply systems, wastewater treatment systems, electrical power supply systems, and site employment. The table shows the acres required for the waste management action and the percent of designated or suitable land areas proposed to be used; the water, wastewater and power demands, and the corresponding percent of current capacity that would be required; and peak construction employment and the percent of current site employment that this construction employment represents.

Table II.1-18. Land Use and Infrastructure Impacts for Treatment and Disposal

	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
Alternatives	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	3	--	11.2	0.94	29,232	1.62	2,066	0.08	4.32	18.76	111	2
Decentralized	37	16	7.5	0.63	11,457	0.64	5,603	0.22	0.97	4.24	430	10
Regionalized	11	12	0.3	0.02	757	0.04	757	0.03	0.11	0.49	39	1
Centralized	1	1	0.3	0.02	757	0.04	757	0.03	0.11	0.49	39	1

Notes: T = treatment; D = Disposal; GPD = gallons per day; MW = megawatts; FTE = full-time employee; -- = disposal is not considered for this alternative.
(1) Based on 1991 Site Employment

II.1.7 Description of Cost Data Tables

DOE estimated costs for building and operating treatment storage and disposal facilities, and for transportation, from both a life-cycle and process perspective, using 1994 dollars.

Life-Cycle Costs: DOE evaluated facility costs for four phases representing the life-cycle of the facilities and their operations: pre-operations, construction, operations and maintenance, and decontamination and decommissioning.

- Costs for pre-operation activities consist of technology and site adaptation, including bench scale tests and demonstration; permitting; plant startup and cold run costs; and related conceptual design, safety analysis, project management, and contingencies.
- Facility construction costs consist of building construction, equipment purchase and installation, contractor overhead, and related design; construction management; project management; and contingencies.
- Operations and maintenance costs consist of annual operations labor and material, maintenance labor and equipment, utilities, contractor supervision and overhead, and related project management and contingencies.
- Decontamination and decommissioning costs consist of facility decontamination and demolition, environmental closure, post-closure, and monitoring activities.

Process Costs: DOE also analyzed costs based on treatment, storage, disposal, and transportation activities.

- Treatment costs include costs to build and operate treatment facilities (such as wastewater treatment or incineration) and support facilities (such as maintenance and certification/shipping facilities).
- Storage capacity, for the purpose of the WM PEIS analysis, was assumed to be sufficient for a number of alternatives as discussed in Chapters 6-10. When necessary, DOE estimated the costs to build and operate sufficient storage capacity.
- Disposal costs include costs to build and operate administration and receiving facilities for disposal as well as the actual disposal units.
- Transportation costs include the costs associated with the physical movement of the waste from one site to another, for either treatment or disposal. Transportation costs are evaluated for both truck transportation and rail shipments, and are displayed as total transportation costs for each alternative. They are not presented in the site data tables.

Volume II contains one table as shown in Table II.1-19 that displays costs for each of the above components. The table first displays total costs as the sum of facility costs (site cost tables exclude transportation). The next columns display total "facility" costs by life-cycle component, followed by columns that display total "facility" costs by process (e.g., treatment, storage, disposal—as applicable).

Table II.1-19. Cost

Alternatives	Number of Sites		Total Cost (Millions)	Life-Cycle Costs				Functional Area Costs		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	--	207	16	53	125	14	88	118	0
Decentralized	37	16	739	72	207	431	29	431	0	308
Regionalized	11	12	96	8	18	61	10	96	0	0
Centralized	1	1	96	8	18	61	10	96	0	0

Notes: T = treatment; D = disposal; -- = disposal is not considered for this alternative.
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not add to the total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.2.0 Argonne National Laboratory-East (ANL-E)

ANL-E currently is custodian of significant volumes of LLMW, LLW, and TRUW. Each of the waste types is treated independently in the following sections.

II.2.1 ANL-E LLMW

Fifteen tables immediately following portray the impacts of LLMW at ANL-E.

Impact Category

No.	Description	Table No.	Page No.
1.	ANL-E—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-2.1-1	2-2
2.	ANL-E—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-2.1-2	2-3
3.	ANL-E—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-2.1-3	2-4
4.	ANL-E—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-2.1-4	2-5
5.	ANL-E—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-2.1-5	2-6
6.	ANL-E—LLMW—Treatment and Disposal: Noncancer Health Risk From Chemical Exposure	II-2.1-6	2-7
7.	ANL-E—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-2.1-7	2-8
8.	ANL-E—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-2.1-8	2-9
9.	ANL-E—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-2.1-9	2-10
10.	ANL-E—LLMW—Impacts on Water Resources Due to Increased Water Use	II-2.1-10	2-11
11.	ANL-E—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-2.1-11	2-12
12.	ANL-E—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)	II-2.1-12	2-13
13.	ANL-E—LLMW—Socioeconomic Impacts for Treatment and Disposal	II-2.1-13	2-14
14.	ANL-E—LLMW—Infrastructure Impacts for Treatment and Disposal	II-2.1-14	2-15
15.	ANL-E—LLMW—Cost	II-2.1-15	2-16

Table II-2.1-1. ANL-E—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	6.5E-05	1.8E-03	2.6E-04	1.2E-06	- -	- -
Decentralized	37	16	6.7E-05	6.4E-03	1.7E-05	7.3E-08	2.6E-05	3.2E-04
Regionalized-1	11	12	3.2E-05	3.8E-03	5.9E-07	8.6E-10	- -	- -
Regionalized-2	7	6	3.2E-05	3.8E-03	5.9E-07	8.6E-10	- -	- -
Regionalized-3	7	1	3.2E-05	3.8E-03	5.9E-07	8.6E-10	- -	- -
Regionalized-4	4	6	3.2E-05	3.8E-03	5.9E-07	8.6E-10	- -	- -
Centralized	1	1	3.2E-05	3.8E-03	5.9E-07	8.6E-10	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-2.1-2. ANL-E—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	-	5.2E-01	8.8E-04	6.2E-06	5.2E-05	2.5E-03	4.2E-06	1.3E-07	2.5E-07	1.6E-01	2.3E-04	6.1E-09	9.8E-06
Decentralized	37	16	3.3E-02	5.6E-05	2.6E-07	3.3E-06	1.5E-04	2.5E-07	5.5E-09	1.5E-08	1.7E-01	2.3E-04	1.6E-07	1.0E-05
Regionalized-1	11	12	1.2E-03	2.0E-06	1.2E-07	1.2E-07	1.7E-06	2.9E-09	1.3E-10	1.7E-10	8.1E-02	1.1E-04	2.3E-09	4.9E-06
Regionalized-2	7	6	1.2E-03	2.0E-06	6.2E-09	1.2E-07	1.7E-06	2.9E-09	1.3E-10	1.7E-10	8.1E-02	1.1E-04	2.3E-09	4.9E-06
Regionalized-3	7	1	1.2E-03	2.0E-06	6.2E-09	1.2E-07	1.7E-06	2.9E-09	1.3E-10	1.7E-10	8.1E-02	1.1E-04	2.3E-09	4.9E-06
Regionalized-4	4	6	1.2E-03	2.0E-06	6.2E-09	1.2E-07	1.7E-06	2.9E-09	1.3E-10	1.7E-10	8.1E-02	1.1E-04	2.3E-09	4.9E-06
Centralized	1	1	1.2E-03	2.0E-06	6.2E-09	1.2E-07	1.7E-06	2.9E-09	1.3E-10	1.7E-10	8.1E-02	1.1E-04	2.3E-09	4.9E-06

Notes:
T = Treatment
D = Disposal

Table II-2.1-3. ANL-E—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	6.6E-02	9.2E-05	3.9E-06
Regionalized-1	11	12	- -	- -	- -
Regionalized-2	7	6	- -	- -	- -
Regionalized-3	7	1	- -	- -	- -
Regionalized-4	4	6	- -	- -	- -
Centralized	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-2.1-4. ANL-E—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	1.4E-09	1.2E-09	- -
Decentralized	37	16	9.1E-11	7.4E-11	8.5E-07
Regionalized-1	11	12	3.3E-12	8.7E-13	- -
Regionalized-2	7	6	3.3E-12	8.7E-13	- -
Regionalized-3	7	1	3.3E-12	8.7E-13	- -
Regionalized-4	4	6	3.3E-12	8.7E-13	- -
Centralized	1	1	3.3E-12	8.7E-13	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative

Table II-2.1-5. ANL-E—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Most Exposed Farm Family Lifetime MEI			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	3	-	2.8E-06	4.8E-09	3.9E-11	2.8E-10	2.5E-06	4.2E-09	1.2E-10	2.5E-10	--	--	--	--
Decentralized	37	16	1.8E-07	3.1E-10	1.7E-12	1.8E-11	1.5E-07	2.5E-10	4.9E-12	1.5E-11	1.7E-03	2.9E-06	1.4E-06	1.7E-07
Regionalized-1	11	12	6.5E-09	1.1E-11	3.9E-14	6.5E-13	1.7E-09	3.0E-12	1.2E-13	1.7E-13	--	--	--	--
Regionalized-2	7	6	6.5E-09	1.1E-11	3.9E-14	6.5E-13	1.7E-09	3.0E-12	1.2E-13	1.7E-13	--	--	--	--
Regionalized-3	7	1	6.5E-09	1.1E-11	3.9E-14	6.5E-13	1.7E-09	3.0E-12	1.2E-13	1.7E-13	--	--	--	--
Regionalized-4	4	6	6.5E-09	1.1E-11	3.9E-14	6.5E-13	1.7E-09	3.0E-12	1.2E-13	1.7E-13	--	--	--	--
Centralized	1	1	6.5E-09	1.1E-11	3.9E-14	6.5E-13	1.7E-09	3.0E-12	1.2E-13	1.7E-13	--	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
-- = Disposal is not considered for this alternative.

Table II-2.1-6. ANL-E—LLMW—Treatment and Disposal: Noncancer Health Risk From Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	1.0E-08	3.0E-08	1.7E-07	- -
Decentralized	37	16	8.0E-10	2.4E-09	8.3E-06	1.7E-02
Regionalized-1	11	12	4.8E-12	1.4E-11	1.6E-07	- -
Regionalized-2	7	6	4.8E-12	1.4E-11	1.6E-07	- -
Regionalized-3	7	1	4.8E-12	1.4E-11	1.6E-07	- -
Regionalized-4	4	6	4.8E-12	1.4E-11	1.6E-07	- -
Centralized	1	1	4.8E-12	1.4E-11	1.6E-07	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this alternative.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of Exposure concentration to chemical-specific occupational threshold limits.

