Office of
Fissile Materials Disposition

United States Department of Energy

Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement

Summary

December 1996

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ABSTRACT: This document analyzes the potential environmental consequences of alternatives for the long-term storage (up to 50 years), including storage until disposition, and disposition of weapons-usable fissile materials from U.S. nuclear weapon dismantlements under the responsibility of the DOE. Long-term storage of nonsurplus inventories of weapons-usable plutonium (Pu) and highly enriched uranium (HEU) are required for national defense purposes, while the disposition of surplus weapons-usable Pu is necessary in order to implement our national nonproliferation policy. In addition to the No Action Alternative, this PEIS assesses three storage alternatives (that is, upgrade at multiple sites, consolidation of Pu, and collocation of Pu and HEU) at six DOE candidate sites located across the country. These sites are Hanford Site, Nevada Test Site, Idaho National Engineering Laboratory, Pantex Plant, Oak Ridge Reservation, and Savannah River Site. Although they are not candidate sites for storage, Rocky Flats Environmental Technology Site (RFETS) and Los Alamos National Laboratory are assessed for the No Action Alternative. For the disposition of surplus Pu, three alternative categories (that is, deep borehole, immobilization, and reactor) with nine primary alternatives are assessed at several DOE and representative sites for analysis purposes. Evaluations of impacts on site infrastructure, water resources, air quality and noise, socioeconomics, waste management, public and occupational health and safety, and environmental justice are included in the assessment. The intersite transportation of nuclear and hazardous materials is also assessed. DOE's Preferred Alternative is identified in this Final PEIS. The Preferred Alternative for storage is a combination of No Action and Upgrade Alternatives for the various DOE sites, and phaseout of Pu storage at RFETS. The Preferred Alternative for disposition of surplus Pu is to pursue a disposition strategy involving a combination of immobilization and reactor alternatives, including vitrification, ceramic immobilization, and existing reactors.

PUBLIC INVOLVEMENT: The DOE issued a Draft PEIS on March 8, 1996, and held a formal public comment period on the Draft through June 7, 1996. In preparing the Final PEIS, DOE considered comments received via mail, fax, electronic bulletin board (Internet), and transcripts of messages recorded by telephone. In addition, comments and concerns were recorded by notetakers during interactive public meetings held during March and April 1996 in Denver, CO, Las Vegas, NV, Oak Ridge, TN, Richland, WA, Idaho Falls, ID, Washington, DC, Amarillo, TX, and North Augusta, SC. Comments received and DOE's responses to those comments are found in Volume IV of the Final PEIS.

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Final Programmatic Environmental Impact Statement/Summary

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FOREWORD

This Summary of the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (PEIS) contains revisions and changes from the Draft PEIS Summary in response to comments, and information regarding the Department's Preferred Alternative. The Draft PEIS Summary has also been reorganized to provide a clear description of the environmental impacts of the Preferred Alternative and the comparison of storage and disposition alternatives including the Preferred Alternative.

The bar charts used in the Draft PEIS Summary to show impacts of various resources have been removed and replaced with narrative descriptions including pertinent data. New sections have been added to present the environmental impacts and cumulative impacts of the Preferred Alternative. Finally, a summary of major issues identified during the comment period and changes to the Draft PEIS is provided. Changes to the Draft PEIS Summary are denoted by sidebars (vertical lines adjacent to the text) in this Final PEIS Summary to facilitate review by the reader.

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LIST OF ACRONYMS AND ABBREVIATIONS

ANL-W	Argonne National Laboratory-West
APSF	Actinide Packaging and Storage Facility
ARIES	Advanced Recovery and Integrated Extraction System
BWR	boiling water reactor
CANDU	Canadian Deuterium Uranium
DNFSB	Defense Nuclear Facilities Safety Board
DoD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DWPF	Defense Waste Processing Facility
EIS	environmental impact statement
ESA	*Endangered Species Act*
ES&H	environmental, safety, and health
FFTF	Fast Flux Test Facility
FMF	Fuel Manufacturing Facility
FONSI	Finding of No Significant Impact
GBZ	glass-bonded zeolite
Hanford	Hanford Site
HEU	highly enriched uranium
HEU EIS	*Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement*
HLW	high-level waste
ICPP	Idaho Chemical Processing Plant
IMNM EIS	*Environmental Impact Statement, Interim Management of Nuclear Materials*
INEL	Idaho National Engineering Laboratory
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
LWR	light water reactor
MEI	maximally exposed individual
MOX	mixed oxide
NEPA	*National Environmental Policy Act* of 1969
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System

NRHP	National Register of Historic Places
NTS	Nevada Test Site
NWPA	*Nuclear Waste Policy Act*
ORR	Oak Ridge Reservation
Pantex	Pantex Plant
PEIS	programmatic environmental impact statement
PFP	Plutonium Finishing Plant
PRA	Probabilistic Risk Assessment
PSD	Prevention of Significant Deterioration
PWR	pressurized water reactor
R&D	Research and Development
RCRA	*Resource Conservation and Recovery Act*
REA	regional economic area
RFETS	Rocky Flats Environmental Technology Site
ROD	Record of Decision
ROI	region of influence
RWMC	Radioactive Waste Management Complex
RWMS	Radioactive Waste Management Site
SRS	Savannah River Site
Stockpile Stewardship and Management PEIS	*Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*
Storage and Disposition PEIS	*Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement*
TRU	transuranic
TSP	total suspended particulates
TSR PEIS	*Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling*
VRM	Visual Resource Management
WIPP	Waste Isolation Pilot Plant
WSA	Weapons Storage Area
Y–12	Y–12 Plant
Y–12 EA	*Environmental Assessment for the Proposed Interim Storage of Highly Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant*
ZPPR	Zero Power Physics Reactor

CHEMICALS AND UNITS OF MEASURE

cm	centimeter
Cs	cesium
Cs-137	cesium-137
CsCl	cesium chloride
gal	gallon
ha	hectare
H_2O	hydrogen oxide, or (light) water
in	inch
kg	kilogram
km	kilometer
l	liter
lb	pound
m^3	cubic meter
mi	mile
MLY	million liters per year
mrem	millirems
PM_{10}	particulate matter less than or equal to 10 microns in diameter
Pu	plutonium
Pu-238	plutonium-238
Pu-242	plutonium-242
PuO_2	plutonium dioxide
t	metric ton
tons	short tons
UO_2	uranium dioxide
yd^3	cubic yards
yr	year

METRIC CONVERSION CHART

To Convert Into Metric			To Convert Out of Metric		
If You Know	**Multiply By**	**To Get**	**If You Know**	**Multiply By**	**To Get**
Length					
inches	2.54	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.0328	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.0936	yards
miles	1.60934	kilometers	kilometers	0.6214	miles
Area					
sq. inches	6.4516	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.092903	sq. meters	sq. meters	10.7639	sq. feet
sq. yards	0.8361	sq. meters	sq. meters	1.196	sq. yards
acres	0.40469	hectares	hectares	2.471	acres
sq. miles	2.58999	sq. kilometers	sq. kilometers	0.3861	sq. miles
Volume					
fluid ounces	29.574	milliliters	milliliters	0.0338	fluid ounces
gallons	3.7854	liters	liters	0.26417	gallons
cubic feet	0.028317	cubic meters	cubic meters	35.315	cubic feet
cubic yards	0.76455	cubic meters	cubic meters	1.308	cubic yards
Weight					
ounces	28.3495	grams	grams	0.03527	ounces
pounds	0.45360	kilograms	kilograms	2.2046	pounds
short tons	0.90718	metric tons	metric tons	1.1023	short tons
Temperature					
Fahrenheit	Subtract 32 then multiply by 5/9ths	Celsius	Celsius	Multiply by 9/5ths, then add 32	Fahrenheit

METRIC PREFIXES

Prefix	Symbol	Multiplication Factor
exa-	E	1 000 000 000 000 000 000 = 10^{18}
peta-	P	1 000 000 000 000 000 = 10^{15}
tera-	T	1 000 000 000 000 = 10^{12}
giga-	G	1 000 000 000 = 10^{9}
mega-	M	1 000 000 = 10^{6}
kilo-	k	1 000 = 10^{3}
hecto-	h	100 = 10^{2}
deka-	da	10 = 10^{1}
deci-	d	0.1 = 10^{-1}
centi-	c	0.01 = 10^{-2}
milli-	m	0.001 = 10^{-3}
micro-	μ	0.000 001 = 10^{-6}
nano-	n	0.000 000 001 = 10^{-9}
pico-	p	0.000 000 000 001 = 10^{-12}
femto-	f	0.000 000 000 000 001 = 10^{-15}
atto-	a	0.000 000 000 000 000 001 = 10^{-18}

Summary

S.1 INTRODUCTION

The end of the Cold War created a legacy of weapons-usable fissile materials both in the United States and the former Soviet Union. Substantial quantities of these materials, including plutonium (Pu) and highly enriched uranium (HEU), are no longer needed for defense purposes. Further agreements on disarmament between the United States and Russia may increase the surplus quantities of these materials. The global stockpiles of weapons-usable fissile materials pose a danger to national and international security in the form of potential proliferation of nuclear weapons and potential environmental, safety, and health consequences if the materials are not properly safeguarded and managed.

In September 1993, President Clinton issued the *Nonproliferation and Export Control Policy* in response to the growing threat of nuclear weapons proliferation. Further, in January 1994, President Clinton and Russia's President Yeltsin issued a *Joint Statement Between the United States and Russia on Nonproliferation of Weapons of Mass Destruction and Means of their Delivery*. In accordance with these policies, the focus of the U.S. nonproliferation efforts in this regard is five-fold: to secure nuclear materials in the former Soviet Union; to ensure safe, secure, long-term storage and disposition of surplus fissile materials; to establish transparent and irreversible nuclear reductions; to strengthen the nuclear nonproliferation regime; and to control nuclear exports.

