U.S. DEPARTMENT OF ENERGY

SUMMARY

Final Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste (DOE/EIS-0375)

January 2016

U.S. DEPARTMENT OF ENERGY

COVER SHEET

Lead Agency: U.S. Department of Energy (DOE)

Cooperating Agency: U.S. Environmental Protection Agency (EPA)

Title: Final *Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste* (DOE/EIS-0375)[1]

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Abstract: The U.S. Department of Energy (DOE) has prepared this Final *Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste* (GTCC EIS) to evaluate the potential environmental impacts associated with the proposed development, operation, and long-term management of a disposal facility or facilities for GTCC low-level radioactive waste (LLRW) and DOE GTCC-like waste. GTCC LLRW has radionuclide concentrations exceeding the limits for Class C LLRW established by the U.S. Nuclear Regulatory Commission (NRC). These wastes are generated by activities licensed by the NRC or Agreement States and cannot be disposed of in currently licensed commercial LLRW disposal facilities. DOE has prepared and is issuing this EIS in accordance with the National Environmental Policy Act, Section 631 of the Energy Policy Act of 2005 (Public Law 109-58), and Section 3 (b) of the Low-Level Radioactive Waste Policy Amendments Act of 1985 (Public Law 99-240).

The NRC LLRW classification system does not apply to radioactive wastes generated or owned by DOE and disposed of in DOE facilities. However, DOE owns or generates LLRW and non-defense-generated transuranic (TRU) radioactive waste, which have characteristics similar to those of GTCC LLRW and for which there may be no path for disposal at the present time. DOE has included these wastes for evaluation in this EIS because similar approaches may be used to dispose of both types of radioactive waste. For the purposes of this EIS, DOE refers to this waste as GTCC-like waste. The total volume of GTCC LLRW and GTCC-like waste

1 Vertical change bars in the margins of this Final EIS indicate revisions and new information added since the Draft EIS was issued in February 2011. Editorial changes are not marked.

addressed in the EIS is about 12,000 m^3 (420,000 ft^3), and it contains about 160 million curies of radioactivity. About three-fourths of this volume is GTCC LLRW, with GTCC-like waste making up the remaining one-fourth of the volume. Much of the GTCC-like waste is TRU waste. DOE has evaluated the potential environmental impacts associated with the range of reasonable alternatives for disposal of GTCC LLRW and GTCC-like waste in this GTCC EIS.

Alternatives Considered: DOE evaluated five alternatives in this GTCC EIS, including a No Action Alternative. One of the four action alternatives is disposal of GTCC LLRW and GTCC-like waste in a geologic repository at the Waste Isolation Pilot Plant (WIPP). The other three action alternatives involve the use of land disposal methods at six federally owned sites and at generic commercial sites. The land disposal alternatives consider the use of intermediate-depth borehole, enhanced near-surface trench, and above-grade vault facilities. The land disposal alternatives cover a spectrum of concepts that could be implemented to dispose of these wastes in order to enable an appropriate site and disposal technology to be selected. Each alternative is evaluated with regard to the transportation and disposal of the entire inventory, but the evaluation of human health and transportation impacts is done on a waste-type basis, so decisions can be made on this basis in the future, as appropriate.

Preferred Alternative: The preferred alternative for the disposal of GTCC and GTCC-like waste is the WIPP geologic repository (Alternative 2) and/or land disposal at generic commercial facilities (Alternatives 3-5). These land disposal conceptual designs could be altered or enhanced, as necessary, to provide the optimal application at a given location. The preferred alternative does not include land disposal at DOE sites. In addition, there is presently no preference among the three land disposal technologies at the generic commercial sites. The analysis in this Final GTCC EIS has provided the Department with the integrated insight needed to identify a preferred alternative with the potential to enable the disposal of the entire waste inventory analyzed in this EIS. Due to the uncertainty regarding the need for legislative changes and/or licensing or permitting changes, further analysis will be needed before a Record of Decision is announced. The Department has determined the preferred alternative would satisfy the needs of the Department for the disposal of GTCC and GTCC-like waste. Prior to making a final decision on which disposal alternative to implement, DOE will submit a Report to Congress to fulfill the requirement of Section 631(b)(1)(B)(i) of the Energy Policy Act of 2005 and await action by Congress. Section 631(b)(1)(B)(i) requires that the report include all alternatives under consideration and all the information required in the comprehensive report to ensure safe disposal of GTCC LLRW that was submitted by the Secretary to Congress in February 1987. DOE will not issue a Record of Decision until its required Report to Congress has been provided and appropriate action has been taken by Congress in accordance with the Energy Policy Act of 2005.

Public Comments: DOE issued an Advance Notice of Intent (ANOI) in the *Federal Register* on May 11, 2005, inviting the public to provide preliminary comments on the potential scope of the EIS. DOE then issued a Notice of Intent (NOI) to prepare this EIS on July 23, 2007; a printing correction was issued on July 31, 2007. The NOI provided responses to the major issues identified by commenters on the ANOI, identified the preliminary scope of the EIS, and announced nine public scoping meetings and a formal scoping comment period lasting from

July 23 through September 21, 2007. DOE used all input received during the scoping process to prepare the Draft GTCC EIS.

A 120-day public comment period on the Draft GTCC EIS began with the publication of the EPA Notice of Availability in the *Federal Register* on February 25, 2011 and closed on June 27, 2011. DOE conducted public hearings at nine locations during April and May of 2011. All comments received on the Draft GTCC EIS were considered in the preparation of this Final GTCC EIS.

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ACRONYMS AND ABBREVIATIONS

ags	above ground surface
ANOI	Advance Notice of Intent
bgs	below ground surface
BWR	boiling water reactor
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CGTO	Consolidated Group of Tribes and Organizations
CH	contact-handled
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
DOE	U.S. Department of Energy
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
FR	*Federal Register*
FTE	full-time equivalent
GMS/OSRP	Office of Global Material Security/Off-Site Source Recovery Project (NNSA)
GTCC	greater-than-Class C
HOSS	hardened on-site storage
INL	Idaho National Laboratory
K_d	distribution coefficient
LANL	Los Alamos National Laboratory
LCF	latent cancer fatality
LLRW	low-level radioactive waste
LLRWPAA	Low-Level Radioactive Waste Policy Amendments Act of 1985
LWA	Land Withdrawal Act (WIPP)
LWB	Land Withdrawal Boundary (WIPP)
NDA	NRC-Licensed Disposal Area
NEPA	National Environmental Policy Act of 1969
NOI	Notice of Intent
NRC	U.S. Nuclear Regulatory Commission
NNSS	Nevada National Security Site (formerly the Nevada Test Site or NTS)
ORR	Oak Ridge Reservation

P.L.	Public Law
PWR	pressurized water reactor
RH	remote-handled
RH LLW EA	Remote-Handled Low-Level Waste Environmental Assessment (INL)
ROD	Record of Decision
SDA	State-Licensed Disposal Area
SRS	Savannah River Site
TA	Technical Area (LANL)
TC&WM EIS	Tank Closure and Waste Management EIS (Hanford)
TRU	transuranic
USC	*United States Code*
VOC	volatile organic compound
WIPP	Waste Isolation Pilot Plant

RADIONUCLIDES

Am-241	americium-241
Am-243	americium-243
C-14	carbon-14
Co-60	cobalt-60
Cs-137	cesium-137
Fe-55	iron-55
I-129	iodine-129
Mn-54	manganese-54
Mo-99	molybdenum-99
Nb-94	niobium-94
Ni-59	nickel-59
Ni-63	nickel-63
Pu-238	plutonium-238
Pu-239	plutonium-239
Pu-240	plutonium-240
Sr-90	strontium-90
Tc-99	technetium-99

UNITS OF MEASURE

ac	acre(s)
ft	foot (feet)
ft^3	cubic foot (feet)
h	hour(s)
ha	hectare(s)
km	kilometer(s)
km^2	square kilometer(s)
m	meter(s)
m^3	cubic meter(s)
MCi	megacurie(s)
mi	mile(s)
mi^2	square mile(s)
mrem	millirem
rad	radiation absorbed dose
rem	roentgen equivalent man
yr	year(s)

CONVERSION TABLE[a]

Multiply	By	To Obtain
acres (ac)	0.4047	hectares (ha)
cubic feet (ft^3)	0.02832	cubic meters (m^3)
feet (ft)	0.3048	meters (m)
miles (mi)	1.609	kilometers (km)
square miles (mi^2)	2.590	square kilometers (km^2)
cubic meters (m^3)	35.31	cubic feet (ft^3)
hectares (ha)	2.471	acres (ac)
kilometers (km)	0.6214	miles (mi)
meters (m)	3.281	feet (ft)
square kilometers (km^2)	0.3861	square miles (mi^2)

[a] Values presented in this Summary have been converted (as necessary) using the above conversion table and rounded to two significant figures.

RADIATION BASICS

A number of terms and concepts related to radiation and radiation doses are used in this Summary. The following text boxes are provided to describe these terms and concepts to aid the readers in understanding the information provided in this Summary.

Radiation Terms and Concepts

What Is Radioactivity? Radioactivity (or activity) is the property of unstable (radioactive) atoms that causes them to spontaneously release energy (radiation) in the form of subatomic particles or photons. Radioactivity is generally measured in curies, which is a rate of radioactive decay. One curie is defined to be 37 billion disintegrations per second.

What Is Radiation? Radiation consists of energy, generally in the form of subatomic particles (neutrons and alpha and beta particles) or photons (x-rays and gamma rays) given off by unstable (radioactive) atoms as they decay to reach a more stable configuration.

How Can Radiation Be Classified? Radiation can be classified as being in one of two categories: ionizing and nonionizing (such as from a laser). The radiation associated with GTCC LLRW and GTCC like waste is ionizing radiation.

What Is Ionizing Radiation? Ionizing radiation is radiation that has sufficient energy to displace electrons from atoms or molecules when it interacts with matter, creating ion pairs. Ionizing radiation is a known human carcinogen.

What Types of Ionizing Radiation Are Associated with GTCC LLRW and GTCC Like Waste? There are five types of ionizing radiation associated with GTCC LLRW and GTCC-like waste.

Alpha Particle An alpha particle consists of two protons and two neutrons and is identical to the nucleus of a helium atom. An alpha particle has a short range in air and cannot penetrate a sheet of paper or the outer layer of skin.

Beta Particle – A beta particle can be either negative (negatron) or positive (positron) and has the mass of an electron. A high-energy beta particle can travel a few meters in air and pass through a sheet of paper but is generally stopped by a thin layer of plastic or aluminum.

Gamma Ray A gamma ray is electromagnetic radiation (photon) given off by the nucleus of an atom as a means of releasing excess energy. A high energy gamma ray can travel several hundred meters in air and requires the use of lead, steel, and concrete shielding to stop it.

X-ray An x-ray is similar to a gamma ray but originates external to the nucleus (from movement of electrons between energy shells). X-rays have less energy than gamma rays, have a shorter range, and are easier to shield.

Neutron – A neutron is one of the two primary building blocks of the nucleus (the other being a proton), and it has no electrical charge. High-energy neutrons can travel long distances in air (similar to gamma rays) and are most effectively stopped with shielding having high concentrations of hydrogen, such as water, concrete, paraffin, and plastic.

What Is Half-Life? The half life of a radionuclide is the length of time for a given amount of a radionuclide to decrease to one-half of its initial amount by radioactive decay.

Radiation Dose

What Is Radiation Dose? In general terms, radiation dose is simply a measure of the amount of energy deposited by ionizing radiation per unit mass of any material and is generally reported in rad (acronym for radiation absorbed dose). One rad is equal to 100 ergs per gram or 0.00001 joule per gram or 0.0000024 calorie per gram. An erg, a joule, and a calorie are units of measures of energy.

How Is Radiation Dose Measured in Humans? The radiation dose to humans is typically given in rem (acronym for roentgen equivalent man) and is the product of the absorbed dose (in rad) and factors related to the relative biological effectiveness of the radiation.

What Are Sources of Radiation? Radiation can come from natural sources and man-made sources. Natural sources of radiation include cosmic radiation, radioactive elements naturally present in the earth's crust and human body, and radon gas naturally present in soil and rock. Man-made sources of radiation include medical procedures, consumer products, nuclear technology (including nuclear power plants), and fallout from past atmospheric nuclear weapons tests.

How Much Radiation Dose Does an Individual Receive? The amount of radiation dose that an individual receives depends on several factors. Cosmic radiation increases with altitude, and terrestrial radiation varies by location in the country. The National Council on Radiation Protection and Measurements recently estimated that an average individual in the United States receives an annual radiation dose of about 620 mrem/yr; half of this dose is from natural sources, and half is from man-made sources, most of which is associated with medical sources.

Typical doses from various natural and man made sources and activities are provided as follows for additional context. These examples were obtained from a website of the U.S. Environmental Protection Agency, which can be consulted for further information (http://www.epa.gov/radiation/understand/calculate.html).

Source	Average Annual Dose (mrem/yr)	Source	Average Annual Dose (mrem/yr)
Cosmic radiation (from outer space)		Internal radiation (in your body)	
At sea level	26	From food and water (e.g., potassium-40)	40
Elevation up to 1,000 ft	28	From indoor air (radon and its decay products)	200
Elevation from 1,000 to 2,000 ft	31	Plutonium-powered pacemaker	100
Elevation from 2,000 to 3,000 ft	35	Air travel by jet	
Elevation from 3,000 to 4,000 ft	41	For each 1,000 miles traveled	1
Elevation from 4,000 to 5,000 ft	47		
Elevation from 5,000 to 6,000 ft	55	Medical diagnostic procedures	
Elevation from 6,000 to 7,000 ft	66	Each medical x ray	40
Elevation from 7,000 to 8,000 ft	79	Each nuclear medicine procedure	14
Above 8,000 ft	96		
		Nuclear weapons fallout (global average)	1
Terrestrial radiation (from soil and rocks)		Household sources	
Gulf States and Atlantic Coast	23	House constructed of brick, stone, or concrete	7
Colorado Plateau	90	Watching television	1
Elsewhere in the United States	46	Computer use	0.1
		Smoke detector	0.08

S.1 INTRODUCTION

This Summary provides an overview of the Final *Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste* (GTCC EIS) prepared by the U.S. Department of Energy (DOE). This Summary describes the wastes and the range of reasonable disposal alternatives evaluated in the GTCC EIS and provides a brief compilation of the major results of the evaluation included in this impact statement. In addition, guidance is provided for locating more detailed information on specific topics in the main body of the document.

Informing the public and fostering public participation are important requirements of the GTCC EIS process. At the end of this Summary is a discussion of the public review opportunities that includes representative comments received from stakeholders during the public scoping period and public comment period for the Draft GTCC EIS. For the GTCC EIS, stakeholders are the people or organizations who have an interest in or may be affected by (1) the lack of disposal capability for these wastes, (2) transportation of these wastes to an alternative disposal site, and (3) activities at the alternative disposal sites for these wastes. Stakeholders include members of the general public; representatives of environmental groups, industry, educational groups, unions, and other organizations; and representatives of Congress, federal agencies, American Indian tribes, state agencies, and local governments.

Readers interested primarily in the major issues and results presented in the GTCC EIS should find their information needs met by this Summary. Key information is presented about the purpose and need for agency action, the proposed action, the range of reasonable alternatives, the potential short- and long-term impacts of implementing each of the alternatives, uncertainties in the analyses, and the public participation process for this EIS. Considerations for developing the preferred alternative are included near the end of this Summary in Section S.7. A preferred alternative has been identified in Section S.8 and included in the Final GTCC EIS following public comment on the Draft GTCC EIS. In addition to the preferred alternative, other major changes made between the Draft and Final GTCC EIS are also summarized in Section S.9. Readers who would like more detail on these and other topics are directed to the pertinent sections of the GTCC EIS. Figure S-1 shows the organization of the GTCC EIS and relationships of its components.

S.1.1 What Is the Purpose and Need for Agency Action?

At this time, there is no disposal capability for GTCC low-level radioactive waste (LLRW). GTCC LLRW is generated by U.S. Nuclear Regulatory Commission (NRC) or Agreement State (i.e., a state that has signed an agreement with NRC to regulate certain uses of radioactive materials within the state) licensees. The NRC identifies four classes of LLRW in Title 10 of the *Code of Federal Regulations* (10 CFR 61.55) for disposal purposes on the basis of the concentrations of specific long- and short-lived radionuclides: Class A, B, C, and GTCC. GTCC LLRW has radionuclide concentrations exceeding the limits for Class C LLRW as

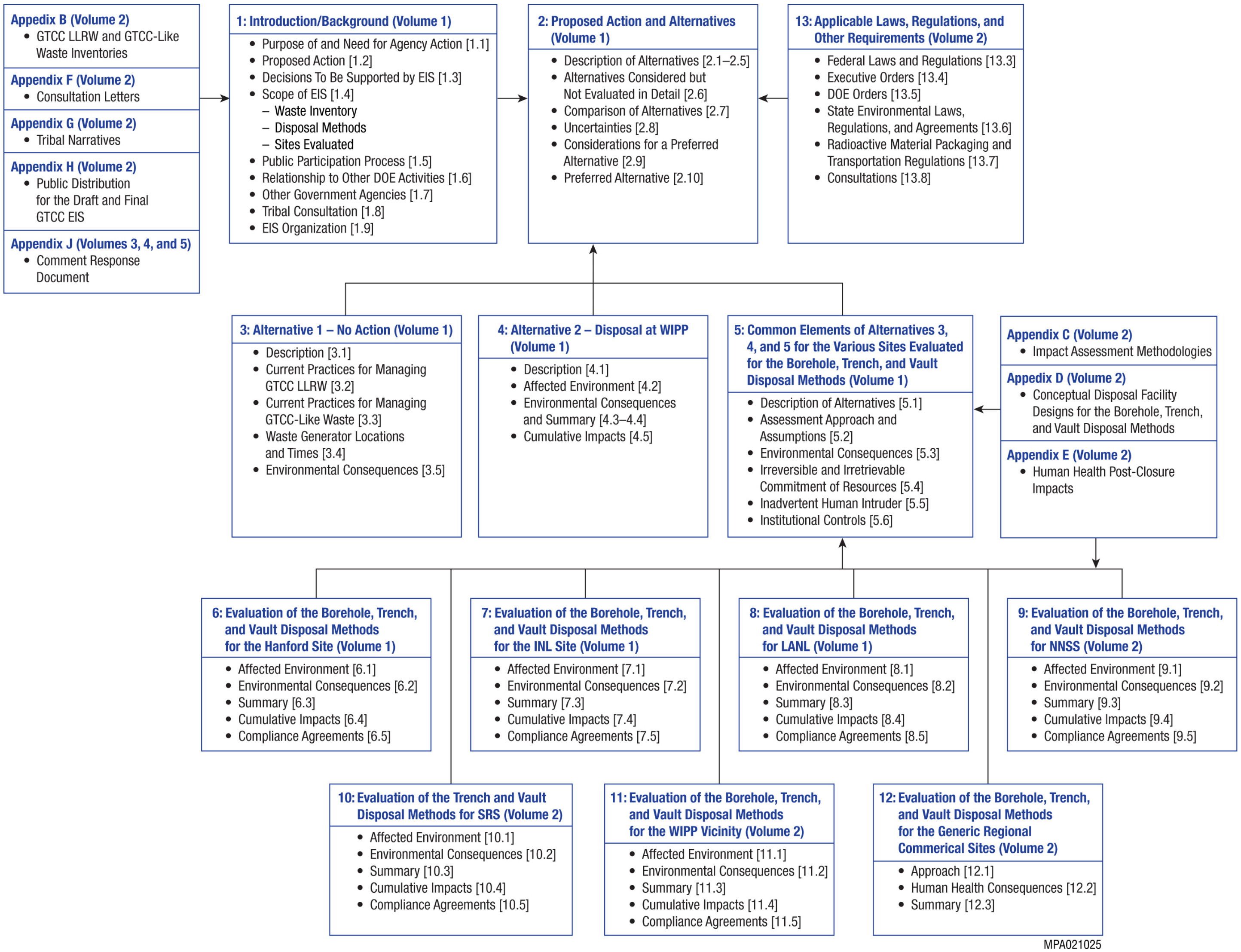


FIGURE S-1 Organization of the GTCC EIS and Relationships of Its Components (Note that in addition to this Summary, the main body of the GTCC EIS is made up of five volumes; the specific volume in which each component is contained is indicated in the figure above.)

provided in 10 CFR 61.55 and requires isolation from the human environment for a longer period of time than do Class A, B, and C LLRW, which are disposed of in existing commercial disposal facilities. GTCC LLRW consists of activated metals from the decommissioning of nuclear reactors, disused or unwanted sealed sources, and Other Waste (i.e., GTCC LLRW that is not activated metals or sealed sources). Other Waste consists of contaminated equipment, debris, scrap metal, filters, resins, soil, and solidified sludges.

Legislative Requirements

Section 3(b)(1)(D) of the LLRWPAA

- Specifies that the federal government is responsible for the disposal of GTCC LLRW.
- Specifies that GTCC LLRW be disposed of in a facility licensed by the NRC.

Section 631 of the Energy Policy Act of 2005

- Requires DOE to submit a report to Congress on disposal alternatives under consideration and await Congressional action before issuing a Record of Decision.

The Low-Level Radioactive Waste Policy Amendments Act of 1985 (LLRWPAA, Public Law [P.L.] 99-240) specifies that the GTCC LLRW that is designated a federal responsibility under Section 3(b)(1)(D) is to be disposed of in a facility that is adequate to protect public health and safety and is licensed by the NRC. In addition, DOE owns and generates both LLRW and non-defense-generated TRU waste, which have characteristics similar to those of GTCC LLRW and for which there may be no path for disposal at the present time. DOE is referring to these wastes as GTCC-like wastes. The use of the term "GTCC-like" is not intended to and does not create a new DOE classification of radioactive waste. Although GTCC-like waste is not subject to the requirements in the LLRWPAA, DOE also intends to determine a path to disposal that is similarly protective of public health and safety.

The September 11, 2001, terrorist attacks and subsequent threats in the U.S. have heightened concerns that terrorists could gain possession of radioactive sealed sources (see text box on page S-11), including sealed sources requiring management as GTCC LLRW, and use them for malevolent purposes. Such an attack has been of particular concern because of the widespread use of sealed sources and other radioactive materials in the United States for beneficial uses by hospitals and other medical establishments, industries, and academic institutions. While secure storage of disused sealed sources is a temporary measure, a disposal capability is needed. The interagency Radiation Source Protection and Security Task Force, established under Section 651(d) of the Energy Policy Act of 2005 (P.L. 109-58), is charged with evaluating and providing recommendations related to the security of radiation sources in the United States from potential terrorist threats, including the use of a radiological source in a radiological dispersal device (e.g., dirty bomb). In August 2006, August 2010, and August 2014 the Task Force submitted reports to the President and

Disused radioactive sealed sources previously used in medical treatments and other applications are one of the GTCC LLRW types for which a disposal capability is needed. Every year, thousands of sealed sources become disused and unwanted in the United States. While secure storage is a temporary measure, unlike permanent disposal, the longer sources remain disused or unwanted, the greater the chance that they will become unsecured or abandoned. Due to their concentrated activity and portability, radioactive sealed sources could be used in radiological dispersal devices (RDDs), commonly referred to as "dirty bombs." An attack using an RDD could result in extensive economic loss, significant social disruption, and potentially serious public health problems.

U.S. Congress. The 2006 report (NRC 2006) stated that "providing disposal methods for GTCC LLRW will have the greatest effect on reducing the total risk of long-term storage for risk significant sources." The 2010 report (NRC 2010) further stated that "by far the most significant challenge identified is access to disposal for disused radioactive sources." The 2014 report (NRC 2014) recommended that "DOE should continue its ongoing efforts to develop GTCC [LLRW] disposal capability." Since 2003, the U.S. Government Accountability Office has issued several reports on matters related to the security of uncontrolled sealed sources. In particular, the 2003 report (GAO 2003, Executive Summary page) stated a concern with DOE's progress in developing a GTCC LLRW disposal facility. In addition, the Energy Policy Act of 2005 (P.L. 109-58) contains several provisions directed at improving the control of sealed sources, including disposal availability.

Accordingly, DOE has prepared this EIS to evaluate the range of reasonable alternatives for the safe and secure disposal of GTCC LLRW and GTCC-like waste. The range of reasonable alternatives addresses approximately 12,000 m^3 (420,000 ft^3) of in-storage and projected (anticipated through 2083) GTCC LLRW and GTCC-like waste. Waste quantity data obtained in 2008 had verification updates made in 2010 as needed, see Sandia (2008) and Argonne (2010). In performing its due diligence in the preparation of this Final EIS, DOE reviewed the waste quantity data and has determined that the expected waste quantity estimates remain valid and are conservative and bounding for the comparative analysis in the Final EIS, and revisions to this information are not necessary.

Disposal Method and Sites

Geologic Repository	WIPP
Intermediate-Depth Borehole	Hanford, INL, LANL, NNSS, WIPP Vicinity, and generic commercial sites
Enhanced Near-Surface Trench	Hanford, INL, LANL, NNSS, SRS, WIPP Vicinity, and generic commercial sites
Above-Grade Vault	Hanford, INL, LANL, NNSS, SRS, WIPP Vicinity, and generic commercial sites

S.1.2 What Is the Proposed Action?

DOE proposes to construct and operate a new facility or facilities or to use an existing facility for the disposal of GTCC LLRW and GTCC-like waste. DOE would then close the facility or facilities at the end of each facility's operational life. Institutional controls, including monitoring, would be employed for a period of time determined during the implementation phase. A combination of disposal methods and locations might be appropriate, depending on the characteristics of the waste among other factors. Disposal methods evaluated are the use of deep geologic disposal (via a geologic repository), an intermediate-depth borehole, an enhanced near-surface trench, and an above-grade vault. The disposal locations evaluated are the Hanford Site, the Idaho National Laboratory (INL) Site, Los Alamos National Laboratory (LANL), the Nevada National Security Site (NNSS), which was formerly known as the Nevada Test Site or NTS, the Savannah River Site (SRS), the Waste Isolation Pilot Plant (WIPP), and the WIPP Vicinity (where two locations are evaluated – one within and one outside the land withdrawal boundary of WIPP). Generic (commercial) sites are also evaluated for the borehole, trench, and vault methods, as applicable. The assumed locations of the generic sites coincide with the four NRC regions. Figures S-2 and S-3 show the sites being considered and the four NRC regions.

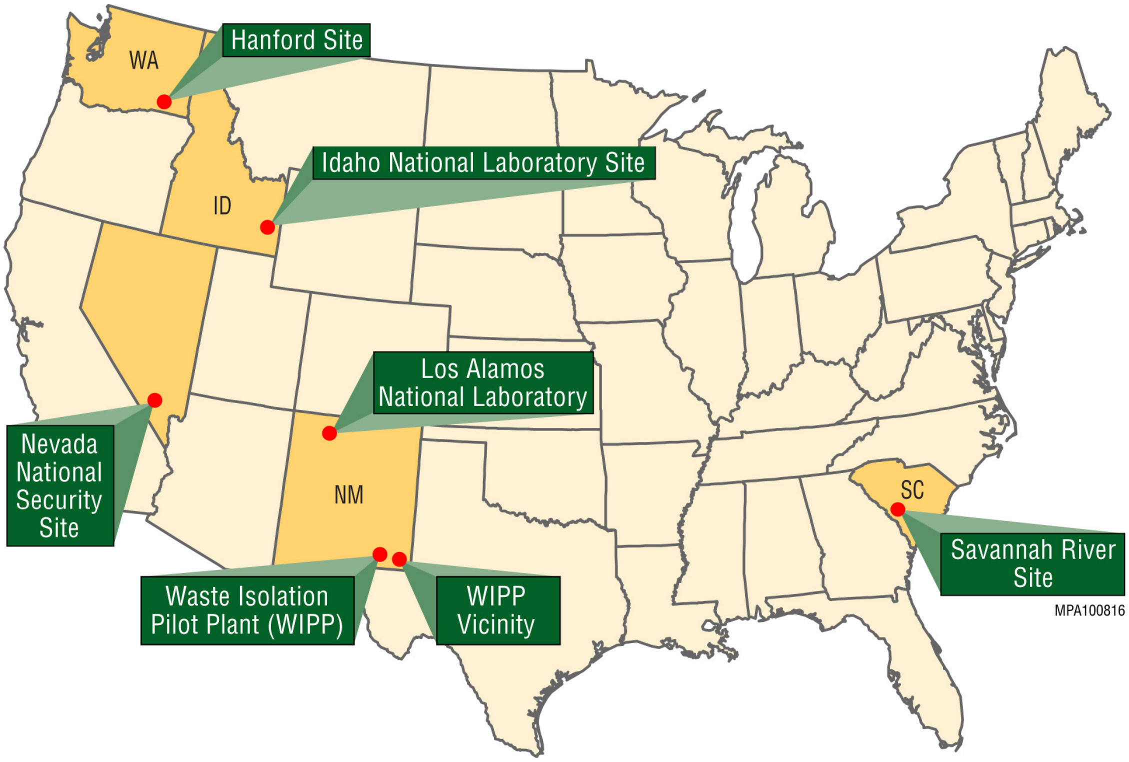


FIGURE S-2 Map of DOE Sites Being Considered for Disposal of GTCC LLRW and GTCC-Like Waste

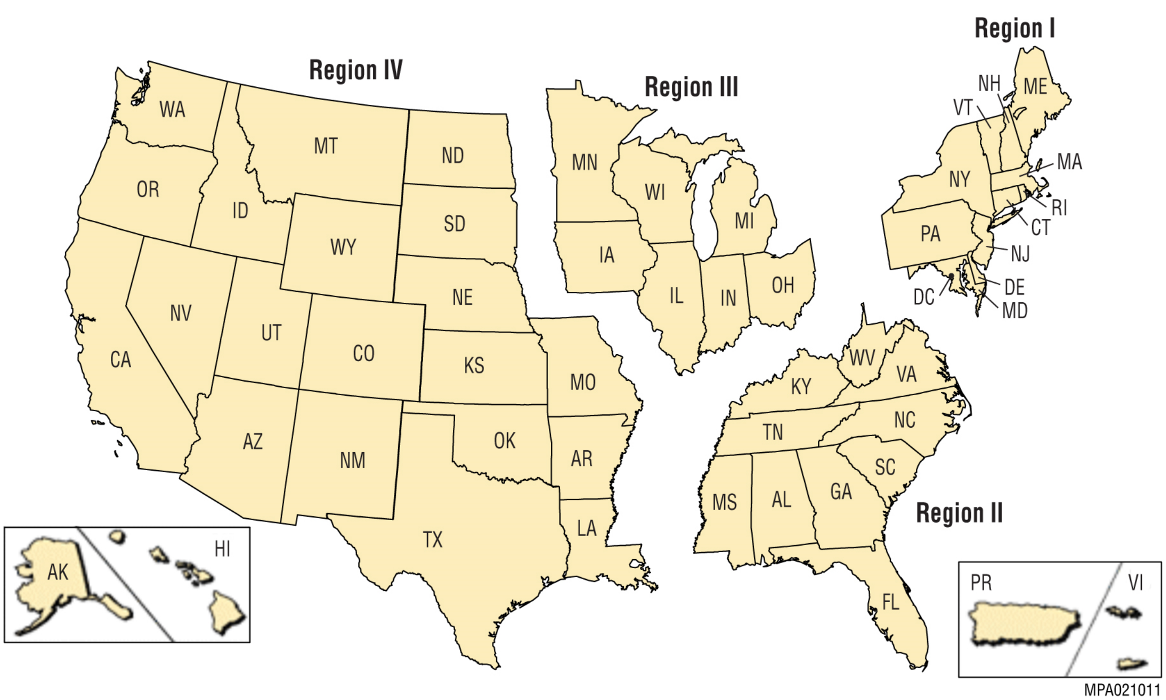


FIGURE S-3 Map Showing the Four NRC Regions Used as the Basis for the Evaluation of the Generic Commercial Sites

S.1.3 What Decisions Are Being Made?