Table II-2.1-7. ANL-E—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	2 (1/1)	2 (2/0)	0	0	0	0	0	0	0	0	0	0
Decentralized	37	16	10 (4/6)	11 (10/1)	0	1 (1/0)	1 (1/0)	2 (1/1)	4 (0/4)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-1	11	12	11 (2/9)	7 (5/2)	0	0	0	1 (0/1)	4 (0/4)	1 (0/1)	0	0	0	0
Regionalized-2	7	6	11 (2/9)	7 (5/2)	0	0	0	1 (0/1)	4 (0/4)	1 (0/1)	0	0	0	0
Regionalized-3	7	1	11 (2/9)	7 (5/2)	0	0	0	1 (0/1)	4 (0/4)	1 (0/1)	0	0	0	0
Regionalized-4	4	6	11 (2/9)	7 (5/2)	0	0	0	1 (0/1)	4 (0/4)	1 (0/1)	0	0	0	0
Centralized	1	1	11 (2/9)	7 (5/2)	0	0	0	1 (0/1)	4 (0/4)	1 (0/1)	0	0	0	0

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-2.1-8. ANL-E—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	--	10 (9/1)	--	0	--	1 (1/0)
Decentralized	37	16	--	44 (39/5)	--	1 (1/0)	--	7 (4/3)
Regionalized-1	11	12	--	27 (20/7)	--	0	--	6 (2/4)
Regionalized-2	7	6	--	27 (20/7)	--	0	--	6 (2/4)
Regionalized-3	7	1	--	27 (20/7)	--	0	--	6 (2/4)
Regionalized-4	4	6	--	27 (20/7)	--	0	--	6 (2/4)
Centralized	1	1	--	27 (20/7)	--	0	--	6 (2/4)

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (5)	Pb (4)	PM10 (6)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	0	0	0	0	0	0	--	--	--	--	--	--
Decentralized	37	16	0	5 (1/4)	0	0	0	2 (0/2)	0	0	0	0	0	0
Regionalized-1	11	12	0	3 (0/3)	0	0	0	2 (0/2)	--	--	--	--	--	--
Regionalized-2	7	6	0	3 (0/3)	0	0	0	2 (0/2)	--	--	--	--	--	--
Regionalized-3	7	1	0	3 (0/3)	0	0	0	2 (0/2)	--	--	--	--	--	--
Regionalized-4	4	6	0	3 (0/3)	0	0	0	2 (0/2)	--	--	--	--	--	--
Centralized	1	1	0	3 (0/3)	0	0	0	2 (0/2)	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicles emission).
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions are assumed to be negligible for all but the Decentralized Alternative.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for ozone. Pollutant is an ozone precursor, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions)
(6) Nonattainment area for this pollutant, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions)

Table II-2.1-9. ANL-E—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	0	0	0	--	--	0	--	--	0	0	0	0
Decentralized	37	16	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-1	11	12	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-2	7	6	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-3	7	1	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-4	4	6	0	0	0	--	--	0	--	--	0	0	0	0
Centralized	1	1	0	0	0	--	--	0	--	--	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	3	-	--	0	0	0	--	0	0	0	--	--
Decentralized	37	16	--	0	0	0	--	0	0	0	--	--
Regionalized-1	11	12	--	0	0	0	--	0	0	0	--	--
Regionalized-2	7	6	--	0	0	0	--	0	0	0	--	--
Regionalized-3	7	1	--	0	0	0	--	0	0	0	--	--
Regionalized-4	4	6	--	0	0	0	--	0	0	0	--	--
Centralized	1	1	--	0	0	0	--	0	0	0	--	--

Notes:
T = Treatment
D = Disposal
-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-2.1-10. ANL-E—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	1337	0.2	- -	37	0.0	- -	0.00
Decentralized	37	16	2826	0.5	- -	919	0.1	- -	0.00
Regionalized-1	11	12	1500	0.2	- -	287	0.0	- -	0.00
Regionalized-2	7	6	1500	0.2	- -	287	0.0	- -	0.00
Regionalized-3	7	1	1500	0.2	- -	287	0.0	- -	0.00
Regionalized-4	4	6	1500	0.2	- -	287	0.0	- -	0.00
Centralized	1	1	1500	0.2	- -	287	0.0	- -	0.00

Notes:
T = Treatment
D = Disposal
Water supplied by groundwater in the Niagara Aquifer. Current water use = 626,000 gallons/day.
Wastewater discharged to the Des Plains River.
Average flow rate of the Des Plains River = 582,000,000 gallons/day.
- - = Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-2.1-11. ANL-E—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLMW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLMW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
- - = No disposal at this site for this alternative.

Table II-2.1-12. ANL-E—LLMW— Percent of Drinking Water Standards for Hazardous Constitutents in Groundwater from Disposal (Contact-Handled)

LLMW Alternatives	T	D	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	30	0	2	0	0
Regionalized-1	11	12	--	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--

LLMW Alternatives	T	D	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	6	0	0	20	1	0	0
Regionalized-1	11	12	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.

Table II-2.1-13. ANL-E—LLMW—Socioeconomic Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	-	19	19	<0.01	0.2	<0.01	<0.01
Decentralized	37	16	53	52	<0.01	0.6	<0.01	<0.01
Regionalized-1	11	12	28	28	<0.01	0.3	<0.01	<0.01
Regionalized-2	7	6	28	28	<0.01	0.3	<0.01	<0.01
Regionalized-3	7	1	28	28	<0.01	0.3	<0.01	<0.01
Regionalized-4	4	6	28	28	<0.01	0.3	<0.01	<0.01
Centralized	1	1	28	28	<0.01	0.3	<0.01	<0.01

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars
(2) Compared to 1990 baseline

Table II-2.1-14. ANL-E—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	3	-	0.6	0.05	1336	0.07	37	0.001	0.08	0.34	25	1
Decentralized	37	16	2.3	0.2	2825	0.16	919	0.04	0.31	1.33	25	1
Regionalized-1	11	12	1.3	0.10	1500	0.08	286	0.01	0.01	0.32	8	0.2
Regionalized-2	7	6	1.3	0.10	1500	0.08	286	0.01	0.01	0.32	8	0.2
Regionalized-3	7	1	1.3	0.10	1500	0.08	286	0.01	0.01	0.32	8	0.2
Regionalized-4	4	6	1.3	0.10	1500	0.08	286	0.01	0.01	0.32	8	0.2
Centralized	1	1	1.3	0.10	1500	0.08	286	0.01	0.01	0.32	8	0.2

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts
(1) Based on 1991 Site Employment

Table II-2.1-15. ANL-E—LLMW—Cost

(1) In 1994 dollars; LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	22	2	7	13	0.4	9	13	0
Decentralized	37	16	59	4	14	38	3	56	- -	3
Regionalized-1	11	12	32	2	4	25	1	32	- -	0
Regionalized-2	7	6	32	2	4	25	1	32	- -	0
Regionalized-3	7	1	32	2	4	25	1	32	- -	0
Regionalized-4	4	6	32	2	4	25	1	32	- -	0
Centralized	1	1	32	2	4	25	1	32	- -	0

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.2.2 ANL-E LLW

Thirteen tables immediately following, portray the impacts of LLW at ANL-E. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	ANL-E—LLW—Treatment and Disposal: Estimated Number of Fatalities	II-2.2–1	2–18
2.	ANL-E—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-2.2–2	2–19
3.	ANL-E—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-2.2–3	2–20
4.	ANL-E—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-2.2–4	2–21
5.	ANL-E—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-2.2–5	2–22
7.	ANL-E—LLW—Emissions in Tons per Year of Criteria Air Pollutants	II-2.2–6	2–23
8.	ANL-E—LLW—Percent of Standard/Guideline for Criteria Air Pollutants	II-2.2–7	2–24
9.	ANL-E—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-2.2–8	2–25
10.	ANL-E—LLW—Impacts on Water Resources Due to Increased Water Use	II-2.2–9	2–26
11.	ANL-E—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-2.2–10	2–27
13.	ANL-E—LLW—Socioeconomic Impacts for Treatment and Disposal	II-2.2–11	2–28
14.	ANL-E—LLW—Infrastructure Impacts for Treatment and Disposal	II-2.2–12	2–29
15.	ANL-E—LLW—Cost	II-2.2–13	2–30

Table II-2.2–1. ANL-E—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	4.2E-02	7.1E-02	2.3E-06	9.3E-09	- -	- -
Decentralized		16	3.2E-02	5.1E-02	2.5E-06	9.8E-09	4.3E-02	6.3E-02
Regionalized-1		12	3.2E-02	5.1E-02	2.5E-06	9.8E-09	- -	- -
Regionalized-2	11	12	3.2E-02	5.1E-02	2.5E-06	9.8E-09	- -	- -
Regionalized-3		6	3.2E-02	5.1E-02	2.5E-06	9.8E-09	- -	- -
Regionalized-4	7	6	3.2E-02	5.1E-02	2.5E-06	9.8E-09	- -	- -
Regionalized-5	4	6	3.2E-02	5.1E-02	2.5E-06	9.8E-09	- -	- -
Regionalized-6		2	3.2E-02	5.1E-02	2.5E-06	9.8E-09	- -	- -
Regionalized-7		2	3.2E-02	5.1E-02	2.5E-06	9.8E-09	- -	- -
Centralized-1		1	3.2E-02	5.1E-02	2.5E-06	9.8E-09	- -	- -
Centralized-2		1	3.2E-02	5.1E-02	2.5E-06	9.8E-09	- -	- -
Centralized-3	7	1	3.2E-02	5.1E-02	2.5E-06	9.8E-09	- -	- -
Centralized-4	7	1	3.2E-02	5.1E-02	2.5E-06	9.8E-09	- -	- -
Centralized-5	1	1	3.2E-02	5.1E-02	2.5E-06	9.8E-09	- -	- -

Note:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative
** Ten sites use existing facilities for Volume Reduction

Table II-2.2–2. ANL-E—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Offsite Population			Noninvolved Worker			WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	4.7E-03	8.0E-06	4.7E-07	1.9E-05	3.2E-08	1.9E-09	1.1E+02	1.5E-01	6.3E-03
Decentralized		16	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Regionalized-1		12	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Regionalized-2	11	12	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Regionalized-3		6	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Regionalized-4	7	6	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Regionalized-5	4	6	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Regionalized-6		2	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Regionalized-7		2	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Centralized-1		1	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Centralized-2		1	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Centralized-3	7	1	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Centralized-4	7	1	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03
Centralized-5	1	1	5.0E-03	8.5E-06	5.0E-07	2.0E-05	3.3E-08	2.0E-09	7.9E+01	1.1E-01	4.8E-03