To demonstrate the U.S. commitment to these objectives, the President announced on March 1, 1995, that 200 metric tons (t) (220 short tons [tons]) of U.S. fissile materials, 38.2 t (42.1 tons) of which is weapons-grade Pu (as stated in the Department of Energy's [DOE's] Openness Initiative of February 6, 1996), had been declared surplus to the U.S. nuclear defense needs. The United States is proceeding with plans and actions to ensure the continued safe, secure, and environmentally sound storage of its own weapons-usable fissile materials and is cooperating with Russia in an effort to reduce the risk of nuclear weapons proliferation. Additionally, DOE and its national laboratories have recently completed a joint study with Russia on technical options for the disposition of weapons-usable Pu.

Weapons-Usable Fissile Materials
(Covered in the Programmatic Environmental Impact Statement)

All isotopes of Pu (except plutonium-238 [Pu-238]) and HEU that contain at least 20 percent uranium-235.[1]

A key element of DOE's decisionmaking is a thorough understanding of the environmental impacts that may occur during the implementation of the proposed action. The *National Environmental Policy Act* of 1969 (NEPA), as amended, requires Federal agencies to prepare an environmental impact statement (EIS) on all major Federal actions significantly affecting the quality of the human environment. In following this process, DOE has prepared the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (Storage and Disposition PEIS) to analyze various storage and disposition alternatives and to provide the necessary background, data, and analyses to help decisionmakers and the public understand the potential environmental impacts of each alternative. The results of the environmental analyses, together with information from technical and economic studies, nonproliferation analysis, and public input, will form the basis for DOE's decisions, which will be given in a Record of Decision (ROD) to be issued no sooner than

[1] Does not include spent nuclear fuel, irradiated targets, uranium-233, or Department of Defense (DoD) weapons program material in use.

30 days after publication of the Environmental Protection Agency's Notice of Availability of the Final PEIS. This process will also provide the United States with the basis and flexibility to implement Pu disposition efforts either multilaterally or bilaterally through negotiations or unilaterally as an example to Russia and other nations.

THE PROPOSED ACTION

The Department proposes to take the following actions for U.S. weapons-usable fissile materials:

- Storage—provide a long-term storage system (for up to 50 years) for nonsurplus Pu and HEU that meets the Stored Weapons Standard[2] and applicable environmental, safety, and health standards while reducing storage and infrastructure[3] costs

> *Stored Weapons Standard*
>
> The high standards of security and accounting for the storage of intact nuclear weapons should be maintained, to the extent practical, for weapons-usable fissile materials throughout dismantlement, storage, and disposition.

- Storage Pending Disposition—provide storage that meets the Stored Weapons Standard for inventories of weapons-usable Pu and HEU[4] that have been or may be declared surplus
- Disposition[5]—convert surplus Pu and Pu that may be declared surplus in the future to forms that meet the Spent Fuel Standard,[2] thereby providing evidence of irreversible disarmament and setting a model for proliferation resistance

> *Spent Fuel Standard*
>
> The surplus weapons-usable Pu should be made as inaccessible and unattractive for weapons use as the much larger and growing quantity of Pu that exists in spent nuclear fuel from commercial power reactors.

The Department's inventories of Pu and HEU are located at a number of DOE sites, including Hanford Site (Hanford), Idaho National Engineering Laboratory (INEL), Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL), Oak Ridge Reservation (ORR), Pantex Plant (Pantex), Rocky Flats Environmental Technology Site (RFETS), and Savannah River Site (SRS). These weapons-usable fissile materials are divided into two categories: surplus and nonsurplus. Surplus materials include those the President

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2 Modified from *Management and Disposition of Excess Weapons Plutonium*, National Academy of Sciences, 1994.

3 Includes electrical power, fuel, transportation network requirements, and safeguards/security.

4 The Storage and Disposition PEIS covers long-term storage of nonsurplus HEU and storage of surplus HEU pending disposition. Until storage decisions are implemented, surplus HEU that has not gone to disposition will continue to be stored pursuant to, and not to exceed the 10-year interim storage time period evaluated in the *Environmental Assessment for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y–12 Plant, Oak Ridge, Tennessee* (Y–12 EA) (DOE/EA-0929, September 1994) and Finding of No Significant Impact (FONSI).

5 Disposition of surplus HEU is addressed in a separate document, the *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (DOE/EIS-0240, June 1996).

has declared surplus to national defense needs in response to recommendations from the Nuclear Weapons Council (made up of representatives from DOE, the DoD, and the Joint Chiefs of Staff) and those that may be declared surplus in the future. The nonsurplus materials include naval nuclear fuel, strategic reserves, programmatic materials (non-weapons research and development [R&D], weapons R&D, and other programmatic materials), and weapons program materials in use, as shown in Figure S.1–1. Weapons program materials in use are not within the scope of the PEIS. The forms of the weapons-usable fissile materials are primarily pits and secondaries (weapons components bearing Pu and HEU, respectively) and metals and oxides of Pu and HEU.

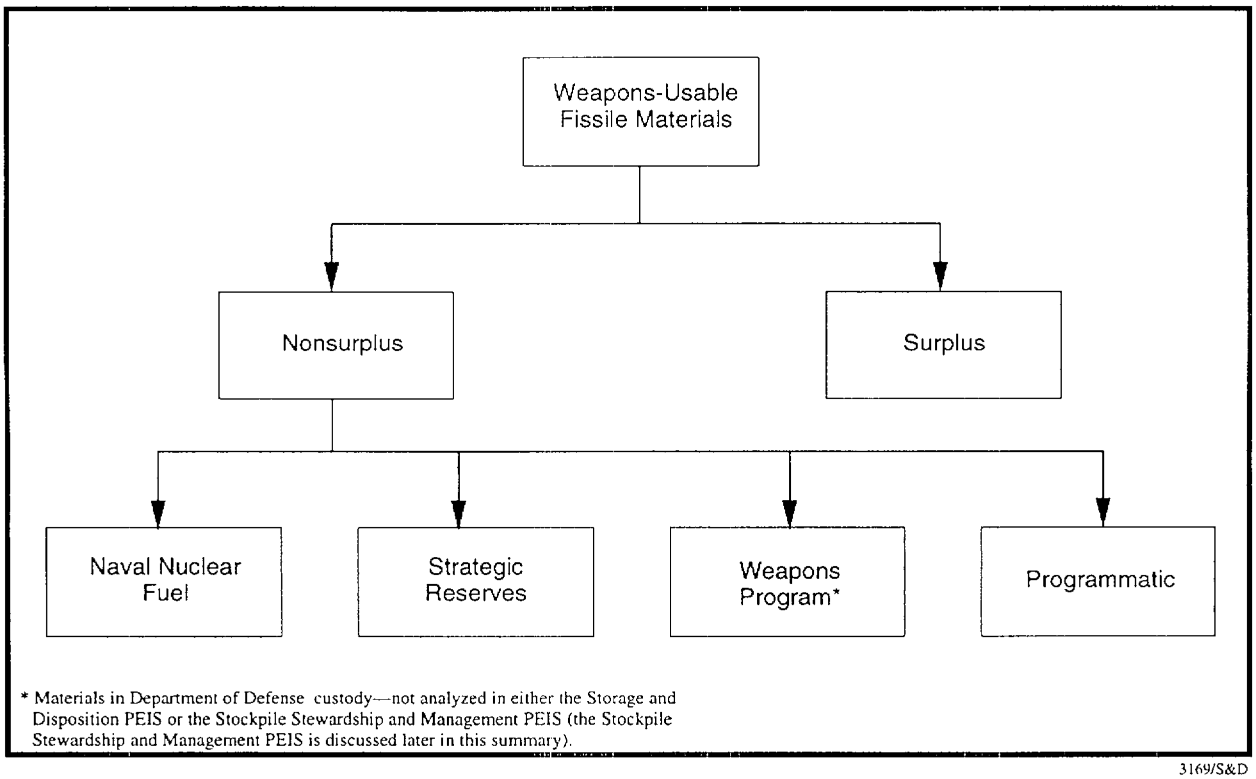

Figure S.1–1. Weapons-Usable Fissile Material Categories.

Purpose of and Need for the Proposed Action

The purpose of the proposed action is to implement the President's *Nonproliferation and Export Control Policy* in a safe, reliable, cost-effective, and timely manner. DOE is proposing a comprehensive program to accomplish this purpose by providing an exemplary long-term storage system for weapons-usable fissile materials, eliminating the stockpile of surplus weapons-usable Pu, and establishing the technical and program infrastructure that will provide for disposition of the surplus weapons-usable Pu in the United States.

The weapons-usable fissile materials declared surplus by the President (March 1995) are in various compositions and forms. A storage plan is needed to provide continued adequate control of these surplus materials and any that may be declared surplus in the future, from now through final disposition, as well as management and long-term storage of nonsurplus fissile materials that will not be subject to disposition. Approximately 89 t (98 tons) of Pu (reported in DOE's Openness Initiative on December 7, 1993) and 994 t (1,095 tons) of HEU (reported in DOE's Openness Initiative on June 29, 1994) were produced by the United States during the period its production facilities were in operation. Some of these materials have been used in weapons or for other programmatic purposes, some of the remainder have been declared surplus, and additional materials could be declared surplus in the future. Disposition of surplus Pu is needed to reduce reliance on

institutional controls and to provide visible evidence of irreversible disarmament. Therefore, a comprehensive long-term storage and disposition action is needed to ensure that weapons-usable fissile materials are properly managed and to prevent the potential increase of environmental, safety, and health risks. DOE also recognizes the need to strengthen national and international arms control efforts by providing a storage and disposition model for the international community. This action will enhance U.S. credibility and flexibility in negotiations on bilateral or multilateral reductions of surplus weapons-usable fissile material inventories.

Scope of the Programmatic Environmental Impact Statement

The Storage and Disposition PEIS analyzes the direct, indirect, and cumulative environmental effects of reasonable alternatives for the long-term storage of nonsurplus Pu and HEU, the storage of surplus Pu and HEU pending disposition, and the disposition of surplus Pu. A separate DOE document, *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (HEU EIS), addresses the disposition of surplus HEU. The HEU EIS (DOE/EIS-0240) was issued in June 1996, and the ROD published on August 5, 1996.