DOE intends for this EIS to provide the information that supports the selection of disposal method(s) and site(s) for the GTCC LLRW and GTCC-like waste. DOE would conduct additional reviews under the National Environmental Policy Act of 1969 (NEPA) to evaluate the potential impacts from constructing and operating the selected disposal method(s) at the selected site(s), as needed.

Before issuing a Record of Decision (ROD) for the selection of disposal method(s) and site(s), DOE will submit a report to Congress to fulfill the requirement of Section 631(b)(1)(B)(i) of the Energy Policy Act of 2005 (P.L. 109-58). Section 631(b)(1)(B)(i) requires that the report include a description of all alternatives under consideration, and all the information required in the comprehensive report on ensuring the safe disposal of GTCC LLRW waste that was submitted by the Secretary to Congress in February 1987. Also, Section 631(b)(1)(B)(ii) requires DOE to await Congressional action. DOE will not issue a ROD until its required Report to Congress has been provided and appropriate action has been taken by Congress in accordance with the Energy Policy Act of 2005.

S.1.4 What Other Government Agencies Are Participating?

Because of its technical expertise in radiation protection, the U.S. Environmental Protection Agency (EPA) participated as a cooperating agency in the preparation of this EIS. The EPA's role as a cooperating agency does not imply its endorsement of DOE's selection of specific approaches, alternatives, or methods. The EPA conducted independent reviews of the Draft and Final EIS and associated documents in accordance with Section 309 of the Clean Air Act (*United States Code*, Volume 42, page 7609 [42 USC 7609]). The NRC participated as a commenting agency on the EIS.

Before implementation of any final decision, DOE would consult with appropriate Federal and state agencies, tribes, the Advisory Council on Historic Preservation, the appropriate State Historic Preservation Officer(s), and pertinent Regional Fish and Wildlife Service Office(s).

S.1.5 What Tribal Consultations Have Been Conducted?

DOE initiated consultation and communication activities on the GTCC EIS with 14 participating American Indian tribal governments that have cultural or historical ties to DOE sites being evaluated in this EIS, as identified in the text box. The consultation activities are being conducted in accordance with President Obama's Memorandum on Tribal Consultation (dated November 5, 2009), Executive Order 13175 (dated November 6, 2000) entitled "Consultation and Coordination with American Indian Tribal Governments," Executive Memorandum (dated September 23, 2004) entitled "Government-to-Government Relationship with Tribal Governments" (White House 2004), and DOE Order 144.1, *American Indian Tribal Government Interaction and Policy*, January 2009. The consultation activities include technical briefings, development of written tribal narratives included in the GTCC EIS related to the specific site affiliated with the tribe, and/or discussions with elected tribal officials, based on individual tribal preferences and mutually agreed-upon protocols.

DOE respects the unique and special relationship between American Indian tribal governments and the Government of the United States, as established by treaty, statute, legal precedent, and the U.S. Constitution. For this reason, DOE has presented tribal views and perspectives in the GTCC EIS to ensure full and fair consideration of tribal rights and concerns before making decisions or implementing programs that could affect tribes. While DOE may not necessarily agree with these views, DOE is committed to its government-to-government relationship with American Indian tribal governments. DOE will continue to work with tribal governments and their designated representatives to protect American Indian cultural resources, sacred sites, and potential traditional cultural properties and to implement appropriate mitigation measures that may reduce potential adverse effects to American Indian resources and interests.

Tribes and Tribal Organizations Participating in GTCC EIS Consultation Activities

Hanford

- Confederated Tribes of the Umatilla Indian Reservation (CTUIR), Pendleton, OR
- Nez Perce, Lapwai, ID
- Wanapum People, Ephrata, WA
- Yakama Nation, Union Gap, WA

Idaho

- Western Shoshone-Bannock Tribes, Fort Hall, ID

Los Alamos

- Acoma Pueblo, Acoma, NM
- Cochiti Pueblo, Cochiti, NM
- Laguna Pueblo, Laguna, NM
- Nambe Pueblo, Santa Fe, NM
- Pojoaque Pueblo, Santa Fe, NM
- Pueblo de San Ildefonso, Santa Fe, NM
- Pueblo of Jemez, Jemez, NM
- Santa Clara Pueblo, Española, NM

Nevada

- The Consolidated Group of Tribes and Organizations (CGTO) representing 16 Paiute and Western Shoshone Tribes. Consultation with these tribal nations is being conducted through the CGTO.

Tribal narratives, which describe the tribe's unique perspective on the DOE sites and environmental resource areas being analyzed in the GTCC EIS, are presented in the GTCC EIS. The following tribes, by site, chose to participate in the development of tribal narratives: Hanford (Confederated Tribes of the Umatilla Indian Reservation [CTUIR], Nez Perce, Wanapum, Yakama Nation); LANL (Cochiti Pueblo, Nambe Pueblo, Pueblo de San Ildefonso, Santa Clara Pueblo); and NNSS (Consolidated Group of Tribes and Organizations [CGTO], consisting of the Pahrump Paiute Tribe, Colorado River Indian Tribes, Duckwater Western Shoshone Tribe, Moapa Paiute Tribe, Bishop Paiute Tribe, Big Pine Paiute Tribe, Ely Western Shoshone Tribe). In addition to developing written narratives, other agreed-upon consultation activities have been initiated. Tribes contributed to the preparation of the Draft EIS and participated in the review of the Draft EIS by attending public meetings regarding GTCC and submitting comments that are addressed in Appendix J of this EIS. Since the receipt of tribal comments in 2011 on the Draft EIS, DOE has continued routine consultation with tribes as part of normal operations at the DOE sites evaluated in this EIS. DOE will continue to involve the tribes in the decision making process for the disposal of GTCC.

Some common issues identified by the tribes include the following:

Climate change. The climate has changed in the past 10,000 years. Tribes perceived that the lives of American Indian people have changed during these climatic shifts, that plant and animal communities have shifted, and that such shifts would occur again in the future (perhaps in the near future, given the potential impacts of global climate change).

Soils and minerals. At each of the potential GTCC disposal locations, regional soils and minerals found at or around the site play an important role in cultural and ceremonial activities.

Ecological impacts on the traditional use of plant and animal species by American Indians. Ecological concerns relate to the fact that the analyses tend to focus on threatened and endangered species and plants. The full range of species needs to be evaluated, especially in terms of American Indian use of plants and animals. Plants are used for medicine, food, basketry, tools, homes, clothing, fire, and social and healing ceremonies. Animals and insects are culturally important, and the relationship between them, the earth, and American Indian people are represented by the roles they play in the stories of American Indian people.

Human health impacts and American Indian pathways analysis. Tribes raised concerns that pathways specific to American Indian peoples be analyzed. They believe that standard calculations of human health exposure as used in the GTCC EIS for the general public are not applicable to American Indian populations.

Cultural resources. Tribal cultural resources include all physical, artifactual, and spiritual aspects for each of the potential areas being evaluated at Hanford, LANL, and NNSS. All things of the natural environment contribute to the cultural resources for the tribal lifestyle.

Visual resources. Views are important cultural resources that contribute to the location and performance of American Indian ceremonies. Viewscapes are typically experienced from high places or tend to provide panoramic views.

Tribal perspectives, comments, and concerns identified during the consultation process, those received during the public scoping process (also see Section S.7.4.2), and all comments received on the Draft GTCC EIS were considered by DOE in identifying the preferred alternative discussed in Section S.8.

S.2 WHAT DOES THE EIS ADDRESS?

S.2.1 What Is GTCC LLRW?

GTCC LLRW is waste that is not generally acceptable for near-surface disposal and for which the waste form and disposal methods must be different and, in general, more stringent than those specified for Class C LLRW. NRC regulations require GTCC LLRW to be disposed of in a geologic repository as defined in 10 CFR Parts 60 and 63, unless proposals for an alternative method are approved by NRC under 10 CFR 61.55(a)(2)(iv).[1]

The concentrations of radionuclides in Classes A, B, and C LLRW limit the length of time that these wastes are generally considered to be hazardous to about 500 to 1,000 years. 10 CFR 61.7(a)(2) notes that near-surface disposal site characteristics for these wastes should be considered in terms of the indefinite future and evaluated for a time frame of at least 500 years. Radioactive decay and the slow migration of radionuclides from the disposal units should reduce the hazard from the radionuclides to safe levels at that time. In contrast, some of the radionuclides in the GTCC LLRW and GTCC-like waste either have long half-lives (in excess of 10,000 years) or are present in high concentrations.

Class A LLRW has the lowest radionuclide concentration limits of the four classes of waste and is usually segregated from other LLRW at the disposal site. Class B LLRW has higher radionuclide concentration limits

NRC Classification System for LLRW

The NRC classification system for the four classes of LLRW (A, B, C, and GTCC) is established in 10 CFR 61.55 and is based on the concentrations of specific short and long-lived radionuclides given in two tables. Classes A, B, and C LLRW are generally acceptable for disposal in near-surface land disposal facilities. GTCC LLRW is LLRW "that is not generally acceptable for near-surface disposal" as specified in 10 CFR 61.55(a)(2)(iv). As stated in 10 CFR 61.7(b)(5), there may be some instances in which waste with radionuclide concentrations greater than permitted for Class C would be acceptable for near-surface disposal with special processing or design.

GTCC LLRW and GTCC-Like Waste

GTCC LLRW refers to LLRW that has radionuclide concentrations that exceed the limits for Class C LLRW given in 10 CFR 61.55. This waste is generated by activities of NRC and Agreement State licensees, and it cannot be disposed of in currently licensed commercial LLRW disposal facilities. The federal government is responsible for the disposal of GTCC LLRW.

GTCC-like waste refers to radioactive waste that is owned or generated by DOE and has characteristics sufficiently similar to those of GTCC LLRW such that a common disposal approach may be appropriate. GTCC-like waste consists of LLRW and non-defense-generated TRU waste that has no identified path for disposal at the present time. The use of the term "GTCC-like" is not intended to and does not create a new DOE classification of radioactive waste.

[1] The GTCC LLRW inventory in the EIS includes GTCC LLRW from the decommissioning of commercial nuclear reactors that are covered by a Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste. A Federal Circuit Court panel ruled that for purposes of determining damages in the spent nuclear fuel litigation, GTCC LLRW waste is considered high-level radioactive waste under the terms of DOE's Standard Contract (*Yankee Atomic Electric Co. v. U.S.*, 536 F. 3d 1268 (Fed. Cir. 2008) and *Pacific Gas & Electric Co. v. U.S.,* 536 F. 3d 1282 (Fed. Cir. 2008)). The court's decision does not affect DOE's responsibility to evaluate reasonable alternatives for a disposal facility or facilities for GTCC LLRW – including GTCC LLRW covered by the Standard Contract – in accordance with applicable law.

than Class A and must meet more rigorous requirements with regard to waste form to ensure its stability after disposal. Class C LLRW is waste that represents a higher long-term risk than does Class A or Class B LLRW. Like Class B waste, Class C waste must meet the more rigorous requirements with regard to waste form to ensure its stability, and it also requires additional measures to be taken at the disposal facility to protect against inadvertent human intrusion.

S.2.2 What Is GTCC-Like Waste?

Three Waste Types

The wastes being addressed in this EIS are divided into three distinct types. These three waste types and their estimated total volumes and radionuclide activities are as follows:

- Activated metals: 2,000 m^3 (71,000 ft^3) and 160 MCi
- Sealed sources: 2,900 m^3 (100,000 ft^3) and 2.0 MCi
- Other Waste: 6,700 m^3 (240,000 ft^3) and 1.3 MCi

About three-fourths of the waste by volume is GTCC LLRW; GTCC-like waste accounts for the remainder.

Consistent with NRC's and DOE's authorities under the Atomic Energy Act of 1954, amended (P.L. 83-703), the NRC LLRW classification system does not apply to radioactive waste that is owned or generated by DOE and disposed of in DOE facilities. However, DOE owns or generates both LLRW and non-defense-generated TRU waste,[2] which have characteristics similar to those of GTCC LLRW and for which there may be no path for disposal. DOE has included these wastes, otherwise known as "GTCC-like waste," for evaluation in the GTCC EIS because a common approach and/or facility could be used. For the purposes of the EIS, the use of the term "GTCC-like" is not intended to and does not create a new DOE classification of radioactive waste.

S.2.3 How Much GTCC LLRW and GTCC-Like Waste Is Addressed in the EIS?

The combined GTCC LLRW and GTCC-like waste inventory addressed in this EIS has a packaged volume of about 12,000 m^3 (420,000 ft^3) and contains a total activity of about 160 million curies (MCi) (see Figure S-4).

For the purposes of analysis in this EIS, both GTCC LLRW and GTCC-like waste are comprised of three waste types: activated metals, sealed sources, and other waste. The waste inventory addressed in the EIS includes both stored inventory (wastes that were already generated and are in storage as of 2008) and projected inventory (wastes that are expected to be generated in the future through 2083). Waste quantity data obtained in 2008 had verification

[2] Defense-generated TRU waste is radioactive waste generated by atomic energy defense activities. "Atomic energy defense activity," as defined by the Nuclear Waste Policy Act of 1982, as amended, means "any activity of the Secretary of Energy performed in whole or in part in carrying out any of the following functions: naval reactors development; weapons activities including defense inertial confinement fusion; verification and control technology; defense nuclear materials production; defense nuclear waste and materials byproducts management; defense nuclear materials security and safeguards and security investigations; and defense research and development." TRU waste that is not generated by atomic energy defense activities is considered non-defense-generated TRU.

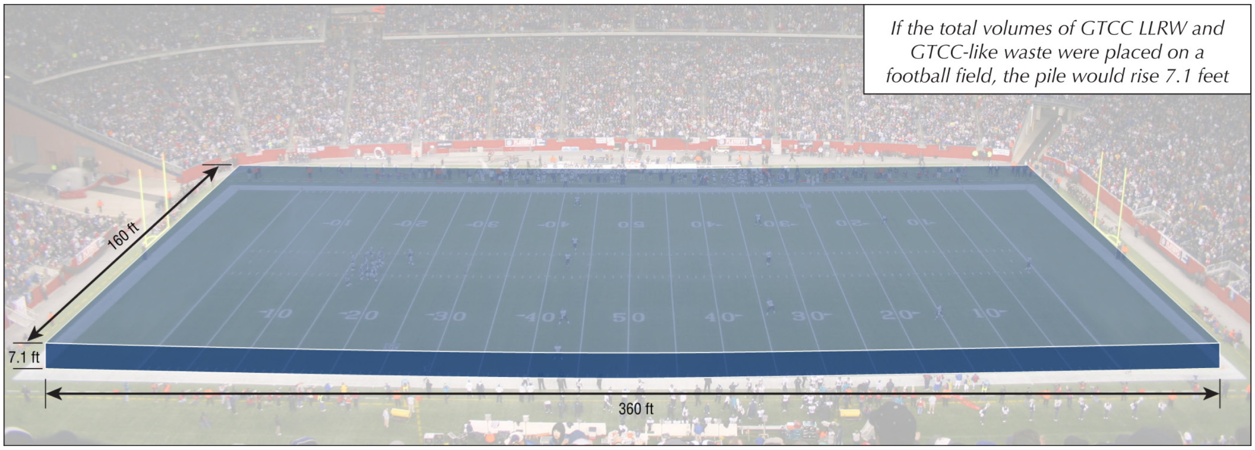
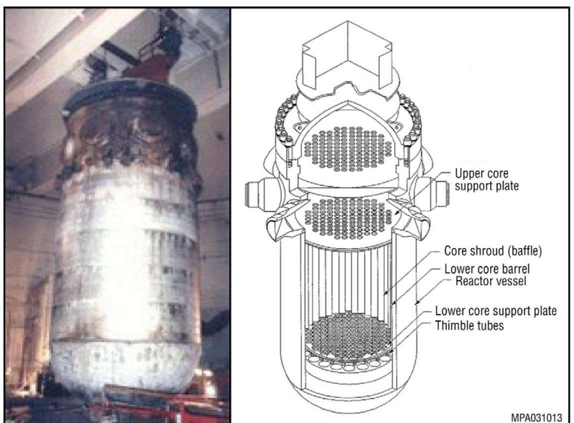


FIGURE S-4 Total Volume of GTCC LLRW and GTCC-Like Waste Addressed in the EIS



Activated Metals at a Glance
(2,000 m^3 [71,000 ft^3] containing 160 MCi)

- Largely generated from the decommissioning of nuclear reactors.
- Include portions of the nuclear reactor vessel, such as the core shroud and core support plate.
- Prevalent radionuclides in activated metals include C 14, Mn 54, Fe 55, Ni 59, Ni-63, Nb-94, and Co-60.
- In the United States, 104 commercial nuclear reactors are operating in 31 states, and more reactors are planned.
- Most reactors are not scheduled to undergo decommissioning for several decades.

Sealed Sources at a Glance
(2,900 m^3 [100,000 ft^3] containing 2.0 MCi)

- Widely used in equipment to diagnose and treat illnesses (particularly cancer), sterilize medical devices, irradiate blood for transplant patients, nondestructively test structures and industrial equipment, and explore geologic formations to find oil and gas.
- Located in hospitals, universities, and industries throughout the United States.
- Unsecured or abandoned sealed sources are a national security concern because of their potential to be used by terrorists in a “dirty bomb.”
- Commonly consist of concentrated radioactive materials encapsulated in small metal containers.
- Radionuclides commonly used in sealed sources include Cs-137, Am 241, and Pu-238.

Other Waste at a Glance
(6,700 m^3 [240,000 ft^3] containing 1.3 MCi)

- Other Waste primarily includes contaminated equipment, debris, scrap metal, filters, resins, soil, and solidified sludges. These wastes are associated with the:
  - Production of Mo-99, which is used in about 16 million medical procedures (e.g., to detect cancer) each year. The United States depends on aging foreign reactors to produce Mo-99, and shortages in recent years due to the unexpected shutdowns of the foreign facilities have highlighted the need to produce Mo 99 in the United States.
  - Production of radioisotope power systems in support of space exploration (e.g., from the plutonium 238 production project) and national security.
  - Environmental cleanup of radioactively contaminated sites including the West Valley Site in New York.
- A wide range of radionuclides may be present in Other Waste, including Tc-99, Cs-137, and a number of transuranic radionuclides including isotopes of plutonium, americium, and curium.

Transuranic (TRU) Waste

TRU waste is radioactive waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes with half-lives greater than 20 years, except for (1) high-level radioactive waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the U.S. Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations; or (3) waste that the NRC has approved for disposal on a case-by case basis in accordance with 10 CFR Part 61. Examples of TRU radionuclides include Pu-238, Pu-239, Pu-240, Am-241, and Am-243.

Contact-Handled and Remote-Handled Waste

As used in this EIS, contact handled (CH) waste refers to GTCC LLRW and GTCC-like waste that has a dose rate of less than 200 mrem/h on the surface of the package. Remote-handled (RH) waste refers to GTCC LLRW and GTCC-like waste that has a surface dose rate of 200 mrem/h or more. These definitions are consistent with the way that these terms are defined for disposal of TRU waste at WIPP.

> **Two Waste Groups**
>
> For purposes of analysis in this EIS, wastes are considered to be in one of two groups.
>
> - Group 1 consists of wastes from currently operating facilities. Some of the Group 1 wastes have already been generated and are in storage awaiting disposal.
> - Group 2 consists of projected wastes from proposed actions or planned facilities not yet in operation.

updates made in 2010 as needed, see Argonne (2010). In performing its due diligence in the preparation of this final EIS, DOE reviewed the waste quantity data and has determined that the expected waste quantity estimates remain valid and are conservative and bounding. The stored inventory includes waste in storage at sites licensed by the NRC or Agreement States (GTCC LLRW) and at certain DOE sites (GTCC-like waste) and consists of all three waste types (activated metals, sealed sources, and Other Waste).

For analysis in this EIS, the three waste types fall into two groups on the basis of uncertainties associated with their generation. Group 1 consists of wastes from currently operating facilities that are either already in storage or are expected to be generated from these facilities (such as commercial nuclear power plants by 2083); all currently operational plants were assumed to have their license renewed for an additional 20 years of operation. All stored GTCC LLRW and GTCC-like wastes are included in Group 1.

Group 2 consists of projected wastes from proposed actions or planned facilities not yet in operation. These actions include those proposed by DOE and those to be conducted by commercial entities (including electric utilities) for an assumed number of new (i.e., still to be licensed or constructed) nuclear power plants. Some or all of the Group 2 waste may never be generated, depending on the outcome of the proposed actions that are independent of this EIS. Such actions include the potential exhumation of previously disposed-of wastes at the West Valley Site in New York, wastes from the production of Mo-99, and wastes from the planned plutonium-238 production project. No stored GTCC LLRW and GTCC-like wastes are included in Group 2. Any potential nuclear fuel cycles involving advanced reactors or recycling of used fuel and the GTCC LLRW and GTCC-like waste associated with these activities are uncertain at this time and therefore not estimated in this EIS. Either of these scenarios could have an impact on the volume of GTCC LLRW and GTCC-like waste generated and requiring disposal, which would be subject to future NEPA review including a review of the types and amount of waste generated and the need for disposal capacity.

The waste volumes and radionuclide activities of the wastes addressed in this EIS are summarized in Table S-1.

The total waste volume in Group 1 is estimated to be 5,300 m^3 (190,000 ft^3), and this waste contains a total of 110 MCi of activity. The radionuclide activity is mainly from the decommissioning of commercial nuclear power reactors currently in operation (see Figure S-5). Group 2 has an estimated waste volume of 6,400 m^3 (230,000 ft^3) and contains a total activity of 49 MCi. Some of this waste is associated with the environmental cleanup of the West Valley Site in New York (a former commercial facility for reprocessing of spent nuclear fuel that has two disposal areas for radioactive waste). The radionuclide activity in the Group 2 wastes would result mainly from the decommissioning of proposed new commercial nuclear power reactors.

TABLE S-1 Summary of Group 1 and Group 2 GTCC LLRW and GTCC-Like Waste Packaged Volumes and Radionuclide Activities[a]

Waste Type	In Storage		Projected		Total Stored and Projected	
	Volume (m^3)	Activity (MCi)[b]	Volume (m^3)	Activity (MCi)	Volume (m^3)	Activity (MCi)
Group 1						
GTCC LLRW						
Activated metals (BWRs)[c] – RH	7.1	0.22	200	30	210	31
Activated metals (PWRs) – RH	51	1.1	620	76	670	77
Sealed sources (Small)[d] – CH	–[e,f]	–	1,800	0.28	1,800	0.28
Sealed sources (Cs-137 irradiators) - CH	–	–	1,000	1.7	1,000	1.7
Other Waste[g] – CH	42	0.000011	–	–	42	0.000011
Other Waste – RH	33	0.0042	1.0	0.00013	34	0.0043
Total	130	1.4	3,700	110	3,800	110
GTCC-like waste						
Activated metals – RH	6.2	0.23	6.6	0.0049	13	0.24
Sealed sources (Small) – CH	0.21	0.0000060	0.62	0.000071	0.83	0.000077
Other Waste – CH	430	0.016	310	0.0062	740	0.022
Other Waste – RH	520	0.096	200	0.17	720	0.26
Total	960	0.34	510	0.18	1,500	0.52
Total Group 1	1,100	1.7	4,200	110	5,300	110
Group 2						
GTCC LLRW						
Activated metals (BWRs) – RH	–	–	73	11	73	11
Activated metals (PWRs) – RH	–	–	300	37	300	37
Activated metals (Other) – RH[h]	–	–	740	0.14	740	0.14
Sealed sources – CH[h]	–	–	23	0.000020	23	0.000020
Other Waste – CH[h]	–	–	1,600	0.024	1,600	0.024
Other Waste – RH[h]	–	–	2,300	0.51	2,300	0.51
Total	–	–	5,000	49	5,000	49
GTCC-like waste						
Activated metals – RH	–	–	–	–	–	–
Sealed sources – CH	–	–	–	–	–	–
Other Waste – CH	–	–	490	0.012	490	0.012
Other Waste – RH	–	–	870	0.48	870	0.48
Total	–	–	1,400	0.49	1,400	0.49
Total Group 2			6,400	49	6,400	49

TABLE S-1 (Cont.)

Waste Type	In Storage		Projected		Total Stored and Projected	
	Volume (m^3)	Activity (MCi)[b]	Volume (m^3)	Activity (MCi)	Volume (m^3)	Activity (MCi)
Groups 1 and 2						
GTCC LLRW						
Activated metals – RH	59	1.4	1,900	160	2,000	160
Sealed sources – CH	–	–	2,900	2.0	2,900	2.0
Other Waste – CH	42	0.00091	1,600	0.024	1,600	0.024
Other Waste – RH	33	0.0042	2,300	0.51	2,300	0.51
Total	130	1.4	8,700	160	8,800	160
GTCC-like waste						
Activated metals – RH	6.2	0.23	6.6	0.0049	13	0.24
Sealed sources – CH	0.21	0.0000060	0.62	0.000071	0.83	0.000077
Other Waste – CH	430	0.016	800	0.02	1,200	0.036
Other Waste – RH	520	0.096	1,100	0.65	1,600	0.75
Total	960	0.34	1,900	0.67	2,800	1.0
Total Groups 1 and 2	1,100	1.7	11,000	160	12,000	160

[a] All values have been rounded to two significant figures. Some totals may not equal sum of individual components because of independent rounding. BWR = boiling water reactor, CH = contact-handled (waste), PWR = pressurized water reactor, RH = remote-handled (waste). Includes waste in storage as of 2008 and projected through 2083. Waste quantity data obtained in 2008 had verification updates made in 2010 as needed, see Argonne (2010). In performing its due diligence in the preparation of this final EIS, DOE reviewed the waste quantity data and has determined that the expected waste quantity estimates remain valid and are conservative and bounding.

[b] MCi means megacurie or 1 million curies.

[c] There are two types of commercial nuclear reactors in operation in the United States, BWRs and PWRs. Different factors were used to estimate the volumes and activities of activated metal wastes for these two types of reactors.

[d] Sealed sources may be physically small but have high concentration of radionuclides.

[e] There are sealed sources currently possessed by NRC licensees that may become GTCC LLRW when no longer needed by the licensee. The current status of individual sources (i.e., whether they are in use, waste, etc.) is subject to change over time. Therefore, due to uncertainty of when the licensees will declare their sources a waste, an estimated volume and activity has been included in the projected inventory.

[f] A dash means that there is no value for that entry.

[g] Other Waste consists of those wastes that are not activated metals or sealed sources; it includes contaminated equipment, debris, scrap metals, filters, resins, soil, solidified sludges, and other materials.