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–3. ANL-E—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	- -	- -	- -
Decentralized		16	1.1E+02	1.5E-01	6.5E-03
Regionalized-1		12	- -	- -	- -
Regionalized-2	11	12	- -	- -	- -
Regionalized-3		6	- -	- -	- -
Regionalized-4	7	6	- -	- -	- -
Regionalized-5	4	6	- -	- -	- -
Regionalized-6		2	- -	- -	- -
Regionalized-7		2	- -	- -	- -
Centralized-1		1	- -	- -	- -
Centralized-2		1	- -	- -	- -
Centralized-3	7	1	- -	- -	- -
Centralized-4	7	1	- -	- -	- -
Centralized-5	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–4. ANL-E—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family - Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	1.3E-11	9.4E-12	- -
Decentralized		16	1.4E-11	1.0E-11	2.9E-05
Regionalized-1		12	1.4E-11	1.0E-11	- -
Regionalized-2	11	12	1.4E-11	1.0E-11	- -
Regionalized-3		6	1.4E-11	1.0E-11	- -
Regionalized-4	7	6	1.4E-11	1.0E-11	- -
Regionalized-5	4	6	1.4E-11	1.0E-11	- -
Regionalized-6		2	1.4E-11	1.0E-11	- -
Regionalized-7		2	1.4E-11	1.0E-11	- -
Centralized-1		1	1.4E-11	1.0E-11	- -
Centralized-2		1	1.4E-11	1.0E-11	- -
Centralized-3	7	1	1.4E-11	1.0E-11	- -
Centralized-4	7	1	1.4E-11	1.0E-11	- -
Centralized-5	1	1	1.4E-11	1.0E-11	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–5. ANL-E—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite MEI			Noninvolved Worker MEI			Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	2.6E-08	4.4E-11	2.6E-12	1.9E-08	3.2E-11	1.9E-12	- -	- -	- -
Decentralized		16	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	5.7E-02	9.7E-05	5.7E-06
Regionalized-1		12	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	- -	- -	- -
Regionalized-2	11	12	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	- -	- -	- -
Regionalized-3		6	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	- -	- -	- -
Regionalized-4	7	6	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	- -	- -	- -
Regionalized-5	4	6	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	- -	- -	- -
Regionalized-6		2	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	- -	- -	- -
Regionalized-7		2	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	- -	- -	- -
Centralized-1		1	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	- -	- -	- -
Centralized-2		1	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	- -	- -	- -
Centralized-3	7	1	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	- -	- -	- -
Centralized-4	7	1	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	- -	- -	- -
Centralized-5	1	1	2.8E-08	4.7E-11	2.8E-12	2.0E-08	3.4E-11	2.0E-12	- -	- -	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the alternative.
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–6. ANL-E—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	10 (3/7)	9 (8/1)	0	1 (1/0)	1 (1/0)	2 (1/1)	4 (0/4)	1 (0/1)	0	0	0	0
Decentralized		16	13 (5/8)	14 (13/2)	0	1 (1/0)	1 (1/0)	2 (1/1)	19 (0/19)	4 (0/4)	0	0	0	2 (0/2)
Regionalized-1		12	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-2	11	12	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-3		6	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-4	7	6	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-5	4	6	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-6		2	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalzied-7		2	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-1		1	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-2		1	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-3	7	1	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-4	7	1	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-5	1	1	8 (1/8)	4 (2/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)

Notes:
T = Treatment
D = Disposal
Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions/worker vehicles emission)
(2) Values = total emissions (stationary-source emissions/mobile-source emission)
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–7. ANL-E—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	–	36 (31/5)	–	0	–	6 (3/3)
Decentralized		16	–	58 (52/6)	–	1 (1/0)	–	9 (5/4)
Regionalized-1		12	–	12 (6/6)	–	0	–	4 (1/4)
Regionalized-2	11	12	–	12 (6/6)	–	0	–	4 (1/4)
Regionalized-3		6	–	12 (6/6)	–	0	–	4 (1/4)
Regionalized-4	7	6	–	12 (6/6)	–	0	–	4 (1/4)
Regionalized-5	4	6	–	12 (6/6)	–	0	–	4 (1/4)
Regionalized-6		2	–	12 (6/6)	–	0	–	4 (1/4)
Regionalzied-7		2	–	12 (6/6)	–	0	–	4 (1/4)
Centralized-1		1	–	12 (6/6)	–	0	–	4 (1/4)
Centralized-2		1	–	12 (6/6)	–	0	–	4 (1/4)
Centralized-3	7	1	–	12 (6/6)	–	0	–	4 (1/4)
Centralized-4	7	1	–	12 (6/6)	–	0	–	4 (1/4)
Centralized-5	1	1	–	12 (6/6)	–	0	–	4 (1/4)

LLW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (5)	Pb (4)	PM10 (6)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	0	4 (0/4)	0	0	0	2 (0/2)	–	–	–	–	–	–
Decentralized		16	0	17 (2/15)	0	0	0	9 (0/9)	–	–	–	–	–	–
Regionalized-1		12	0	4 (0/4)	0	0	0	2 (0/2)	–	–	–	–	–	–
Regionalized-2	11	12	0	4 (0/4)	0	0	0	2 (0/2)	–	–	–	–	–	–
Regionalized-3		6	0	4 (0/4)	0	0	0	2 (0/2)	–	–	–	–	–	–
Regionalized-4	7	6	0	4 (0/4)	0	0	0	2 (0/2)	–	–	–	–	–	–
Regionalized-5	4	6	0	4 (0/4)	0	0	0	2 (0/2)	–	–	–	–	–	–
Regionalized-6		2	0	4 (0/4)	0	0	0	2 (0/2)	–	–	–	–	–	–
Regionalzied-7		2	0	4 (0/4)	0	0	0	2 (0/2)	–	–	–	–	–	–
Centralized-1		1	0	4 (0/4)	0	0	0	2 (0/2)	–	–	–	–	–	–
Centralized-2		1	0	4 (0/4)	0	0	0	2 (0/2)	–	–	–	–	–	–
Centralized-3	7	1	0	4 (0/4)	0	0	0	2 (0/2)	–	–	–	–	–	–
Centralized-4	7	1	0	4 (0/4)	0	0	0	2 (0/2)	–	–	–	–	–	–
Centralized-5	1	1	0	4 (0/4)	0	0	0	2 (0/2)	–	–	–	–	–	–

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicle emissions).
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for all alternatives are assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for ozone. Pollutant is an ozone precursor, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
(6) Nonattainment area for this pollutant, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–8. ANL-E—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	10**	6	0	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	0	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	0	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized		16	--	--	--	--	--	--	--	--	--	--
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--
Centralized-1		1	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–9. ANL-E—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	1875	0.3	- -	640	0.1	- -	<0.1
Decentralized		16	12053	1.9	- -	1014	0.2	- -	<0.1
Regionalized-1		12	2099	0.3	- -	646	0.1	- -	<0.1
Regionalized-2	11	12	2099	0.3	- -	646	0.1	- -	<0.1
Regionalized-3		6	2099	0.3	- -	646	0.1	- -	<0.1
Regionalized-4	7	6	2099	0.3	- -	646	0.1	- -	<0.1
Regionalized-5	4	6	2099	0.3	- -	646	0.1	- -	<0.1
Regionalized-6		2	2099	0.3	- -	646	0.1	- -	<0.1
Regionalized-7		2	2099	0.3	- -	646	0.1	- -	<0.1
Centralized-1		1	2099	0.3	- -	646	0.1	- -	<0.1
Centralized-2		1	2099	0.3	- -	646	0.1	- -	<0.1
Centralized-3	7	1	2099	0.3	- -	646	0.1	- -	<0.1
Centralized-4	7	1	2099	0.3	- -	646	0.1	- -	<0.1
Centralized-5	1	1	2099	0.3	- -	646	0.1	- -	<0.1

Notes:
T = Treatment
D = Disposal
Water supplied by groundwater in the Niagara Aquifer. Current water use = 626,000 gallons/day.
Wastewater discharged to the Des Plains River. Average flow rate of the Des Plains River = 582,000,000 gallons/day.
** Ten sites use existing facilities for Volume Reduction.
- - = Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-2.2–10. ANL-E—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized		16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1		12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3		6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1		2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2		1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for Volume Reduction
-- = Disposal is not considered for this Alternative.

Table II-2.2–11. ANL-E—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	10**	6	125	100	0.00	1.2	0.00	0.00
Decentralized		16	344	344	0.01	4.0	0.00	0.00
Regionalized-1		12	94	94	0.00	1.1	0.00	0.00
Regionalized-2	11	12	94	94	0.00	1.1	0.00	0.00
Regionalized-3		6	94	94	0.00	1.1	0.00	0.00
Regionalized-4	7	6	94	94	0.00	1.1	0.00	0.00
Regionalized-5		6	94	94	0.00	1.1	0.00	0.00
Regionalized-6		2	94	94	0.00	1.1	0.00	0.00
Regionalized-7		2	94	94	0.00	1.1	0.00	0.00
Centralized-1		1	94	94	0.00	1.1	0.00	0.00
Centralized-2		1	94	94	0.00	1.1	0.00	0.00
Centralized-3	7	1	94	94	0.00	1.1	0.00	0.00
Centralized-4	7	1	94	94	0.00	1.1	0.00	0.00
Centralized-5	1	1	94	94	0.00	1.1	0.00	0.00

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–12. ANL-E—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	10**	6	0.8	0.06	1875	0.10	640	0.02	0.11	0.49	53	1
Decentralized		16	4.1	0.33	12053	0.67	1014	0.04	1.70	7.40	195	4
Regionalized-1		12	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Regionalized-2	11	12	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Regionalized-3		6	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Regionalized-4	7	6	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Regionalized-5	4	6	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Regionalized-6		2	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Regionalized-7		2	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Centralized-1		1	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Centralized-2		1	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Centralized-3	7	1	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Centralized-4	7	1	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1
Centralized-5	1	1	1.5	0.12	2099	0.12	646	0.02	0.21	0.90	59	1

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1990 Site Employment.
** Ten sites use existing facilities for Volume Reduction.

Table II-2.2–13. ANL-E—LLW—Cost

LLW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	142	8	28	101	5	142	0	0
Decentralized		16	389	30	93	177	89	106	0	283
Regionalized-1		12	106	9	30	61	6	106	0	0
Regionalized-2	11	12	106	9	30	61	6	106	0	0
Regionalized-3		6	106	9	30	61	6	106	0	0
Regionalized-4	7	6	106	9	30	61	6	106	0	0
Regionalized-5	4	6	106	9	30	61	6	106	0	0
Regionalized-6		2	106	9	30	61	6	106	0	0
Regionalized-7		2	106	9	30	61	6	106	0	0
Centralized-1		1	106	9	30	61	6	106	0	0
Centralized-2		1	106	9	30	61	6	106	0	0
Centralized-3	7	1	106	9	30	61	6	106	0	0
Centralized-4	7	1	106	9	30	61	6	106	0	0
Centralized-5	1	1	106	9	30	61	6	106	0	0

Notes:
** Ten sites use existing facilities for Volume Reduction
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.2.3 ANL-E TRUW

Twelve tables immediately following portray the impacts of TRUW at ANL-E. These impacts are presented in the following tables.