The Storage and Disposition PEIS includes analyses of storing 89 t (98 tons) of Pu and 994 t (1,093 tons) of HEU (reported in DOE's Openness Initiative referenced above). The PEIS also analyzes the disposition of a nominal 50 t (55.1 tons) of Pu, including the 38.2 t (42.1 tons) of Pu that has been declared surplus as well as Pu that may be declared surplus in the future (although the exact quantity of Pu that may be declared surplus is not known at this time). The locations of the surplus material in the DOE complex are shown in Figures S.1–2 and S.1–3.

The Storage and Disposition PEIS assumes that the weapons-usable fissile material is in a stabilized form; the PEIS begins, as a starting point, after stabilization has been completed. DOE is currently in the process of stabilizing and repackaging weapons-usable fissile materials and placing them in safe, secure storage awaiting decisions on long-term storage and disposition. For Pu, this is being accomplished in accordance with the corrective actions identified in DOE's *Plutonium Vulnerability Management Plan* (DOE/EM-0199). This plan was developed in response to an assessment in DOE's *Plutonium Working Group Report* (DOE/EH-0415) and recommendations by the Defense Nuclear Facilities Safety Board (DNFSB) in DNFSB Recommendation 94-1. In addition, Pu materials will also meet the *Criteria for Safe Storage of Plutonium Metals and Oxides* (DOE-STD-3013-94), a DOE standard for long-term storage (at least 50 years) of these materials. Similarly, the HEU materials requiring long-term storage will meet criteria for safe storage of HEU metals and oxides; these criteria are under development at this time. Appropriate environmental documentation will be prepared, as necessary, for stabilizing and repackaging the Pu and HEU materials to meet respective long-term storage criteria.

Following the discontinuance of nuclear weapons material production, large quantities of residues remained as a result of the chemical and thermal processes used to separate and purify Pu. Examples of residue forms include some impure oxides and metals, halide salts, combustibles, ash, sludges, and contaminated glass. To meet requirements of DOE's *Plutonium Vulnerability Management Plan,* as well as various compliance agreements with State and local regulatory agencies, some Pu residues must be stabilized. As a result of the stabilization process, portions of the residues will potentially be concentrated and stored. These concentrates may be in a form and concentration (greater than 50 percent Pu by weight) that is weapons-usable and are therefore included in the PEIS.[6]

The Storage and Disposition PEIS pertains to weapons-usable fissile materials that meet all of the standards and criteria previously described. Fissile materials present in spent nuclear fuel or irradiated targets from reactors

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[6] As a result of the stabilization process, there will also be non-weapons-usable Pu or HEU contaminated wastes or residues (less than 50 percent Pu by weight) that would not be within the scope of the PEIS. On November 19, 1996, DOE announced its intention to prepare an EIS on the *Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site* (61 FR 58866). This EIS will evaluate the potential environmental impacts associated with reasonable management alternatives for certain Pu residues and all scrub alloy currently stored at RFETS.

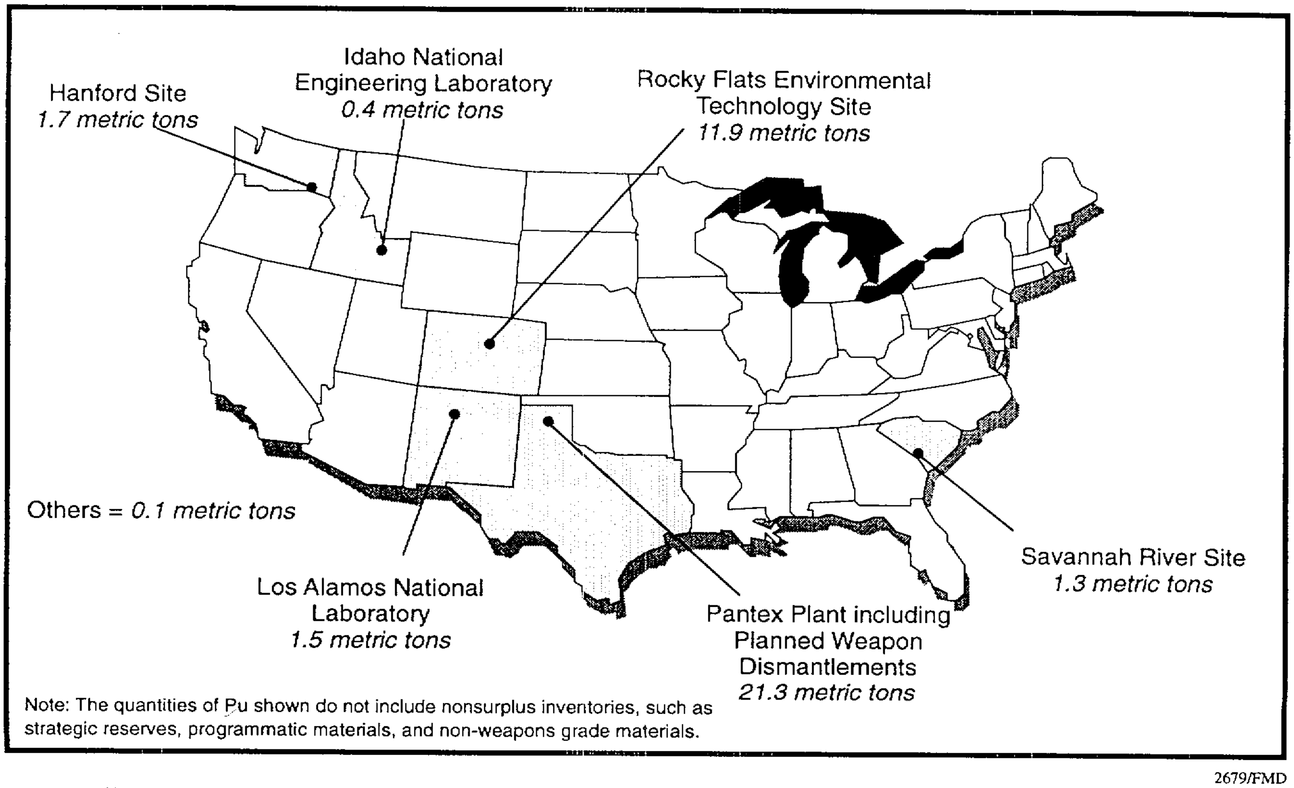

Figure S.1–2. Department of Energy Locations With Surplus Weapons-Grade Plutonium Inventories in September 1994.

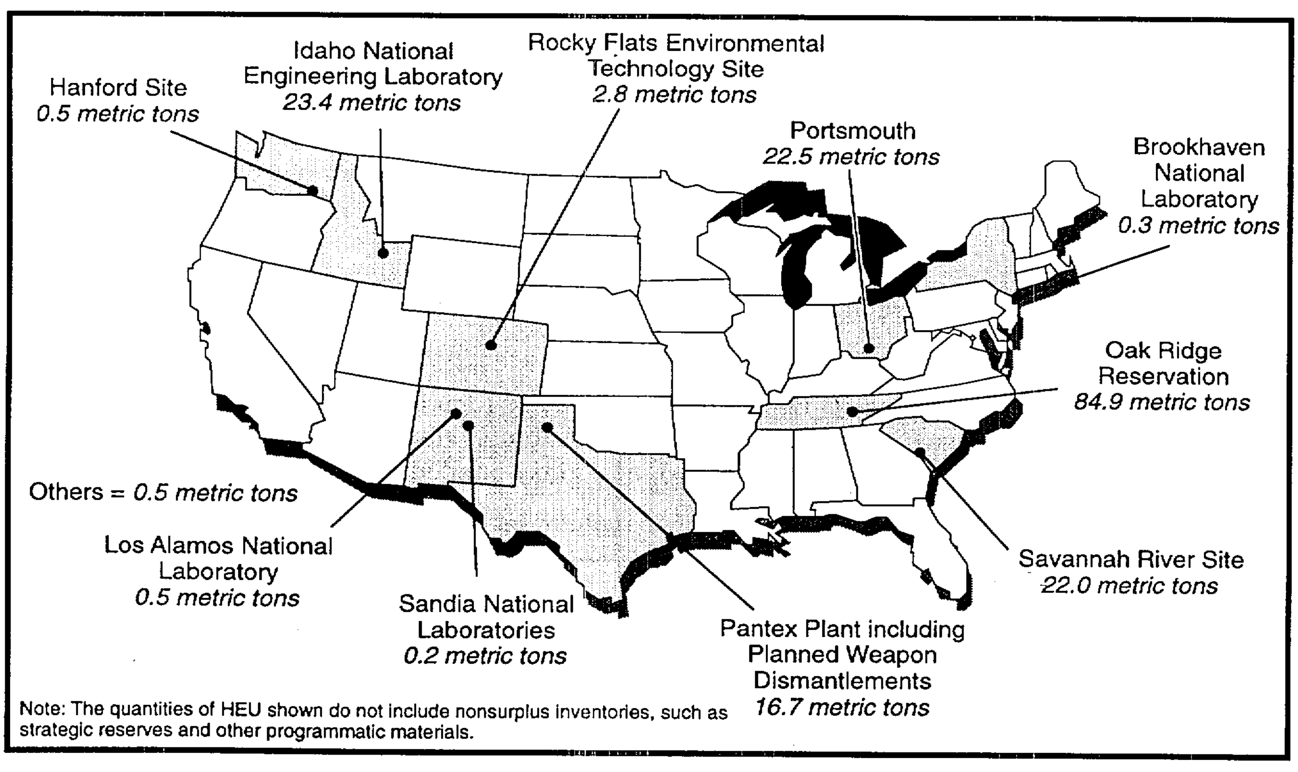

Figure S.1–3. Department of Energy Locations With Surplus Highly Enriched Uranium Inventories on February 6, 1996.

are not covered in the PEIS; they are not considered weapons-usable because separation of the relevant isotopes from these highly radioactive materials requires significant remote chemical processing. Reprocessing and extraction of Pu from spent fuel is not proposed, and is beyond the scope and the fundamental nonproliferation purpose of the program covered by the PEIS.