[h] Wastes from the West Valley Site NDA and SDA are reflected in the inventories listed under Group 2 activated metals, sealed sources, and Other Waste - RH/CH. Of the 740 m^3 under activated metals, 210 m^3 is from the NDA and 525 m^3 is from the SDA; 23 m^3 of sealed sources is from the SDA; 1,600 m^3 of Other Waste - CH is from the SDA; and 1,950 m^3 of Other Waste - RH included 1,943 m^3 from the NDA and 7.34 m^3 from the SDA.

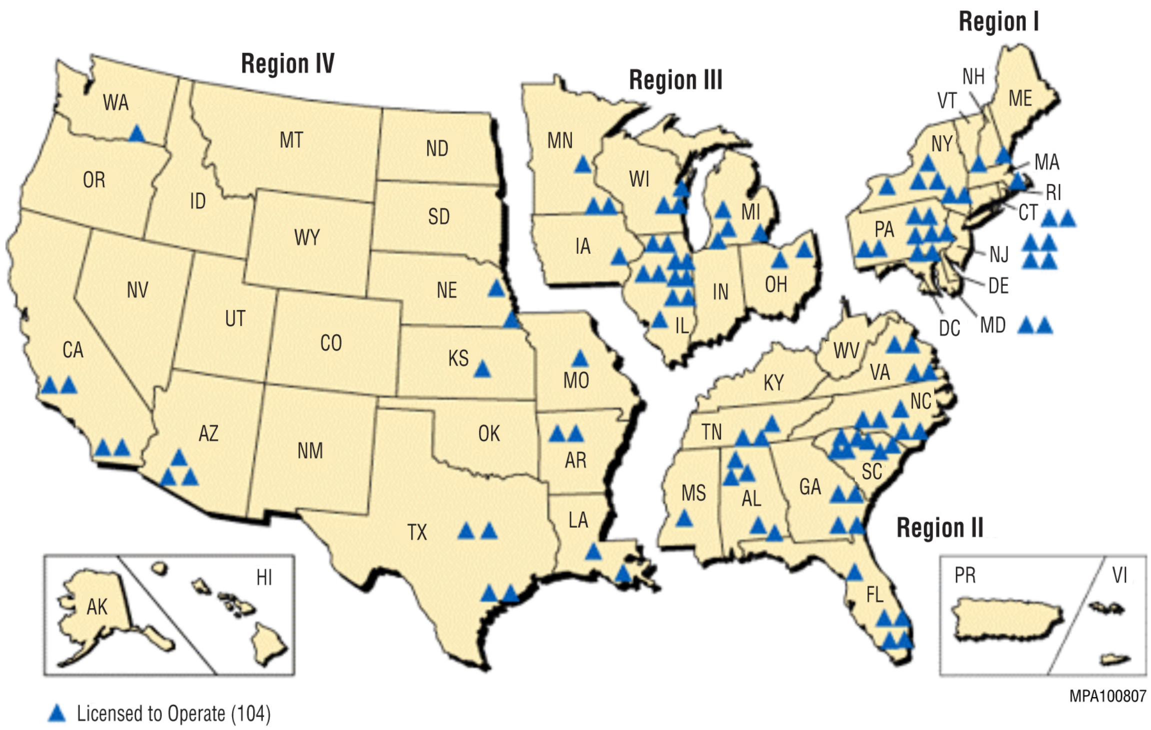


FIGURE S-5 Map Showing the Four NRC Regions and the Locations of Currently Operating Commercial Nuclear Power Plants

The total estimated volume of mixed waste (waste containing hazardous chemical constituents in addition to radionuclides) in Group 1 is about 170 m^3 (6,000 ft^3). Current information is insufficient to allow a reasonable estimate of the amount of Group 2 waste that could be mixed waste. Most of the Group 1 mixed waste is GTCC-like waste; only 4 m^3 (140 ft^3) is GTCC LLRW. Available information indicates that much of this waste is characteristic hazardous waste as regulated under the Resource Conservation and Recovery Act; therefore, this EIS assumes that for the land disposal methods, the generators will treat the waste to render it nonhazardous under federal and state laws and requirements. WIPP, however, can accept defense-generated TRU mixed waste as provided in the WIPP Land Withdrawal Act (LWA) of 1992 as amended (P.L. 102-579 as amended by P.L. 104-201).

S.2.4 What Is the Assumed Time Frame for GTCC LLRW and GTCC-Like Waste Disposal?

Waste would be received at the disposal facilities over an extended period of time. The actual start date for operations is uncertain at this time and dependent upon, among other things, the alternative or alternatives selected, additional NEPA review as required, characterization studies, and other actions necessary to initiate and complete construction and operation of a GTCC LLRW and GTCC-like waste disposal facility. For purposes of analysis in the GTCC EIS, DOE assumed a start date of disposal operations in 2019. However, given these uncertainties, the actual start date could vary. The receipt rate of the various waste types assumed for purposes of analysis in the GTCC EIS is shown in Figure S-6. Approximately 8,500 m^3 (300,000 ft^3) of the total GTCC LLRW and GTCC-like waste inventory of 12,000 m^3 (420,000 ft^3) is projected to be available for disposal during the first 16 years of disposal operations (i.e., the years 2019–2035). Most of this waste consists of disused sealed sources, which present a national security concern and therefore have a greater near-term disposal need, and Other Waste (e.g., debris from DOE environmental cleanup activities, waste from the planned production of radioisotope power systems in support of space exploration and national security, and waste from the planned production of Mo-99 for cancer treatment and other important medical procedures). Beyond the year 2035, the primary waste volumes are projected to be disused sealed sources and GTCC LLRW activated metal waste from decommissioning nuclear reactors. This future activated metal waste accounts for approximately 98% of the total activity of the GTCC LLRW and GTCC-like waste inventory.

S.2.5 What Is the Range of Reasonable Alternatives Evaluated in the EIS?

DOE evaluated the following five alternatives in the EIS:

- Alternative 1: No Action,

- Alternative 2: Disposal at the WIPP geologic repository,

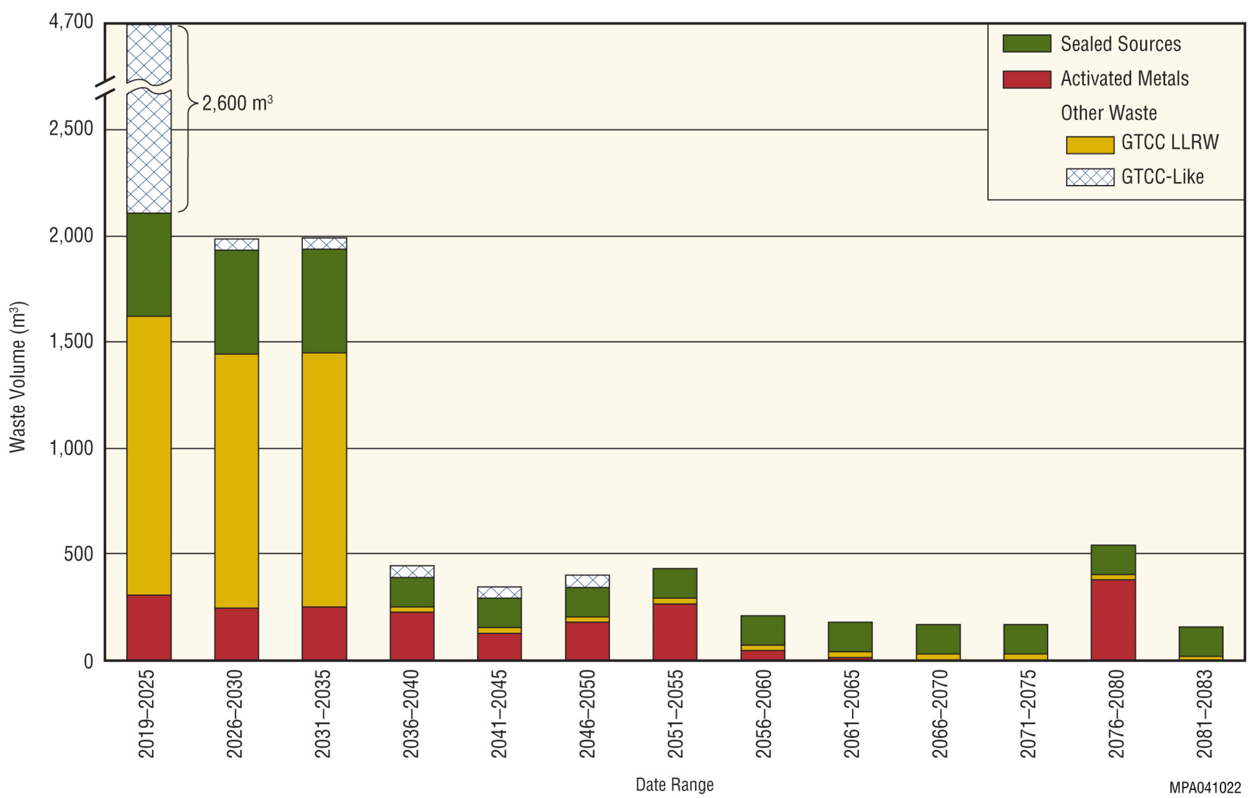


FIGURE S-6 Assumed Timeline for Receipt of GTCC LLRW and GTCC-Like Waste for Disposal

- Alternative 3: Disposal in a new borehole disposal facility,
- Alternative 4: Disposal in a new trench disposal facility, and
- Alternative 5: Disposal in a new vault disposal facility.

For the purposes of the analysis, DOE assumed construction of a new borehole, trench, or vault at all sites analyzed. This assumption provided conservatism in the evaluation methodology. However, an existing borehole, trench, or above-grade vault that meets the conceptual designs discussed in the EIS could be used.

Figure S-7 illustrates the disposal depths associated with the four action alternatives (Alternatives 2 through 5). DOE evaluated the use of an existing geologic repository (WIPP in New Mexico) and/or the construction of a new borehole, trench, or vault facility or facilities to safely dispose of the GTCC LLRW and GTCC-like waste. Combinations of disposal alternatives may be appropriate based on the characteristics of the waste type and other considerations (e.g., waste volumes, physical and radiological characteristics, and operational considerations). The new facility or facilities could be located at DOE sites having waste disposal missions, including the Hanford Site in Washington, the INL Site in Idaho, LANL in New Mexico, NNSS (formerly NTS) in Nevada, and SRS in South Carolina. In addition, such a disposal facility could be located on lands in the vicinity of WIPP (within or outside the land withdrawal boundaries of WIPP) or on generic nonfederal (commercial or private) lands.

DOE developed the four action alternatives after careful consideration of the waste inventory, disposal methods, and comments received during the public scoping period for the GTCC EIS. The WIPP repository is evaluated to determine the feasibility of the disposal of GTCC

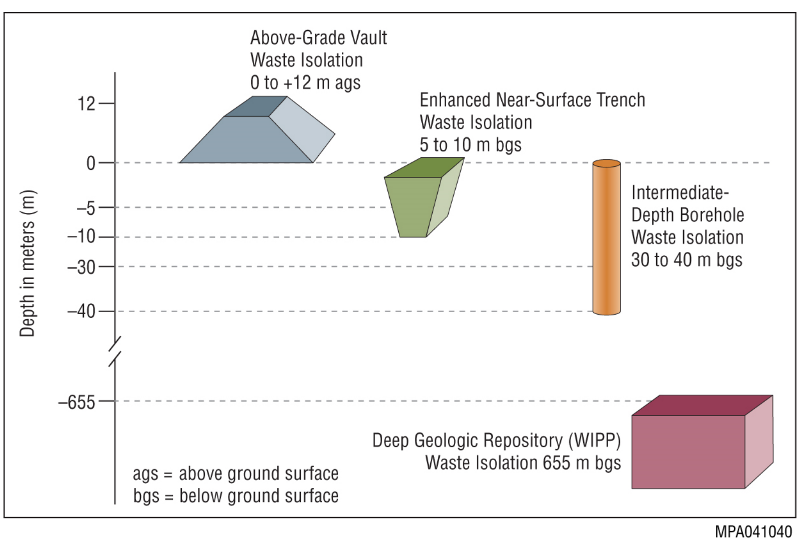


FIGURE S-7 Waste Isolation Depths for Proposed GTCC LLRW and GTCC-Like Waste Disposal Methods

LLRW and GTCC-like waste at a geologic repository. The designs for the land disposal facilities that are evaluated in this EIS are conceptual and generic in nature so that the performance of the sites with regard to employing the disposal methods considered in this EIS can be compared. These land disposal conceptual designs could be altered or enhanced, as necessary, to provide the optimal application at a given location.

Reference locations are identified for evaluating Alternatives 3 to 5 (borehole, trench, and vault) since these alternatives involve the construction of new disposal facilities. The reference locations, which have characteristics representative of the actual location that could be used for waste disposal purposes, are used in this EIS to compare disposal methodologies and sites. These reference locations at the DOE sites are generally in areas of these sites that have been used for other waste disposal activities or in which other disposal facilities or activities are also planned. If a site or sites were selected for possible implementation of a land disposal method or methods, a follow-on site-specific NEPA evaluation and documentation, as appropriate, along with a further optimization by a selection study, would be conducted to identify the location or locations within a given site that would be considered the best ones to accommodate the land disposal method(s). Figures indicating the reference locations of the land disposal facilities are given in this Summary. Reference locations have not been identified for the generic commercial disposal facilities, and these facilities are evaluated for potential human health impacts in this EIS on a regional basis (coinciding with the four NRC regions) by using input parameters assumed to be representative of each of the regions as a whole.

The five alternatives are described here.

S.2.5.1 Alternative 1: No Action

Under the No Action Alternative, current practices for storing GTCC LLRW and GTCC-like waste would continue in accordance with current requirements (e.g., NRC, state, DOE). The GTCC LLRW generated by the operation of commercial nuclear reactors (mainly activated metal waste) would continue to be stored at the various nuclear reactor sites that generated this waste or at other reactors owned by the same utility. Sealed sources would continue to be stored at interim storage and generator sites. Other Waste would also remain stored and managed at the generator or interim storage sites. In a similar manner, all stored and projected GTCC-like waste would remain at current DOE storage and generator locations (these wastes are being stored at several DOE sites as identified in Table S-2). Under this alternative, DOE would take no further action to develop disposal capability for these wastes, and current practices for managing these wastes would continue into the future. It is further assumed that for the short term, management of the stored wastes would continue for 100 years (a time period typically assumed for active institutional controls), and long-term impacts are analyzed for the period beyond 100 years and up to 10,000 years to be consistent with the time frame analyzed for the proposed disposal alternatives (i.e., Alternatives 2 to 5). National security concerns over the lack of a disposal capability for sealed sources that are GTCC LLRW would not be addressed.

TABLE S-2 Current Storage and Generator Locations of the GTCC LLRW and GTCC-Like Waste Addressed in the GTCC EIS[a]

Waste Type	GTCC LLRW	GTCC-Like Waste
Group 1		
Activated metals - RH	Various states (see Figure S-5)	INL Site (Idaho) ORR (Tennessee)
Sealed sources - CH	Various states	LANL (New Mexico)
Other Waste - CH	Babcock and Wilcox (Virginia) Waste Control Specialists (Texas)	West Valley Site (New York) INL Site (Idaho) Babcock and Wilcox (Virginia)
Other Waste - RH	Virginia and Texas	West Valley Site (New York) INL Site (Idaho) ORR (Tennessee) Babcock and Wilcox (Virginia)
Group 2		
Activated metals - RH	Various states	–
Sealed sources - CH	West Valley Site (New York)	–
Other Waste - CH	West Valley Site (New York)	West Valley Site (New York) ORR (Tennessee)
Other Waste - RH	West Valley Site (New York) Missouri University Research Reactor (Missouri) Babcock and Wilcox (Virginia)	West Valley Site (New York) ORR (Tennessee)

[a] Other Waste consists of those wastes that are not activated metals or sealed sources; it includes contaminated equipment, debris, scrap metal, filters, resins, soil, solidified sludges, and other materials. A dash means no volume for that waste type. INL = Idaho National Laboratory, LANL = Los Alamos National Laboratory, ORR = Oak Ridge Reservation.

S.2.5.2 Alternative 2: Disposal at WIPP

This alternative involves the disposal of GTCC LLRW and GTCC-like waste at WIPP. The operation at WIPP involves disposal of TRU waste generated by atomic energy defense activities by emplacement in underground disposal rooms that are mined as part of a panel and an access drift. Each mined panel consists of seven rooms. Contact-handled (CH) TRU waste containers are emplaced on disposal room floors, and remote-handled (RH) TRU waste containers are currently emplaced in horizontal boreholes in disposal room wall spaces. However, the EPA and New Mexico Environment Department have approved DOE use of shielded containers for safe emplacement of selected RH TRU waste streams with lower activity levels on the floor of the repository. The use of the shielded containers will enable DOE to significantly increase the efficiency of transportation and disposal operations for RH TRU waste at WIPP. For RH TRU waste streams with higher activity levels, such as those levels exhibited in the near term by activated metals removed from recently shutdown nuclear reactors, a similar, more heavily shielded container could be used. Consistent with the approval for the shielded container and the potential extension to a more heavily shielded container, this EIS assumes all activated metal waste and Other Waste - RH would be packaged in shielded containers that would be emplaced on the floor of the mined panel rooms in a manner similar to that used for the emplacement of CH waste.

The analysis discussed in this EIS assumes that disposal procedures and practices at WIPP would continue, except for the emplacement of activated metals and Other Waste - RH on room floors (not in wall spaces, as is the current procedure). It is also assumed that all aboveground support facilities would be available for the disposal of GTCC LLRW and GTCC-like waste and that construction of additional aboveground facilities would not be required to dispose of the entire inventory of GTCC LLRW and GTCC-like waste. However, the construction of up to 26 additional underground rooms would be required. Underground rooms are constructed by conventional mining techniques that use an electric-powered continuous miner rather than blasting. The mined salt is transported underground by haul trucks; once there, the salt is placed on the salt hoist and lifted to the surface. The exact locations and orientations of these rooms would be determined on the basis of mining engineering, safety, and other factors. Refer to Section 4.1.4.1 and Figure 4.1.4 1 in the EIS for additional information on construction. Figure S-8 shows the current WIPP layout including underground shafts.

Prior to implementation of this alternative, further evaluation and analysis of alternative technologies and methods to optimize the transport, handling, and emplacement of the wastes would be conducted to identify those technologies and methods that would minimize to the extent possible any potential impacts to human health or the environment. Follow-on WIPP-specific NEPA review would be conducted to examine in greater detail the potential impacts associated with the disposal of GTCC LLRW and GTCC-like waste at WIPP, as appropriate. DOE acknowledges that only defense-generated TRU waste is currently authorized for

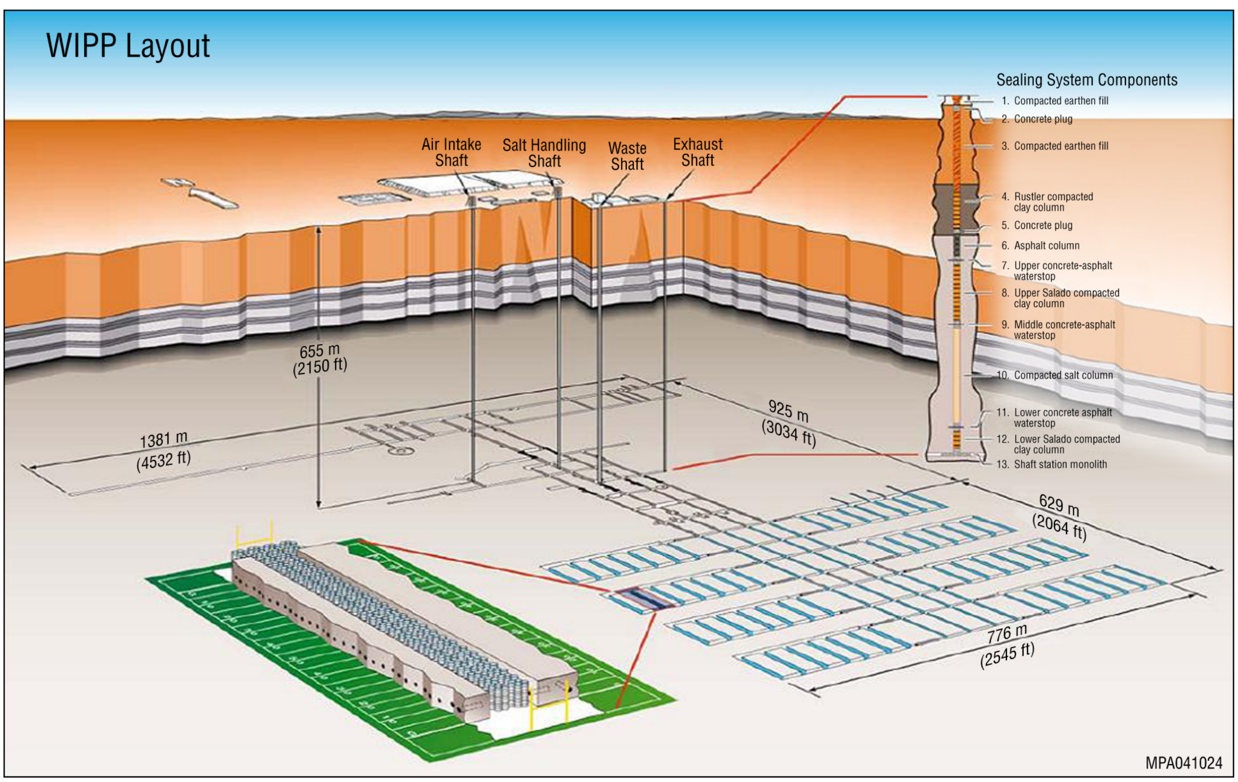


FIGURE S-8 Current WIPP Layout

disposal at the WIPP geologic repository under the WIPP LWA as amended (P.L. 102-579 as amended by P.L. 104-201), and that legislation would be required to allow disposal of waste other than TRU waste generated by atomic energy defense activities at WIPP and/or for siting a new facility within the land withdrawal area.

It should be noted that waste disposal operations at WIPP were suspended on February 5, 2014, following a fire involving an underground vehicle. Nine days later, on February 14, 2014, a radiological event occurred underground at WIPP, contaminating a portion of the mine primarily along the ventilation path from the location of the incident and releasing a small amount of contamination into the environment.

DOE will resume disposal operations at WIPP when it is safe to do so. The schedule for restart of limited operations is currently under review. DOE is continuing to characterize and certify TRU waste at the Idaho National Laboratory, Oak Ridge National Laboratory, Savannah River Site, and Argonne National Laboratory for eventual shipment to WIPP. TRU waste continues to be generated at the Hanford site and Lawrence Livermore National Laboratory. DOE is carefully evaluating and analyzing the impacts on storage requirements and commitments with state regulators at the generator sites. These efforts will inform decisions related to the availability of storage for certified TRU waste until waste shipments to WIPP can resume. Detailed information on the status of recovery activities at WIPP can be found at http://www.wipp.energy.gov/wipprecovery/recovery.html.

S.2.5.3 Alternative 3: Disposal in a New Intermediate-Depth Borehole Disposal Facility

Alternative 3 involves the construction, operations, and post-closure performance of a new borehole facility for the GTCC LLRW and GTCC-like waste inventory. Reference locations at the following five sites are evaluated for this alternative: the Hanford Site, the INL Site, LANL, NNSS, and the WIPP Vicinity. Because of the shallow depth to groundwater at SRS, this alternative is not evaluated for this site. Of the four NRC regions considered for the generic commercial facility, only NRC Region IV was evaluated for this alternative, since the depth to groundwater at the other three regions is considered too shallow for application of the borehole method. A cross section of a conceptual borehole design is shown in Figure S-9. For purposes of the EIS analysis, a borehole with a depth of 40 m (130 ft) was evaluated.

To dispose of the entire inventory of GTCC LLRW and GTCC-like waste, the conceptual design indicates that about 44 ha (110 ac) of land would be required for the 930 boreholes needed to accommodate the waste packages of GTCC LLRW and GTCC-like waste (see Figure S-10). This acreage would include land required for supporting infrastructure, such as facilities or buildings for receiving and handling waste packages or containers, and space for a stormwater retention pond (to collect stormwater runoff and truck washdown). Less acreage and fewer boreholes would be required if a decision were made to only dispose of certain GTCC LLRW and GTCC-like waste types in a borehole facility. The borehole method entails borehole designs constructed at depths below 30 m (100 ft) but above 300 m (1,000 ft) below ground surface (bgs). Boreholes can vary widely in diameter (from 0.3 to 3.7 m [1 to 12 ft]), and the

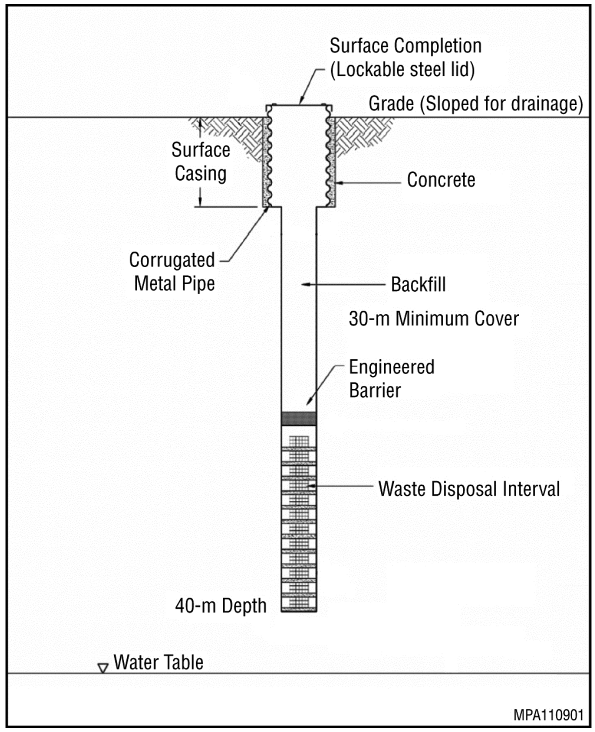


FIGURE S-9 Cross Section of the Conceptual Design for an Intermediate-Depth Borehole

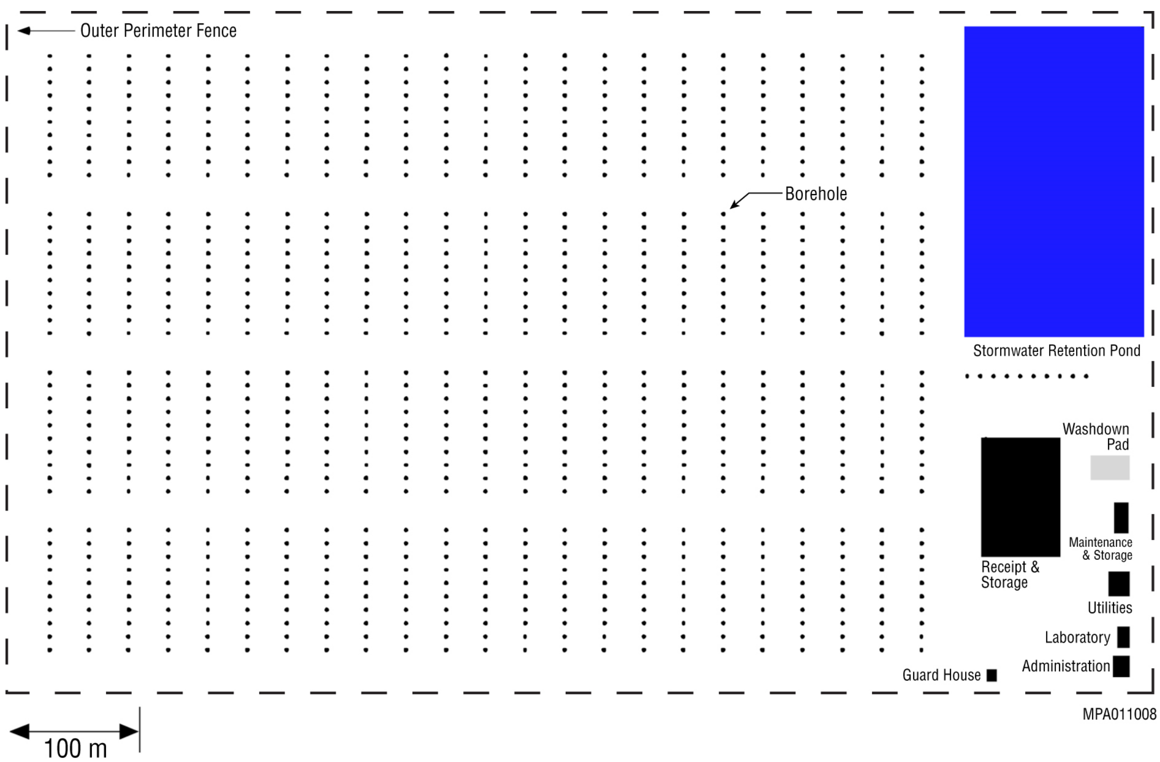


FIGURE S-10 Layout of Conceptual Borehole Facility proximity of one borehole to another can vary depending on the design of the facility. GTCC LLRW and GTCC-like waste disposal placement is assumed to be about 30 to 40 m (100 to 130 ft) bgs. After placement of the wastes in the borehole, an engineered barrier (reinforced concrete) would be added above the disposal containers to deter inadvertent drilling into the isolated waste during the post-closure period, and backfill would be added to the surface level.