Impact Category

No.	Description	Table No.	Page No.
1.	ANL-E—TRUW—Treatment: Estimated Number of Fatalities	II-2.3-1	2-32
2.	ANL-E—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-2.3-2	2-33
4.	ANL-E—TRUW—Treatment: MEI Probability of Cancer Fatality	II-2.3-3	2-34
5.	ANL-E—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects	II-2.3-4	2-35
6.	ANL-E—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure	II-2.3-5	2-36
7.	ANL-E—TRUW—Emissions in Tons per Year of Criteria Air Pollutants	II-2.3-6	2-37
8.	ANL-E—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants	II-2.3-7	2-38
9.	ANL-E—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-2.3-8	2-39
10.	ANL-E—TRUW—Impacts on Water Resources Due to Increased Water Use	II-2.3-9	2-40
13.	ANL-E—TRUW—Socioeconomic Impacts for Treatment	II-2.3-10	2-41
14.	ANL-E—TRUW—Infrastructure Impacts for Treatment	II-2.3-11	2-42
15.	ANL-E—TRUW—Cost	II-2.3-12	2-43

Table II-2.3-1. ANL-E—TRUW—Treatment: Estimated Number of Fatalities

TRUW Alternatives	Treatment						
	Number of Sites		Treatment Standard	WM Worker		Offsite Population Radiation Exposure	Noninvolved Workers Radiation Exposure
	CH Treat	RH Treat		Radiation Exposure	Physical Hazards		
No Action **	16	5	WIPP WAC	9.8E-07	2.8E-02	6.2E-07	3.2E-09
Decentralized ***	16	5	WIPP WAC	8.8E-03	1.2E-01	2.0E-06	1.0E-08
Regionalized-1	5	2	Reduce Gas	8.8E-03	4.5E-02	1.7E-06	9.0E-09
Regionalized-2	5	2	LDR	8.8E-03	4.5E-02	1.7E-06	9.0E-09
Regionalized-3	3	2	LDR	8.8E-03	4.5E-02	1.7E-06	9.0E-09
Centralized	WIPP	2	LDR	8.8E-03	4.5E-02	1.7E-06	9.0E-09

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at 16 sites, then transfered to interim storage at 10 sites, then to WIPP.

Table II-2.3-2. ANL-E—TRUW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

Number of Sites			Offsite Population				Noninvolved Workers				WM Workers			
CH Treat	RH Treat	Treat STD	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
16	5	WIPP WAC	1.2E-03	2.1E-06	3.8E-10	1.2E-07	6.5E-06	1.1E-08	8.0E-12	6.5E-10	2.5E-03	3.4E-06	4.8E-10	1.5E-07
16	5	WIPP WAC	4.0E-03	6.7E-06	1.5E-09	4.0E-07	2.1E-05	3.5E-08	3.1E-11	2.1E-09	2.2E+01	3.1E-02	1.9E-09	1.3E-03
5	2	Reduce Gas	3.5E-03	5.9E-06	2.9E-09	3.5E-07	1.8E-05	3.1E-08	6.0E-11	1.8E-09	2.2E+01	3.1E-02	2.8E-09	1.3E-03
5	2	LDR	3.5E-03	5.9E-06	2.9E-09	3.5E-07	1.8E-05	3.1E-08	6.0E-11	1.8E-09	2.2E+01	3.1E-02	2.8E-09	1.3E-03
3	2	LDR	3.5E-03	5.9E-06	2.9E-09	3.5E-07	1.8E-05	3.1E-08	6.0E-11	1.8E-09	2.2E+01	3.1E-02	2.8E-09	1.3E-03
WIPP	2	LDR	3.5E-03	5.9E-06	2.9E-09	3.5E-07	1.8E-05	3.1E-08	6.0E-11	1.8E-09	2.2E+01	3.1E-02	2.8E-09	1.3E-03

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
T = Treatment
D = Disposal

Table II-2.3-3. ANL-E—TRUW—Treatment: MEI Probability of Cancer Fatality

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment	
	CH Treat	RH Treat		Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability
No Action**	16	5	WIPP WAC	3.5E-12	3.2E-12
Decentralized***	16	5	WIPP WAC	1.1E-11	1.0E-11
Regionalized-1	5	2	Reduce Gas	9.7E-12	9.0E-12
Regionalized-2	5	2	LDR	9.7E-12	9.0E-12
Regionalized-3	3	2	LDR	9.7E-12	9.0E-12
Centralized	WIPP	2	LDR	9.7E-12	9.0E-12

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives disposal at WIPP is assumed.
***In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-2.3–4. ANL-E—TRUW—Treatment: MEI Probability of Cancer Incidences and Genetic Effects

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment							
				Offsite MEI				Noninvolved Worker MEI			
	CH Treat	RH Treat		Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action **	16	5	WIPP WAC	6.9E-09	1.2E-11	0.0E+00	6.9E-13	6.5E-09	1.1E-11	0.0E+00	6.5E-13
Decentralized ***	16	5	WIPP WAC	2.2E-08	3.7E-11	0.0E+00	2.2E-12	2.1E-08	3.5E-11	2.8E-14	2.1E-12
Regionalized-1	5	2	Reduce Gas	1.9E-08	3.3E-11	1.3E-14	1.9E-12	1.8E-08	3.1E-11	5.4E-14	1.8E-12
Regionalized-2	5	2	LDR	1.9E-08	3.3E-11	1.3E-14	1.9E-12	1.8E-08	3.1E-11	5.4E-14	1.8E-12
Regionalized-3	3	2	LDR	1.9E-08	3.3E-11	1.3E-14	1.9E-12	1.8E-08	3.1E-11	5.4E-14	1.8E-12
Centralized	WIPP	2	LDR	1.9E-08	3.3E-11	1.3E-14	1.9E-12	1.8E-08	3.1E-11	5.4E-14	1.8E-12

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites then to WIPP.
MEI = Maximally Exposed Individual

Table II-2.3–5. ANL-E—TRUW—Treatment: Noncancer Health Risk From Chemical Exposure

TRUW Alternatives	Number of Sites		Treatment Standard	Treatment		
	CH Treat	RH Treat		Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index
No Action**	16	5	WIPP WAC	7.7E-13	2.3E-12	1.9E-08
Decentralized***	16	5	WIPP WAC	5.9E-12	1.7E-11	3.8E-08
Regionalized-1	5	2	Reduce Gas	1.0E-11	3.0E-11	1.4E-07
Regionalized-2	5	2	LDR	1.0E-11	3.0E-11	1.4E-07
Regionalized-3	3	2	LDR	1.0E-11	3.0E-11	1.4E-07
Centralized	WIPP	2	LDR	1.0E-11	3.0E-11	1.4E-07

Notes:
MEI = Maximally Exposed Individual
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The Hazard Quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of exposure concentration to chemical-specific occupational threshold limits.

Table II-2.3-6. ANL-E—TRUW—Emissions in Tons per Year of Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treat STD	Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action**	16	5	WIPP WAC	- -	- -	- -	- -	- -	- -	6 (0/6)	1 (0/1)	0	0	0	1 (0/1)
Decentralized***	16	5	WIPP WAC	34 (2/32)	12 (6/6)	0	0	1 (1/0)	5 (1/4)	10 (0/10)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-1	5	2	Reduce Gas	32 (2/30)	10 (4/6)	0	0	0	4 (0/4)	7 (0/7)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-2	5	2	LDR	22 (2/20)	10 (6/4)	0	1 (1/0)	1 (1/0)	3 (1/2)	9 (0/9)	2 (0/2)	0	0	0	1 (0/1)
Regionalized-3	3	2	LDR	22 (2/20)	10 (6/4)	0	1 (1/0)	1 (1/0)	3 (1/2)	9 (0/9)	2 (0/2)	0	0	0	1 (0/1)
Centralized	WIPP	2	LDR	22 (2/20)	10 (6/4)	0	1 (1/0)	1 (1/0)	3 (1/2)	9 (0/9)	2 (0/2)	0	0	0	1 (0/1)

Notes:

Emissions <1 ton per year are shown as zeros. VOC = Volatile Organic Compounds.

CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.

(1) Values = total emissions (equipment emissions / worker vehicles emission).

(2) Values = total emissions (stationary-source emissions / mobile-source emissions).

** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-2.3-7. ANL-E—TRUW—Percent of Standard/Guideline for Criteria Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Construction					
				Percent of Tons/Year General Conformity Rule (1)					
	CH Treat	RH Treat		CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	- -	- -	- -	- -	- -	- -
Decentralized	16	5	WIPP WAC	- -	49 (23/26)	- -	1 (0/0)	- -	17 (2/15)
Regionalized-1	5	2	Reduce Gas	- -	40 (16/24)	- -	0	- -	16 (2/14)
Regionalized-2	5	2	LDR	- -	34 (25/9)	- -	1 (1/0)	- -	8 (2/6)
Regionalized-3	3	2	LDR	- -	34 (25/9)	- -	1 (1/0)	- -	8 (2/6)
Centralized	WIPP	2	LDR	- -	34 (25/9)	- -	1 (1/0)	- -	8 (2/6)

TRUW Alternatives	Number of Sites		Treat STD	Operations & Maintenance											
				Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	CH Treat	RH Treat		CO (4)	NO2 (5)	Pb (4)	PM10 (6)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	16	5	WIPP WAC	0	5 (0/5)	0	0	0	3 (0/3)	- -	- -	- -	- -	- -	- -
Decentralized	16	5	WIPP WAC	0	9 (1/8)	0	0	0	5 (0/5)	- -	- -	- -	- -	- -	- -
Regionalized-1	5	2	Reduce Gas	0	5 (0/5)	0	0	0	3 (0/3)	- -	- -	- -	- -	- -	- -
Regionalized-2	5	2	LDR	0	8 (0/8)	0	0	0	5 (0/5)	- -	- -	- -	- -	- -	- -
Regionalized-3	3	2	LDR	0	8 (0/8)	0	0	0	5 (0/5)	- -	- -	- -	- -	- -	- -
Centralized	WIPP	2	LDR	0	8 (0/8)	0	0	0	5 (0/5)	- -	- -	- -	- -	- -	- -

Notes:
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR only applies to pollutants in nonattainment.
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions for all alternatives assumed to be negligible.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for ozone. Pollutant is an ozone precursor, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
(6) Nonattainment area for this pollutant, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-2.3-8. ANL-E—TRUW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

TRUW Alternatives	Number of Sites		Treatment Standard	Operations & Maintenance											
	CH Treat	RH Treat		Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action**	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Decentralized***	16	5	WIPP - WAC	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-1	5	2	Reduce Gas	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-2	5	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--
Regionalized-3	3	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--
Centralized	WIPP	2	LDR	0	--	--	--	0	0	--	--	--	--	--	--

TRUW Alternatives	Number of Sites		Treat STD	Operations & Maintenance									
	CH Treat	RH Treat		Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action**	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Decentralized***	16	5	WIPP - WAC	0	0	--	--	--	0	0	--	--	--
Regionalized-1	5	2	Reduce Gas	0	0	--	--	--	0	0	--	--	--
Regionalized-2	5	2	LDR	0	0	--	--	--	0	0	--	--	--
Regionalized-3	3	2	LDR	0	0	--	--	--	0	0	--	--	--
Centralized	WIPP	2	LDR	0	0	--	--	--	0	0	--	--	--

Notes:

** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.

*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.