Decisions to be Made

The Storage and Disposition Draft PEIS was circulated for public review and comment from March 8 through June 7, 1996. Eight public meetings in the vicinity of DOE sites under consideration for the Proposed Action, and in Washington, DC, were held during the comment period. Approximately 8,700 comments were received from other Federal government agencies, State and local governments, Native American tribes, special interest groups, and the public. These comments, along with DOE's responses, became a part of the Final PEIS. DOE also made available for public review, the results of the technical, cost and schedule analyses in July and October 1996, as well as the nonproliferation analysis in November 1996. Along with the PEIS, these analyses will support a formal ROD regarding Pu and HEU storage and surplus Pu disposition. [Text deleted.] These decisions are as follows:

For storage:

- The strategy for long-term storage of nonsurplus weapons-usable Pu and nonsurplus HEU
- The strategy for storage of surplus Pu and surplus HEU pending disposition
- The storage site(s) and (if appropriate) facilities

For disposition:

- The strategy and technologies for disposition of surplus weapons-usable Pu

The Department, with interagency coordination, will then issue the ROD. Following the ROD, subsequent tiered and project-specific NEPA documents will be prepared. The tiered NEPA reviews will analyze alternative locations for disposition activities.

Plutonium Immobilization

A process that converts Pu to a chemically stable form for disposition. The forms analyzed in the PEIS include glass (through vitrification), ceramic (through ceramic immobilization), and glass-bonded zeolite (through electrometallurgical treatment).

Mixed Oxide Fuel

A blend of uranium dioxide [UO_2] and plutonium dioxide [PuO_2] that produces a fuel suitable for use in a nuclear reactor to generate electric power.

Light Water Reactor

A nuclear reactor in which circulating water consisting of light water (hydrogen oxide [H_2O]) is used to cool the reactor core and reduce the energy of neutrons created in the core by fission reactions. All commercial reactors in the United States are LWRs.

Canadian Deuterium Uranium Reactor

A Canadian nuclear reactor in which the circulating water consists of heavy water (deuterium oxide). Deuterium is an isotope of hydrogen having twice the mass of hydrogen. All commercial reactors in Canada are heavy water reactors.

S.2 PREFERRED ALTERNATIVE

STORAGE

The Department's Preferred Alternative for storage is to reduce, over time, the number of locations where the various forms of Pu are stored, through a combination of storage alternatives in conjunction with a combination of disposition alternatives. DOE would begin implementing this Preferred Alternative by moving surplus Pu from RFETS as soon as possible, transporting the pits to Pantex as early as 1997, and the non-pit Pu materials to SRS beginning in 2002. Over time, DOE would store Pu in upgraded facilities at Pantex and in an expanded, planned new facility at SRS, and store nonsurplus HEU and surplus HEU pending disposition in upgraded and consolidated facilities at ORR. Storage facilities would also be modified, as needed, to accommodate international inspection requirements consistent with the President's *Nonproliferation and Export Control Policy*. Accordingly, DOE's Preferred Alternative for storage would call for the following actions:

- **Phase out storage of all weapons-usable Pu at RFETS beginning in 1997; move pits to Pantex, and non-pit materials to SRS.** At Pantex, DOE would repackage pits from RFETS in Zone 12, then place them in existing storage facilities in Zone 4, pending completion of facility upgrades in Zone 12. At SRS, DOE would expand the planned new Actinide Packaging and Storage Facility (APSF), and move non-pit Pu materials from RFETS, after stabilization at RFETS, to the expanded APSF upon completion. The small number of pits currently at RFETS that are not in shippable form would be placed in a shippable condition in accordance with existing procedures prior to shipment to Pantex. Additionally, some pits and non-pit Pu materials from RFETS could be used at SRS, LANL, and LLNL for tests and demonstrations of aspects of disposition technologies (see Preferred Alternative for disposition as discussed later in this section). All non-pit weapons-usable Pu materials currently stored at RFETS are surplus.

- **Upgrade storage facilities at Zone 12 South (to be completed by 2004) at Pantex to store those pits currently stored at Pantex, and pits from RFETS, pending disposition. Storage facilities at Zone 4 would continue to be used for these pits prior to completion of the upgrade.** This action would place pits at a central location where most pits already reside and where expertise and infrastructure exist to accommodate pit storage.

- **In accordance with the Preferred Alternative in the *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (Stockpile Stewardship and Management PEIS), store Strategic Reserve pits at Pantex in the facilities discussed above. To the extent not reflected above, store Strategic Reserve materials in accordance with the Preferred Alternative in the Stockpile Stewardship and Management PEIS.**

- **Expand the APSF (Upgrade Alternative) at SRS to store those surplus, non-pit Pu materials currently at SRS and surplus non-pit Pu materials from RFETS, pending disposition** (see Preferred Alternative for disposition as discussed later in this section). The APSF would be built by 2001 pursuant to the *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (IMNM EIS) (DOE/EIS-0220) and ROD, and the expansion to accommodate RFETS material would be completed by 2002. The RFETS surplus non-pit Pu materials would be moved to SRS after stabilization is performed at RFETS under corrective actions in response to recommendation 94-1 by the DNFSB, and after completion of the APSF expansion. This action would place non-pit Pu materials in a new storage facility, in a location with existing expertise and Pu handling capabilities and where potential disposition activities could occur (see Preferred Alternative for disposition as discussed later in this section). Strategic pits currently located at SRS would be stored in accordance with the Preferred Alternative in the Stockpile Stewardship and Management PEIS. There are no strategic non-pit materials currently located at SRS.

- **Continue current storage (No Action) of surplus Pu at Hanford and INEL, pending disposition** (or movement to lag storage[7] at the disposition facilities). This action would allow surplus Pu to remain at the sites with existing expertise and Pu handling capabilities, and where potential disposition activities could occur (see Preferred Alternative for disposition as discussed later in this section). There are no nonsurplus weapons-usable Pu materials currently stored at either site.

- **Continue current storage (No Action) of surplus Pu at LANL, pending disposition** (or movement to lag storage at the disposition facilities). This Pu would be stored in stabilized form with the nonsurplus Pu in the upgraded Nuclear Material Storage Facility pursuant to the No Action Alternative for the site.

- **Take No Action at the Nevada Test Site (NTS).** DOE would not add Pu to sites that do not currently have Pu in storage.

- **Upgrade storage facilities at the Y–12 Plant (Y–12) (to be completed by 2004, or earlier) at ORR to store nonsurplus HEU and surplus HEU pending disposition.** Existing storage facilities at Y–12 would be modified to meet natural phenomena requirements, as documented in *Natural Phenomena Upgrade of the Downsized/Consolidated Oak Ridge Uranium/Lithium Plant Facilities* (Y/EN-5080, 1994). Storage facilities would be consolidated and the storage footprint would be reduced as surplus HEU is dispositioned and blended to low-enriched uranium, pursuant to the HEU EIS. Consistent with the Preferred Alternative in the Stockpile Stewardship and Management PEIS, HEU strategic reserves would be stored at the Y–12 Plant.

DISPOSITION

The Department's Preferred Alternative for the disposition of surplus Pu is to pursue a disposition strategy that allows for immobilization of surplus weapons Pu in glass or ceramic forms and burning of the surplus Pu as mixed oxide (MOX) fuel in existing reactors. The disposition of the surplus Pu using these technological approaches would depend on the results of future technology development and demonstrations, site-specific environmental analyses, and detailed cost proposals as well as nonproliferation considerations. The results of

[7] Lag storage is temporary storage at the applicable disposition facility.

these efforts and negotiations with Russia and other nations will ultimately determine the timing and extent to which either or both technologies are deployed.[8]

Under this Preferred Alternative, the U.S. policy not to encourage the civil use of Pu and, accordingly, not to itself engage in Pu reprocessing for either nuclear power or nuclear explosive purposes will not change. Although under the Preferred Alternative some Pu may ultimately be burned in existing reactors, every possible means will be pursued to ensure that Federal support for this unique disposition mission does not encourage other civil uses of Pu or Pu reprocessing. The United States, however, will maintain its commitments regarding the use of Pu in civil nuclear programs in Western Europe and Japan.

Proceeding with this strategy would provide increased flexibility to initiate Pu disposition promptly, and help assure disposition efforts could be accomplished in a timely manner. Establishing the means for expeditious Pu disposition would also help provide the basis for an international cooperative effort that can result in reciprocal, irreversible Pu disposition actions by Russia. DOE's preferred disposition strategy signals a strong U.S. commitment to reducing its stockpile of surplus Pu, thereby effectively meeting the purpose of and need for the Proposed Action.

To accomplish the Pu disposition mission, DOE would consider, to the extent practical, new as well as modified existing buildings and facilities for portions of the disposition activities. The PEIS analyzes new facilities for most disposition alternatives to obtain bounding environmental impacts. DOE would analyze and compare existing and new buildings and facilities for the technologies chosen as part of this strategy in subsequent, tiered NEPA review. In addition, all disposition facilities would be designed or modified, as needed, to accommodate international inspection requirements consistent with the President's *Nonproliferation and Export Control Policy*. Accordingly, DOE's Preferred Alternative for Pu disposition involves the following strategy and supporting actions:

- **Immobilize Pu materials using vitrification or ceramic immobilization.** The immobilization technology could be used for processing pure or impure forms of Pu. Vitrification or ceramic immobilization could include the can-in-canister variant, which could utilize the existing high-level wastes (HLW) and the Defense Waste Processing Facility (DWPF) at SRS, or new facilities at Hanford or SRS. DOE would continue the R&D leading to the demonstration of the can-in-canister variant at the DWPF using surplus Pu.