S.2.5.4 Alternative 4: Disposal in a New Enhanced Near-Surface Trench Disposal Facility

Alternative 4 involves the construction, operations, and post-closure performance of a new trench disposal facility. This alternative is evaluated for the Hanford Site, the INL Site, LANL, NNSS, SRS, and the WIPP Vicinity. The conceptual design of the trench is shown in Figure S-11. Alternative 4 is evaluated for the generic commercial sites in NRC Regions II and IV in order to allow for a comparison with the federal sites in these two regions.

To dispose of the entire inventory of GTCC LLRW and GTCC-like waste, the conceptual design for the trench method includes 29 trenches occupying a footprint of about 20 ha (50 ac) (see Figure S-12). This acreage includes land required for supporting infrastructure, such as facilities or buildings for receiving and handling waste packages or containers, and space for a stormwater retention pond (to collect stormwater runoff and truck washdown). Each trench would be approximately 3-m (10-ft) wide, 11-m (36-ft) deep, and 100-m (330-ft) long. GTCC LLRW and GTCC-like waste disposal placement is assumed to be about 5 to 10 m (15 to 30 ft) bgs. After wastes were placed in the trench, an engineered barrier (a reinforced concrete layer)

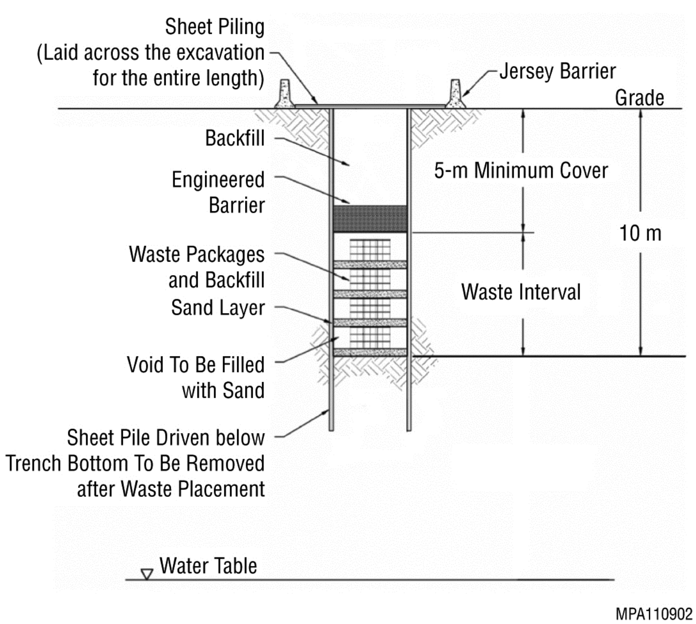


FIGURE S-11 Cross Section of the Conceptual Design for a Trench

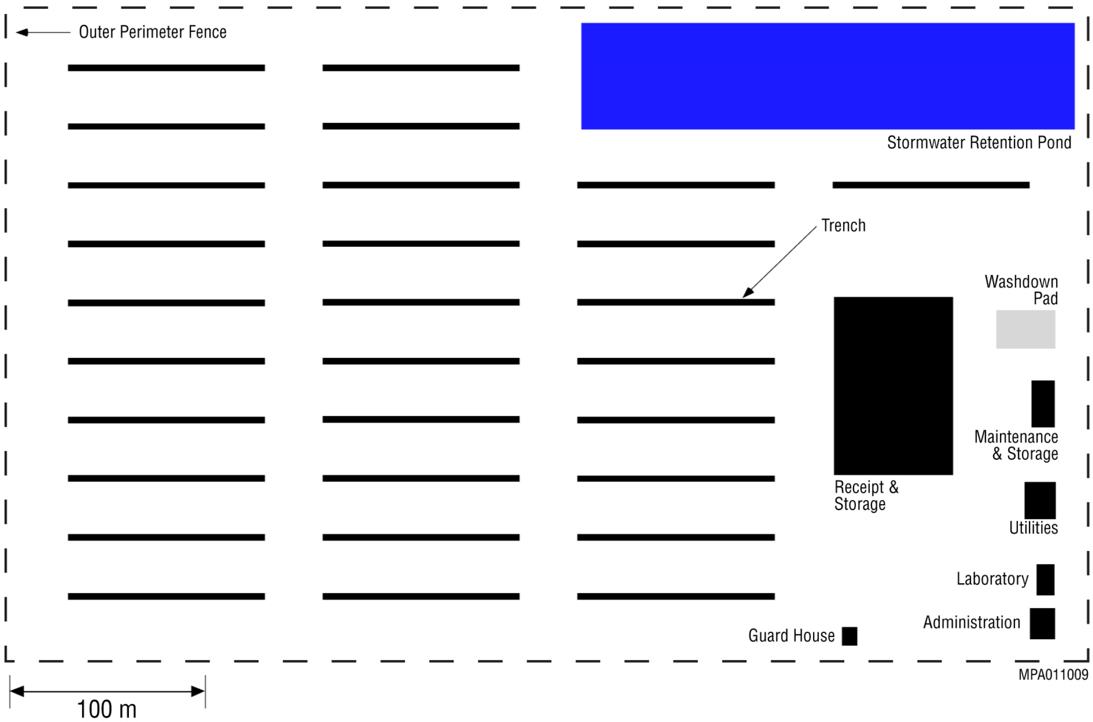


FIGURE S-12 Layout of a Conceptual Trench Facility

would be placed on top, and backfill would be added to the surface level. The additional concrete layer would provide additional shielding during the operational period, and at some sites where the material through which drilling would be done is typically soft (e.g., sand or clay), the layer could deter inadvertent drilling into the buried waste during the post-closure period. Measures would be included in the designs of the facilities to reduce the likelihood for future inadvertent human intrusion. In addition to the concrete cover noted above, the conceptual design for the trench is deeper and narrower than conventional near-surface LLRW disposal facilities to minimize this potential intrusion during the post-closure period. Additional intruder barriers would also be adopted for those sites in hard rock settings. Protecting against an inadvertent human intruder would be a key feature of the final facility design.

S.2.5.5 Alternative 5: Disposal in a New Above-Grade Vault Disposal Facility

Alternative 5 involves the construction, operations, and post-closure performance of a new vault disposal facility at the Hanford Site, the INL Site, LANL, NNSS, SRS, and the WIPP Vicinity. The conceptual design of the vault is shown in Figure S-13. Alternative 5 is evaluated for the generic commercial site in all four NRC regions. The conceptual design for the vault disposal employs a reinforced concrete vault constructed near grade level, with the footings and floors of the vault situated in a slight excavation just below grade.

The vault disposal facility to emplace the entire GTCC LLRW and GTCC-like waste inventory would consist of 12 vaults (each with 11 vault cells) and occupy a footprint of about 24 ha (60 ac) (see Figure S-14). This acreage would include land required for supporting

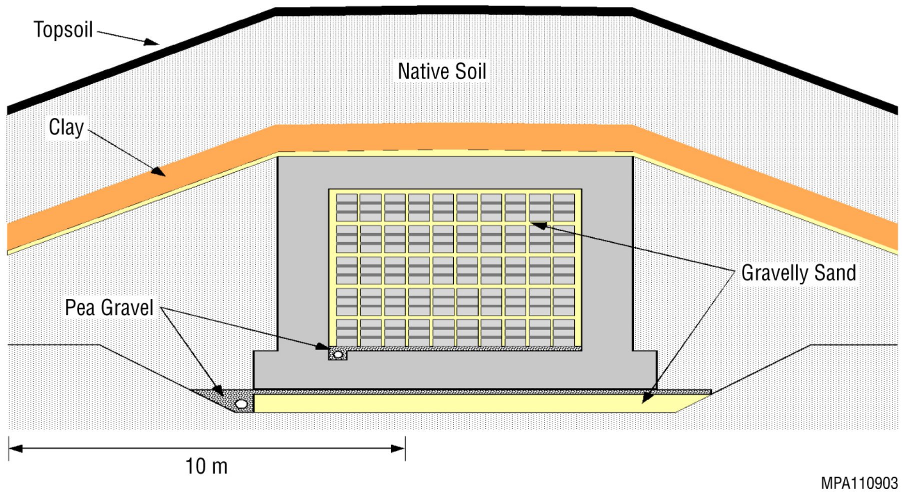


FIGURE S-13 Schematic Cross Section of the Conceptual Design for a Vault Cell

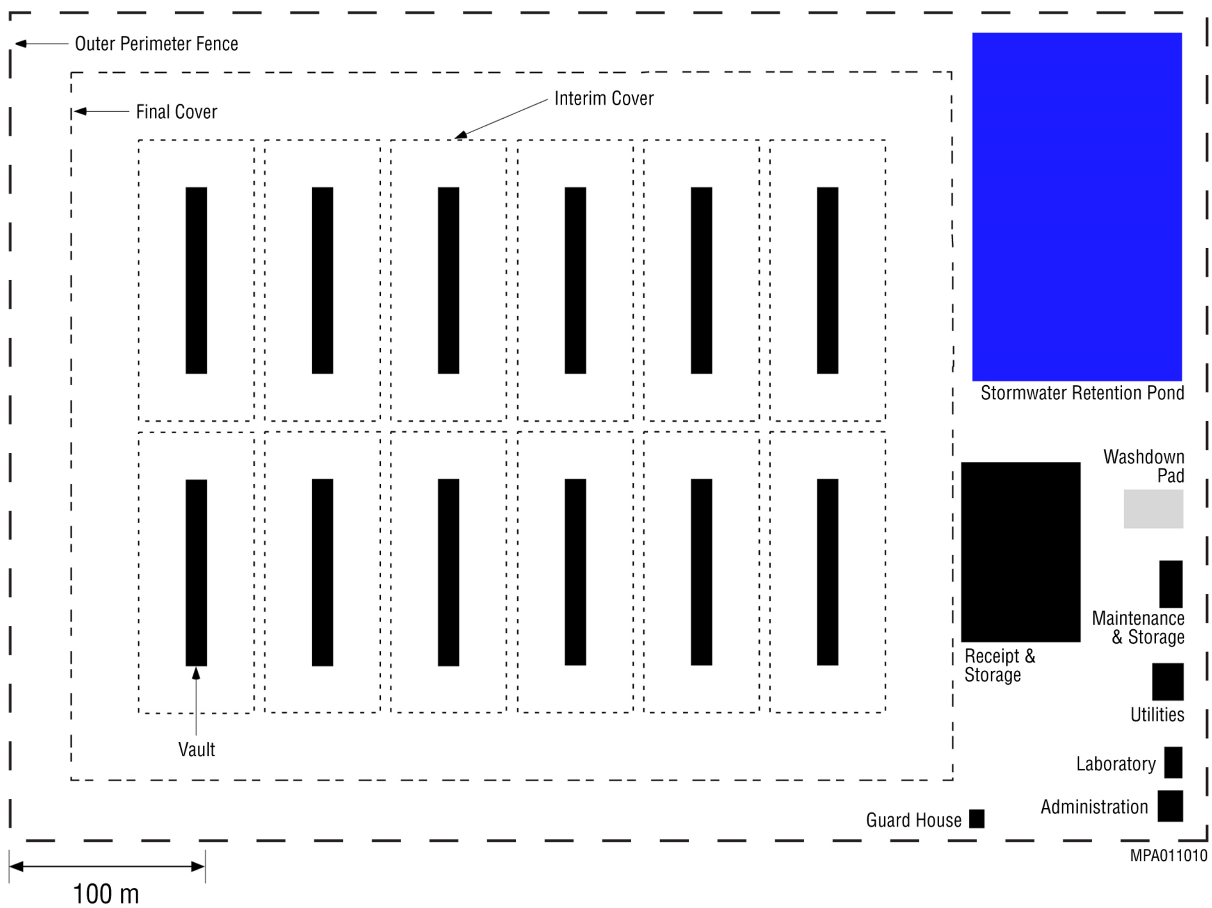


FIGURE S-14 Layout of a Conceptual Vault Disposal Facility

infrastructure, such as facilities or buildings for receiving and handling waste packages or containers, and space for a stormwater retention pond (to collect stormwater runoff and truck washdown). Each vault would be about 11-m (36-ft) wide, 94-m (310-ft) long, and 7.9-m (26-ft) tall, with 12 vaults situated in a linear array. The interior cell would be 8.2-m (27-ft) wide, 7.5-m (25-ft) long, and 5.5-m (18-ft) high, with an internal volume of 340 m^3 (12,000 ft^3) per cell. Double interior walls with an expansion joint would be included after every second cell. The thick concrete walls and earthen cover would minimize inadvertent intrusion into the vault. GTCC LLRW and GTCC-like waste disposal placement is assumed to be about 4.3 to 5.5 m (14 to 18 ft) above ground surface.

S.2.6 Which Sites Are Evaluated for a GTCC LLRW and GTCC-Like Waste Disposal Facility?

For deep geologic disposal, DOE evaluated WIPP in New Mexico because of its characteristics as a geologic repository. For the borehole method, DOE evaluated reference locations at five federally owned sites: Hanford Site, INL, LANL, NNSS, and the WIPP Vicinity. For the trench, and vault disposal methods, DOE evaluated reference locations at six federally owned sites: Hanford Site, INL, LANL, NNSS, SRS, and the WIPP Vicinity. In addition, the three land disposal methods were evaluated for generic commercial sites in the four regions that make up the United States (coinciding with NRC's four regions), as shown in Figure S-3. The evaluations of the reference locations are intended to serve as a starting point for each of the sites being considered, and if a site was selected for possible implementation of any of the three land disposal methods, follow-on-site-specific NEPA evaluation and documentation, as appropriate, along with further optimization by a selection study, would be conducted to identify the location or locations within a given site that would be considered the best ones to accommodate a borehole, trench, or vault disposal facility.

S.2.6.1 Waste Isolation Pilot Plant (WIPP)

WIPP is a DOE facility and is the first deep underground geologic repository in the United States. It is permitted by the EPA and the State of New Mexico to safely and permanently dispose of defense-generated TRU waste (WIPP LWA as amended [P.L. 102-579 as amended by P.L. 104-201]). The facility began disposal operations in 1999. WIPP is located 42 km (26 mi) east of Carlsbad, New Mexico, in the Chihuahuan Desert in the southeast corner of the state (see Figure S-15). The WIPP facility sits in the approximate center of a 41-km^2 (16-mi^2) area that was withdrawn from public domain and transferred to DOE (see Figure S-16). Project facilities include disposal rooms that are mined 655 m (2,150 ft) under the ground in a salt formation (the Salado Formation) that is 610-m (2,000-ft) thick and has been stable for more than 200 million years.

The facility footprint itself encompasses 14 fenced ha (35 fenced ac) of surface space and about 12 km (7.5 mi) of underground excavations in the Salado Formation. There are four shafts to the underground: the waste shaft, salt handling shaft, air intake shaft, and exhaust shaft (see Figure S-8). There are several miles of paved and unpaved roads in and around the WIPP site, and an 18-km-long (11-mi-long) access road runs north from the site to U.S. Highway 62-180.

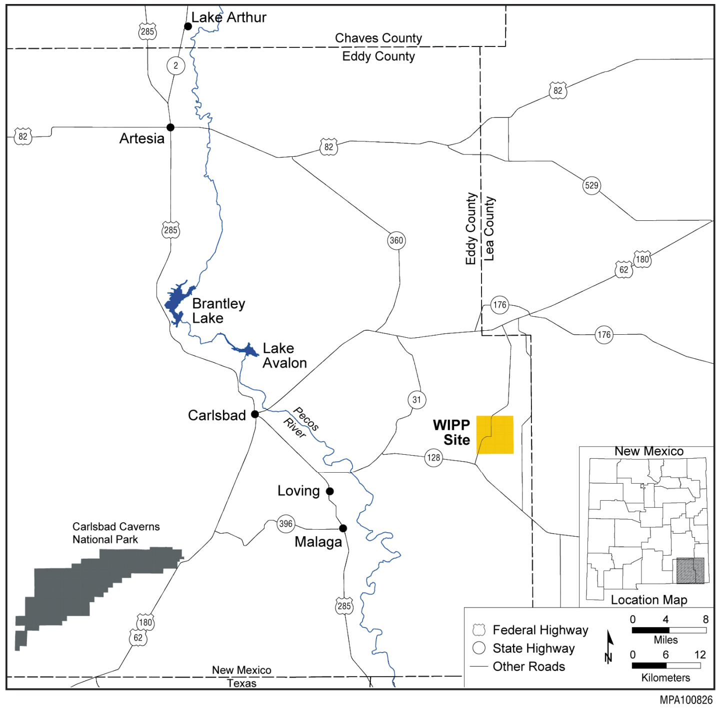


FIGURE S-15 General Location of WIPP in Eddy County, New Mexico

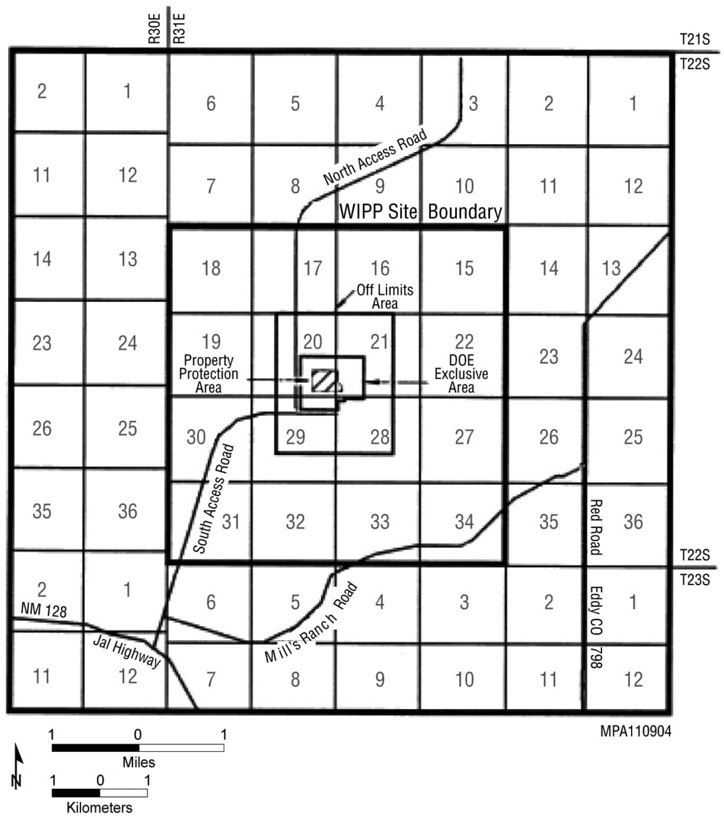


FIGURE S-16 Land Withdrawal Area Boundary at WIPP

The access road that is used to bring TRU waste shipments to WIPP is a wide, two-lane road with paved shoulders.

S.2.6.2 Hanford Site

The GTCC reference location at the Hanford Site is south of the 200 East Area in the central portion of the Hanford Site (Figure S-17). The 200 East and West Areas are located on a plateau about 11 and 8 km (7 and 5 mi), respectively, south of the Columbia River. Historically, these areas have been dedicated to fuel reprocessing and to waste management and disposal activities.

Current waste management activities at the Hanford Site include the treatment and disposal of LLRW on-site, the processing and certification of TRU waste pending its disposal at WIPP, and the storage of high-level radioactive waste on-site pending treatment and ultimate disposal. DOE will continue to defer the importation of off-site waste at Hanford, at least until the Waste Treatment Plant (WTP) is operational, subject to appropriate NEPA review and consistent with its previous preferred alternative for waste management (74 FR 67189). The limitations and exemptions defined in DOE's January 6, 2006, Settlement Agreement with the State of Washington (as amended on June 5, 2008) regarding *State of Washington v. Bodman* (Civil No. 2:03-cv-05018-AAM), signed by DOE, the State of Washington Department of Ecology, the Washington State Attorney General's Office, and the U.S. Department of Justice, will remain in place. The main areas where waste management activities occur are the 200 West Area and the 200 East Area. These 200 Areas cover about 16 km^2 (6 mi^2). Activities at the 200 Areas include the operation of lined trenches for the disposal of LLRW and mixed LLRW and the operation of the Environmental Restoration Disposal Facility for the disposal of LLRW generated by environmental restoration activities that are being conducted at the Hanford Site to comply with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). DOE will dispose of LLW and MLLW at the Integrated Disposal Facility from the tank treatment operations, WTP and effluent treatment operations, on-site non-CERCLA sources, Fast Flux Test Facility decommissioning and onsite waste management (74 FR 67189). U.S. Ecology, Inc., operates a commercial LLRW disposal facility on a 40-ha (100-ac) site leased by the State of Washington near the 200 East Area. The facility is licensed by the State of Washington.

S.2.6.3 Idaho National Laboratory (INL) Site

The GTCC reference location at the INL Site, which is southwest of the Advanced Test Reactor Complex in the south central portion of the INL Site (Figure S-18), serves as a basis for evaluation. If the INL Site is selected, the final location for a GTCC land disposal facility will be based on further analysis. The Advanced Test Reactor is dedicated to research supporting DOE missions, including nuclear technology research. The Remote-Handled Low-Level Waste Environmental Assessment (RH LLW EA; INL 2011) identified its preferred site to be one that is located to the southwest of the ATR Complex in the same area as the GTCC reference location. The GTCC site, if sited at the INL Site, would not be expected to affect the preferred site selected by the RH LLW EA.

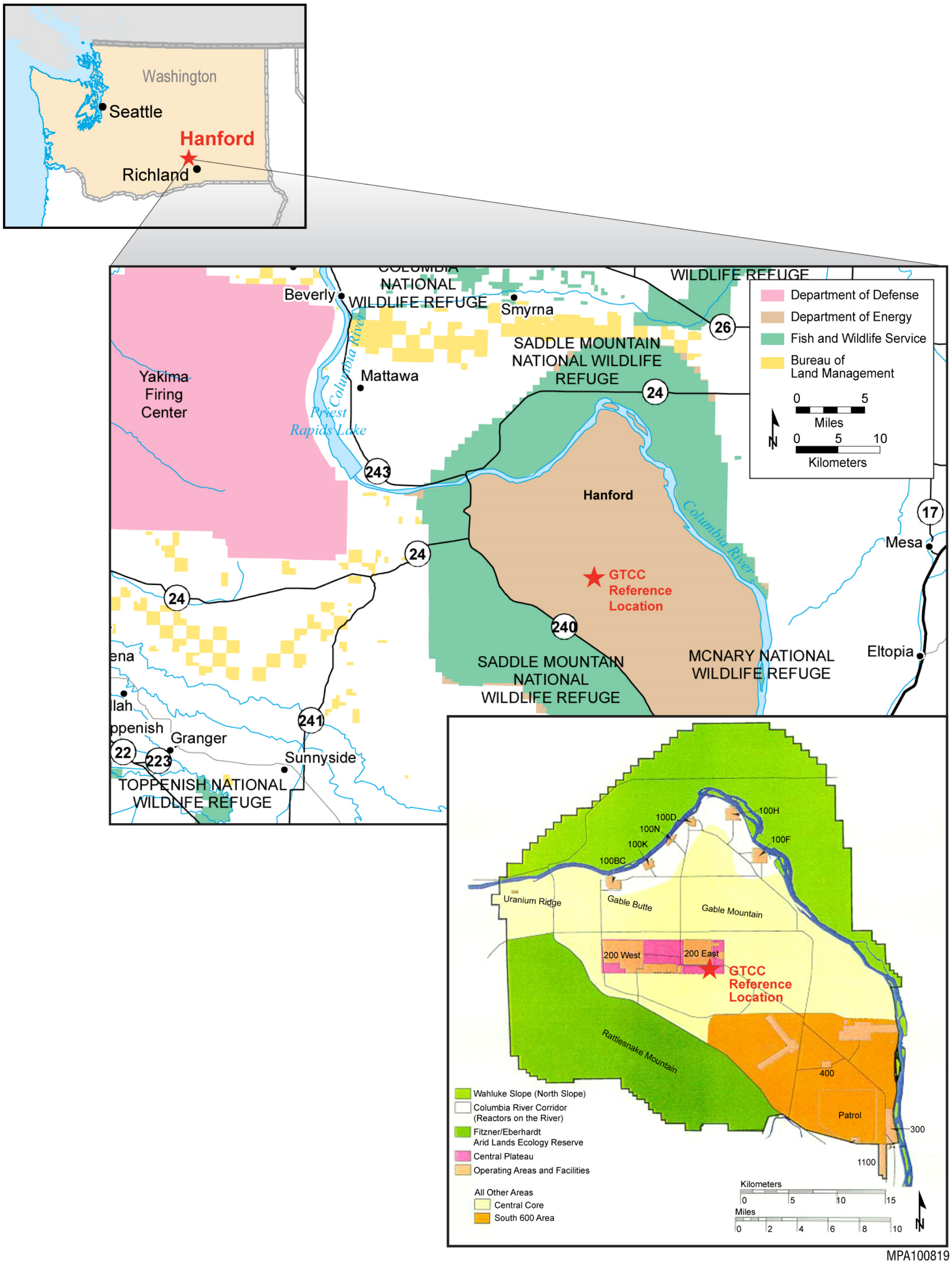


FIGURE S-17 GTCC Reference Location at the Hanford Site

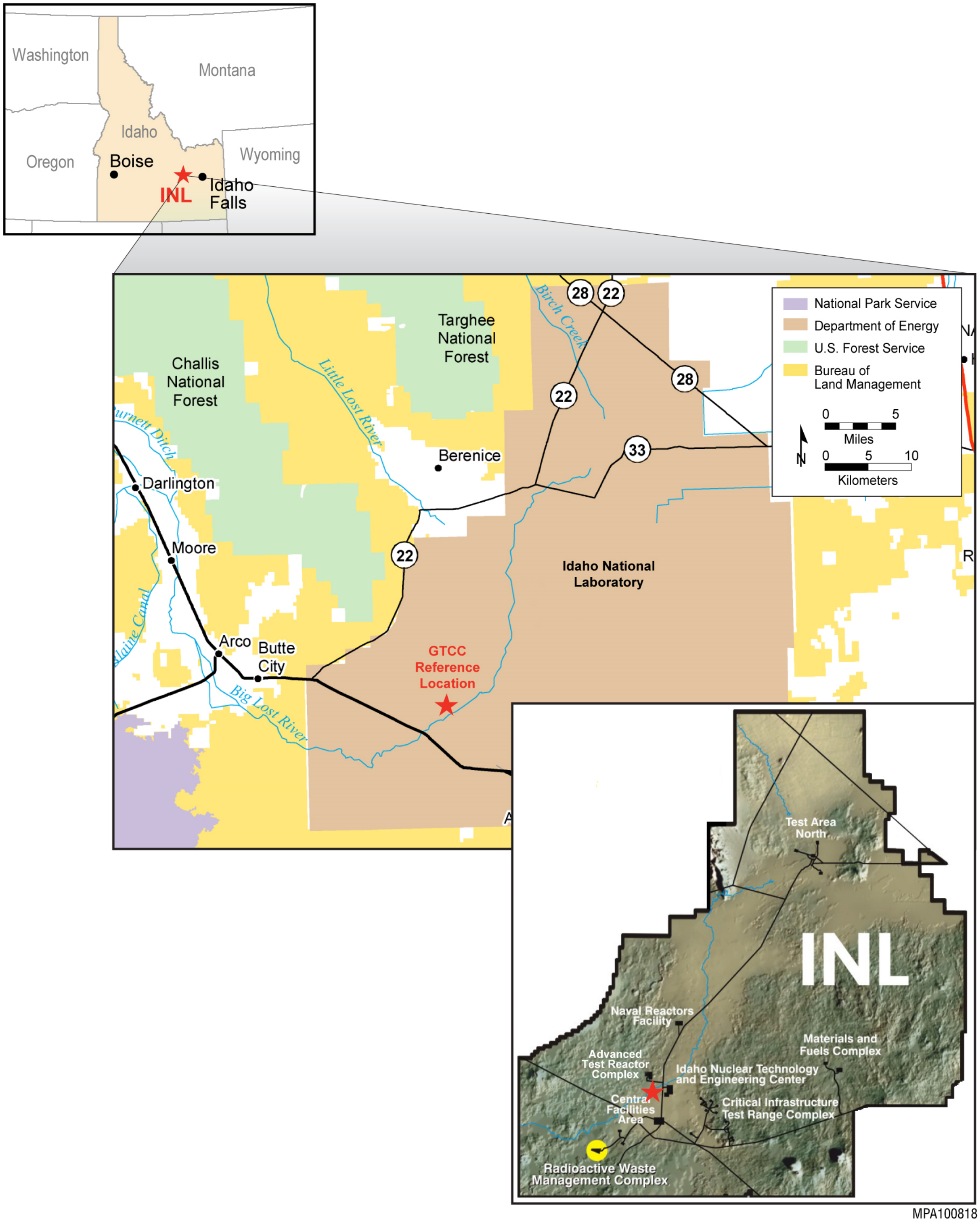


FIGURE S-18 GTCC Reference Location at the INL Site

Current waste management activities at the INL Site include the treatment and storage of mixed LLRW on-site, the treatment of LLRW on-site and its disposal on-site or off-site in DOE or commercial facilities, the storage of TRU waste on-site and its preparation for and shipment to WIPP, and the storage of high-level radioactive waste and spent nuclear fuel on-site pending the disposal of these last two materials. These wastes originate from DOE activities and from the on-site Naval Reactors Program. LLRW (RH waste) from INL Site operations is disposed of at the Subsurface Disposal Area at the Radioactive Waste Management Complex. CH LLRW is sent off-site. TRU waste is also stored and treated at the Radioactive Waste Management Complex and Idaho Nuclear Technology and Engineering Center to prepare it for disposal at WIPP.