Percentages <1% are shown as zeros. CH = contact handled. RH = remote handled

Table II-2.3-9. ANL-E—TRUW—Impacts on Water Resources Due to Increased Water Use

TRUW Alternatives	Number of Sites		Treatment Standard	Construction			Operations			
	CH Treat	RH Treat		Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action**	16	5	WIPP WAC	- -	- -	- -	921	0.1	- -	<0.1
Decentralized***	16	5	WIPP WAC	4769	0.8	- -	1509	0.2	- -	<0.1
Regionalized-1	5	2	Reduce Gas	3207	0.5	- -	941	0.2	- -	<0.1
Regionalized-2	5	2	LDR	3726	0.6	- -	941	0.2	- -	<0.1
Regionalized-3	3	2	LDR	3726	0.6	- -	941	0.2	- -	<0.1
Centralized	WIPP	2	LDR	3726	0.6	- -	941	0.2	- -	<0.1

Notes:
Water supplied by groundwater in the Niagara Aquifer. Current water use = 626,000 gallons/day.
Wastewater discharged to the Des Plains River.
Average flow rate of the Des Plains River = 582,000,000 gallons/day.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
- - = Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-2.3-10. ANL-E—TRUW—Socioeconomic Impacts for Treatment

TRUW Alternatives	Number of Sites		Effect of Implementation of Alternatives						
					Jobs		Income		
	CH Treat	RH Treat	Treatment Standard	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action**	16	5	WIPP WAC	91	73	0.00	0.9	0.00	0.0
Decentralized***	16	5	WIPP WAC	292	292	0.01	3.4	0.00	0.0
Regionalized-1	5	2	Reduce Gas	198	199	0.01	2.3	0.00	0.0
Regionalized-2	5	2	LDR	295	295	0.01	3.4	0.00	0.0
Regionalized-3	3	2	LDR	295	295	0.01	3.4	0.00	0.0
Centralized	WIPP	2	LDR	295	295	0.01	3.4	0.00	0.0

Notes:
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-2.3-11. ANL-E—TRUW—Infrastructure Impacts for Treatment

TRUW Alternatives	Number of Sites		Treatment Standard	Effect of Implementation of Alternatives									
				Land Use		Water		Waste Water		Power		Employment (FTE)	
	CH Treat	RH Treat		Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action**	16	5	WIPP WAC	0	0.00	921	0.05	921	0.05	0.09	0.41	0	0.00
Decentralized***	16	5	WIPP WAC	2.7	0.23	4769	0.26	1509	0.06	0.44	1.93	172	3.90
Regionalized-1	5	2	Reduce Gas	1.4	0.12	3207	0.18	941	0.04	0.27	1.17	114	2.60
Regionalized-2	5	2	LDR	1.8	0.15	3726	0.21	941	0.04	0.31	1.34	207	4.60
Regionalized-3	3	2	LDR	1.8	0.15	3726	0.21	941	0.04	0.31	1.34	207	4.60
Centralized	WIPP	2	LDR	1.8	0.15	3726	0.21	941	0.04	0.31	1.34	207	4.60

Notes:
GPD = Gallons per Day
MW = Megawatts Electric
FTE = Full Time Equivalent
(1) Based on 1990 Site Employment.
** For No Action Alternative, storage is indefinite: no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.

Table II-2.3-12. ANL-E—TRUW—Cost

TRUW Alternatives	Number of Sites		Treatment Standard (2)	Total Cost (Millions) (1)	Life-Cycle Component				Functional Area		
	CH Treat	RH Treat			Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Retrieval Characterization (Millions)	Treatment (Millions)	Storage (Millions)
No Action**	11	5	WIPP - WAC	104	0	0	86	18	0	92	12
Decentralized***	16	5	WIPP - WAC	330	25	89	183	33	0	308	22
Regionalized-1	5	2	Reduce Gas	224	18	56	140	10	0	224	0
Regionalized-2	5	2	LDR	334	24	118	178	14	0	334	0
Regionalized-3	3	2	LDR	334	24	118	178	14	0	334	0
Centralized	WIPP	2	LDR	334	24	118	178	14	0	334	0

Notes:
** For No Action Alternative, storage is indefinite; no disposal at WIPP is assumed, for all other alternatives, disposal at WIPP is assumed.
*** In Decentralized Alternative, TRUW is processed at all 16 sites, then transferred to interim storage at 10 sites, then to WIPP.
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.
(2) Treatment standard (STD) applied: treat to WIPP Waste Acceptance Criteria (WIPP WAC), treat for reduced gas generation (Reduce Gas), treat to Land Disposal Restrictions (LDR).

II.3.0 BNL

BNL currently is custodian of significant volumes of LLMW. The waste type is treated independently in the following sections.

II.3.1 BNL LLMW

Fifteen tables immediately following portray the impacts of LLMW at BNL.

Impact Category

No.	Description	Table No.	Page No.
1.	BNL—LLMW—Treatment and Disposal: Estimated Number of Fatalities	II-3.1-1	3-2
2.	BNL—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-3.1-2	3-3
3.	BNL—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-3.1-3	3-4
4.	BNL—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality	II-3.1-4	3-5
5.	BNL—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-3.1-5	3-6
6.	BNL—LLMW—Treatment and Disposal: Noncancer Health Risk From Chemical Exposure	II-3.1-6	3-7
7.	BNL—LLMW—Emissions in Tons per Year of Criteria Air Pollutants	II-3.1-7	3-8
8.	BNL—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants	II-3.1-8	3-9
9.	BNL—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-3.1-9	3-10
10.	BNL—LLMW—Impacts on Water Resources Due to Increased Water Use	II-3.1-10	3-11
11.	BNL—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)	II-3.1-11	3-12
12.	BNL—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)	II-3.1-12	3-13
13.	BNL—LLMW—Socioeconomic Impacts for Treatment and Disposal	II-3.1-13	3-14
14.	BNL—LLMW—Infrastructure Impacts for Treatment and Disposal	II-3.1-14	3-15
15.	BNL—LLMW—Cost	II-3.1-15	3-16

Table II-3.1-1. BNL—LLMW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	3	-	7.3E-05	2.0E-03	1.1E-04	7.0E-07	- -	- -
Decentralized	37	16	1.2E-04	1.6E-02	1.2E-05	7.1E-08	6.1E-05	1.5E-03
Regionalized-1	11	12	5.7E-05	4.0E-03	5.2E-08	3.2E-10	- -	- -
Regionalized-2	7	6	5.7E-05	4.0E-03	5.2E-08	3.2E-10	- -	- -
Regionalized-3	7	1	5.7E-05	4.0E-03	5.2E-08	3.2E-10	- -	- -
Regionalized-4	4	6	5.7E-05	4.0E-03	5.2E-08	3.2E-10	- -	- -
Centralized	1	1	5.7E-05	4.0E-03	5.2E-08	3.2E-10	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-3.1-2. BNL—LLMW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population				Noninvolved Workers				WM Worker			
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Chemical Cancer Incidence	Radiation Genetic Effects
No Action	3	-	2.3E-01	3.9E-04	8.0E-06	2.3E-05	1.4E-03	2.4E-06	2.8E-07	1.4E-07	1.8E-01	2.6E-04	1.9E-08	1.1E-05
Decentralized	37	16	2.4E-02	4.1E-05	7.3E-07	2.4E-06	1.4E-04	2.4E-07	2.5E-08	1.4E-08	3.1E-01	4.3E-04	1.9E-06	1.8E-05
Regionalized-1	11	12	1.0E-04	1.8E-07	9.0E-09	1.0E-08	6.4E-07	1.1E-09	3.1E-10	6.4E-11	1.4E-01	2.0E-04	1.6E-08	8.5E-06
Regionalized-2	7	6	1.0E-04	1.8E-07	9.0E-09	1.0E-08	6.4E-07	1.1E-09	3.1E-10	6.4E-11	1.4E-01	2.0E-04	1.6E-08	8.5E-06
Regionalized-3	7	1	1.0E-04	1.8E-07	9.0E-09	1.0E-08	6.4E-07	1.1E-09	3.1E-10	6.4E-11	1.4E-01	2.0E-04	1.6E-08	8.5E-06
Regionalized-4	4	6	1.0E-04	1.8E-07	9.0E-09	1.0E-08	6.4E-07	1.1E-09	3.1E-10	6.4E-11	1.4E-01	2.0E-04	1.6E-08	8.5E-06
Centralized	1	1	1.0E-04	1.8E-07	9.0E-09	1.0E-08	6.4E-07	1.1E-09	3.1E-10	6.4E-11	1.4E-01	2.0E-04	1.6E-08	8.5E-06

Notes:
T = Treatment
D = Disposal

Table II-3.1-3. BNL—LLMW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	3	-	- -	- -	- -
Decentralized	37	16	1.5E-01	2.1E-04	9.2E-06
Regionalized-1	11	12	- -	- -	- -
Regionalized-2	7	6	- -	- -	- -
Regionalized-3	7	1	- -	- -	- -
Regionalized-4	4	6	- -	- -	- -
Centralized	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.

Table II-3.1-4. BNL—LLMW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	3	-	1.5E-09	7.8E-10	- -
Decentralized	37	16	1.6E-10	7.9E-11	1.1E-05
Regionalized-1	11	12	7.0E-13	3.6E-13	- -
Regionalized-2	7	6	7.0E-13	3.6E-13	- -
Regionalized-3	7	1	7.0E-13	3.6E-13	- -
Regionalized-4	4	6	7.0E-13	3.6E-13	- -
Centralized	1	1	7.0E-13	3.6E-13	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative

Table II-3.1-5. BNL—LLMW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment								Disposal			
			Offsite Population MEI				Noninvolved Worker MEI				Most Exposed Farm Family Lifetime MEI			
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Chemical Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	3	-	3.0E-06	5.2E-09	1.3E-10	3.0E-10	1.6E-06	2.6E-09	1.3E-10	1.6E-10	--	--	--	--
Decentralized	37	16	3.2E-07	5.4E-10	1.2E-11	3.23-11	1.6E-07	2.7E-10	1.2E-11	1.6E-11	2.1E-02	3.6E-05	8.1E-06	2.1E-06
Regionalized-1	11	12	1.4E-09	2.4E-12	1.5E-13	1.4E-13	7.1E-10	1.2E-12	1.5E-13	7.1E-14	--	--	--	--
Regionalized-2	7	6	1.4E-09	2.4E-12	1.5E-13	1.4E-13	7.1E-10	1.2E-12	1.5E-13	7.1E-14	--	--	--	--
Regionalized-3	7	1	1.4E-09	2.4E-12	1.5E-13	1.4E-13	7.1E-10	1.2E-12	1.5E-13	7.1E-14	--	--	--	--
Regionalized-4	4	6	1.4E-09	2.4E-12	1.5E-13	1.4E-13	7.1E-10	1.2E-12	1.5E-13	7.1E-14	--	--	--	--
Centralized	1	1	1.4E-09	2.4E-12	1.5E-13	1.4E-13	7.1E-10	1.2E-12	1.5E-13	7.1E-14	--	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
-- = Disposal is not considered for this alternative.