- **Convert Pu materials into MOX fuel for use in existing reactors.** Pure materials including pits, pure metal, and oxides could be converted without extensive processing into MOX fuel for use in existing commercial reactors. Other, already separated forms of surplus Pu would require additional cleanup (not reprocessing of spent nuclear fuel). The MOX fuel would be used in existing light water reactors (LWRs) with a once-through fuel cycle, with no reprocessing and subsequent reuse of the spent fuel. If partially completed LWRs were to be completed by other parties, they would be considered for this mission. The MOX fuel would be fabricated in a domestic, government-owned facility at a DOE site.

  The Department would retain using MOX fuel in Canadian Deuterium Uranium (CANDU) reactors in Canada in the event that a multilateral agreement to use CANDU reactors is negotiated among Russia, Canada, and the United States. DOE would engage in a test and demonstration for CANDU MOX fuel as appropriate and consistent with future cooperative efforts with Russia and Canada.

With regard to the above, for purposes of analysis of an approach involving a combination of both technologies, approximately 70 percent of the surplus Pu was identified to be in forms (metals and other pure forms) suitable

[8] Through these efforts, the President would be provided the basis and flexibility to initiate disposition efforts either multilaterally or bilaterally through negotiations or unilaterally as an example to Russia and other nations.

for MOX fuel. The actual percentage and timing for disposition of the surplus Pu using either or a combination of both of the technological approaches would depend on the results of international agreements, future technology development and demonstrations, site-specific environmental assessments, and detailed cost proposals to be completed within the next 2 years. The results of these efforts, as well as nonproliferation considerations and negotiations with Russia and other nations, will ultimately determine the timing and extent to which either or both technologies are deployed for disposition of surplus Pu. In the event both technologies are deployed, and because the time required for Pu disposition using reactors would be longer than that for immobilization, it is probable that some surplus Pu would be immobilized initially, prior to completion of reactor irradiation for other surplus Pu. Deployment of this strategy would involve the following supporting actions:

- **Constructing and operating a Pu vitrification or ceramic immobilization facility at either Hanford or SRS.** DOE would analyze alternative locations at these two sites for constructing new or potentially using modified existing buildings in subsequent tiered NEPA review. SRS has existing facilities and infrastructure to support an immobilization mission, and Hanford has existing plans for constructing and operating immobilization facilities for the wastes in Hanford tanks. DOE would not create new infrastructure for immobilizing Pu with HLW or cesium (Cs) at INEL, NTS, ORR, or Pantex.

- **Constructing and operating a Pu conversion facility[9] at either Hanford or SRS.** DOE would collocate the Pu conversion facility with the vitrification or ceramic immobilization facility discussed above. In subsequent, tiered NEPA reviews, DOE would analyze alternative locations at Hanford and SRS, for constructing new or potentially using modified existing buildings.

- **Constructing and operating a pit disassembly/conversion facility[10] at Hanford, INEL, Pantex, or SRS.** DOE would not add Pu to sites that do not currently have Pu in storage. Therefore, two sites analyzed in the PEIS, NTS and ORR, would not be considered further for Pu disposition activities. DOE would analyze alternative locations at Hanford, INEL, Pantex, and SRS for constructing new or potentially using modified existing buildings in subsequent tiered NEPA review. DOE would demonstrate the Advanced Recovery and Integrated Extraction System (ARIES) concept at LANL for pit disassembly/conversion beginning in fiscal year 1997.

- **Constructing and operating a domestic, government-owned, MOX fuel fabrication facility at Hanford, INEL, Pantex, or SRS.** DOE would not add Pu to sites that do not currently have Pu in storage. Therefore, two sites analyzed in the PEIS, NTS and ORR, would not be considered further for Pu disposition activities. The MOX fuel fabrication facility would serve only the finite mission of fabricating MOX fuel using surplus Pu for the purpose of Pu disposition. DOE would analyze alternative locations at Hanford, INEL, Pantex, and SRS, for constructing new or potentially using modified existing buildings in subsequent tiered NEPA review.

Depending upon decisions in the ROD and pursuant to appropriate NEPA review(s), DOE would continue R&D and engage in further testing and demonstrations of Pu disposition technologies which may include: dissolution of small quantities of Pu in both glass and ceramic formulation; experiments with immobilization equipment and systems; fabrication of MOX fuel pellets for demonstrations of reactor irradiation at INEL; mechanical milling and mixing of Pu and feed forms; and testing of shipping and storage containers for certification, in addition to the testing and demonstrations previously described for the can-in-canister immobilization variant

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9 The Pu conversion facility would convert surplus non-pit Pu material (using a wet chemical process) into a metal or oxide form suitable for use at the next facility in the disposition process.

10 The pit disassembly/conversion facility would dissemble, reshape, and convert surplus Pu pits (using a dry chemical process) into an unclassified metal or oxide form suitable for use at the next facility in the disposition process. In addition, some non-pit Pu material may also be processed in this facility.

and the ARIES. These tests and demonstrations would slightly reduce the quantity of RFETS pit and non-pit materials to be stored at Pantex and SRS, respectively.

The storage and disposition actions proposed for various DOE sites by the Preferred Alternative are summarized in Table S.2–1.

Table S.2–1. Storage and Disposition Actions Proposed by the Preferred Alternative

Action	Hanford	NTS	INEL	Pantex	ORR	SRS	RFETS	LANL
Storage								
No Action	X[a]	X[b]	X[a]					X[a]
Upgrade				X[c]	X[d]	X[e]		
Phaseout							X	
Disposition[f]								
Pit Disassembly/Conversion	X		X	X		X		
MOX Fuel Fabrication	X		X	X		X		
Pu Conversion	X					X		
Immobilization	X					X		

[a] Pending subsequent tiered NEPA decisions for disposition of surplus Pu.
[b] NTS does not currently store either Pu or HEU.
[c] For storage of those pits currently at Pantex and pits from RFETS.
[d] For storage of HEU only.
[e] For storage of only those Pu materials currently at SRS and non-pit Pu materials from RFETS.
[f] "X" denotes potential sites for locating the disposition facilities pending subsequent tiered NEPA decisions. Only one of each facility is needed for accomplishing the disposition mission.

S.3 DEVELOPMENT OF ALTERNATIVES

The Storage and Disposition PEIS analyzes a number of reasonable alternatives for storage and disposition in addition to the No Action Alternative. DOE used a screening process along with public input to identify a range of reasonable alternatives for the storage and disposition of weapons-usable fissile materials. The process was conducted by a screening committee that consisted of experts from DOE assisted by technical advisors from DOE's national laboratories and other support staff. The committee was responsible for identifying the reasonable alternatives to be evaluated. It compared alternatives against screening criteria, considered input from the public, and used technical reports and analyses from the national laboratories and industry to develop a final list of alternatives.

The first step in the screening process was to develop criteria against which to judge potential alternatives. The criteria were developed for the screening process based on the President's *Nonproliferation and Export Control Policy* of September 1993, the *Joint Statement Between the United States and Russia on Nonproliferation of Weapons of Mass Destruction and the Means of Their Delivery* of January 1994, and the analytical framework established by the National Academy of Sciences in its 1994 report, *Management and Disposition of Excess Weapons Plutonium*. The criteria include resistance to theft and diversion; resistance to retrieval and reuse; impact to environment, safety, and health (ES&H); public and institutional acceptance; timeliness and technological viability; cost-effectiveness; international cooperation; and additional benefits. The criteria were discussed at the public scoping workshops, and participants were invited to comment further using questionnaires. The questionnaires allowed participants to rank criteria based on relative importance, comment on the appropriateness of the criteria, and suggest new criteria. Details on how the screening process was developed and applied, and the results obtained from the process, were published in a separate report, the *Summary Report of the Screening Process* (DOE/MD-0002, March 1995). Figures S.3–1 and S.3–2 show the results of the screening process for the long-term storage and the disposition options, respectively, including the

options that were selected as reasonable alternatives for analysis in the PEIS, the options that were disqualified and eliminated, and the reasons for disqualification and elimination (given in parentheses).[11]

STORAGE OPTIONS

NO ACTION	Baseline
UPGRADE EXISTING INTERIM STORAGE FACILITIES	Reasonable
CONSOLIDATE STORAGE AT DOE SITES	Reasonable
UTILIZE FACILITIES AT NON-DOE DOMESTIC SITES	Eliminated (Cost-Effectiveness, ES&H)
UTILIZE NON-DOMESTIC SITES	Disqualified (Higher Safeguard and Security Risks)

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Figure S.3–1. Results of the Screening Process—Long-Term Storage Options.

DEVELOPMENT OF LONG-TERM STORAGE ALTERNATIVES

For storage, DOE began with five potential alternatives (see Figure S.3–1), including the No Action Alternative. The screening process identified two action alternatives as reasonable: (1) upgrade storage facilities and (2) consolidate storage at DOE sites. The second alternative was later refined and converted into two alternatives: consolidate Pu storage at one site (while HEU storage remains at ORR), and collocation of Pu and HEU storage at one site. [Text deleted.] Subalternatives and options were also added (see discussions in next section). In addition, the Preferred Alternative for storage (discussed previously) was developed and reflects a combination of the Upgrade Alternative, sub-options, and the No Action Alternative.

To select candidate sites for long-term storage, DOE used a separate set of siting criteria consistent with those used in the evaluation of sites for reconfiguration of the Nuclear Weapons Complex in February 1991. The siting criteria included population; ES&H; socioeconomics; transportation; and site availability and flexibility. The process resulted in six candidate storage sites: Hanford, NTS, INEL, Pantex, ORR, and SRS.

Development of Long-Term Storage Subalternatives

With the exception of weapons program materials in use, the Storage and Disposition PEIS analyzes the environmental impacts of reasonable alternatives for long-term storage of all surplus and nonsurplus weapons-usable fissile material categories (see Figure S.1–1). In DOE's Stockpile Stewardship and Management PEIS, a portion of the nonsurplus weapons-usable fissile materials, namely the strategic reserve materials and the plutonium-242 (Pu-242) materials used for weapons R&D, is analyzed for long-term storage. The Preferred Alternative in the Stockpile Stewardship and Management PEIS is to move Pu-242 currently stored at SRS to LANL for long-term storage. The Storage and Disposition PEIS includes a subalternative analyzing the environmental effects of each long-term storage alternative without the strategic reserve materials and weapons R&D materials.[12] Preparation of these two documents is being closely coordinated to ensure that all necessary information is available to the decisionmaker. Preferred alternatives are being presented to the Secretary of Energy on both PEISs for the Secretary's decisions and the publication of the RODs.