S.2.6.4 Los Alamos National Laboratory (LANL)

The GTCC reference location at LANL is situated in three undeveloped and relatively undisturbed areas within Technical Area (TA)-51 and TA-54 on Mesita del Buey: Zone 6, North Site, and North Site Expanded (Figure S-19). Zone 6 is slightly less than 7 ha (17 ac) in area. It is not fenced, but access by road is controlled by a gate. The total area of the North Site is about 16 ha (39 ac). The North Site Expanded section adds another 23 ha (57 ac). The primary function of TA-54 is the management of radioactive and hazardous chemical wastes. Its northern border coincides with the boundary between LANL and the Pueblo de San Ildefonso; its southeastern boundary borders the community of White Rock. A subsurface volatile organic compound (VOC) vapor plume is present in the vadose zone at the Material Disposal Area L within TA-54. The primary source of these subsurface VOC vapors are the two shaft fields at Material Disposal Area L.

Current waste management activities at LANL include the storage of mixed LLRW, the disposal of LLRW on-site, the storage of TRU waste on-site, and the storage of sealed sources recovered by the Office of Global Material Security/Off-Site Source Recovery Project (GMS/OSRP) for national security or public health and safety reasons pending disposal. Area G at TA-54 currently accepts on-site LLRW for disposal; also, in special cases, off-site waste has been accepted from other DOE sites for disposal. Engineered shafts are actively used to dispose of RH LLRW.

Since 1989, DOE has funded the Environmental Program at LANL to complete the cleanup of the environmental legacy contamination brought about from seven decades of nuclear weapons development and management, as well as government-sponsored nuclear science and energy research.[3] Groundwater sampling data from monitoring wells at LANL indicate the presence of chromium groundwater contamination beneath Mortandad Canyon near the property boundary between LANL and the Pueblo de San Ildefonso. This chromium contamination is a result of historical use of potassium dichromate – a corrosion inhibitor – in non-nuclear cooling-tower water that was discharged to an outfall as part of LANL operational maintenance

[3] Legacy contamination is generally defined as the contamination of the environment resulting from pre-1999 Los Alamos National Laboratory activities and waste-management practices within DOE's environmental management scope.

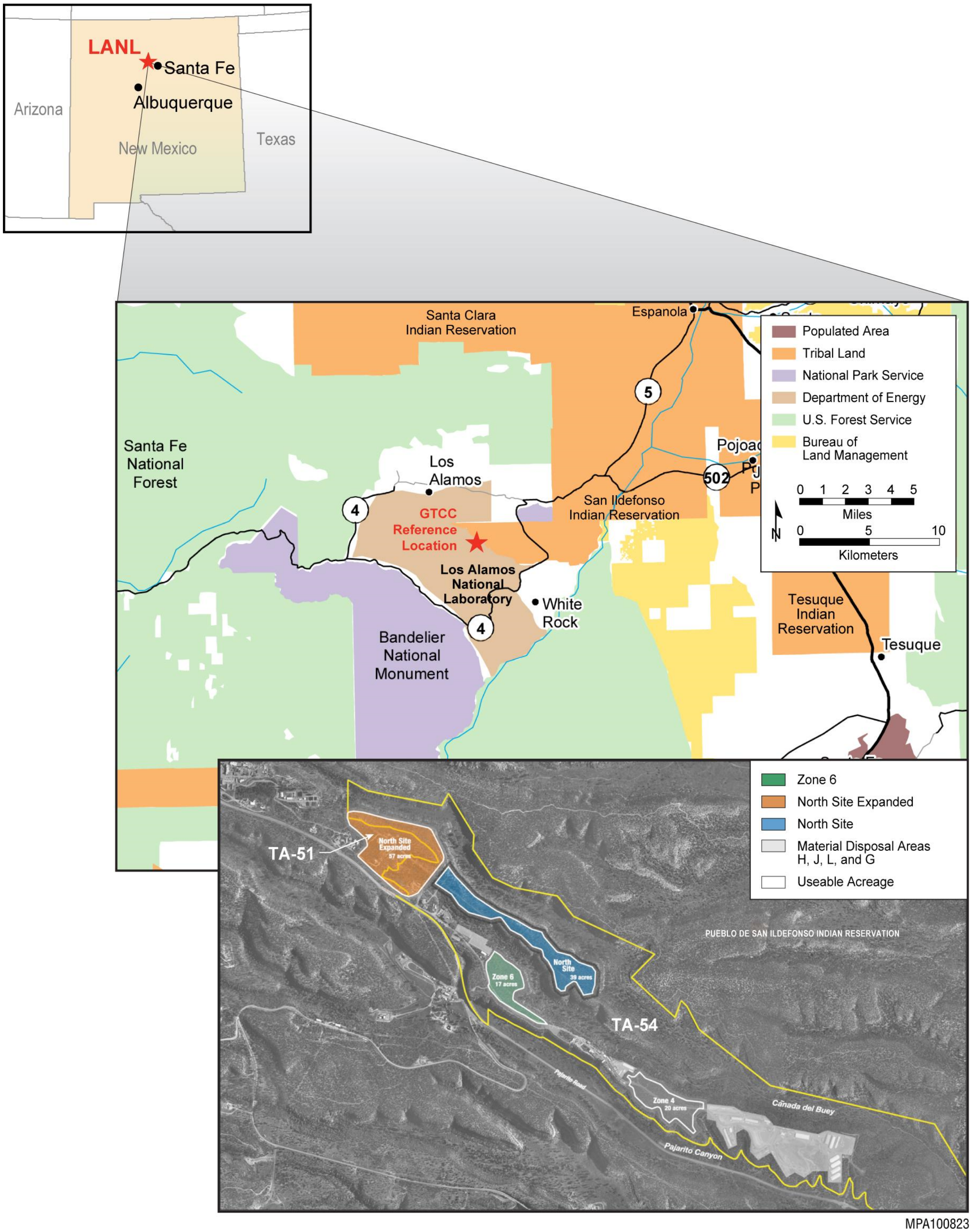


FIGURE S-19 GTCC Reference Location at LANL

activities. DOE evaluated a proposed interim measure that would control migration of the chromium groundwater contamination plume off LANL lands and the feasibility of long-term corrective actions intended to remediate the chromium plume in an environmental assessment (DOE/EA-2005).[4]

S.2.6.5 Nevada National Security Site (NNSS)

The GTCC reference location for NNSS is identified within Area 5 and serves as a basis for evaluation (Figure S-20). Area 5 is one of two areas (the second is Area 3) at NNSS that support the site's radioactive waste management program. Area 5 is located in the southeastern section of NNSS in Frenchman Flat. If NNSS is selected, the final location for a GTCC disposal facility will be based on further analysis. NNSS presently serves as a disposal site for LLRW and mixed LLRW generated by DOE facilities. It is also an interim storage site for a limited amount of newly generated TRU mixed wastes pending transfer to WIPP for disposal. From 1984 through 1989, boreholes (at depths of 21 to 37 m [70 to 120 ft]) were used at the Area 5 Radioactive Waste Management Site to dispose of higher-activity LLRW and TRU waste.

S.2.6.6 Savannah River Site (SRS)

The GTCC reference location is situated on an upland ridge within the Tinker Creek drainage, about 3.2 km (2 mi) to the northeast of Z-Area in the north-central portion of SRS (Figure S-21). The area is not currently being used for waste management.

SRS currently manages high-level waste, TRU waste, LLRW, and mixed LLRW. High-level waste is vitrified at the Defense Waste Processing Facility and stored on-site pending disposal. TRU waste is stored, prepared for shipment, and shipped to WIPP for disposal. LLRW is treated and disposed of on-site, or it is prepared for shipment to be disposed of at other DOE sites (e.g., NNSS) or commercial facilities. On-site facilities for LLRW disposal include engineered trenches and vaults.

S.2.6.7 WIPP Vicinity

WIPP Vicinity refers to Township 22 South, Range 31 East, Sections 27 and 35, with each section containing a total of 260 ha (640 ac) or 2.6 km^2 (1 mi^2). Only a portion of Section 27 or Section 35, if selected, would be needed to accommodate a new GTCC LLRW and GTCC-like waste disposal facility. Section 27 is within the WIPP Land Withdrawal Boundary (LWB), while Section 35 is just outside the WIPP LWB to the southeast (Figure S-22). Section 27 is administered by DOE, and Section 35 is administered by the Bureau of Land Management in the U.S. Department of the Interior. WIPP is located in Eddy County in southeastern New Mexico, about 42 km (26 mi) east of the city of Carlsbad. The land is a

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[4] *Final Environmental Assessment for Chromium Plume Control Interim Measure and Plume-Center Characterization, Los Alamos National Laboratory, Los Alamos, New Mexico* (December 2015). http://energy.gov/nepa/ea-2005-chromium-plume-control-interim-measure-and-plume-center-characterization-los-alamos.

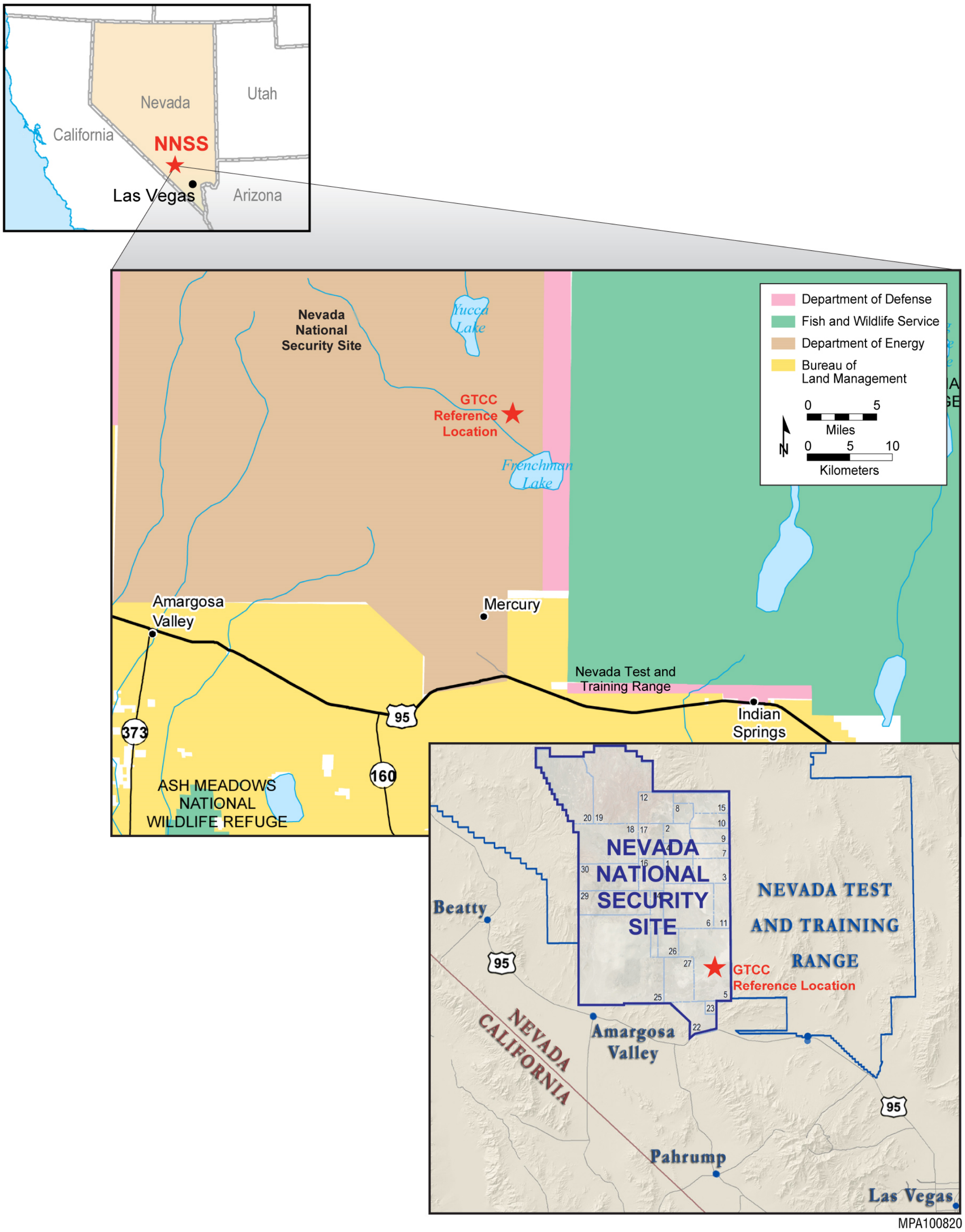

FIGURE S-20 GTCC Reference Location at NNSS

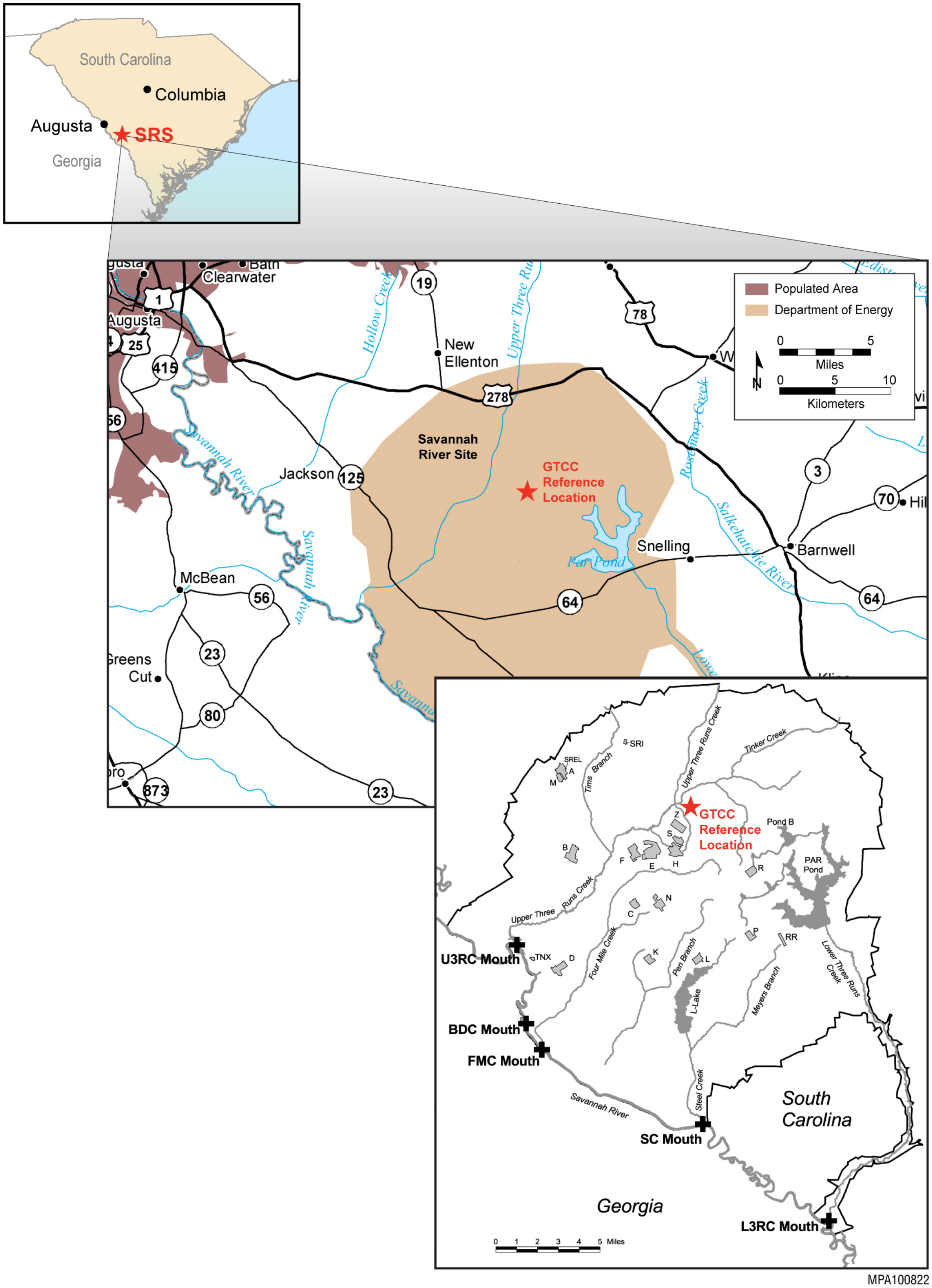

FIGURE S-21 GTCC Reference Location at SRS

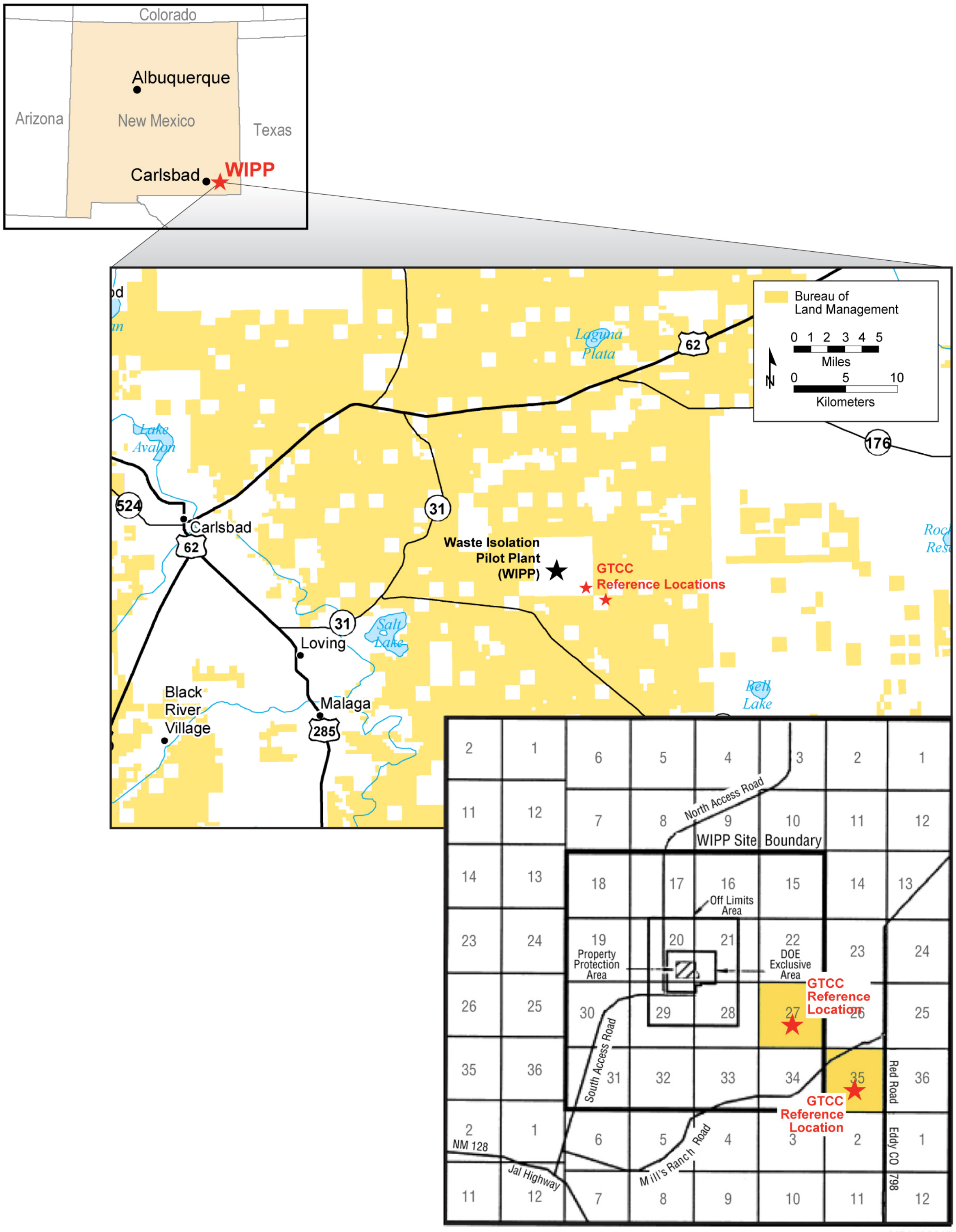

FIGURE S-22 GTCC Reference Locations (Sections 27 and 35) at the WIPP Vicinity relatively flat, sparsely inhabited area (about 118,556 people in an 80-km [50-mi] radius, according to the 2010 census), known as Los Medaños (Spanish for “the dunes”).

There are no potash or oil and gas leases on Section 27 since it is part of the land that has been withdrawn. Section 35 contains oil and gas leases. Currently, no waste management activities are being conducted at Section 27 or Section 35.

S.2.6.8 Generic Regional Commercial Disposal Sites

In the absence of specific commercial sites, DOE evaluated generic commercial facilities in the EIS to allow DOE to make a determination regarding disposal of GTCC LLRW and GTCC-like waste in such a facility. DOE solicited technical capability statements from commercial vendors that might be interested in constructing and operating a GTCC LLRW and GTCC-like waste disposal facility in a request for information in the *FedBizOpps* on July 1, 2005. Although at the time, several commercial vendors expressed an interest, no vendors provided specific information on disposal locations and methods for analysis in the EIS. On June 20, 2014 Waste Control Specialists, LLC, (WCS), filed (and resubmitted on July 21, 2014) a Petition for Rulemaking with the Texas Commission on Environmental Quality (TCEQ) requesting the State of Texas to revise certain provisions of the Texas Administrative Code to remove prohibitions on disposal of GTCC LLRW, GTCC-like waste and TRU waste at its TCEQ licensed facilities. On January 30, 2015, TCEQ sent a letter to the NRC requesting guidance on the State of Texas’s authority to license disposal of GTCC LLRW, GTCC-like waste and TRU waste. This matter is under review by NRC.

Should DOE identify a specific commercial facility or facilities for the disposal of GTCC LLRW and GTCC-like waste, DOE would conduct site-specific NEPA reviews, as appropriate. The generic commercial sites are evaluated in the GTCC EIS on the basis of a regional approach that divides the United States into four regions consistent with the designations of Regions I through IV of the NRC. The states that make up each of these four regions are shown in Figure S-3. Region I comprises the 11 states in the northeast; Region II comprises the 10 states in the southeast; Region III comprises the 7 states in the Midwest; and Region IV comprises the remaining 22 states in the western part of the country.

Current commercially operated LLRW disposal facilities for non-GTCC LLRW are located in Region II (a facility in Barnwell, South Carolina, which receives Class A, B, and C waste) and Region IV (facilities in Richland, Washington, and in Clive, Utah, which receive Class A, B, and C wastes and Class A waste, respectively). Another disposal facility (located in Region IV in Andrews County, Texas) has been licensed and is now operating and available to dispose of Class A, B, and C wastes. The federal sites evaluated in the EIS are also located within these same two regions.

S.2.7 Alternatives Considered but Not Evaluated in Detail

DOE identified the alternatives for detailed analysis in the EIS on the basis of the rationale provided in the Notice of Intent (NOI) for the GTCC EIS (72 FR 40135). Several comments received during the scoping process indicated that DOE should include alternatives in addition to those identified in the NOI. However, none of the suggested alternatives were determined to be a reasonable alternative.

In the NOI for the GTCC EIS, DOE identified co-disposal of the GTCC LLRW and GTCC-like waste at the then-proposed Yucca Mountain repository as one alternative to be considered; however, DOE did not include this as an alternative in the GTCC EIS because since publication of the NOI, the Secretary of Energy determined that developing a permanent repository for high-level waste and spent nuclear fuel at Yucca Mountain, Nevada, is not a workable option, and the repository will not be developed. Therefore, DOE concluded that co-disposal at a Yucca Mountain repository is not a reasonable alternative and has eliminated it from evaluation in this EIS.

DOE did not evaluate developing a geologic repository exclusively for disposal of GTCC LLRW and GTCC-like wastes because DOE determined that such an alternative is not reasonable due to the time and cost associated with siting a deep geologic repository and the relatively small volume of GTCC LLRW and GTCC-like wastes identified in the GTCC EIS. The results presented in this EIS for the WIPP geologic repository alternative are indicative of the high degree of waste isolation that would be provided by disposal in a geologic repository.

In addition, the NOI for the GTCC EIS also identified ORR as a site to be evaluated for potential disposal of GTCC LLRW and GTCC-like waste by using a land disposal method because of its ongoing waste disposal mission. Based on internal reviews conducted by the Low-Level Waste Disposal Facility Federal Review Group, DOE determined that the site is not appropriate for disposal of LLRW containing high concentrations of long-lived radionuclides (such as those found in GTCC LLRW and GTCC-like waste), especially those with high mobility in the subsurface environment. For this reason, DOE concluded that ORR is not a reasonable disposal site alternative and eliminated it from detailed evaluation in this EIS.

S.2.8 Which Resource Areas Are Analyzed in the EIS?

DOE evaluated each alternative for its potential consequences on the following 11 environmental resource areas, as shown in Figure S-23:

- Climate, air quality, and noise,
- Geology and soils,
- Water resources,
- Human health,
- Ecology,
- Socioeconomics,
- Environmental justice,
- Land use,
- Transportation,
- Cultural resources, and
- Waste management.

In addition to the above resource areas, DOE evaluated inadvertent human intrusion and cumulative impacts to address the impacts that could result from implementation of the proposed GTCC action at each site in combination with past, present, and future planned activities (including federal and nonfederal activities) at or in the vicinity of that site.

S.3 SUMMARY AND COMPARISON OF POTENTIAL ENVIRONMENTAL IMPACTS

DOE has evaluated the resource areas shown in Figure S-23 for each of the alternatives in the GTCC EIS for disposal of the entire inventory of GTCC LLRW and GTCC-like waste. The resource areas are evaluated for the construction, operations, and post-closure phases of the proposed action. The decommissioning of the disposal facility is also part of the proposed action, but because the facility would not be closed and properly decommissioned until some time in the far future (decades), the impact analysis for the decommissioning phase would be conducted at that time. These evaluation results are presented in Table S-3. This table presents a comparison of the potential impacts of the five alternatives on the resource areas shown in Figure S-23.