Table II-3.1-6. BNL—LLMW—Treatment and Disposal: Noncancer Health Risk From Chemical Exposure

LLMW Alternatives	Number of Sites		Treatment			Disposal
	T	D	Offsite MEI Hazard Index	Noninvolved Worker MEI Hazard Index	WM Worker Exposure Index	Hypothetical Farm Family Most Exposed Lifetime Hazard Index
No Action	3	-	1.3E-07	1.3E-07	4.4E-07	- -
Decentralized	37	16	1.8E-08	1.8E-08	5.0E-05	1.6E-01
Regionalized-1	11	12	1.1E-10	1.1E-10	4.4E-07	- -
Regionalized-2	7	6	1.1E-10	1.1E-10	4.4E-07	- -
Regionalized-3	7	1	1.1E-10	1.1E-10	4.4E-07	- -
Regionalized-4	4	6	1.1E-10	1.1E-10	4.4E-07	- -
Centralized	1	1	1.1E-10	1.1E-10	4.4E-07	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this alternative.
MEI = Maximally Exposed Individual
Hazard Index = Sum of hazard quotient values for all noncarcinogenic chemicals. The hazard quotient is the chemical-specific ratio of media exposure concentrations to concentrations believed to have no appreciable adverse effects.
Exposure Index = Ratio of Exposure concentration to chemical-specific occupational threshold limits.

Table II-3.1-7. BNL—LLMW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	2 (1/1)	2 (2/0)	0	0	0	0	1 (0/1)	0	0	0	0	0
Decentralized	37	16	11 (0/11)	3 (1/2)	0	0	0	1 (0/1)	2 (0/2)	0	0	0	0	0
Regionalized-1	11	12	0	0	0	0	0	0	1 (0/1)	0	0	0	0	0
Regionalized-2	7	6	0	0	0	0	0	0	1 (0/1)	0	0	0	0	0
Regionalized-3	7	1	0	0	0	0	0	0	1 (0/1)	0	0	0	0	0
Regionalized-4	4	6	0	0	0	0	0	0	1 (0/1)	0	0	0	0	0
Centralized	1	1	0	0	0	0	0	0	1 (0/1)	0	0	0	0	0

Notes:
T = Treatment
D = Disposal
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-3.1-8. BNL—LLMW—Percent of Standard/Guideline for Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction					
			Percent of Tons/Year General Conformity Rule (1)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	--	8 (7/1)	--	--	--	2 (1/1)
Decentralized	37	16	--	14 (5/9)	--	--	--	6 (1/5)
Regionalized-1	11	12	--	0	--	--	--	0
Regionalized-2	7	6	--	0	--	--	--	0
Regionalized-3	7	1	--	0	--	--	--	0
Regionalized-4	4	6	--	0	--	--	--	0
Centralized	1	1	--	0	--	--	--	0

LLMW Alternatives	Number of Sites		Operations & Maintenance											
			Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
	T	D	CO (4)	NO2 (5)	Pb (4)	PM10 (4)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	3	-	0	1 (0/1)	0	0	0	0	--	--	--	--	--	--
Decentralized	37	16	0	2 (0/2)	0	0	0	1 (0/1)	0	0	0	0	0	0
Regionalized-1	11	12	0	1 (0/1)	0	0	0	0	--	--	--	--	--	--
Regionalized-2	7	6	0	1 (0/1)	0	0	0	0	--	--	--	--	--	--
Regionalized-3	7	1	0	1 (0/1)	0	0	0	0	--	--	--	--	--	--
Regionalized-4	4	6	0	1 (0/1)	0	0	0	0	--	--	--	--	--	--
Centralized	1	1	0	1 (0/1)	0	0	0	0	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicles emission).
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions are assumed to be negligible for all but the Decentralized Alternative.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for ozone. Pollutant is an ozone precursor, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions).

Table II-3.1-9. BNL—LLMW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLMW Alternatives	Number of Sites		Operations & Maintenance											
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide	1,2-Dichloro-ethane	Lead
No Action	3	-	0	0	0	--	--	0	--	--	0	0	0	0
Decentralized	37	16	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-1	11	12	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-2	7	6	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-3	7	1	0	0	0	--	--	0	--	--	0	0	0	0
Regionalized-4	4	6	0	0	0	--	--	0	--	--	0	0	0	0
Centralized	1	1	0	0	0	--	--	0	--	--	0	0	0	0

LLMW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	3	-	--	0	0	0	--	0	0	0	--	--
Decentralized	37	16	--	0	0	0	--	0	0	0	--	--
Regionalized-1	11	12	--	0	0	0	--	0	0	0	--	--
Regionalized-2	7	6	--	0	0	0	--	0	0	0	--	--
Regionalized-3	7	1	--	0	0	0	--	0	0	0	--	--
Regionalized-4	4	6	--	0	0	0	--	0	0	0	--	--
Centralized	1	1	--	0	0	0	--	0	0	0	--	--

Notes:
T = Treatment
D = Disposal
-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.

Table II-3.1-10. BNL—LLMW—Impacts on Water Resources Due to Increased Water Use

LLMW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	3	-	1736	<0.1	- -	117	<0.1	- -	<0.1
Decentralized	37	16	2083	<0.1	- -	370	<0.1	- -	<0.1
Regionalized-1	11	12	0	<0.1	- -	42	<0.1	- -	<0.1
Regionalized-2	7	6	0	<0.1	- -	42	<0.1	- -	<0.1
Regionalized-3	7	1	0	<0.1	- -	42	<0.1	- -	<0.1
Regionalized-4	4	6	0	<0.1	- -	42	<0.1	- -	<0.1
Centralized	1	1	0	<0.1	- -	42	<0.1	- -	<0.1

Notes:
T = Treatment
D = Disposal
Water supplied by groundwater in the Upper Glacial Aquifer and Magothy Aquifer. Current water use = 4,500,000 gallons/day.
Wastewater discharged to the Peconic River.
Average flow rate of the Peconic River = 1,000,000 gallons/day.
- - = Stream Flow is not considered for this site.
<0.1 indicates that the percentage is less than 0.1%.

Table II-3.1-11. BNL—LLMW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal (Contact-Handled)

LLMW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLMW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	3	-	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
- - = No disposal at this site for this alternative.

Table II-3.1-12. BNL—LLMW—Percent of Drinking Water Standards for Hazardous Constituents in Groundwater from Disposal (Contact-Handled)

LLMW Alternatives	T	D	Acetone	Arsenic	Barium	Benzene	Cadmium	Carbon Tetrachloride	Chromium	Cyanide
No Action	3	-	--	--	--	--	--	--	--	--
Decentralized	37	16	0	0	0	20	0	1	0	0
Regionalized-1	11	12	--	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--	--

LLMW Alternatives	T	D	1,2-dichloro-ethane	Lead	Mercury	Methylene Chloride	Selenium	Silver	1,2,2-trichloro-1,1-trifluoroethane
No Action	3	-	--	--	--	--	--	--	--
Decentralized	37	16	7	0	0	7	3	1	0
Regionalized-1	11	12	--	--	--	--	--	--	--
Regionalized-2	7	6	--	--	--	--	--	--	--
Regionalized-3	7	1	--	--	--	--	--	--	--
Regionalized-4	4	6	--	--	--	--	--	--	--
Centralized	1	1	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
"--" = No disposal at this site for this alternative.

Table II-3.1-13. BNL—LLMW—Socioeconomic Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Annual Jobs	% Annual Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	3	-	22	18	0.00	0.2	0.00	0.00
Decentralized	37	16	88	92	0.01	1.0	0.00	0.00
Regionalized-1	11	12	7	8	0.00	0.1	0.00	0.00
Regionalized-2	7	6	7	8	0.00	0.1	0.00	0.00
Regionalized-3	7	1	7	8	0.00	0.1	0.00	0.00
Regionalized-4	4	6	7	8	0.00	0.1	0.00	0.00
Centralized	1	1	7	8	0.00	0.1	0.00	0.00

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline.

Table II-3.1-14. BNL—LLMW—Infrastructure Impacts for Treatment and Disposal

LLMW Alternatives	Number of Sites		Effect of Implementation of Alternatives									
			Land Use		Water		Waste Water		Power		Employment (FTE)	
	T	D	Acres Required	% of Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Power Required (MW) (2)	% Current Capacity	Peak Construction Employment	% of Current Employment (1)
No Action	3	-	1.0	0.03	1736	0.03	117	0.01	0.23	0.49	10	0.3
Decentralized	37	16	1.6	0.06	2083	0.03	370	0.02	0.2	0.42	86	2
Regionalized-1	11	12	0.0	0.00	42	0.00	42	0.00	0.06	0.12	0	0
Regionalized-2	7	6	0.0	0.00	42	0.00	42	0.00	0.06	0.12	0	0
Regionalized-3	7	1	0.0	0.00	42	0.00	42	0.00	0.06	0.12	0	0
Regionalized-4	4	6	0.0	0.00	42	0.00	42	0.00	0.06	0.12	0	0
Centralized	1	1	0.0	0.00	42	0.00	42	0.00	0.06	0.12	0	0

Notes:
T = Treatment
D = Disposal
GPD = Gallons per Day
MW = Megawatts
(1) Based on 1991 Site Employment. (2) Electrical requirement for the Decentralized Alternative is less than that for the No Action Alternative because of the decreased waste volume after treatment.

Table II-3.1-15. BNL—LLMW—Cost

LLMW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	3	-	25	2	4	9	10	10	15	0
Decentralized	37	16	84	14	44	21	6	84	0	0
Regionalized-1	11	12	8	0	0	4	5	8	0	0
Regionalized-2	7	6	8	0	0	4	5	8	0	0
Regionalized-3	7	1	8	0	0	4	5	8	0	0
Regionalized-4	4	6	8	0	0	4	5	8	0	0
Centralized	1	1	8	0	0	4	5	8	0	0

Notes:
T = Treatment
D = Disposal
The Life-Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum of these may not reflect the true total cost.
(1) In 1994 dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.