Because of the cleanup agreement for RFETS, the proximity of RFETS to the Denver metropolitan area, and the fact that three out of the five most vulnerable facilities identified in DOE's *Plutonium Working Group Report on Environmental, Safety, and Health Vulnerabilities Associated With the Department's Plutonium Storage* (DOE/EH-0415, November 1994) are located at the site, RFETS is considered as a storage site only under the

[11] Following issuance of the screening report, two changes were made during subsequent meetings of the screening committee; that is, options I6 (glass material oxidation/dissolution system) and R1 (Euratom MOX fuel fabrication/reactor burning) were eliminated.

[12] The Storage and Disposition PEIS also analyzes the "umbrella" option, for each storage alternative, of storing strategic reserves and weapons R&D material together with other nonsurplus material.

STORAGE OPTIONS		
S1	NO DISPOSITION ACTION (CONTINUED STORAGE)	Baseline
S2	RADIATION BARRIER ALLOY (STORAGE)	Eliminated (Open-Ended, ES&H)
DIRECT DISPOSAL OPTIONS		
D1	DIRECT EMPLACEMENT IN HLW REPOSITORY	Disqualified (Retrievability, Timeliness)
D2	DEEP BOREHOLE (IMMOBILIZATION)	Reasonable
D3	DEEP BOREHOLE (DIRECT EMPLACEMENT)	Reasonable
D4	DISCARD TO WASTE ISOLATION PILOT PLANT	Disqualified (Capacity)
D5	HYDRAULIC FRACTURING	Disqualified (Technical Viability)
D6	DEEP WELL INJECTION	Disqualified (ES&H)
D7	INJECTION INTO CONTINENTAL MAGMA	Eliminated (Technical Viability, ES&H)
D8	MELTING IN CRYSTALLINE ROCK	Disqualified (Technical Viability)
D9	DISPOSAL UNDER ICE CAPS	Disqualified (Technical Viability, ES&H)
D10	SEABED (PLACEMENT ON OCEAN FLOOR)	Disqualified (ES&H)
D11	SUB-SEABED EMPLACEMENT	Eliminated (Technical Viability)
D12	OCEAN DILUTION	Disqualified (ES&H)
D13	DEEP SPACE LAUNCH	Eliminated (Retrievability, ES&H)
IMMOBILIZATION OPTIONS (WITH RADIONUCLIDES)		
I1	UNDERGROUND NUCLEAR DETONATION	Disqualified (ES&H, Licensing/Regulatory)
I2	BOROSILICATE GLASS IMMOBILIZATION (RETROFITTED DWPF)	Eliminated[a]
I3	VITRIFICATION (BOROSICLICATE GLASS IMMOBILIZATION [NEW FACILITY])	Reasonable
I4	CERAMIC IMMOBILIZATION	Reasonable
I5	ELECTROMETALLURGICAL TREATMENT	Reasonable
I6	GLASS MATERIAL OXIDATION/DISSOLUTION SYSTEM	Eliminated (Technical Maturity)
REACTOR AND ACCELERATOR OPTIONS		
R1	EURATOM MOX FABRICATION/REACTOR BURNING	Eliminated (Timeliness)
R2	EXISTING LWRs	Reasonable
R2A	PARTIALLY COMPLETED LWRs	Reasonable
R3	EVOLUTIONARY OR ADVANCED LWRs	Reasonable
R4	NAVAL PROPULSION REACTORS	Disqualified (Transparency)
R5	MODULAR HELIUM REACTORS	Eliminated (Technical Maturity)
R6	CANDU HEAVY WATER REACTORS	Reasonable
R7	ADVANCED LIQUID METAL REACTORS WITH PYROPROCESSING	Eliminated (Technical Maturity, ES&H)
R8	ACCELERATOR CONVERSION/MOLTEN SALT	Eliminated (Technical Maturity)
R9	ACCELERATOR CONVERSION/PARTICLE BED	Eliminated (Technical Maturity)
R10	EXISTING LWRs WITH REPROCESSING	Disqualified (Theft/Diversion, Policy)
R11	ADVANCED LWRs WITH REPROCESSING	Disqualified (Theft/Diversion, Policy)
R12	ACCELERATOR-DRIVEN MODULAR HELIUM REACTORS	Eliminated (Technical Maturity)
R13	ADVANCED LIQUID METAL REACTORS WITH RECYCLE	Disqualified (Technical Maturity, Policy)
R14	PARTICLE BED REACTORS	Eliminated (Technical Maturity)
R15	MOLTEN SALT REACTORS	Eliminated (Technical Maturity)

[a] In this option, the present DWPF at SRS would have a new, specially designed melter installed. Much of the supporting equipment would require major retrofitting for this application because DWPF was not designed for criticality control. Retrofitting the DWPF would create additional total personnel radiation exposure and would significantly interfere with its mission to stabilize and treat HLW, resulting in delays and cost escalation. Note that eliminating this "DWPF Upgrade" variant does not preclude other DWPF-related variants of the Vitrification and Ceramic Immobilization Alternatives (such as adding an adjunct melter adjacent to the DWPF or the can-in-canister approach in the DWPF) if these other variants do not introduce increased radiation or Pu criticality concerns into the DWPF. Can-in-canister at a retrofitted DWPF is discussed in Appendix O and would be examined along with other site-specific alternatives in subsequent NEPA review tiered from the PEIS.

Note: ES&H=Environmental Safety and Health.

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Figure S.3–2. Results of the Screening Process—Surplus Plutonium Disposition Options.

No Action Alternative in the Storage and Disposition PEIS. For other long-term storage alternatives, existing Pu stored at RFETS (approximately 12.9 t [14.2 tons], as stated in DOE's Openness Initiative of December 7, 1993) would be moved to one or more other Pu storage sites. Therefore, DOE developed a subalternative under the Upgrade at Multiple Sites Alternative to analyze the storage of all or some Pu from RFETS at each candidate site. The phaseout of Pu storage at RFETS is also analyzed.

Two other locations, LANL and LLNL, also store quantities of Pu material. As of September 1994, LLNL stored 0.3 t (0.3 tons), and LANL stored 2.7 t (3.0 tons) of Pu. Quantities at LLNL are weapons R&D and operational feedstock materials not surplus to government needs; consequently, none of the Pu stored at LLNL falls within the scope of the Storage and Disposition PEIS. Some Pu material at LANL does fall within scope of the Storage and Disposition PEIS. Approximately 1.5 t (1.7 tons) of Pu material at LANL have been declared surplus to national security needs. As a result, storage of the current Pu inventory at LANL is analyzed under the No Action Alternative. Because LANL is not a candidate storage site, environmental impacts associated with a partial phaseout at LANL and relocation of the surplus Pu material to one or more of the candidate storage sites, is analyzed.

Development of Disposition Alternatives

For disposition, DOE began with 37 potential alternatives (see Figure S.3–2), including the No Disposition Action in which the surplus Pu would remain in long-term storage. Using the same general criteria as those for long-term storage, DOE identified 11 alternatives for surplus Pu disposition, including deep borehole (immobilization), deep borehole (direct emplacement), vitrification (borosilicate glass immobilization), ceramic immobilization, electrometallurgical treatment, glass material oxidation/dissolution, Euratom MOX fuel fabrication/reactor burning, existing LWRs, partially completed LWRs, evolutionary or advanced LWRs, and CANDU reactors. Upon further study of supply/demand conditions for Euratom MOX fuel and due to lack of maturity of the technologies for glass material oxidation/dissolution, DOE deleted the glass material oxidation/dissolution and the Euratom MOX fuel fabrication/reactor burning alternatives. However, MOX fuel fabrication (but not reactor burning) at European facilities remains a reasonable short-term option for the Existing LWR Alternative. Therefore, a total of nine reasonable disposition alternatives in addition to the No Disposition Action and the Preferred Alternative, were selected for analysis in the PEIS. These alternatives were grouped into three categories: Deep Borehole, Immobilization, and Reactor.

Facilities under each alternative within the Immobilization and Deep Borehole Categories could be designed such that they could disposition all the surplus Pu over their operating lives. Each disposition alternative under the Reactor Category would consist of reactors that could use all the MOX fuel produced from surplus Pu. However, existing surplus Pu comes in various forms, and some of these forms may not be suitable for conversion to MOX fuel without specialized chemical processing. The Preferred Alternative for disposition of surplus weapons-usable Pu, discussed previously, involves a combination of disposition alternatives.The Storage and Disposition PEIS identifies the reasonable long-term storage and disposition alternatives as follows:

Deep Borehole
A borehole extended several kilometers below the water table into ancient, geologically stable rock formations.

Storage:

- Storage Alternatives
  - Preferred Alternative (Combination)
  - Upgrade at Multiple Sites Alternative
  - Consolidation of Pu Alternative
  - Collocation of Pu and HEU Alternative
  - No Action Alternative

- Candidate Storage Sites
  - Hanford
  - NTS
  - INEL
  - Pantex
  - ORR
  - SRS

Environmental impacts of each storage alternative and the No Action Alternative are analyzed for each of the six candidate storage sites, to allow (1) the comparison of impacts by site for each alternative and (2) the comparison of impacts by alternative for each site. As a result, decisions can be made to select a single storage alternative for all sites or a combination of different alternatives for different sites.