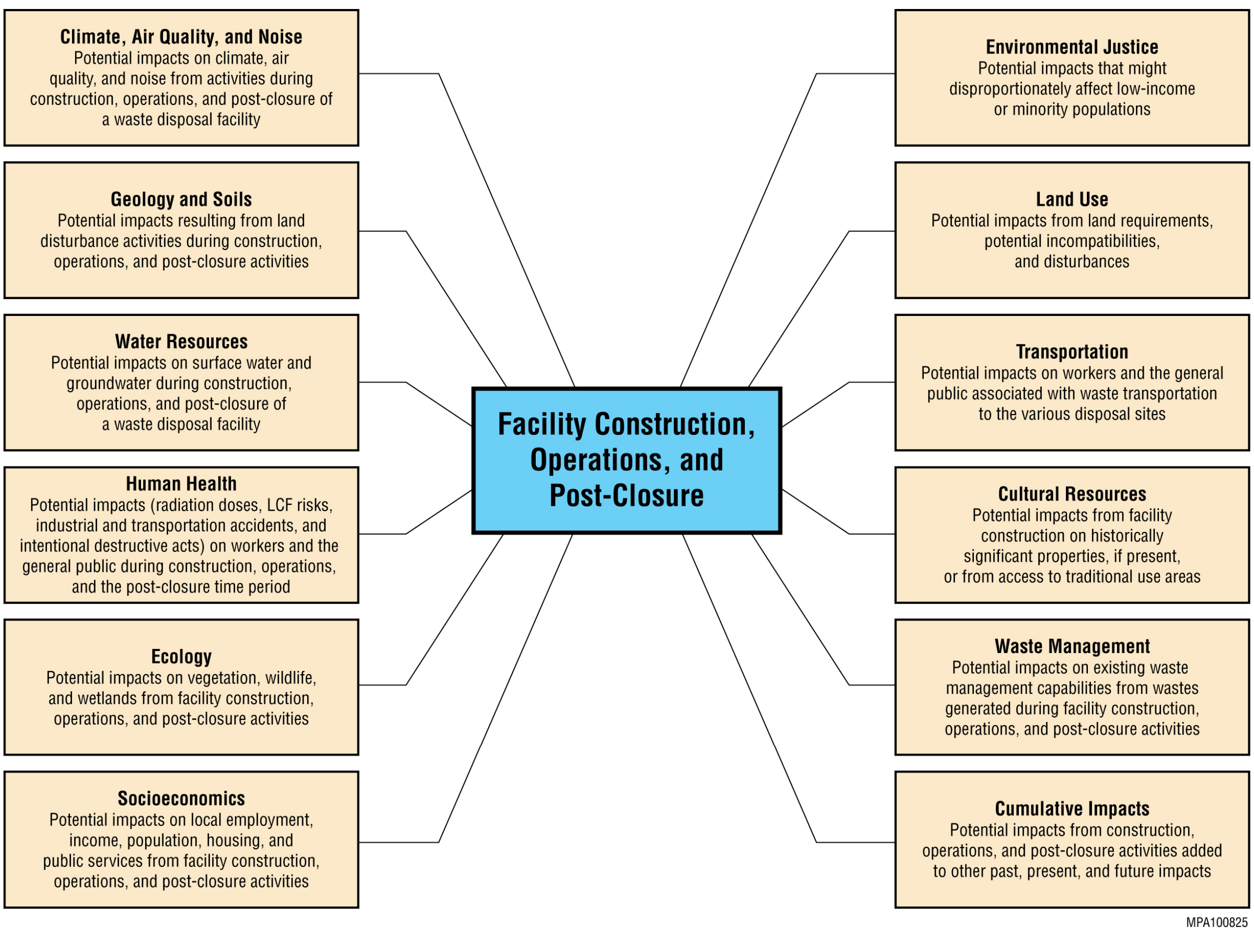

FIGURE S-23 Environmental Resource Areas on Which the Impacts of the Alternatives Are Evaluated

TABLE S-3 Comparison of Potential Impacts

	Alternative				
Resource Area	Alternative 1 No Action	Alternative 2 WIPP Geologic Repository	Alternative 3 Borehole	Alternative 4 Trench	Alternative 5 Vault
Climate, Air Quality, and Noise	No incremental impacts due to construction activities for a disposal facility are expected because none would be undertaken. It is assumed that the current facility operations in the storage sites would continue and result in minimal impacts.	Impacts would be low because most construction and operational activities would occur below ground. Emissions associated with Alternative 2 are lower than those for Alternatives 3 to 5.	Construction and operational activities would be within the boundaries of all the sites evaluated, and these activities would contribute little to concentrations of airborne pollutants or noise at or beyond the site boundaries. For most sites, during the construction phase, peak annual emissions associated with the borehole method would be between those associated with the trench and vault methods, with the vault method resulting in the highest relative emissions and the trench method having the lowest of the three methods. Construction related emissions from all three disposal methods would generally add 1% or less to emissions in the nearby areas surrounding the various sites (the exception would be at NNSS where SO_2 and NO_x emissions could add about 3%). Peak annual emissions from the operation of a borehole, trench, and vault facility at the various sites would be lower than those for the peak annual construction phase. Emissions of greenhouse gases are expected to be low and not result in significant climate change concerns. Noise levels at a distance of 690 m (2,300 ft) from the source would be below the EPA guideline of 55 dBA or decibels for all the sites evaluated. This distance is smaller than the distance between the GTCC reference locations and the respective nearest off-site residences. Estimated distances of the GTCC reference locations from the respective nearest known off-site residences are as follows: >6 km (4 mi) at the Hanford Site; >11 km (7 mi) at the INL Site; about 3.5 km (2.2 mi) at LANL (nearest residence in White Rock); >6 km (4 mi) at NNSS; >14 km (9 mi) at SRS; and >5 km (3 mi) at the WIPP Vicinity.		
Geology and Soils	No incremental impacts due to construction activities for a disposal facility are expected because none would be undertaken. It is assumed that the current facility operations in the storage sites would continue and result in minimal impacts.	No incremental impacts are expected because construction, operational, and post-closure activities would not involve additional land disturbance.	Impacts would be proportional to the total land area affected. The borehole method would disturb the most land, followed by the trench and vault methods. No adverse impacts are expected, and no significant changes to surface topography would occur. The potential for erosion would be lower at the five western sites evaluated (Hanford Site, INL Site, LANL, NNSS, and WIPP Vicinity) than at the eastern site (SRS) because of the low precipitation rates at the western sites.		

TABLE S-3 (Cont.)

Resource Area	Alternative: Alternative 1 No Action	Alternative 2 WIPP Geologic Repository	Alternative 3 Borehole	Alternative 4 Trench	Alternative 5 Vault
Water Resources	No incremental impacts due to construction activities for a disposal facility are expected because none would be undertaken. It is assumed that the facility operations in the storage sites would continue and result in minimal impacts.	Incremental impacts would be minor when added to those associated with operations at WIPP.	Impacts on water resources would generally be small at all sites evaluated. The increase in water use is less than 1% of the current annual use as capacity at the sites evaluated. Impacts on surface water and groundwater resources from surficial spills would be expected to be low. Water consumption associated with the borehole method during construction would be about 530,000 L/yr (140,000 gal/yr), which is the smallest amount associated with the three land disposal methods. The corresponding values for the trench and vault methods are 1,000,000 L/yr (270,000 gal/yr) and 3,300,000 L/yr (860,000 gal/yr), respectively. The initial construction period was assumed to be about 3.4 years for all three land disposal methods. The amount of potable and raw water consumed during the operational phase of the borehole method would also be the smallest of the three disposal methods; it would be about 2,500,000 L/yr (650,000 gal/yr). A total of 5,300,000 L/yr (1,400,000 gal/yr) would be required for operating either the trench or the vault method.		
Human Health Annual Collective Worker Dose[a]	Human health impacts from waste storage activities would be low. The annual occupational dose from these activities is estimated to be 4 person-rem, which corresponds to an annual LCF risk of 0.002.	The annual collective worker dose at WIPP is estimated to be 0.29 person-rem, which corresponds to an annual LCF risk of 0.0002. No fatalities and 3 lost workdays per year could occur due to occupational injuries.	The annual collective worker dose estimates for the disposal facility would be the same for all the sites evaluated because the same number of workers are assumed; the dose estimates, however, vary by disposal method. The annual collective worker doses are estimated to be 2.6 person-rem for the borehole method, 4.6 person-rem for the trench method, and 5.2 person-rem for the vault method. These doses correspond to annual LCF risks of 0.002, 0.003, and 0.003, respectively. No fatalities are expected to occur during waste disposal operations, and the number of lost workdays per year due to occupational injuries would range from 1 to 2 for the three alternatives, with the borehole method having the lowest number and the vault method having the highest number.		

TABLE S-3 (Cont.)

Resource Area	Alternative Alternative 1 No Action	Alternative 2 WIPP Geologic Repository	Alternative 3 Borehole	Alternative 4 Trench	Alternative 5 Vault
Human Health (Cont.) Maximum Long-Term Impacts	The estimated maximum long-term human health impacts could range up to 470 rem/yr, which corresponds to an annual LCF risk of 0.3.	Both the annual dose and LCF risk would be zero because there would be no releases to the accessible environment and therefore no radiation doses and LCF risks during the first 10,000 years following closure of the WIPP repository. This is noted in Section 5.1.12.1 of the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* issued in 1997 (DOE/EIS-0026-S-2).	The estimated maximum long-term human health impacts for the borehole method range from 0 mrem/yr (NNSS, WIPP Vicinity, and generic commercial Region IV) to 820 mrem/yr (INL Site). These doses correspond to an annual LCF risk of 0 to 0.0005. For the trench method, the estimates range from 0 mrem/yr (NNSS, WIPP Vicinity, and generic commercial Region IV) to 2,100 mrem/yr (INL Site), with a corresponding annual LCF risk of 0 to 0.001. For the vault method, the estimates range from 0 mrem/yr (NNSS, WIPP Vicinity, and generic commercial Region IV) to 2,300 mrem/yr (INL Site), with a corresponding annual LCF risk of 0 to 0.001. The estimates for the vault method are generally highest, followed by the trench and then the borehole methods. Table S-4 presents a tabulation of the estimates for long-term human health impacts.		
Human Health (Cont.) Waste Handling Accident to an Individual	The impacts from a waste handling accident to an individual from storage activities were not analyzed; storage practices are assumed to follow applicable requirements.	The impacts from a waste handling accident to an individual from current storage activities were not re-analyzed in this EIS as analysis was performed in Chapter 5 of "The WIPP Disposal Phase Final Supplement EIS (EIS-0026-S-2, September 1997); the accident analysis in the EIS has been reviewed by EM and is still representative and bounding. It is expected that the dose and LCF risk to an individual from this accident would be similar to those estimated for disposal at the WIPP Vicinity (i.e., highest individual dose of 7.5 rem with corresponding LCF risk of 0.005).	For the borehole, trench, and vault methods, the highest individual dose and LCF risk from a waste handling accident is for an individual assumed to be located 100 m (330 ft) from a fire involving an SWB. This individual is expected to be a noninvolved worker. While the estimates for all the sites evaluated are fairly comparable, they vary from site to site, depending on local meteorology and the assumed location of the nearest individual. The estimates are the same for all three methods. The estimates are as follows (the dose in rem is given first, followed by the LCF risk in parentheses): 16 (0.009) for the Hanford Site, 11 (0.007) for the INL Site, 12 (0.007) for LANL, 2.4 (0.001) for NNSS, and 7.5 (0.005) for the WIPP Vicinity. Because the calculations depend on the specific meteorology and location of the nearest individual, estimates were not performed for the generic commercial disposal facilities; however, it is expected that the impacts would be comparable to those listed above for the federal sites.		

TABLE S-3 (Cont.)

Resource Area	Alternative Alternative 1 No Action	Alternative 2 WIPP Geologic Repository	Alternative 3 Borehole	Alternative 4 Trench	Alternative 5 Vault
Human Health (Cont.) Waste Handling Accident to Nearby Population	The impacts from a waste handling accident to the nearby population from current storage activities were not analyzed. Current storage practices are assumed to follow applicable requirements.	The impacts from a waste handling accident involving a fire involving an SWB were not calculated for disposal of GTCC LLRW and GTCC-like waste at the WIPP repository; however, it is expected that the dose and LCF risk to a population from this accident would be similar to those estimated for disposal at the WIPP Vicinity (i.e., highest population dose of 7.0 person-rem with corresponding LCF risk of 0.004).	For the borehole, trench, and vault methods, the highest population dose and LCF risk from a waste handling accident is for a nearby population assumed to be located 100 m (330 ft) from a fire involving an SWB. The estimates are the same for all three methods but vary from site to site, depending on the local meteorology and assumed locations and number of the nearest population, with the highest estimate generated for LANL. The estimates are as follows (the dose in person-rem is given first, followed by the LCF risk in parentheses): 95 (0.06) for the Hanford Site, 13 (0.008) for the INL Site, 160 (0.1) for LANL, 0.47 (0.0003) for NNSS, and 7.0 (0.004) for the WIPP Vicinity. Because the calculations depend on the specific meteorology and locations and number of nearby populations, estimates were not performed for the generic commercial disposal facilities; however, it is expected that the impacts would be comparable to those listed above for the federal sites.		
Ecological Resources	No incremental impacts due to construction activities for a disposal facility are expected because none would be undertaken. It is assumed that the current facility operations in the storage sites would continue and result in minimal impacts.	Incremental impacts on habitat and wildlife would be localized and not result in adverse population-level effects.	Impacts on ecological resources would generally be small at all sites evaluated because of the relatively small amount of land affected. Impacts would be incurred by the individuals using the impacted areas, but population-level impacts are not expected. There are no federally listed or state-listed threatened or endangered species reported to be in the GTCC project areas at the INL Site or WIPP Vicinity. Construction activities could affect federal or state candidate species or species under review for federal listing at the INL Site or WIPP Vicinity. Impacts on these species would likely be small, since the area of habitat disturbance would be small relative to the overall size of such habitat in the area. Several federally listed or state-listed bird and mammal species occur within the GTCC project areas at the Hanford Site, SRS, LANL, and NNSS. Impacts on these species would likely be small, since the area of habitat disturbance would be small relative to the overall size of such habitat in the area. Adverse impacts would be minimized by conducting biological surveys in the project area and using good engineering practices to minimize impacts on the environment.		

TABLE S-3 (Cont.)

Resource Area	Alternative: Alternative 1 No Action	Alternative 2 WIPP Geologic Repository	Alternative 3 Borehole	Alternative 4 Trench	Alternative 5 Vault
Socioeconomics	No incremental impacts due to construction activities for a disposal facility are expected because none would be undertaken. It is assumed that the current facility operations in the storage sites would continue and result in minimal impacts.	Impacts would be small because all construction and waste disposal activities could be conducted by the current workforce at WIPP.	The socioeconomic impacts would be small for all three alternatives at all of the sites considered. Estimated peak construction year in-migration would range from a low of 10 (borehole method at NNSS) to a high of 127 (vault method at WIPP Vicinity), requiring less than 1% of the vacant housing in the peak year. Operations would create about 38 to 51 direct jobs and about the same number of indirect jobs, resulting in an increase of less than 0.1% in the annual employment growth rate. The income during operations would be about $4 to $5 million per year.		
Environmental Justice	No incremental impacts due to construction activities for a disposal facility are expected because none would be undertaken. It is assumed that the current facility operations in the storage sites would continue and result in minimal impacts.	There would be no incremental impacts beyond those that have already occurred on the minority and low-income populations near the site.	The construction, operations, and post-closure of the land disposal facilities are not expected to result in the potential for disproportionately high and adverse impacts on minority and low-income populations in the vicinity of the sites considered in this EIS. DOE will continue to consult with American Indian tribes and coordinate with them to ensure that their concerns are considered. Subsequent NEPA review to support any GTCC implementation would consider any unique exposure pathways (such as subsistence fish, vegetation or wildlife consumption, and well water use) to determine any additional potential health and environmental impacts.		
Land Use	No incremental impacts due to construction activities for a disposal facility are expected because none would be undertaken. It is assumed that the current facility operations in the storage sites would continue and result in minimal impacts.	No changes in land use at the WIPP site or surrounding area would occur. No additional land surface within the existing footprint of the WIPP site would be affected by the construction of the additional underground rooms at WIPP to emplace the GTCC LLRW and GTCC-like waste, except for the small increased amount of land within the existing facility boundary needed to store excavated material (salt) from the repository.	The amounts of land required for the three alternatives are 20 ha (50 ac) for the trench method, 24 ha (60 ac) for the vault method, and 44 ha (110 ac) for the borehole method. Sufficient space is available at all of the sites to allow for disposal of GTCC LLRW and GTCC-like waste in a manner compatible with ongoing nearby activities. It may be necessary to modify the current land use classification at the reference locations at SRS and the WIPP Vicinity in order to allow disposal facility construction and operational activities to occur.		

TABLE S-3 (Cont.)

Resource Area	Alternative 1 No Action	Alternative 2 WIPP Geologic Repository	Alternative 3 Borehole	Alternative 4 Trench	Alternative 5 Vault
Transportation	No transportation impacts would occur because no wastes would be shipped.	A total of 33,700 truck shipments or 11,800 rail shipments would be required to transfer the GTCC LLRW and GTCC-like waste to WIPP. This could result in 1 non-radiological fatality from rail accidents and 2 non-radiological fatalities for trucks. For truck transportation, the collective population dose is estimated to be 68 person-rem (with an LCF risk of 0.04, which includes an accident risk of 3 × 10^{-5} LCF), and the worker dose is estimated to be 180 person-rem (with an LCF risk of 0.1). The values for truck transportation are larger by factors of 1.6 and 3, respectively, than the corresponding values for rail transportation. The impacts are lower for use of rail than trucks because the number of shipments required is smaller. The number of estimated shipments to the WIPP repository is larger than the number associated with the other three action alternatives, primarily due to the assumption that activated metals and RH wastes with higher external dose rates would be packaged in shielded canisters for disposal at WIPP prior to being loaded onto the transport vehicles. All wastes being shipped to WIPP are assumed to be CH wastes, and the external dose rates are taken to be 0.5 and 1.0 mrem/h at 1 m for use of truck and rail, respectively. Although the number of estimated shipments to the WIPP repository is larger than the number associated with the other alternatives, the overall estimated public and worker doses are less because the wastes are shipped as CH wastes. Should the WIPP repository be selected as the option for disposal of these wastes, further evaluation and analysis to optimize the waste	A total of 12,600 truck shipments or about 5,000 rail shipments would be required to transfer the GTCC LLRW and GTCC-like waste to the various alternate disposal sites. This could result in 1 non-radiological fatality from accidents for both truck and rail. The collective population dose for truck transportation ranges from 69 person-rem (SRS) to 170 person-rem (Hanford Site) and could result in an LCF risk of up to 0.1, which includes an accident risk of up to 5 × 10^{-5} LCF. The worker doses for truck transportation range from 170 person-rem (SRS) up to 500 person-rem and could result in an LCF risk of up to 0.3. The values for truck transportation are larger by factors of 1 to 3 than the corresponding values for rail transportation, depending on which disposal site is addressed. The impacts are lower for use of rail than truck because a smaller number of shipments is required. The external dose rates for CH packages are assumed to be 0.5 and 1.0 mrem/h at 1 m for truck and rail, respectively, which are the same as those used for Alternative 2. The external dose rates for RH packages are taken to be 2.5 and 5.0 mrem/h at 1 m for truck and rail, respectively. About 94% of all shipments would be composed of RH waste. Because of the large percentage of RH shipments, the radiological transportation impacts for Alternatives 3, 4, and 5 are generally greater than those for Alternative 2. Should one of the land disposal methods be selected as the option for disposal of these wastes, further evaluation and analysis to optimize the waste shipment configuration would be conducted to minimize to the extent possible the number of shipments and potential transportation impacts.		

TABLE S-3 (Cont.)

Resource Area	Alternative 1 No Action	Alternative 2 WIPP Geologic Repository	Alternative 3 Borehole	Alternative 4 Trench	Alternative 5 Vault
Transportation (Cont.)		shipment configuration would be conducted to minimize to the extent possible the number of shipments and potential transportation impacts.			
Cultural Resources	No incremental impacts would occur because continued waste storage would not result in disturbance of additional areas that were not already affected.	No incremental impacts are expected because construction, operational, and post-closure activities would not involve additional land disturbance.	The likelihood of impacting cultural resources is proportional to the amount of land disturbed, with the borehole method requiring the greatest amount of land disturbance. Procedures given in Section 106 of the National Historic Preservation Act would be followed as appropriate to mitigate any impacts on these resources. Local American Indian tribes would be consulted to ensure no traditional cultural properties were impacted. There are no known cultural resources within the GTCC reference locations at the Hanford Site and INL Site. Eighteen cultural resources are reported to be in and near the GTCC reference location at LANL, with some sites considered eligible for listing under the National Historic Preservation Act. A handful of very small lithic scatters are located within the GTCC reference location at NNSS. There are seven archaeological sites within the GTCC reference location at SRS. Some isolated prehistoric artifacts and possibly some larger prehistoric cultural resources would be found in the GTCC reference locations at the WIPP Vicinity.		
Waste Management	No incremental impacts are expected because no construction or operational activities for disposal of GTCC LLRW and GTCC-like waste would be performed.	The small quantities of hazardous and nonhazardous waste produced during waste disposal activities would be managed in the same manner as similar wastes generated by operations at WIPP.	The small quantities of nonradioactive (hazardous and nonhazardous waste) and radioactive (solid and liquid LLRW) waste produced during construction and waste disposal activities would be managed in the same manner as wastes produced by ongoing operations at the various DOE sites evaluated. Specific waste management plans would be prepared as necessary to address these wastes for the WIPP Vicinity.		

[a] The annual occupational doses for the three land disposal alternatives were based on an average annual dose rate of 0.2 rem per full-time equivalent (FTE) worker and the annual number of FTE workers estimated for waste disposal. An "FTE worker" for waste disposal purposes would not actually be one worker but would likely consist of several individually badged workers, since the workers would perform other tasks in addition to waste disposal. The worker dose estimates for Alternative 2 were based on actual doses that have occurred during defense-generated TRU waste disposal operations.

Potential environmental consequences under the No Action Alternative would result from continuing the practices currently used to manage these wastes for both the short term and long term. However, it is assumed that current facility operations in the storage sites would continue for the short term and result in minimal impacts on most resource areas (e.g., air quality, geology, water resources, ecological resources, socioeconomics, land use, transportation, and cultural resources). The main concerns are associated with the long-term human health impacts that could result from storage of this waste. Calculations performed for the GTCC EIS indicate that long-term human health impacts for the No Action Alternative (analyzed for the period beyond 100 years and up to 10,000 years to be consistent with the time frame analyzed for Alternatives 2 to 5) could be as high as 470 rem/yr with a lifetime latent cancer fatality (LCF) risk of 0.3 associated with that one year of exposure (as compared to the highest estimate of 12 rem/yr and LCF risk of 0.007 [in generic commercial Region I] or 2.3 rem/yr and LCF risk of 0.001 [at federal sites] for the action alternatives [i.e., Alternatives 2 to 5]), depending on the region of the country in which a storage site might be located.

The results of the EIS analysis indicate that the potential impacts on the various environmental resource areas (shown in Figure S-23) from the action alternatives (i.e., Alternatives 2 to 5) would be small and would not vary significantly among the sites evaluated. Like the No Action Alternative, but potentially to a much lesser extent, the exception would be the long-term human health impacts in the post-closure phase for Alternatives 3 to 5 (borehole, trench, and vault disposal) as calculated on the basis of impacts to a hypothetical resident farmer near a disposal facility. For Alternative 2, there would be no releases to the accessible environment and therefore no radiation doses or LCF risks during the first 10,000 years following closure of the WIPP repository. Table S-4 presents a more detailed comparison of the long-term human health impacts. The radiological impacts to members of the general public as described in this EIS are incremental to, and, in most cases, small, compared to those from natural and man-made sources of radiation, which result in an annual exposure of about 310 mrem/yr each, for a total of about 610 mrem/yr per individual (NCRP 2009).

On the basis of the site-specific precipitation rates that were assumed, it is estimated that the federal sites located in the arid regions of the country (Hanford Site, LANL, NNSS, and WIPP Vicinity) would generally have lower long-term human health impacts from the groundwater pathway than would the sites located in more humid regions (such as SRS). The exception is the INL Site, which is shown in Table S-4 to have the highest dose and LCF risk estimates (estimated to be up to 2.3 rem/yr and 0.001, respectively). The INL Site results are primarily due to the distribution coefficient (K_d) of zero assumed in the calculations for the radionuclides identified in the waste inventory; this assumption was made as a conservative approach to account for the basalt layer that is present in some parts of the INL Site (including the GTCC reference location). Essentially, this assumption considers radionuclides to be released to the full extent once the basalt layer has been penetrated. Estimates of long-term human health impacts from the groundwater pathway for the No Action Alternative also indicate that the arid regions would result in lower doses and LCF risks.

Site- and radionuclide-specific K_ds were assumed in the long-term human health calculations and can vary significantly between sites. K_ds provide an indication of the degree to which the radionuclide would adhere to soil and not move with the percolating water. The higher

TABLE S-4 Comparison of Estimated Potential Maximum Human Health Long-Term Impacts for Alternatives 1 to 5[a]

	Maximum Human Health Long-Term Impacts[b]	
Alternative	**Annual Dose (rem/yr)**	**Annual LCF Risk**
1: No Action	470	0.3
2: WIPP (geologic repository)	0[c,d]	0[c,d]
3: Borehole method		
Hanford Site	0.0048	0.000003
INL Site	0.82	0.0005
LANL	0.16	0.00009
NNSS	0	0
WIPP Vicinity	0	0
Generic Commercial Region IV	0	0
4: Trench method		
Hanford Site	0.048	0.00003
INL Site	2.1	0.001
LANL	0.38	0.0002
NNSS	0	0
SRS	1.7	0.001
WIPP Vicinity	0	0
Generic Commercial Region II	1.2	0.0007
Generic Commercial Region IV	0	0
5: Vault method		
Hanford Site	0.049	0.00003
INL Site	2.3	0.001
LANL	0.43	0.0003
NNSS	0	0
SRS	1.3	0.0008
WIPP Vicinity	0	0
Generic Commercial Region I	12	0.007
Generic Commercial Region II	1.2	0.0007
Generic Commercial Region III	0.53	0.0003
Generic Commercial Region IV	0	0

[a] Radiation doses are given to two significant figures, and LCF risks are given to one significant figure. A value of zero for long-term human health impacts means that the radioactive contamination does not reach the well of the hypothetical receptor (for Alternatives 1, 3, 4, and 5) or the Culebra Dolomite at WIPP for Alternative 2.

Footnotes continued on next page.

TABLE S-4 (Cont.)

[b] For Alternatives 1, 3, 4, and 5, these impacts are the peak long-term annual radiation doses and LCF risks estimated to occur within the first 10,000 years after closure of the waste disposal facility to a hypothetical resident farmer 100 m (330 ft) downgradient from the edge of the disposal facility. For Alternative 2, there would be no releases to the accessible environment and therefore no radiation doses and LCF risks during the first 10,000 years following closure of the WIPP repository, as noted in Section 5.1.12.1 of the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* issued in 1997 (DOE/EIS-0026-S-2).

[c] The disposal of defense-generated TRU waste at WIPP is conducted in accordance with the standards and criteria in 40 CFR Parts 191 and 194. As noted in footnote b, there would be no releases to the accessible environment for disposal of defense-generated TRU wastes at WIPP in the first 10,000 years following closure, and the corresponding annual dose and LCF risk are both reported as zero.

[d] The post-closure impacts from disposing of the GTCC LLRW and GTCC-like waste at WIPP were evaluated in the same manner as was done for disposal of defense TRU waste in this repository. This analysis indicates that the GTCC LLRW and GTCC-like waste inventory could be disposed of at WIPP in compliance with existing regulations. However from a statute perspective, DOE acknowledges that only defense-generated TRU waste is currently authorized for disposal at the WIPP geologic repository under the WIPP LWA as amended (P.L. 102-579 as amended by P.L. 104-201), and that legislation would be required to allow disposal of waste other than TRU waste generated by atomic energy defense activities at WIPP and/or for siting a new facility within the land withdrawal area.

the K_d for a specific radionuclide, the more that radionuclide would adhere to soil particles. Sites that have high K_ds would generally result in lower groundwater radionuclide concentrations than those with lower K_ds.

SRS was estimated to have the second-highest potential dose and LCF risks after the INL Site. The peak annual dose to the hypothetical resident farmer receptor at SRS is estimated to be about 1.7 rem/yr, with C-14, Tc-99, and I-129 being the major radionuclide contributors to the dose. The K_ds assumed for these three radionuclides are very low and generally the same as those used for all the federal sites evaluated in the EIS. As a result, these same three radionuclides are also the major contributors to the dose and LCF risk to the hypothetical resident farmer for the groundwater pathway to the federal sites in the western part of the country. However, the low precipitation rates for these sites resulted in generally lower peak annual doses and LCF risks than those for SRS, which is located in a more humid region.

Finally, of the three waste types, the activated metals and sealed sources would result in lower peak annual doses and LCF risks than would the Other Waste. This would occur because the Other Waste type is physically the most leachable of the three waste types. In the GTCC EIS, it is assumed that the Other Waste would be stabilized with grout to minimize degradation over time. This would also reduce leaching of radionuclides. The activated metal and sealed source wastes are much more durable than the stabilized Other Waste, and leaching from these two waste types would be much lower over the long term.

These results are intended to be viewed in a comparative manner, given the uncertainties associated with this analysis. A number of simplifying assumptions are made for the purposes of the comparative analysis in this EIS, especially in terms of the long-term performance of engineered materials assumed for the borehole, trench, and vault disposal facilities. It is expected that detailed, site-specific assessments that would include more specific calculations on the physical and chemical performance of different engineered materials would be made before implementation of any alternative.

The results presented here should not be used for regulatory compliance purposes in the future, and they should not be compared with site-specific performance assessments that have been conducted for existing waste disposal facilities. Such assessments are based on site-specific exposure scenarios and conditions. However, the assessment in this EIS does provide useful information to guide the decision-making process for identifying the most appropriate alternative to manage these GTCC LLRW and GTCC-like waste.

S.4 CUMULATIVE IMPACTS

Potential impacts of the GTCC proposed action are considered in combination with the impacts of past, present, and reasonably foreseeable future actions. Cumulative impacts are evaluated for Alternatives 2 to 5. DOE did not evaluate the cumulative impacts of the No Action Alternative at the many privately-owned and operated locations, since such an evaluation would involve making speculative assumptions about environmental conditions and future activities at those locations where GTCC LLRW could be stored.

For Alternative 2, the low potential impacts of that alternative indicate that the cumulative impacts from the construction, operations, and post-closure phases of the proposed action at the WIPP site would be small and would not exceed regulatory requirements established for the WIPP facility. The post-closure performance analysis performed for emplacement of all GTCC LLRW and GTCC-like waste at WIPP demonstrates that disposal of these wastes would result in WIPP still being in compliance with existing regulatory requirements for technical performance.

For Alternatives 3 to 5 at the federal sites, the estimated impacts from the GTCC proposed action are not expected to contribute substantially to cumulative impacts for the various resource areas evaluated, with the likely exception of potential human health impacts in the long term. That is, during the post-closure phase of the proposed action, potential leaching of radionuclides from the GTCC LLRW and GTCC-like waste inventory into groundwater could contribute to doses and LCF risks to a hypothetical resident farmer located about 100 m (330 ft) from the edge of the borehole, trench, or vault disposal facility at the federal reference locations (i.e., at the Hanford Site, the INL Site, LANL, and SRS). For the Hanford Site, as stated in the

Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (DOE 2012), when the impacts of technetium-99 from past leaks and cribs and trenches (ditches) are combined, DOE believes it may not be prudent to add significant additional technetium-99 to the existing environment. Therefore, one means of mitigating this impact would be for DOE to limit disposal of off-site waste streams containing iodine-129 or technetium-99 at Hanford. The post-closure doses and LCF risks are summarized in Table S-4. The resident farmer scenario is assumed to be conservative (i.e., one that overestimates the expected dose and LCF risk) because it assumes a total loss of institutional control and institutional memory with regard to the disposal facility. The sites evaluated are on federal land and would most likely continue to be managed by the federal government for a long time. Follow-on NEPA evaluations to support further considerations of siting a new borehole, trench, or vault disposal facility at the sites evaluated in this EIS would provide more detailed analyses of site-specific issues relative to cumulative impacts.