II.3.2 BNL LLW

Thirteen tables immediately following portray impacts of LLW at BNL. These tables are presented as follows:

Impact Category

No.	Description	Table No.	Page No.
1.	BNL — LLW — Treatment and Disposal: Estimated Number of Fatalities	II-3.2–1	3-18
2.	BNL — LLW — Treatment: Estimated Number of Cancer Incidences and Genetic Effects	II-3.2–2	3-19
3.	BNL — LLW — Disposal: Estimated Number of Cancer Incidences and Genetic Effects	II-3.2–3	3-20
4.	BNL — LLW — Treatment and Disposal: MEI Probability of Cancer Fatality	II-3.2–4	3-21
5.	BNL — LLW — Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects	II-3.2–5	3-22
7.	BNL — LLW —Emissions in Tons per Year of Criteria Air Pollutants	II-3.2–6	3-23
8.	BNL — LLW —Percent of Standard/Guideline for Criteria Air Pollutants	II-3.2–7	3-24
9.	BNL — LLW — Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants	II-3.2–8	3-25
10.	BNL — LLW — Impacts on Water Resources Due to Increased Water Use	II-3.2–9	3-26
11.	BNL — LLW — Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal	II-3.2–10	3-27
13.	BNL — LLW — Socioeconomic Impacts for Treatment and Disposal	II-3.2–11	3-28
14.	BNL — LLW — Infrastructure Impacts for Treatment and Disposal	II-3.2–12	3-29
15.	BNL — LLW — Cost	II-3.2–13	3-30

Table II-3.2-1. BNL—LLW—Treatment and Disposal: Estimated Number of Fatalities

LLMW Alternatives	Number of Sites		Treatment				Disposal	
			WM Worker		Offsite Population	Noninvolved Workers	WM Worker	
	T	D	Radiation Exposure	Physical Hazards	Radiation Exposure	Radiation Exposure	Radiation Exposure	Physical Hazards
No Action	10**	6	6.0E-02	5.1E-02	2.2E-06	1.1E-08	- -	- -
Decentralized	- -	16	3.6E-02	2.2E-02	9.7E-09	2.4E-11	3.8E-02	2.3E-02
Regionalized-1	- -	12	3.9E-02	4.3E-02	2.3E-06	3.1E-11	- -	- -
Regionalized-2	11	12	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Regionalized-3	- -	6	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Regionalized-4	7	6	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Regionalized-5	4	6	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Regionalized-6	- -	2	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Regionalized-7	- -	2	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Centralized-1	- -	1	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Centralized-2	- -	1	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Centralized-3	7	1	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -
Centralized-4	7	1	3.4E-09	2.0E-02	2.3E-06	1.2E-08	- -	- -
Centralized-5	1	1	3.9E-02	4.3E-02	2.3E-06	1.2E-08	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.
** = Ten sites use existing facilities for volume reduction.

Table II-3.2-2. BNL—LLW—Treatment: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Offsite Population			Noninvolved Workers			WM Worker		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	4.4E-03	7.4E-06	4.4E-07	2.3E-05	3.9E-08	2.3E-09	1.5E+02	2.1E-01	9.0E-03
Decentralized	- -	16	1.9E-05	3.3E-08	1.9E-09	4.8E-08	8.1E-11	4.8E-12	9.1E+01	1.3E-01	5.5E-03
Regionalized-1	- -	12	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Regionalized-2	11	12	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Regionalized-3	- -	6	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Regionalized-4	7	6	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Regionalized-5	4	6	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Regionalized-6	- -	2	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Regionalized-7	- -	2	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Centralized-1	- -	1	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Centralized-2	- -	1	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Centralized-3	7	1	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Centralized-4	7	1	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03
Centralized-5	1	1	4.7E-03	7.9E-06	4.7E-07	2.4E-05	4.1E-08	2.4E-09	9.9E+01	1.4E-01	5.9E-03

Notes:
T = Treatment
D = Disposal
** = Ten sites use existing facilities for volume reduction.

Table II-3.2-3. BNL—LLW—Disposal: Estimated Number of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		WM Workers		
	T	D	Dose (person-rem)	Radiation Cancer Incidence	Radiation Genetic Effects
No Action	10**	6	- -	- -	- -
Decentralized	- -	16	9.4E+01	1.3E-01	5.6E-03
Regionalized-1	- -	12	- -	- -	- -
Regionalized-2	11	12	- -	- -	- -
Regionalized-3	- -	6	- -	- -	- -
Regionalized-4	7	6	- -	- -	- -
Regionalized-5	4	6	- -	- -	- -
Regionalized-6	- -	2	- -	- -	- -
Regionalized-7	- -	2	- -	- -	- -
Centralized-1	- -	1	- -	- -	- -
Centralized-2	- -	1	- -	- -	- -
Centralized-3	7	1	- -	- -	- -
Centralized-4	7	1	- -	- -	- -
Centralized-5	1	1	- -	- -	- -

Notes:
T = Treatment
D = Disposal
- - = Disposal is not considered for this Alternative.
** = Ten sites use existing facilities for volume reduction.

Table II-3.2–4. BNL—LLW—Treatment and Disposal: MEI Probability of Cancer Fatality

LLMW Alternatives	Number of Sites		Treatment		Disposal
	T	D	Offsite MEI Cancer Fatality Probability	Noninvolved Worker MEI Cancer Fatality Probability	Hypothetical Farm Family Most Exposed Lifetime MEI Cancer Fatality Probability
No Action	10**	6	2.9E-11	1.3E-11	- -
Decentralized	- -	16	1.3E-13	2.7E-14	4.6E-04
Regionalized-1	- -	12	3.1E-11	1.3E-11	- -
Regionalized-2	11	12	3.1E-11	1.3E-11	- -
Regionalized-3	- -	6	3.1E-11	1.3E-11	- -
Regionalized-4	7	6	3.1E-11	1.3E-11	- -
Regionalized-5	4	6	3.1E-11	1.3E-11	- -
Regionalized-6	- -	2	3.1E-11	1.3E-11	- -
Regionalized-7	- -	2	3.1E-11	1.3E-11	- -
Centralized-1	- -	1	3.1E-11	1.3E-11	- -
Centralized-2	- -	1	3.1E-11	1.3E-11	- -
Centralized-3	7	1	3.1E-11	1.3E-11	- -
Centralized-4	7	1	3.1E-11	1.3E-11	- -
Centralized-5	1	1	3.1E-11	1.3E-11	- -

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
- - = Disposal is not considered under the Alternative
** = Ten sites use existing facilities for volume reduction

Table II-3.2-5. BNL—LLW—Treatment and Disposal: MEI Probability of Cancer Incidences and Genetic Effects

LLMW Alternatives	Number of Sites		Treatment						Disposal		
			Offsite Population MEI			Noninvolved Worker MEI			Hypothetical Farm Family Most Exposed Lifetime MEI		
	T	D	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability	Dose (rem)	Radiation Cancer Incidence Probability	Radiation Genetic Effects Probability
No Action	10**	6	5.8E-08	9.9E-11	5.8E-12	2.5E-08	4.3E-11	2.5E-12	--	--	--
Decentralized	--	16	2.6E-10	4.4E-13	2.6E-14	5.3E-11	9.0E-14	5.3E-15	9.2E-01	1.6E-03	9.2E-05
Regionalized-1	--	12	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Regionalized-2	11	12	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Regionalized-3	--	6	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Regionalized-4	7	6	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Regionalized-5	4	6	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Regionalized-6	--	2	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Regionalized-7	--	2	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Centralized-1	--	1	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Centralized-2	--	1	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Centralized-3	7	1	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Centralized-4	7	1	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--
Centralized-5	1	1	6.2E-08	1.1E-10	6.2E-12	2.7E-08	4.6E-11	2.7E-12	--	--	--

Notes:
T = Treatment
D = Disposal
MEI = Maximally Exposed Individual
-- = Disposal is not considered for this alternative.
** = Ten sites use existing facilities for volume reduction

Table II-3.2-6. BNL—LLW—Emissions in Tons per Year of Criteria Air Pollutants

LLMW Alternatives	Number of Sites		Construction Emissions in Tons/Year (1)						Operations & Maintenance Emissions in Tons/Year (2)					
	T	D	CO	NO2	Pb	PM10	SO2	VOC	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Decentralized	- -	16	23 (8/14)	25 (22/3)	0	2 (2/0)	2 (2/0)	4 (2/2)	12 (0/12)	3 (1/2)	0	0	0	1 (0/1)
Regionalized-1	- -	12	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-2	11	12	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-3	- -	6	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-4	7	6	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-5	4	6	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-6	- -	2	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Regionalized-7	- -	2	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-1	- -	1	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-2	- -	1	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-3	7	1	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-4	7	1	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)
Centralized-5	1	1	10 (2/8)	7 (5/2)	0	0	0	1 (0/1)	5 (0/5)	1 (0/1)	0	0	0	1 (0/1)

Notes:
T = Treatment
D = Disposal
** = Ten sites use existing facilities for volume reduction
Emissions <1 tons per year are shown as zeros. VOC = Volatile Organic Compounds.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
(1) Values = total emissions (equipment emissions / worker vehicles emission).
(2) Values = total emissions (stationary-source emissions / mobile-source emission).

Table II-3.2-7. BNL—LLW—Percent of Standard/Guideline for Criteria Air Pollutants

LLW Alternatives	T	D	Construction Percent of Tons/Year General Conformity Rule (1)					
			CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	--	26 (20/6)	--	--	--	6 (2/4)
Decentralized	--	16	--	100 (88/12)	--	--	--	15 (8/7)
Regionalized-1	--	12	--	26 (20/6)	--	--	--	6 (2/4)
Regionalized-2	11	12	--	26 (20/6)	--	--	--	6 (2/4)
Regionalized-3	--	6	--	26 (20/6)	--	--	--	6 (2/4)
Regionalized-4	7	6	--	26 (20/6)	--	--	--	6 (2/4)
Regionalized-5	4	6	--	26 (20/6)	--	--	--	6 (2/4)
Regionalized-6	--	2	--	26 (20/6)	--	--	--	6 (2/4)
Regionalzied-7	--	2	--	26 (20/6)	--	--	--	6 (2/4)
Centralized-1	--	1	--	26 (20/6)	--	--	--	6 (2/4)
Centralized-2	--	1	--	26 (20/6)	--	--	--	6 (2/4)
Centralized-3	7	1	--	26 (20/6)	--	--	--	6 (2/4)
Centralized-4	7	1	--	26 (20/6)	--	--	--	6 (2/4)
Centralized-5	1	1	--	26 (20/6)	--	--	--	6 (2/4)

LLW Alternatives	T	D	Percent of Tons/Year Standard or Guideline (2)						Percent of NAAQS Concentration (3)					
			CO (4)	NO2 (5)	Pb (4)	PM10 (4)	SO2 (4)	VOC (5)	CO	NO2	Pb	PM10	SO2	VOC
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	--	16	0	14 (4/10)	0	1	0	6 (0/6)	--	--	--	--	--	--
Regionalized-1	--	12	--	4 (0/4)	--	--	--	3 (0/3)	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	--	6	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6	--	2	--	--	--	--	--	--	--	--	--	--	--	--
Regionalzied-7	--	2	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--