Disposition:

- Preferred Alternative (Combination)

- Deep Borehole Category
  - Direct Disposition Alternative
  - Immobilized Disposition Alternative

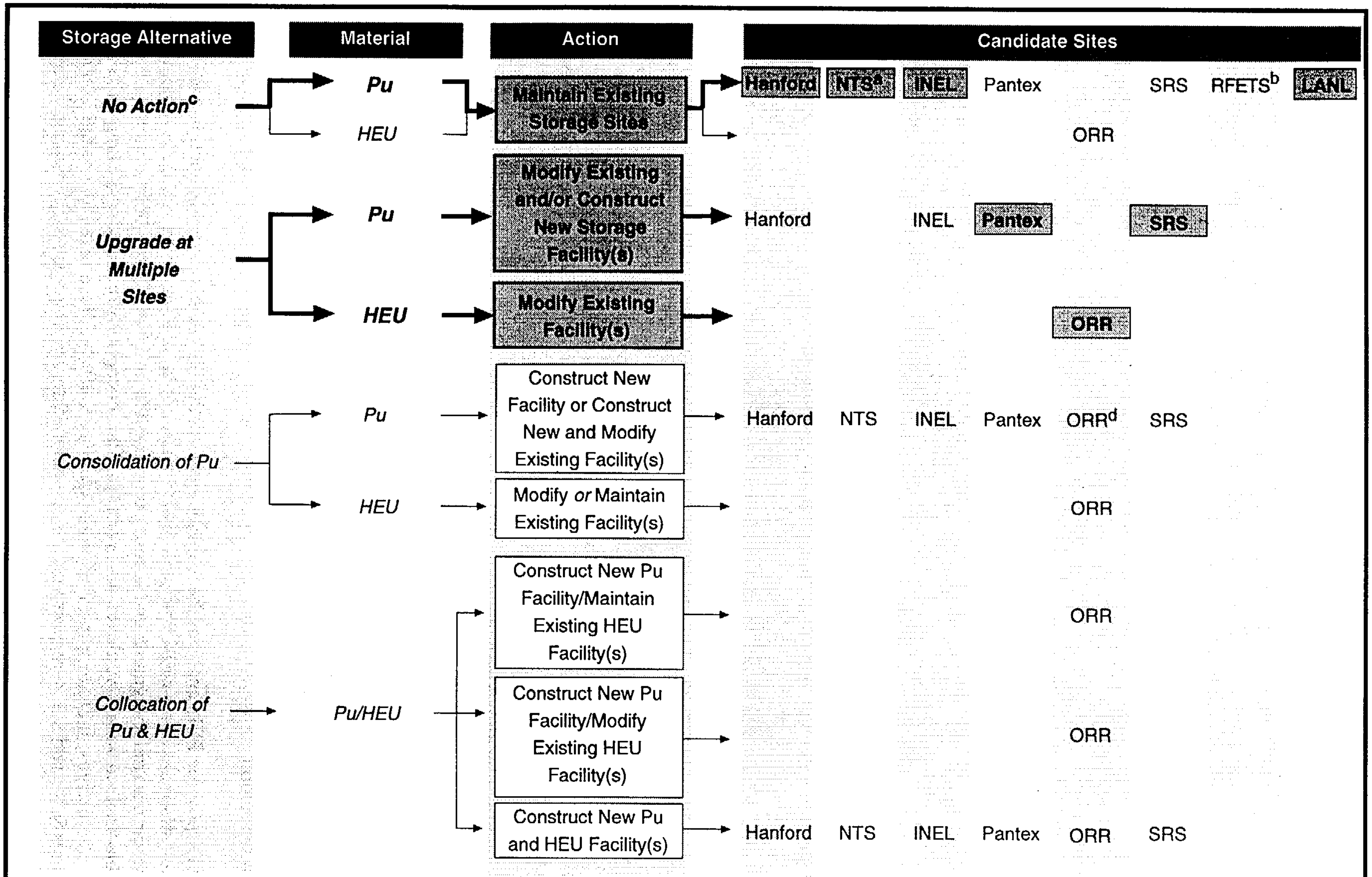
- Immobilization Category
  - Vitrification Alternative
  - Ceramic Immobilization Alternative
  - Electrometallurgical Treatment Alternative

- Reactor Category
  - Existing LWR Alternative
  - Partially Completed LWR Alternative
  - Evolutionary LWR Alternative
  - CANDU Reactor Alternative

- No Disposition Action

The Storage and Disposition PEIS analyzes the reasonable alternatives in addition to the No Action Alternative. For the No Action Alternative, all weapons-usable fissile materials would remain in storage at existing sites using proven nuclear material safeguards and security procedures. For the No Disposition Action Alternative, all weapons-usable fissile materials would remain in storage. The conceptual structures for the long-term storage and disposition alternatives, including the Preferred Alternative (in boldface text and shaded boxes), are presented in Figures S.3–3 and S.3–4, respectively. A more detailed description of these alternatives follows.

[Text deleted.]



[a] Although NTS does not currently store either Pu or HEU, the No Action Alternative is included here as a basis against which other storage and disposition alternatives are analyzed.
[b] As part of the Preferred Alternative, Pu storage at RFETS would be phased out with pits sent to Pantex and non-pit materials sent to SRS.
[c] Under the No Action Alternative, DOE would not undertake any new construction projects except those that are considered part of ongoing site operations to ensure continued safe, secure storage. However, any new facility construction deemed necessary to maintain safe, secure storage would be addressed in appropriate, individual site-specific EISs and site development plans.
[d] If Pu is consolidated at ORR, the presence of the HEU material already residing at the Y–12 Plant would create a HEU collocation condition and is therefore portrayed as the Collocation Alternative.
Note: Bold text and shaded boxes indicate Preferred Alternative.

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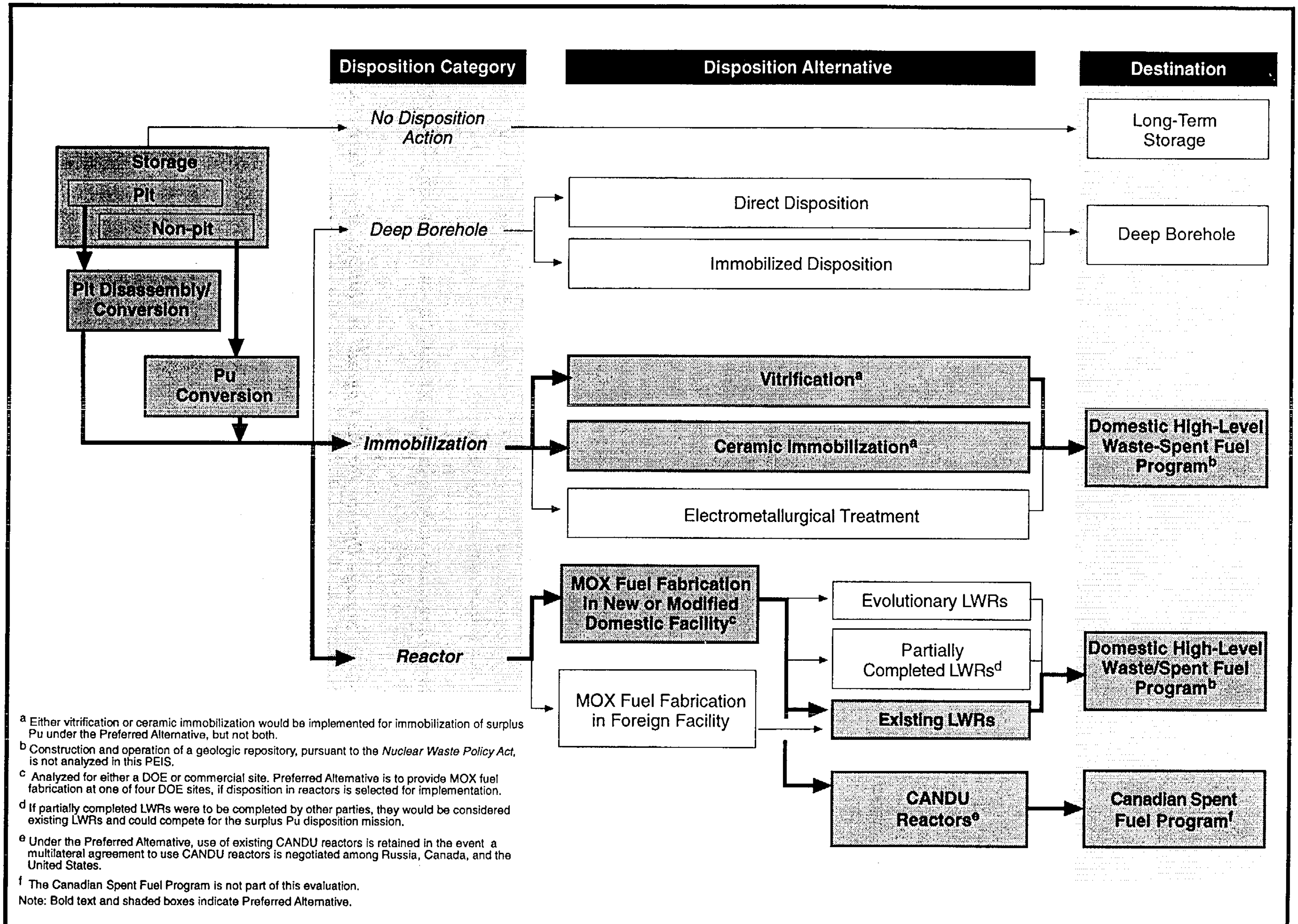
Figure S.3–3. Long-Term Storage Alternatives, Including the Preferred Alternative for Storage.



[a] Either vitrification or ceramic immobilization would be implemented for immobilization of surplus Pu under the Preferred Alternative, but not both.

[b] Construction and operation of a geologic repository, pursuant to the *Nuclear Waste Policy Act*, is not analyzed in this PEIS.

[c] Analyzed for either a DOE or commercial site. Preferred Alternative is to provide MOX fuel fabrication at one of four DOE sites, if disposition in reactors is selected for implementation.

[d] If partially completed LWRs were to be completed by other parties, they would be considered existing LWRs and could compete for the surplus Pu disposition mission.