S.5 UNCERTAINTIES ASSOCIATED WITH THE EVALUATIONS IN THE GTCC EIS

The impact analyses conducted for the GTCC EIS used methodologies and approaches consistent with Council on Environmental Quality and DOE requirements and guidance for preparing an EIS. Uncertainties associated with the various environmental resource areas evaluated in this EIS are not unique to the GTCC EIS. As previously discussed, the results of the impact analyses for the action alternatives (summarized in Sections S.3 and S.4) indicate that the impacts on the various resource areas from the proposed action would be generally small and that they would not vary much among the sites evaluated, with the possible exception of potential post-closure impacts on human health. The results from the analysis of human health impacts in the post-closure phase indicate that potential future doses and LCF risks to a hypothetical resident farmer could vary significantly by site. Hence, the discussion on uncertainties focuses on this aspect of the analysis because it provides information useful in identifying a preferred alternative.

Several factors could alter the estimated human health impacts associated with disposal of these wastes, including changes in (1) the waste volume and radionuclide inventory, (2) the assumptions about the design and layout of the facilities, (3) the assumptions used to simulate how long the integrity of the engineered barriers and waste stabilizing agents would stay intact, and (4) the assumptions about site characteristics used as input for the calculations.

The radiological impacts on human health would depend mostly on the total radioactivity and the mix of radionuclides that would make up the waste. That is, if the waste volumes doubled but total activity remained the same, it is anticipated that there would be no major change in the potential radiological impacts. Increasing the total radionuclide activity by a factor of two with the same mix of radionuclides, however, would essentially double the potential radiological impacts. Because the uncertainty with regard to the waste inventory is generally low to moderate, the inventory does not represent a major source of uncertainty in the human health impact analysis.

Changes in the design and layout of the disposal facility could also change the potential human health impacts. For purposes of analysis in the EIS, the depths of the disposal area available for waste placement are assumed to be 4.3 to 5.5 m (14 to 18 ft) above ground surface (ags) for vaults, at 5 to 10 m (15 to 30 ft) bgs for trenches, and from 30 to 40 m (100 to 130 ft) bgs for boreholes. Changes in the design and layout of the disposal facility could result in changes in the total area and the subsequent depths of the waste disposal horizon in the EIS analyses. The footprint of the disposal facility, along with the distance from the edge of the facility to an off-site hypothetical well where potential radiation exposures are assumed to occur, determines the total distance that the radionuclides need to travel in the groundwater aquifer to cause a radiation dose. For example, a decrease in the footprint of the disposal facility would shorten the distance from the midpoint of the waste zone to the off-site well. This shorter distance would increase the radionuclide concentrations in the groundwater at an off-site well because there would be less dilution, and it would result in somewhat higher doses from the use of this groundwater. Calculations based on actual distances during implementation should provide a more representative estimate.

Changes to the design of the disposal facility could result in changes to the area potentially exposed to infiltrating water. A larger disposal area would allow more water infiltration and result in more radionuclides leaching out to deeper soils. Alternatively, a smaller area (with a subsequent greater depth of waste disposal) would result in a shorter soil column beneath the disposal units through which radionuclides leaching from the disposal area would need to travel to reach the groundwater table. The overall effect that could result from changes in the geometrical configuration of the disposal cells needs to be assessed with regard to the time frame used to evaluate the potential impacts and the specific site in question. However, these changes would not add a significant amount of uncertainty to the results, unless major changes were made to the current conceptual facility designs used in these analyses.

For the GTCC EIS, it is assumed that the engineered barriers (including the cover) would remain effective for the first 500 years after closure of the disposal facility and that during this time, essentially no infiltrating water would reach the wastes from the top of the disposal facility. It is assumed that after 500 years, some amount of infiltrating water (20% of the site-specific natural infiltration rate reported for each of the sites evaluated) would contact the wastes through the top of the disposal facility, and that the water infiltration rate to the perimeter and beneath the disposal facilities would be 100% of the site-specific natural infiltration rate. It should be noted that if the infiltration rate to the top of the disposal facility is increased, the dose estimates would also increase. It is also assumed that the Other Waste would be stabilized with grout or other material and that this stabilizing agent would be effective for 500 years. No credit is taken for the effectiveness of this stabilizing agent after 500 years. The radionuclides in the disposed-of wastes would be available for leaching by infiltrating water after 500 years.

Many of the radionuclides in the GTCC LLRW and GTCC-like wastes have very long half-lives, so the 500-year effectiveness period assumed for purposes of analysis in this EIS is relatively short and would not result in an appreciable reduction in the total hazard associated with these wastes as a result of radioactive decay, especially when the time it would take for these radionuclides to reach the hypothetical off-site receptor is considered. The uncertainty is related to how much longer the engineered barriers and stabilization process could remain effective for the sites at which the potential impacts are estimated to be high.

In addition, global climate change impacts might add another aspect of uncertainty with regard to the long-term performance of the borehole, trench, and vault waste disposal facilities at the sites evaluated in the GTCC EIS. Since 1990, the average annual precipitation over the United States has increased by about 5%, but there were regional differences, e.g., increases mostly in the Northeast, Midwest, and southern Great Plains and a mix of increases and decreases in much of the Southeast and Southwest (Melillo et al. 2014). The global climate change model predictions indicate that in the Southwestern United States, drier or prolonged drought conditions could arise notably in the spring, whereas Northern areas could become wetter.

Although the global climate change impacts are modeled only to the year 2100, these initial indications can be used to provide a perspective on what impacts global climate change might have on the proposed borehole, trench, and vault waste disposal facilities at the various reference locations or regions evaluated in this EIS. As discussed previously, the water infiltration rate is one of the key input parameters that affect how much radioactivity could leach from waste in the disposal facility. On the basis of the global climate change predictions under a higher (i.e., worst-case) emission scenario (Melillo et al. 2014), average annual infiltration rates at the sites located in the Southwest (e.g., LANL, NNSS, WIPP Vicinity, and the generic commercial location in the southern part of NRC Region IV) are expected to decrease slightly or remain the same, while rates at the sites located in the Northwest (e.g., Hanford and INL Sites) and in the Southeast (e.g., SRS), would increase slightly.

On the basis of Melillo et al. (2014), it can be said that the maximum increase or decrease in precipitation under a higher emission scenario would be up to 20% depending on the season. Under a lower emission scenario, these percentages would be lower, and thus climate changes would probably not have any significant impacts on GTCC LLRW and GTCC-like waste disposal operations. This is because slight increases in precipitation are expected in humid sites such as SRS. For sites located in drier areas, such as Hanford, INL, LANL, NNSS, and WIPP/WIPP Vicinity, changes of up to about 20% by season would be expected under a higher emission scenario but these changes are not significant due to its lower annual precipitation. However, because the post-closure human health estimates presented in the GTCC EIS are for 10,000 years or more, and because current global climate change model projections extend only to the year 2100, it is uncertain whether the indications discussed here would continue for the 10,000-year post-closure period analyzed in the GTCC EIS.

Most of the long-term radiation doses and LCF risks associated with the groundwater pathway would be attributable to leaching of the Other Waste. By using robust engineering designs and redundant measures to contain the radionuclides in the disposal unit (i.e., increasing the time period of effectiveness of covers and stabilizing agents), the potential releases of radionuclides would be delayed and reduced to very low levels, thereby minimizing the potential groundwater contamination and its associated human health impacts in the future.

The modeling simulation conducted for the GTCC EIS is a simplified representation of more complex soil and groundwater processes, and this simplification adds uncertainty to the results. The RESRAD-OFFSITE computer code was used for this analysis, and input parameters were determined on a site-specific basis, as available; most were obtained from previous analyses performed at these sites. In addition, the site-specific distribution coefficients used as input into the model calculations have inherent uncertainties associated with them, and it is difficult to assign values for the level and direction of uncertainty that exist in the distribution coefficients for each site and from site to site.

It is assumed in this EIS that a resident farmer would be located 100 m (330 ft) downgradient from the edge of the disposal facility and would develop a well as a source of drinking water. This assumption is considered to be conservative because the distance from the edge of the disposal facility to such an individual (given the current configurations of the alternative sites evaluated in this EIS) would be much longer. Use of a more realistic distance would result in much lower doses than those presented in this EIS. This distance adds a great deal of uncertainty and conservatism to the results presented in this EIS.

Finally, the human health impacts estimated for a hypothetical resident farmer (provided in Table S-3) are intended to serve as indicators of the performance or effectiveness of each of the land disposal methods at each of the sites evaluated and are expected to provide a metric for comparing the relative performance of the land disposal methods at these sites. When considering which GTCC disposal alternative to select, DOE will consider the potential dose to the hypothetical resident farmer as well as other factors described in Section S.7 of this Summary.

S.6 PUBLIC INVOLVEMENT

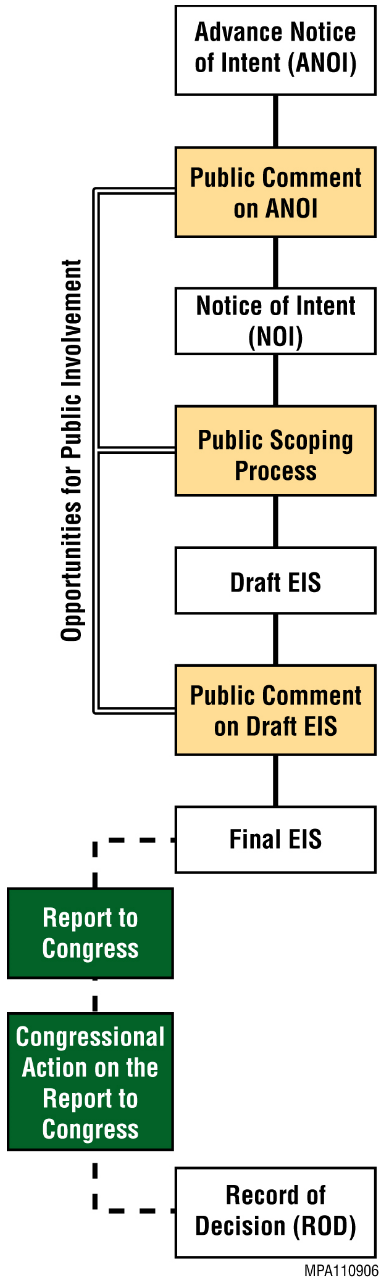

FIGURE S-24 GTCC EIS NEPA Process

DOE is committed to communicating to the public information about the GTCC EIS to ensure that potentially affected communities, tribal groups, and other interested parties understand DOE's proposed action and are given the opportunity to participate in decisions that may affect them. DOE issued the Advance Notice of Intent on May 11, 2005 (70 FR 24775) and the NOI on July 23, 2007. DOE issued a printing correction for the NOI on July 31, 2007. DOE also established a public website at the same time it issued the NOI (www.gtcceis.anl.gov) in order to give the public access to information on the NEPA process, the EIS, and public involvement opportunities. The NEPA process followed by DOE for the GTCC EIS is shown in Figure S-24.

The NOI announced nine public scoping meetings and a comment period from July 23 through September 21, 2007, during which time DOE solicited comments from stakeholders, including federal, state, and local agencies; American Indian tribal representatives; and the general public to assist in defining the proposed action, alternatives, and issues requiring analysis.

S.6.1 Public Scoping Comments on the Notice of Intent

DOE received 249 comment records via emails, faxes, letters, and transcripts of oral comments. DOE considered all oral and written public comments in identifying the range of alternatives for the EIS.

Comments received during the public scoping period focused on the amount of inventory being included for evaluation in the EIS, the sites that would be considered, the disposal methods or technologies that would be considered, the resource areas to be evaluated, and the impact assessment methodologies. Representative comments and DOE responses are provided as follows. The first set of comments presents those determined to be within the EIS scope, and the second set presents those determined to be outside the scope of the EIS.

S.6.1.1 Comments Determined To Be Within EIS Scope

- *Disposal of GTCC LLRW and GTCC-like waste at the sites proposed in the NOI should not be considered because these sites are still undergoing cleanup. In addition, these sites either have regulatory conditions or site characteristics (e.g., geology) that make them unsuitable for consideration in the EIS.*

  The basis for proposing the sites to be considered in the NOI and evaluated in the EIS was their mission compatibility, in the sense that all of these sites have radioactive waste disposal operations as part of their current missions. These sites are thus considered viable for analysis for disposal of this waste in the EIS. The scope of the EIS includes the identification of potential disposal sites and the evaluation of the feasibility and effectiveness of these sites for hosting a safe disposal facility for GTCC LLRW and GTCC-like waste.

- *The preferred alternative for disposal of GTCC LLRW and GTCC-like waste should be a geologic repository.*

  Disposal at WIPP, a geologic repository, is one of the alternatives evaluated in the Draft EIS, and a preferred alternative in the Final EIS. In addition, DOE is evaluating alternative methods of disposal (i.e., borehole, trench, and vault disposal). NRC regulations governing disposal of GTCC LLRW contemplate that nongeologic disposal alternatives may be approved (see 10 CFR 61.55(a)(2)(iv)).

- *More detailed characterization information should be provided on the waste inventory, including the source of the waste, its location (by state), and its specific characteristics. It is not clear how the volumes and activities for stored and projected waste were developed, and the distinction between what is considered stored versus what is considered projected is not clear either. The sources of information and important assumptions used to develop this information should be provided in the EIS, along with an indication of the accuracy of the estimates.*

  The GTCC EIS and supporting documents provide characterization information on wastes to allow for a comparative analysis of potential environmental impacts associated with the disposal of these wastes. The approach used by DOE to develop the inventory information are provided in the EIS and in supporting documents, including the identification of relevant resources and DOE's due diligence in determining that current expected waste quantity estimates remain valid, and are conservative and bounding for the purposes of this comparative analysis (see Sections S.2.1 and S.2.4). The EIS also provides information on the current location of GTCC LLRW and GTCC-like waste producers (e.g., Table S-2 of this Summary).

- *The EIS should identify the quantity of mixed waste requiring disposal and identify the process for working with the EPA and respective state agencies to manage these wastes.*

  The GTCC LLRW and GTCC-like waste inventory includes a very small volume of mixed waste that may require disposal. It is assumed that the generator of the waste will treat it to remove the hazardous waste characteristic or obtain a waiver from the appropriate regulatory authority so that the waste is no longer regulated as mixed waste. No mixed GTCC LLRW or GTCC-like waste is assumed to be disposed of in the sites being evaluated in the EIS. The volume of potential mixed waste is about 170 m^3 (6,000 ft^3).

- *What is the scope of the EIS and evaluation endpoints (e.g., period of time with respect to risk of release)? The EIS should identify long-term monitoring requirements for the disposal sites.*

  The scope of the EIS addresses all aspects associated with disposal of GTCC LLRW and GTCC-like waste. Impacts are evaluated at the various time periods associated with the actions needed to safely dispose of these wastes. The long-term impacts on groundwater are evaluated for 10,000 years or to the point of maximum dose and LCF risk, whichever is longer. The EIS identifies the need for long-term monitoring of disposal sites, as appropriate.

- *The EIS should incorporate available site-specific data for the generic commercial facility evaluations. In addition, the evaluation of the disposal of*

GTCC LLRW and GTCC-like waste in boreholes for all sites being evaluated should be based on actual site data.

Site-specific data were used to identify the important parameters necessary to site and operate a disposal facility for GTCC LLRW and GTCC-like waste at arid and humid generic sites. The analyses of the various disposal technologies (including the use of boreholes) in the EIS were based on actual site data to the extent necessary to provide reliable evaluations. A site-specific evaluation would be done in a subsequent NEPA review as appropriate.

- *Consultation with tribal nations should be initiated early in the process.*

  Tribes contributed to the preparation of the Draft EIS and participated in the review of the Draft EIS by attending public meetings regarding GTCC and submitting comments that are addressed in Appendix J of this EIS. Since the receipt of tribal comments in 2011 on the Draft EIS, DOE has continued routine consultation with tribes as part of normal operations at the DOE sites evaluated in this EIS. DOE will continue to involve the tribes in the decision making process for the disposal of GTCC.

- *The EIS should identify all federal and state agencies and any jurisdictional authority by law and/or special expertise. Also, the EIS should address all pertinent regulatory issues and standards, including NRC regulation of a facility at a DOE site.*

  The EPA is a cooperating agency on the EIS because of its expertise in radiation protection. The NRC is a commenting agency. Pertinent regulatory issues and standards associated with disposal of GTCC LLRW and GTCC-like waste are addressed in the EIS.

S.6.1.2 Comments Determined To Be Outside EIS Scope

- *In addition to considering disposal at WIPP in the EIS, efforts should be initiated to site and construct a new geologic repository for GTCC LLRW and GTCC-like waste in case this repository is not acceptable.*

  As discussed in the NOI (72 FR 40135), DOE does not plan to evaluate an additional deep geologic repository facility because siting another deep geologic repository facility for GTCC LLRW and GTCC-like waste would be impractical due to the cost and time involved and the relatively small volume of GTCC LLRW and GTCC-like waste.

- *Hardened on-site storage (HOSS) should be added to the alternatives evaluated in the EIS. In addition, HOSS should be the preferred alternative.*

HOSS and other waste storage approaches beyond the No Action Alternative are considered to be outside the scope of the EIS because they do not meet the purpose and need for agency action. Consistent with Congressional direction in Section 631 of the Energy Policy Act of 2005 (P.L. 109-58), DOE plans to complete an EIS and a ROD for a permanent disposal facility for this waste, not for long-term storage options. In addition, the No Action Alternative evaluates storage of this waste consistent with ongoing practices.

- *The EIS should include disposal options for Class B and Class C LLRW in its scope.*

  Inclusion of Class B and Class C LLRW is beyond the scope of the EIS. DOE is responsible under the LLRWPAA (P.L. 99-240) for the disposal of GTCC LLRW and DOE wastes. States and Compacts are responsible for the disposal of Class A, B, and C LLRW.

- *The GTCC LLRW inventory needs to be expanded to address the disposal and possible consolidation and concentration of Class B and Class C LLRW by commercial nuclear utilities, resulting in additional GTCC LLRW.*

  The waste inventory is based on the best available information on GTCC LLRW, and it considers utility waste resulting from decommissioning activities. Data on the GTCC LLRW that might be generated by the concentration and consolidation of Class B and Class C LLRW are difficult to ascertain at this time because of the speculative nature of these events. The uncertainty that would be introduced in the EIS process by including this potential volume is not warranted.

- *Additional radioactive wastes should not continue to be produced until there is a waste disposal solution for these materials.*

  This issue is beyond the scope of the EIS, which is limited to the evaluation of the potential environmental impacts from using various disposal options for GTCC LLRW and GTCC-like waste.

- *The EIS should address the increased sensitivity of children, the elderly, pregnant women, and women in general to radiation exposure. The analysis should not be based on a reference man but on the reference family concept. In addition to radiation doses, estimates of the cancer risks should be provided in the EIS to allow for a comparison to EPA carcinogenic risk standards.*

  The concerns with regard to the increased sensitivity of various elements of the population are noted. The EIS presents a comparative analysis of the potential radiation doses and LCF risks to members of the general public (as represented by an adult receptor) from use of the various disposal alternatives presented in the NOI. As such, the level of detail requested here is not necessary for the purposes of the EIS, and the hazards associated with management of these wastes are presented in terms of the annual dose and LCF risk to a potentially exposed adult receptor.

The estimates for dose and LCF risk were based on a resident farmer receptor, which is considered a conservative scenario that accounts for the largest number of pathways of potential exposure. The primary pathway of concern, however, is the ingestion of groundwater potentially contaminated with radionuclides released from wastes at the proposed disposal facility. The estimated dose and LCF risk to an adult receptor presented in the EIS are considered conservative (relative to any other potential receptor) because the ingestion rate assumed for water intake is the 90th percentile value for the general public recommended by the EPA (i.e., two liters per day for 365 days per year) (EPA 2000).

Follow-on NEPA evaluations will be conducted, as needed, to assess potential human health impacts on a site-specific basis (accounting for sensitive populations as applicable) when a disposal site or location is identified.

- *Further research on and/or investigation of other treatment and disposal technologies currently being developed should be considered to ensure that these wastes are managed safely. The hazards posed by GTCC LLRW and GTCC-like waste are comparable to those from high-level radioactive wastes and should be managed in a similar manner.*

  Further research on treatment and disposal technologies is not needed to ensure these wastes are safely managed and that disposal complies with the LLRWPAA (P.L. 99-240), which makes the federal government responsible for the disposal of GTCC LLRW. It would not be reasonable to analyze in detail an essentially unlimited number of additional non-DOE or nonfederal sites. Nevertheless, DOE also conducted a generic evaluation of commercial disposal facilities on nonfederal lands in the EIS in order to provide, to the extent possible, information regarding the potential long-term performance of other (nonfederal) locations for siting a GTCC LLRW and GTCC-like waste land disposal facility.

S.6.2 Public Comments on Draft EIS

All scoping comments received were considered in the preparation of the EIS. A Notice of Availability (NOA) for the Draft GTCC EIS was published in the *Federal Register* on February 25, 2011 (76 FR 10574), and it began a 120-day public comment period that ended on June 27, 2011. All comments received on the Draft EIS were considered in the preparation of the Final GTCC EIS.

DOE received a total of 1,196 comment records, which accounted for 3,982 individual comments. Of the 1,196 comment records received, 154 were from organizations or federal or state agencies; 495 were from private citizens; and 547 were campaign letters, emails, or web comments received from six organizations (i.e., Snake River Alliance, Friends of the Gorge, Concerned Citizens for Nuclear Safety, Nuclear Watch, Citizen Letter, and the Brookfield Assisted Living Facility). Written comments were received via letter, email, or through submission of a comment form provided at the public hearings or on the project website. Oral comments are included in transcripts documenting each of the public hearings held on the Draft GTCC EIS.

Comments were reviewed and responses prepared by policy experts, technical subject matter experts, and NEPA experts. Comments were evaluated to determine whether alternatives and analyses presented in the Draft EIS should be modified, whether additional or corrected information is needed, and whether additional or revised text would clarify the information being conveyed. The comments received have been summarized into 10 comment topics, which are presented here, along with corresponding responses (detailed responses to each of the comment records can be found in Appendix J, Section J.3):

1. *Disposal of GTCC LLRW and GTCC-Like Waste at a New Near-Surface Land Disposal Facility at DOE Sites Evaluated (i.e., at the Hanford Site, INL Site, LANL, SRS, NNSS, and the WIPP Vicinity) – Comments received recommended that specific sites should be removed from consideration in developing a GTCC LLRW and GTCC-like waste near-surface land disposal facility.*

   The disposal methods and sites evaluated in the EIS encompass the range of reasonable alternatives for the disposal of GTCC LLRW and GTCC-like waste, consistent with NEPA implementing regulations in the *Code of Federal Regulations* at 40 CFR Parts 1500–1508. In this GTCC EIS, DOE analyzed a range of disposal methods (i.e., geologic repository, near-surface trench, intermediate-depth borehole, and above-grade vault) and federally owned sites (i.e., Hanford Site, INL Site, LANL, NNSS, SRS, and the WIPP Vicinity, for which two reference locations – one within and one outside the WIPP LWB – were considered). DOE has determined that it was reasonable to analyze these six sites because they currently have operating radioactive waste disposal facilities, except for the WIPP Vicinity, which is near an operating geologic repository and has basic infrastructure to support the facility.

2. *Disposal of GTCC LLRW and GTCC-Like Waste at WIPP – Commenters were opposed to the possible use of WIPP for disposal of GTCC LLRW and GTCC-like waste based on legal and technical considerations.*

   DOE acknowledges that only defense-generated TRU waste is currently authorized for disposal at the WIPP geologic repository under the WIPP LWA as amended (P.L. 102-579 as amended by P.L. 104-201), and that legislation would be required to allow disposal of waste other than TRU waste generated by atomic energy defense activities at WIPP and/or for siting a new facility within the land withdrawal area. It would also be necessary to revise the *Agreement for Consultation and Cooperation between Department of Energy and the State of New Mexico for the Waste Isolation Pilot Plant,* the WIPP compliance certification with EPA, and the WIPP Hazardous Waste Facility Permit. In addition, follow-on NEPA project-specific review, including further characterization of the waste (e.g., radionuclide inventory and heat loads) as well as the proposed packaging for disposal would have to be conducted. The WIPP has been certified by the EPA as an acceptable facility for the disposal of defense-generated TRU waste. The physical and chemical characteristics of the GTCC LLRW and GTCC-like waste proposed for disposal in the WIPP repository are comparable to the TRU wastes currently being disposed of in the repository. Based on the GTCC EIS evaluation, disposal of GTCC LLRW and GTCC-like waste at WIPP would result in minimal environmental impacts on all resource areas evaluated, including human health and transportation.

3. *Consideration of Other Alternatives Not Evaluated in Detail in the EIS Including Use of HOSS, the Proposed Yucca Mountain Repository, a New Geologic Repository, and Other Disposal Methods (e.g., Mined Cavities) and Alternatives (e.g., Treatment of Waste and Alternative Sources of Energy) – Some commenters requested that the EIS include HOSS as a reasonable alternative for managing all or a portion of the GTCC LLRW and GTCC-like waste inventory, and others indicated that the best approach for disposal of GTCC LLRW and GTCC-like wastes would be to dispose of the entire inventory in a new geologic repository.*

   The use of HOSS and other approaches for long-term storage of GTCC LLRW and GTCC-like wastes are outside the scope of this EIS because they do not meet the purpose and need for agency action. Consistent with Congressional direction in Section 631 of the Energy Policy Act of 2005 (P.L. 109-58), DOE plans to complete an EIS and a ROD for a permanent disposal facility for this waste, not for long-term storage options. The action alternatives evaluated in the GTCC EIS also did not include interim storage of GTCC LLRW and GTCC-like waste until a geologic repository for spent nuclear fuel and high-level radioactive waste becomes available because such interim storage is outside the scope of the GTCC EIS. The purpose of the GTCC EIS is to evaluate the range of reasonable alternatives for the safe and secure disposal of GTCC LLRW and GTCC-like wastes.

4. *NEPA Process and Procedures – The Draft EIS does not comply with NEPA because it did not identify a preferred alternative and because sufficient opportunity for public comment was not provided. Many commenters suggested that DOE do a better job of getting the word out about the EIS and the public hearings.*

DOE believes that this EIS complies with NEPA. NEPA implementing regulations, 40 CFR 1502.14(e), do not require a preferred alternative to be included in a Draft EIS if an agency does not have one. DOE's notification about the public hearings followed normal practices, with advance notice in the Federal Register and notices in local media. DOE held nine public hearings during the 120-day public comment period on the Draft GTCC EIS which extended from February 25, 2011 through June 27, 2011 – a length of time substantially longer than the 45-day minimum Council on Environmental Quality requirement for public comment on a Draft EIS (40 CFR Part 1506.10 (c)).

5. *Tribal and Cultural Resources Concerns – The EIS should consider American Indian tribal concerns. Comments including those from the Santa Clara Pueblo, the Pueblo de San Ildefonso, and the Confederated Tribes and Bands of the Yakama Nation, raised several concerns that DOE proposals rely on institutional controls.*

   DOE appreciates the input provided by the Santa Clara Pueblo, the Pueblo de San Ildefonso, and the Confederated Tribes and Bands of the Yakama Nation on the EIS, both in the tribal narratives and in comments on the Draft EIS. This input was considered by DOE in identifying a preferred alternative. DOE initiated government-to-government consultations with potentially affected American Indian tribes in a timely manner consistent with DOE Order 144.1. These consultations were done at a time that DOE had compiled and developed adequate information for the Draft EIS (including identification of the GTCC LLRW and GTCC-like waste inventory) to allow for an informed consultation with potentially affected American Indian tribes. In the EIS, it was assumed that institutional controls of the land disposal units would be maintained for 100 years and that corrective measures could be implemented during this time period to ensure that the engineered barriers lasted for at least 500 years. This assumption is consistent with the institutional control time frame given in both NRC and DOE requirements and was determined to be a reasonable approach for assessing the long-term performance of the disposal units in the EIS.

6. *Transportation Analysis and Impacts – Radioactive waste that has been generated off-site should not be transported to the sites evaluated for disposal and for which the EIS does not identify specific routes or the proportion of wastes that would likely travel those routes. Commenters said that the transportation analysis should consider larger-volume packages and that the supporting information for the facility and transportation accident analyses should have been available.*

   Transportation of GTCC LLRW and GTCC-like waste from generating facilities to a GTCC LLRW disposal facility is a required component of the disposal process that would be identified for the GTCC LLRW and GTCC-like waste because the disposal site(s) or location(s) would not be the same as the generator sites as stated in the EIS. Based on the analysis conducted for this EIS, the transportation of GTCC LLRW and GTCC-like waste to a centralized disposal facility or facilities would result in lower overall human health risks compared to the No Action Alternative and can be conducted in a safe manner based in compliance with federal and state comprehensive regulatory requirements. The primary radiological transportation risk to the public for any alternative is from the low level of radiation emanating from the transport vehicle. The EIS shows that such risks are small. The magnitude of the collective population risk is primarily determined by the number of routes, the length of each route, the number of shipments along each route, the external dose rate of each shipment, and the population density along a given route. The primary differences among alternatives from the standpoint of transportation are the lengths of the routes as determined by the location of the disposal sites (destination of the shipments). Thus, higher collective population risks are associated with alternatives that require transportation over longer distances. All alternatives involve routes that have similar characteristics, with no significant differences for comparison among alternatives; all require transportation through a range of rural and urban areas. In addition, the routes used in the analysis are considered representative routes because the actual routes used would be determined in the future. For each disposal site, the routes most affected would be the interstate highways that are closest to the site. The transportation analysis as presented in the EIS is conservative in that consideration of the larger volume TRUPACT III and spent nuclear fuel casks could result in potentially reduced impact estimates than those presented due to fewer required shipments. However, while these packages are viable options for transport of the GTCC LLRW and GTCC-like waste, consideration of their use as an option in the EIS did not influence the identification of the preferred alternative.