T = Treatment
D = Disposal
** = Ten sites use existing facilities for volume reduction.
Percentages <1% are shown as zeros. PSD = Prevention of Significant Deterioration. GCR = General Conformity Rule.
CO = carbon monoxide. NO2 = nitrogen dioxide. Pb = lead. PM10 = particulate matter less than 10 microns in diameter. SO2 = sulfur dioxide.
VOC = volatile organic compounds. NAAQS = National Ambient Air Quality Standard.
(1) GCR de minimus levels are applied, since PSD regulations are not applicable to construction activities. Values = % of total emissions (% of equipment emissions / % of worker vehicles emission).
(2) Percent of either PSD or GCR tons per year (tpy) limit as indicated by pollutant footnote.
(3) The value presented is the highest of all NAAQS averaging periods for that pollutant. Stationary-source emissions are assumed to be negligible for all but the Decentralized Alternative.
(4) Attainment area for this pollutant, therefore PSD increment levels are applied. Values are for stationary-source emissions only.
(5) Nonattainment area for this pollutant, therefore GCR de minimus levels are applied. Values = % of total emissions (% of stationary-source emissions / % of mobile-source emissions)

Table II-3.2-8. BNL—LLW—Percent of Standard/Guideline for Hazardous Air Pollutants and Toxic Air Pollutants

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Total Radio-nuclides	Acetone	Benzene	Bromo-dichloro-methane	Butyl Alcohol	Carbon Tetra-chloride	Chloro-form	Chloro-methane	Chromium VI	Cyanide
No Action	10**	6	0	--	--	--	--	--	--	--	--	--
Decentralized	--	16	0	--	--	--	--	--	--	--	--	--
Regionalized-1	--	12	0	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	0	--	--	--	--	--	--	--	--	--
Regionalized-3	--	6	0	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	0	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	0	--	--	--	--	--	--	--	--	--
Regionalized-6	--	2	0	--	--	--	--	--	--	--	--	--
Regionalized-7	--	2	0	--	--	--	--	--	--	--	--	--
Centralized-1	--	1	0	--	--	--	--	--	--	--	--	--
Centralized-2	--	1	0	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	0	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	0	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	0	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites		Operations & Maintenance									
	T	D	Methanol	Methylene Chloride	Selenium	Silver	1,1,2,2-Tetrachloro-ethane	1,2,2-Trichloro, 1,1-Trifluoro-ethane	1,1,1-Trichloro-ethane	1,1,2-Trichloro-ethane	Triochloro-fluoro-methane	Vinyl Chloride
No Action	10**	6	--	--	--	--	--	--	--	--	--	--
Decentralized	--	16	--	--	--	--	--	--	--	--	--	--
Regionalized-1	--	12	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--
Regionalized-3	--	6	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--
Regionalized-6	--	2	--	--	--	--	--	--	--	--	--	--
Regionalized-7	--	2	--	--	--	--	--	--	--	--	--	--
Centralized-1	--	1	--	--	--	--	--	--	--	--	--	--
Centralized-2	--	1	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--

Notes:
T= Treatment
D = Disposal
-- = Emissions of this hazardous or toxic air pollutant are assumed to be negligible.
Percentages <1% are shown as zeros.
** Ten sites use existing facilities for volume reduction.

Table II-3.2-9. BNL—LLW—Impacts on Water Resources Due to Increased Water Use

LLW Alternatives	Number of Sites		Construction			Operations			
	T	D	Water Use GPD	% Current Use	% Stream Flow	Water Use GPD	% Current Use	% Stream Flow	Waste Water % Stream Flow
No Action	10**	6	1,259	<0.1	--	442	<0.1	--	<0.1
Decentralized	--	16	8,000	0.2	--	886	<0.1	--	<0.1
Regionalized-1	--	12	1,259	<0.1	--	442	<0.1	--	<0.1
Regionalized-2	11	12	1,259	<0.1	--	442	<0.1	--	<0.1
Regionalized-3	--	6	1,259	<0.1	--	442	<0.1	--	<0.1
Regionalized-4	7	6	1,259	<0.1	--	442	<0.1	--	<0.1
Regionalized-5	4	6	1,259	<0.1	--	442	<0.1	--	<0.1
Regionalized-6	--	2	1,259	<0.1	--	442	<0.1	--	<0.1
Regionalized-7	--	2	1,259	<0.1	--	442	<0.1	--	<0.1
Centralized-1	--	1	1,259	<0.1	--	442	<0.1	--	<0.1
Centralized-2	--	1	1,259	<0.1	--	442	<0.1	--	<0.1
Centralized-3	7	1	1,259	<0.1	--	442	<0.1	--	<0.1
Centralized-4	7	1	1,259	<0.1	--	442	<0.1	--	<0.1
Centralized-5	1	1	1,259	<0.1	--	442	<0.1	--	<0.1

Notes:
T = Treatment
D = Disposal
GPD = Gallons per day
Water supplied by groundwater in the Upper Glacial and Magothy aquifers. Current water use = 4,500,000 gallons/day.
Wastewater discharged to the Peconic River. Average flow rate of the Peconic River = 1,000,000 gallons/day.
** Ten sites use existing facilities for volume reduction.
<0.1 indicates that the percentage is less than 0.1%.

Table II-3.2-10. BNL—LLW—Radionuclide Concentrations in Groundwater (Percent of Comparison Criteria) for Disposal

LLW Alternatives	Number of Sites T	Number of Sites D	Ac 225	Ac 227	Am 241	Am 242	Am 243	C 14	Cs 135	Cs 137	Cm 242	Cm 244	Cm 245	I 129	Pb 210	Np 237	Ni 59	Ni 63	Pd 107	Pu 238	Pu 239	Pu 240	Pu 241
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	--	16	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Regionalized-1	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	--	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

LLW Alternatives	Number of Sites T	Number of Sites D	Po 210	K 40	Pa 231	Ra 223	Ra 226	Sm 151	Se 79	Sr 90	Tc 99	Th 227	Th 228	Th 229	Th 230	Th 232	Sn 126	U 233	U 234	U 235	U 236	U 238	Y 90	Zr 93
No Action	10**	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Decentralized	--	16	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0
Regionalized-1	--	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-2	11	12	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-3	--	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-4	7	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-5	4	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-6	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Regionalized-7	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-1	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-2	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-3	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-4	7	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Centralized-5	1	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
T = Treatment
D = Disposal
** Ten sites use existing facilities for volume reduction
-- = Disposal is not considered for this Alternative.

Table II-3.2-11. BNL—LLW—Socioeconomic Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Effect of Implementation of Alternatives					
				Jobs		Income		
	T	D	Cost (Millions) (1)	Jobs	% Change in ROI (2)	ROI Annual Income (Millions) (1)	% Change in Annual Income (Millions) (1)	% ROI Population Increase (2)
No Action	10**	6	98	102	<0.01	1.2	<0.01	<0.01
Decentralized	- -	16	203	212	0.02	2.4	<0.01	0.01
Regionalized-1	- -	12	98	102	<0.01	1.2	<0.01	<0.01
Regionalized-2	11	12	98	102	<0.01	1.2	<0.01	<0.01
Regionalized-3	- -	6	98	102	<0.01	1.2	<0.01	<0.01
Regionalized-4	7	6	98	102	<0.01	1.2	<0.01	<0.01
Regionalized-5	4	6	98	102	<0.01	1.2	<0.01	<0.01
Regionalized-6	- -	2	98	102	<0.01	1.2	<0.01	<0.01
Regionalized-7	- -	2	98	102	<0.01	1.2	<0.01	<0.01
Centralized-1	- -	1	98	102	<0.01	1.2	<0.01	<0.01
Centralized-2	- -	1	98	102	<0.01	1.2	<0.01	<0.01
Centralized-3	7	1	98	102	<0.01	1.2	<0.01	<0.01
Centralized-4	7	1	98	102	<0.01	1.2	<0.01	<0.01
Centralized-5	1	1	98	102	<0.01	1.2	<0.01	<0.01

Notes:
T = Treatment
D = Disposal
(1) In 1990 dollars.
(2) Compared to 1990 baseline.
** Ten sites use existing facilities for volume reduction.

Table II-3.2-12. BNL—LLW—Infrastructure Impacts for Treatment and Disposal

LLW Alternatives	Number of Sites		Land Use		Water		Waste Water		Power		Employment	
	T	D	Acres Required	% Designated or Suitable Land Area	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Demand (GPD)	% Current Capacity	Peak Construction Employment	% of Current Employment
No Action	10**	6	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Decentralized	- -	16	2.8	0.10	8000	0.13	865	0.04	1.10	3.14	113	3
Regionalized-1	- -	12	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Regionalized-2	11	12	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Regionalized-3	- -	6	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Regionalized-4	7	6	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Regionalized-5	4	6	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Regionalized-6	- -	2	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Regionalized-7	- -	2	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Centralized-1	- -	1	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Centralized-2	- -	1	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Centralized-3	7	1	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Centralized-4	7	1	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74
Centralized-5	1	1	1.2	0.04	1258	0.02	441	0.02	0.12	0.26	62	1.74

Notes:
T = Treatment
D = Disposal
GPD = Gallons per day
- - = Disposal is not considered for this Alternative.
** = Ten sites use existing facilities for volume reduction.

Table II-3.2-13. BNL—LLW—Cost

LLW Alternatives	Number of Sites		Total Cost (Millions) (1)	Cost by Life-Cycle Component (1)				Cost by Functional Area (1)		
	T	D		Pre-Operations (Millions)	Construction (Millions)	Operations & Maintenance (Millions)	Decontamination & Decommissioning (Millions)	Treatment (Millions)	Storage (Millions)	Disposal (Millions)
No Action	10**	6	111	9	41	55	6	111	0	0
Decentralized	--	16	230	17	72	129	12	110	0	120
Regionalized-1	--	12	111	9	41	55	6	111	0	0
Regionalized-2	11	12	111	9	41	55	6	111	0	0
Regionalized-3	--	6	111	9	41	55	6	111	0	0
Regionalized-4	7	6	111	9	41	55	6	111	0	0
Regionalized-5	4	6	111	9	41	55	6	111	0	0
Regionalized-6	--	2	111	9	41	55	6	111	0	0
Regionalized-7	--	2	111	9	41	55	6	111	0	0
Centralized-1	--	1	111	9	41	55	6	111	0	0
Centralized-2	--	1	111	9	41	55	6	111	0	0
Centralized-3	7	1	111	9	41	55	6	111	0	0
Centralized-4	7	1	111	9	41	55	6	111	0	0
Centralized-5	1	1	111	9	41	55	6	111	0	0

Notes:
** Ten sites use existing facilities for volume reduction
T = Treatment
D = Disposal
The Life Cycle Components and the Functional Area have been rounded to the nearest million, and therefore the sum may not reflect the true total cost.
(1) In 1994 Dollars; Total Cost = Sum of the Life Cycle Components = Sum of the Functional Areas.