7. *Model Assumptions for Post-Closure Human Health Impacts – Commenters indicated a number of issues associated with the long-term modeling in the EIS, such as conceptual designs that were too generic, assumptions about uniform environmental conditions, and other unsupported assumptions.*

   The EIS analyses are based on conceptual engineering information and necessitated the use of a number of simplifying assumptions. This approach is consistent with NEPA, which requires such analyses to be made early in the decision-making process. The various land disposal conceptual designs were assumed to be constructed and operated in a comparable manner at each of the various sites. In performing these evaluations, a number of engineering measures were included in the conceptual facility designs to minimize the likelihood of contaminant migration from the disposal units. No facility design can guarantee that radionuclide migration from the facility would not occur over and beyond a 10,000-year time period. It was assumed that these measures would perform similarly for all conceptual designs, remaining intact for 500 years after the disposal facility closed. After 500 years, the barriers would gradually fail. It should be emphasized that project- and site-specific engineering factors would be incorporated into the actual facility designs of the site or sites selected in the ROD to dispose of GTCC LLRW and GTCC-like waste. DOE recognizes that modeling potential releases of radionuclides from the conceptual disposal sites far into the future approximates what might actually occur and is therefore subject to technical uncertainty.

8. *Waste Inventory – The GTCC LLRW and GTCC-like waste inventory addressed in the EIS is much too limited.*

The GTCC LLRW and GTCC-like waste inventory evaluated in the Draft EIS included all GTCC LLRW and GTCC-like waste in storage as of 2008, plus GTCC LLRW and GTCC-like waste including buried wastes at the West Valley site, as well as wastes that could reasonably be expected to be generated in the near future. For the purposes of this analysis, waste disposal is assumed to occur from 2019 through 2083. The GTCC LLRW and GTCC-like waste inventory includes stored and projected wastes from the 104 nuclear power plants currently in operation as well as from the 18 commercial reactors that have already been shut down. It also includes projected GTCC LLRW from another planned 33 new reactors that have not yet been constructed. It is not reasonable to extend data beyond existing information on the commercial nuclear power industry to develop estimates of GTCC LLRW that could result from future decommissioning of these reactors, some of which may never be built. In addition, it is possible that new reactor technology could change the projected volumes of GTCC LLRW. In performing its due diligence in the preparation of this final EIS, DOE determined the GTCC LLRW and the GTCC-like waste inventory estimates used in the EIS to be conservative and bounding. This inventory remains valid and is appropriate for use in the EIS and for the development of the preferred alternative for disposal of GTCC LLRW and GTCC-like waste.

9. *Cumulative Impacts – Commenters suggested that the environmental impacts of all potential sources of radioactive contamination at the site, in addition to the impacts associated with transportation of the GTCC LLRW and GTCC-like waste to the Hanford Site, need to be addressed in the cumulative impacts analyses presented in this EIS.*

DOE has analyzed cumulative impacts at the Hanford Site in this GTCC EIS and indicates that the disposal of GTCC LLRW and GTCC-like waste at the Hanford Site could result in a radiation dose estimate to a nearby hypothetical future resident farmer of about 49 mrem/yr within the first 10,000 years, and most of this dose would be due to I-129 or Tc-99 in groundwater. Based on the cumulative impacts discussed in the Hanford TC&WM EIS (DOE 2012), when the impacts of Tc-99 from past leaks and cribs and trenches (ditches) are combined, DOE believes it may not be prudent to add significant additional

Tc-99 to the existing environment. Therefore, one means of mitigating this impact would be for DOE to limit disposal of off-site waste streams containing these radionuclides at the Hanford Site.

10. *Statutory/Regulatory and Policy Issues – Commenters indicated that any facility used for the disposal of GTCC LLRW and GTCC-like waste will have to be licensed by the NRC as provided in Section 3(b)(1)(D) of the LLRWPAA, and, as such, disposal criteria would need to be established. Commenters suggested that since GTCC LLRW is commercially generated radioactive waste, it should be disposed of at a commercial site and not at one or more DOE sites. Commenters also questioned how the requirement for NRC licensing of a GTCC LLRW disposal facility would be done if this facility was located at a DOE site, especially if such a facility was used for commercial GTCC LLRW and GTCC-like waste. Commenters suggested that the NRC should have been a more active participant in this process to ensure that the proposed alternatives could actually be implemented.*

    DOE determined that the most efficient approach was to address both GTCC LLRW and GTCC-like waste, which have many similar physical and radioactive characteristics, in a single NEPA process. DOE's intent is to facilitate the overall process for addressing the disposal needs of both waste types.

    The LLRWPAA (P.L. 109-58) specifies that GTCC LLRW, designated a federal responsibility under section 3(b)(1)(D) that results from activities licensed by the NRC, is to be disposed of in an NRC-licensed facility that has been determined to be adequate to protect public health and safety. However, unless specifically provided by law, the NRC does not have authority to license and regulate facilities operated by or on behalf of DOE. Further, the LLRWPAA does not limit DOE to using only non-DOE facilities or sites for GTCC LLRW disposal. Accordingly, if DOE selects facility operated by or on behalf of DOE for disposal of GTCC LLRW for which it is responsible under section 3(b)(1)(D), clarification from Congress would be needed to determine NRC's role in licensing such a facility and related issues. In addition, clarification from Congress may be needed on NRC's role if DOE selects a commercial GTCC LLRW disposal facility licensed by an Agreement State rather than by NRC.

    The NRC served as a commenting agency on the GTCC EIS and therefore did not actively participate in the preparation of the GTCC EIS. Issues associated with potential regulatory changes or NRC licensing would be addressed as necessary to enable implementation.

S.7 WHAT DID DOE CONSIDER IN DEVELOPING THE PREFERRED ALTERNATIVE?

DOE is selecting a combination of alternatives as the preferred alternative identified in the Final GTCC EIS and discussed in Section S.8 of this summary. DOE's preferred alternative would fulfill DOE's statutory mission and responsibilities and considers (1) comments received on the Draft GTCC EIS from the public; (2) DOE and NRC requirements for the disposal of LLRW, such as those as found in 10 CFR Part 61 and DOE Order 435.1, Radioactive Waste Management; and (3) environmental, technical, economic and other findings presented in the GTCC EIS.

The following text summarizes key considerations related to the alternatives analyzed in the EIS. In addition to public comments, these considerations include waste type characteristics, disposal method considerations, and disposal location considerations.

S.7.1 Public Comments

DOE has considered all comments received on the Draft EIS in identifying the preferred alternative presented in the Final GTCC EIS. See Section S.6 for additional information regarding the public involvement process for the GTCC EIS. The Draft GTCC EIS considered the public scoping comments on the NOI that were received, and it evaluated the conceptual designs for enhanced land disposal methods as alternatives to the deep geologic disposal method, which the NRC currently considers to be an acceptable method for disposing of GTCC LLRW. A summary of the public comments on the Draft GTCC EIS is in the Final GTCC EIS, and a synopsis of that summary is presented in Section S.8 of this summary.

S.7.2 Waste Type Characteristics

The three types of GTCC LLRW and GTCC-like waste (activated metals, sealed sources, and Other Waste) addressed in the EIS come from different sources and have different physical, chemical, and radiological characteristics. In addition, some waste types differ in terms of their availability for disposal at specific times. Thus, it might be appropriate to use different disposal methods for different waste types. Key factors related to the three GTCC LLRW and GTCC-like waste types that might determine whether one disposal method would be more appropriate than another include the following:

- *Radionuclide inventory.* The GTCC LLRW and GTCC-like waste include a wide range of radionuclides. Sealed sources generally consist of one (or possibly a few) radionuclides, whereas activated metal waste and the Other Waste type contain a larger number of radionuclides. Some of these radionuclides (such as strontium-90 [Sr-90] and Cs-137) have relatively short half-lives of about 30 years, whereas others (such as Pu-239) have half-lives of more than 10,000 years. Both the total inventory and mix of radionuclides are important to consider when selecting (an) appropriate disposal method(s) for a particular waste type.

A number of TRU radionuclides decay to radioactive progeny, and the presence of these in-growth radionuclides needs to be addressed. Also, some radionuclides emit significant amounts of gamma radiation (such as Co-60 and Cs-137), whereas others emit very little or no such radiation. The activated metals are expected to have the highest gamma exposure rates of the three waste types, and the sealed sources are expected to have the lowest exposure rates. The Other Waste is divided into CH and RH wastes, because some of the Other Waste could contain significant concentrations of fission products and neutron activation products that could decay and release significant amounts of gamma radiation, whereas others might have very little of these radionuclides.

The concentrations of long-lived radionuclides in waste determine how long it will remain hazardous. Many of the GTCC-like wastes have long-lived TRU radionuclides, and so they will remain hazardous for many thousands of years. Similar wastes are currently being disposed of in a geologic repository (WIPP) because of this concern. Also, the relative mobility of the radionuclides in groundwater systems varies widely; some radionuclides (such as Tc-99 and I-129) are quite mobile, while radioactive metals tend to bind with the soil particles and move more slowly in the environment.

- *Waste form stability.* While all of the GTCC LLRW and GTCC-like waste are solids, some are much more durable than others. It is assumed that activated metal wastes would retain their integrity for very long periods, while the Other Waste would be stabilized in a grout matrix to ensure the integrity of its waste form. Sealed sources are also very robust and are expected to retain their form for long time periods. Waste form stability influences the longevity of a disposal facility, with forms that could degrade more quickly being a long-term concern.

- *Size.* Some GTCC activated metal wastes are large metallic items that can be disposed of more readily in a near-surface trench or vault than in a borehole or geologic repository (WIPP). Use of boreholes or a geologic repository might require more waste handling to make the physical size of the waste manageable than use of trenches or vaults and could result in greater worker doses.

- *Availability for disposal.* While some GTCC LLRW and GTCC-like waste are currently in storage and available for disposal, much of the GTCC LLRW and GTCC-like waste will not be generated for several decades (see Figure S-6). The activated metal wastes are mainly associated with commercial nuclear power plants, and most of them are expected to operate for 20 years or more. Excess or unwanted radioactive sealed sources represent a national security concern, so their disposal is a high priority.

On the basis of these factors, it is important to take into account the characteristics of a specific waste type with the site and disposal method under consideration to ensure the timely, cost-effective, and safe disposal of GTCC LLRW and GTCC-like waste. Sealed sources (which are generally small and durable) might be good candidates for borehole disposal, whereas other large wastes (such as activated metal wastes) might be better suited for trenches and vaults. Many of the sealed sources recovered by the DOE GMS/OSRP for national security or public health and safety purposes meet the criteria for disposal at existing DOE facilities (when GMS/OSRP recovers sealed sources, DOE typically takes ownership of the sources and may dispose of them at DOE facilities if they meet waste acceptance criteria for such facilities). The long-term hazards associated with GTCC LLRW and GTCC-like waste might preclude the use of certain disposal sites and methods, especially those that could result in groundwater contamination.

S.7.3 Disposal Methods

Disposal Method Considerations

Factor	Criterion
Inadvertent human intrusion	Favors methods that minimize the potential for inadvertent human intrusion
Construction and operational experience	Favors methods that have been successfully used in the past to manage similar wastes
Post-closure care	Favors methods that minimize the potential need for long-term maintenance after the facility has closed
Cost	Favors methods that result in cost effective waste disposal

Key factors considered in identifying a preferred disposal method for GTCC LLRW and GTCC-like waste include (1) protecting the inadvertent human intruder, (2) leveraging operational experience, (3) minimizing institutional controls, and (4) achieving cost-effective disposal. Each of these factors is discussed here.

S.7.3.1 Inadvertent Human Intrusion

An inadvertent intruder is a person who might occupy the disposal site after closure and engage in normal activities, such as agricultural activities or the construction of buildings, or other pursuits in which the person might be unknowingly exposed to radiation from the waste (10 CFR 61.2). Human intrusion impacts might be mitigated by the waste form and packaging, institutional controls, and engineered and natural barriers (e.g., grouting and depth of disposal). All four disposal methods analyzed in this EIS include a combination of some or all these mitigation features.

S.7.3.2 Construction and Operational Experience

All four disposal methods have been used to some degree in the United States or other countries to dispose of radioactive waste similar to the three waste types analyzed in the GTCC EIS.

- *Deep geologic disposal.* The DOE WIPP facility is currently the only operating deep geologic repository in the United States. Since it began operations in 1999, the facility has successfully received more than 64,000 m^3 (2,300,000 ft^3) of CH and RH TRU waste generated by DOE atomic energy defense activities. This waste includes radioactive sealed sources, debris, and other waste similar to GTCC LLRW and GTCC-like waste. Most of the GTCC-like waste is similar to waste currently being disposed of at WIPP, except that it may not be authorized for disposal at WIPP under the WIPP LWA as amended (P.L. 102-579 as amended by P.L. 104-201).

- *Boreholes.* DOE demonstrated the use of borehole facilities to dispose of radioactive waste at NNSS (formerly NTS), which operated from 1984 through 1989 and received DOE waste similar to GTCC LLRW. Borehole disposal is receiving increased attention from the International Atomic Energy Agency as an option for disposal of disused sealed sources. Currently, there are no NRC-licensed borehole facilities in the United States. The advantages of the borehole method are as follows: (1) it may be amenable to receiving intermittent or low-volume waste like GTCC LLRW and GTCC-like waste; (2) it is visually unobtrusive; (3) it has the potential for robust long-term isolation of wastes; and (4) no workers need to enter the disposal borehole, which thereby minimizes worker hazards. Boreholes also provide the greatest amount of natural shielding (the surrounding soil) of any of the three land disposal methods. A disadvantage of the borehole method is the low volume capacity of the borehole and the much higher volume of unused space surrounding each borehole. Consequently, a very large number of boreholes (approximately 930 boreholes) would be required to manage the entire GTCC LLRW and GTCC-like waste volume. As mentioned above, the technology might be better suited to specific waste types (e.g., sealed sources), for which fewer boreholes would be required. Also, use of boreholes may be limited by underground injection control regulations or other requirements, such as the Safe Drinking Water Act.

- *Trenches.* Trenches are used for the disposal of LLRW in the United States and at a number of sites around the world. Commercial facilities dispose of Class A, B, and C LLRW in trenches and vaults. In addition, DOE uses trenches to dispose of its LLRW, including LLRW comparable to GTCC LLRW (e.g., Sr-90 radioisotope thermoelectric generators) on the basis of performance assessment analyses (systematic analyses of the potential risks posed by waste management systems). SRS currently disposes of large equipment (e.g., large cesium sources and other LLRW) in trenches by using the components-in-grout technique. This technique allows large equipment to be disposed of in trenches, and the waste form is surrounded with grout on all sides (bottom, sides, top). This approach will limit future subsidence and the release of radionuclides. The conceptual design for the trench that is evaluated in the GTCC EIS employs a deeper (11-m or 35-ft deep) and narrower (3-m or 10-ft wide) design than conventional belowground, near-surface radioactive waste disposal facilities in order to protect the facility from inadvertent human intrusion. Potential operational advantages of the trench include (1) its visual unobtrusiveness, (2) its ease of construction, and (3) the relative ease with which the wastes can be disposed of. Potential disadvantages include (1) the increased possibility of exposing workers to radiation hazards (i.e., more than that presented by boreholes), unless temporary covers or shields would be used, and (2) the possibility that this method might provide less protection from future intrusion into the wastes, as compared to boreholes and deep geologic disposal.

- *Vaults.* Vaults similar to the design presented in the GTCC EIS have been operated by DOE at SRS and other DOE facilities for the disposal of LLRW. This disposal method is more commonly used in humid environments, where belowground disposal methods might be limited by shallow groundwater. The conceptual design for the vault includes thick reinforced concrete walls, floors, and ceilings. To further isolate the waste, an engineered cover system is included in the design. Potential advantages of the vault include these: (1) it can be inspected visually and be more easily monitored than the other alternative land disposal methods; (2) because of its high visibility, inadvertent human intrusion is unlikely; and (3) it does not rely on waste packages for structural support (i.e., structural support is provided by the concrete cells). Potential disadvantages include these: (1) its active maintenance requirements (including active institutional controls) are likely to be more extensive than those of the other methods because of its visibility and exposure to the elements; (2) the costs to construct and operate it are higher than those of the other alternative land disposal methods; (3) it has a higher potential for exposing workers to radiation hazards than the other land disposal methods, unless temporary shielding or waste covers are used; and (4) it could attract intentional intruders because of its visibility.

S.7.3.3 Post-Closure Care Requirements

Some disposal methods might need to rely more on post-closure care than others. Because an above-grade vault is exposed to the elements, it might require more active institutional controls than the trench, borehole, and deep geologic disposal methods, extending to times beyond the period of active institutional control normally considered when evaluating the safety of waste management facilities. If post-closure care is not maintained, vaults could pose a greater potential for radiological exposures to the public. Consequently, maintenance of active institutional controls is considered particularly important for this technology to achieve post-closure safety. Long term post-closure care requirements for the trench, borehole, and deep geologic methods should be less.

S.7.3.4 Construction and Operating Costs

The estimated cost to construct and operate a GTCC LLRW and GTCC-like waste disposal facility ranges from $250 million for disposal at a new trench facility to $570 million for disposal at the WIPP geologic repository, as shown in Table S-5. The cost estimates for each disposal method are based on the assumption that all GTCC LLRW and GTCC-like waste would

TABLE S-5 Costs of GTCC LLRW and GTCC-Like Waste Disposal Alternatives[a]

Disposal Method	Cost to Construct Facility (in millions of $)[b]	Cost to Operate Facility (in millions of $)[c]	Total Cost to Construct and Operate Facility (in millions of $)
WIPP	14	560	570
Borehole	210	120	330
Trench	88	160	250
Vault	360	160	520

[a] Costs are rounded to two significant figures.

[b] Construction costs for the WIPP facility are for 26 new rooms. Construction costs for the borehole, trench, and vault disposal facilities are for 930 boreholes, 29 trenches, and 12 vaults (consisting of 130 total vault cells), respectively, and the supporting infrastructure.

[c] The operational cost for WIPP is based on the actual per-shipment cost for fiscal year 2008. Operational costs assume 20 years of facility operations for the borehole, trench, and vault disposal methods. On the basis of the assumed receipt rates, the majority of the wastes would be available for emplacement during the first 15 years of operations. The actual start date for operations is uncertain at this time and dependent upon, among other things, the alternative or alternatives selected, additional NEPA review as required, characterization studies, and other actions necessary to initiate and complete construction and operation of a GTCC LLRW and GTCC-like waste disposal facility. For purposes of analysis in the GTCC EIS, DOE assumed a start date of disposal operations in 2019. However, given these uncertainties, the actual start date could vary.

be disposed of by that method, although different combinations of disposal methods could be used for the different waste types. Costs for facility permits, licenses, transportation, packaging, and post-closure activities are not included in the estimates.

S.7.4 Disposal Location Considerations

The GTCC EIS evaluates six federal locations for the potential disposal of GTCC LLRW and GTCC-like waste, of which one is in a humid environment (SRS) and five are in semi-arid or arid environments (Hanford, INL, LANL, NNSS,WIPP/WIPP Vicinity). In addition, the GTCC EIS evaluates generic commercial locations in four regions of the United States. On the basis of the results presented in the GTCC EIS, key factors to be

Disposal Location Considerations

Factor	Criterion
Human health risk	Favors alternatives that reduce human health risk to both workers and the public.
Cultural resources	Favors alternatives that avoid adverse impacts to known cultural sites.
Laws, regulations, and other requirements	Favors alternatives that would not be inconsistent with current laws and other requirements.

considered in identifying a preferred disposal location for GTCC LLRW are potential human health risks for the post-closure long-term phase (including potential cumulative human health impacts from the post-closure phase); cultural resources and tribal concerns; and existing laws, regulations, and other requirements.

S.7.4.1 Human Health Impacts

Potential human health impacts include (1) potential exposure of workers and the general public to radiation during routine conditions and accidents and (2) direct impacts on workers and the public from industrial and transportation accidents. All potential impacts were considered in developing the preferred alternative. A primary consideration is the potential long-term (post-closure) impacts on members of the general public who might be exposed to radioactive contaminants released from the waste packages that are transported in groundwater and migrate to an accessible location, such as a groundwater well. Consequently, potential cumulative long-term human health impacts at each of the sites evaluated would likewise be of primary consideration. For example, the long-term doses and LCF risks estimated for the GTCC proposed action for the Hanford Site should be considered relative to the findings presented in the *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington* (TC&WM EIS) (DOE 2012). According to the TC&WM EIS, receipt of off-site waste streams that contain specific amounts of certain isotopes, specifically I-129 and Tc-99, could cause an adverse impact on the environment. The Tc-99 inventory from off-site waste streams evaluated in the TC&WM EIS shows potential impacts that are less significant than those of I-129. However, when the impacts of Tc-99 from past leaks and cribs and trenches (ditches) are combined, DOE believes it may not be prudent to add significant additional Tc-99 to the existing environment. Therefore, one means of mitigating this impact would be for DOE to limit disposal of off-site waste streams containing I-129 or Tc-99 at Hanford.

With regard to transportation impacts, the optimal location would be one that is close to the waste-generating sources. This location would minimize the overall transportation distance and would have the lowest potential impacts on human health. However, most of the waste generators are located in the eastern half of the United States, and these areas have more humid climates than do sites in the western part of the country. The more humid sites (SRS and generic Regions I and II) were shown to generally have greater long-term impacts from the groundwater pathway, and this concern is a major consideration in identifying an acceptable location for a GTCC LLRW and GTCC-like waste disposal facility. This does not mean that a site in a humid region could not be used for such a facility. Rather, a facility in a humid environment would have to rely more on engineering measures and institutional controls to ensure that the long-term hazards were maintained at acceptable levels.

S.7.4.2 Cultural Resources and Tribal Concerns

Cultural resources include, among other things, definitive locations of traditional cultural or religious importance to specified social or cultural groups, such as American Indian tribes ("traditional cultural properties"). DOE consulted with participating tribes who have cultural or historical ties to DOE sites being analyzed in the GTCC EIS. Tribal perspectives, comments, and concerns (e.g., environmental justice issues) identified during the consultation process were considered by DOE in selecting disposal alternative(s) for analysis in this EIS. DOE will continue to consult the tribes throughout the implementation of the disposal.

S.7.4.3 Laws, Regulations, and Other Requirements

A number of laws, regulations, and requirements (including state permits) apply to the disposal alternatives considered in the GTCC EIS. These include requirements that generally apply to all proposed disposal locations as well as those that apply to a specific site (e.g., WIPP LWA as amended [P.L. 102-579 as amended by P.L. 104-201] and other required state permits). DOE considered all applicable laws, regulations, and other requirements in developing the preferred alternative. In 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," the NRC classifies LLRW into four classes (Classes A, B, and C, and GTCC LLRW) on the basis of the concentrations of short-lived and long-lived radionuclides (10 CFR 61.55). By controlling isotope concentrations in each class, the NRC regulations seek to control potential radiation exposures to future receptors, including inadvertent human intruders (e.g., a water well driller) after the period of active institutional control has ended. The NRC states in 10 CFR 61.7(b)(5) that GTCC LLRW is "generally unacceptable" for near-surface disposal but also recognizes that "there may be some instances where waste with concentrations greater than permitted for Class C waste would be acceptable for near-surface disposal with special processing or design."

The NRC regulations require GTCC LLRW to be disposed of in a geologic repository, as defined in 10 CFR Part 60 or 63, unless proposals for an alternative method are approved by NRC under 10 CFR 61.55(a)(2)(iv). The NRC regulations identify one approved method for the disposal of GTCC LLRW and GTCC-like waste (a geologic repository), but they acknowledge that other disposal methods could be approved.

In addition to protecting individuals from inadvertent intrusion, the preferred disposal alternative must protect the general population and involved workers from potential releases of radioactivity during facility construction and disposal operations. Long-term impacts after completion of the disposal operations and closure of the disposal facility also need to be considered. DOE developed the preferred alternative by considering these aspects along with the various other environmental resource areas discussed in this EIS. DOE structured the GTCC EIS so that the preferred alternative could be identified on the basis of a waste type, site, and disposal method. The preferred alternative is discussed in Section S.8 of this Summary.

S.8 PREFERRED ALTERNATIVE IDENTIFIED

In developing the preferred alternative for the disposal of GTCC LLRW and GTCC-like wastes, DOE considered national security concerns, the projected timing of waste generation and the potential long-term impacts on human health and the environment at the various disposal locations evaluated in the GTCC EIS. DOE also took into consideration applicable laws and requirements (e.g., WIPP LWA as amended [P.L. 102-579 as amended by P.L. 104-201], the LLRWPAA [P.L. 99-240]; other required state permits), costs, compliance with agreements, public input on the Draft EIS, national and state priorities, and other appropriate information.

Given the diverse characteristics (e.g., different radionuclide inventories, range of physical conditions, and derived from both commercial and DOE sources) of GTCC and GTCC-like waste analyzed in this EIS, the preferred alternative selected is not limited to one disposal technology. The preferred alternative for the disposal of GTCC and GTCC-like waste is the WIPP geologic repository (Alternative 2) and/or land disposal at generic commercial facilities (Alternatives 3-5). These land disposal conceptual designs could be altered or enhanced, as necessary, to provide the optimal application at a given location. The preferred alternative does not include land disposal at DOE sites. In addition, there is presently no preference among the three land disposal technologies at the generic commercial sites. The factors considered during the development of the preferred alternative include those discussed in Section S.7 and in the GTCC EIS in Section 2.9: public comment provided on the draft GTCC EIS; disposal site impacts including potential human health impacts, cultural resources and tribal concerns; waste types impacts including radionuclide inventory and characteristics and availability for disposal; and disposal method impacts including inadvertent human intrusion, construction and operation and cost. The analysis in this Final GTCC EIS has provided the Department with the integrated insight needed to identify a preferred alternative with the potential to enable the disposal of the entire waste inventory analyzed in this EIS. Due to the uncertainty regarding the need for legislative changes and/or licensing or permitting changes, further analysis will be needed before a Record of Decision is announced. The Department has determined that the preferred alternative would satisfy the needs of the Department for the disposal of GTCC and GTCC-like waste.

As required by NEPA, DOE will not issue a ROD sooner than 30 days after the issuance of the Final EIS. Prior to issuing a ROD regarding which disposal alternative to implement, DOE must submit a Report to Congress to fulfill the requirement of Section 631(b)(1)(B)(i) of the Energy Policy Act of 2005 (P.L. 109-58) and await action by Congress. Section 631(b)(1)(B)(i) requires that the report include all alternatives under consideration and all the information required in the comprehensive report to ensure safe disposal of GTCC LLRW that was submitted by the Secretary to Congress in February 1987.[5]

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[5] In accordance with the requirements in section 3(b)(3) the LLRWPAA, the 1987 report (http://www.gtcceis.anl.gov/documents/docs/DOE_NE-0077.pdf) included: (1) an identification of the radioactive waste involved, including the source of such waste, and the volume, concentration, and other relevant characteristics of the waste; (2) an identification of the federal and non-federal options for disposal of the waste; (3) a description of actions proposed to ensure the safe disposal of the waste; (4) a description of the projected costs of undertaking such actions; (5) an identification of the options for ensuring that the beneficiaries of the activities resulting in the generation of the waste bear all reasonable costs of disposing of such wastes; and (6) an identification of any statutory authority required for disposal of the waste.

S.9 PRIMARY CHANGES MADE TO THE EIS

On the basis of the public comments received (as summarized in Section S.6.2), the primary change made to the Draft EIS to prepare the Final EIS was the addition of Appendix J, which provides a comment response summary that addresses the comments received on the Draft EIS as well as detailed responses to individual comments, in addition to the discussion of the preferred alternative for the disposal of GTCC LLRW and GTCC-like wastes, which is presented in Section S.8. In performing its due diligence in preparation of this Final EIS, DOE reviewed the waste quantity data and determined that the current expected waste quantity estimates remain valid, are conservative and bounding for the comparative analysis in the Final EIS, and revisions to this information are not necessary. Information that related to census data was also updated to reflect the 2010 census data for the Final EIS; including, for example, socioeconomic, transportation, and environmental justice impacts. The transportation accident analysis was reviewed, and the source terms used in the accident consequence assessment were included in the presentation of the analysis. Other revisions (for clarification or editorial purposes) were also made as a result of public comments received on the Draft GTCC EIS. Finally, site information was also updated on the basis of the further review conducted by DOE Field Offices and information from annual site environmental reports (for the year 2014).

S.10 REFERENCES

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