[e] Under the Preferred Alternative, use of existing CANDU reactors is retained in the event a multilateral agreement to use CANDU reactors is negotiated among Russia, Canada, and the United States.

[f] The Canadian Spent Fuel Program is not part of this evaluation.

Note: Bold text and shaded boxes indicate Preferred Alternative.

Figure S.3–4. Surplus Plutonium Disposition Alternatives, Including the Preferred Alternative for Disposition.

S.4 DESCRIPTION OF ALTERNATIVES

S.4.1 LONG-TERM STORAGE ALTERNATIVES AND RELATED ACTIVITIES

No Action

[Text deleted.]

Under the No Action Alternative, all weapons-usable fissile materials would remain at existing storage sites. Maintenance at existing storage facilities would be done as required to ensure safe operation for the balance of the facility's useful life. Sites covered under the No Action Alternative include Hanford, INEL, Pantex, ORR, SRS, RFETS, and LANL. Although there are no weapons-usable fissile materials within the scope of the PEIS stored currently at NTS, it is also analyzed under No Action to provide an environmental basis against which impacts of the storage and disposition alternatives are analyzed. The Preferred Alternative for storage calls for No Action at Hanford, INEL, and LANL pending disposition.

Preferred Alternative

The Preferred Alternative for storage is described in Section S.2.

Upgrade at Multiple Sites

Under this alternative for storage, DOE would either modify certain existing facilities or build new facilities, depending on the site's requirements to meet standards for nuclear material storage facilities, and would utilize existing site infrastructure to the extent possible. These modified or new facilities would be designed to operate for up to 50 years. Pu materials currently stored at Hanford, INEL, Pantex, and SRS would remain at those four sites, and HEU would remain at ORR. This alternative does not apply to NTS because NTS does not currently store weapons-usable fissile materials that are within the scope of the PEIS.

A subalternative of relocating portions of the Pu inventory from RFETS and LANL (for a total of 14.4 t [15.9 tons] according to DOE's Openness Initiatives of December 7, 1993, and February 6, 1996, respectively) to one or more of the four existing Pu storage sites is analyzed. Storage without strategic reserve and weapons R&D materials is also included as a subalternative.

Within some of the five candidate storage sites under this alternative, there are one or more storage options. A summary of these options is presented in Table S.4.1–1.

Table S.4.1–1. Long-Term Storage Options for the Upgrade at Multiple Sites Alternative[a]

Candidate Site	Storage Option
Hanford	Modify Existing Fuels and Materials Examination Facility for Pu Storage, or Construct New 200 West Area Facility for Pu Storage
INEL	Modify Existing and Construct New Argonne National Laboratory-West Facilities for Continued Pu Storage
Pantex (Preferred Alternative)	Modify Existing Zone 12 South Facilities for Continued Pu Storage
ORR (Preferred Alternative)	Modify Existing Y–12 Plant Facilities for Continued HEU Storage
SRS (Preferred Alternative)	Modify New Actinide Packaging and Storage Facility for Continued Pu Storage

[a] Proposed storage facility locations were primarily based on optimal use of existing facilities, and are in accordance with current site development and utilization plans and proposals.

Consolidation of Plutonium

Under this alternative, Pu materials at existing sites would be removed, and the entire DOE inventory of Pu would be consolidated at one site, while the HEU inventory would remain at ORR. Again, the four sites with existing Pu storage are candidate sites for Pu consolidation. In addition, NTS and ORR are candidate sites for this alternative. Consolidation of Pu at ORR would result in a situation in which inventories of Pu and HEU are collocated at one site; this alternative is therefore analyzed as the Collocation Alternative at ORR.

A subalternative to account for the separate storage without strategic reserve and weapons R&D materials is also included. Storage options for the six candidate sites under this alternative are presented in Table S.4.1–2.

Table S.4.1–2. Long-Term Storage Options for the Consolidation of Plutonium Alternative

Candidate Site[a]	Storage Option
Hanford	Construct New Pu Storage Facility Adjacent to 200 East Area
NTS	Modify Existing Tunnel Drifts and Construct New Material Handling Building at the P-Tunnel, or Construct New Pu Storage Facility in Area 6
INEL	Construct New Pu Storage Facility Adjacent to the Idaho Chemical Processing Plant
Pantex	Construct New and Modify Existing Zone 12 South Facilities, or Construct New Pu Storage Facility in Zone 12 South
SRS	Construct New Pu Storage Facility Adjacent to Z Area

[a] Consolidation of Pu at ORR results in a collocation condition with HEU. See ORR Collocation Alternative in Table S.4.1–3.

Collocation of Plutonium and Highly Enriched Uranium

Under the Collocation Alternative, the entire DOE inventory of Pu would be consolidated and collocated at the same site as the HEU inventory. The six candidate sites are Hanford, NTS, INEL, Pantex, ORR, and SRS.

A subalternative for the separate storage without strategic reserve and weapons R&D materials is also included. Storage options for the six candidate sites under this alternative are presented in Table S.4.1–3.

Table S.4.1–3. Long-Term Storage Options for the Collocation of Plutonium and Highly Enriched Uranium Alternative

Candidate Site	Storage Option
Hanford	Construct New Pu and HEU Storage Facilities Adjacent to 200 East Area
NTS	Modify Existing Tunnel Drifts and Construct New Material Handling Building at the P-Tunnel, or Construct New Pu and HEU Storage Facilities in Area 6
INEL	Construct New Pu and HEU Storage Facilities Adjacent to the Idaho Chemical Processing Plant
Pantex	Construct New Pu and HEU Storage Facilities in Zone 12 South
ORR	Construct New Pu Storage Facility Northwest of Oak Ridge National Laboratory and Maintain Existing (No Action) HEU Storage Facilities at Y–12 Plant, or Construct New Pu Storage Facility Northwest of Oak Ridge National Laboratory and Modify Existing HEU Storage Facilities at Y–12 Plant, or Construct New Pu and HEU Storage Facilities Northwest of Oak Ridge National Laboratory
SRS	Construct New Pu and HEU Storage Facilities Adjacent to Z Area

S.4.2 Plutonium Disposition Alternatives and Related Activities

[Text deleted.] The disposition technologies analyzed in the PEIS are those that would convert surplus Pu into a form that meets the Spent Fuel Standard. For the purpose of environmental impact analyses for the various disposition alternatives, both generic and specific sites are used to provide perspective on these alternatives. Under each alternative, there are various ways to implement the alternative. These "variants" (such as the can-in-canister[13]) are shown in Table S.4.2–1 to provide a range of available options for consideration.

The first step in Pu disposition is to remove the surplus Pu from storage, then process this material in a pit disassembly/conversion facility (for pits, a component of nuclear weapons) or in a Pu conversion facility (for non-pit materials). The processing would convert the Pu material into a form suitable for each of the disposition alternatives described in the following sections. The pit disassembly/conversion facility and the Pu conversion facility are assumed to be built at a DOE site. Therefore, the six candidate sites for long-term storage were used to evaluate the potential environmental impacts of constructing and operating these facilities.

No Disposition Action

A "No Pu Disposition" action means disposition would not occur, and surplus Pu-bearing weapon components (pits) and other forms, such as metal and oxide, would remain in storage in accordance with decisions on the long-term storage of weapons-usable fissile materials.

Preferred Alternative

The Preferred Alternative for disposition is described in Section S.2.

Deep Borehole Category

Under this category, surplus weapons-usable Pu would be disposed of in deep boreholes that are drilled at least 4 kilometers (km) (2.5 miles [mi]) into ancient, geologically stable rock formations beneath the water table. The deep borehole provides a geologic barrier against potential proliferation. A generic site is used for the construction and operation of a borehole complex where the surplus Pu would be prepared for emplacement in the borehole. This complex would consist of five major facilities: processing; drilling; emplacing/sealing; waste management; and support (security, maintenance, and utilities).

Direct Disposition

Under the Direct Disposition Alternative, surplus Pu would be removed from storage, processed as necessary, converted to a form suitable for emplacement, packaged, and placed in a deep borehole. The deep borehole would be sealed to isolate the Pu from the accessible environment. Long-term performance of the deep borehole would depend on the stability of the geologic system. A generic site is used for the borehole complex to analyze the environmental impact of this alternative.

Immobilized Disposition

Under the Immobilized Disposition Alternative, the surplus Pu would be removed from storage, processed, and converted to a suitable form for shipment to a ceramic immobilization facility. The output of this facility would be spherical ceramic pellets containing Pu, facilitating handling during transportation and emplacement. The ceramic pellets (about 2.54 centimeters [cm] [1 inch {in}] in diameter and containing 1 percent Pu by weight) would then be placed in drums and shipped to the borehole complex. At the deep borehole site, the ceramic

[13] In the can-in-canister variant, cans of Pu glass or Pu ceramic would be placed in a DWPF canister or a DWPF type canister. This canister would then be filled with borosilicate glass containing HLW. This variant is described in Appendix O of the Final PEIS.

Table S.4.2–1. Description of Variants Under Plutonium Disposition Alternatives

Alternatives Analyzed	Possible Variants
• Deep Borehole Direct Disposition	• Arrangement of Pu in different types of emplacement canisters.
• Deep Borehole Immobilized Disposition	• Emplacement of pellet-grout mix. • Pumped emplacement of pellet-grout mix. • Pu concentration loading, size and shape of ceramic pellets.
• New Vitrification Facilities	• Collocated pit disassembly/conversion, Pu conversion, and immobilization facilities. • Use of either Cs-137 from capsules or HLW as a radiation barrier. • Wet or dry feed preparation technologies. • An adjunct melter adjacent to the DWPF at SRS, in which borosilicate glass frit with Pu (without highly radioactive radionuclides) is added to borosilicate glass containing HLW from the DWPF. • A can-in-canister approach at SRS in which cans of Pu glass (without highly radioactive radionuclides) are placed in DWPF canisters which are then filled with borosilicate glass containing HLW in the DWPF (See Appendix O of the Final PEIS). • A can-in-canister approach similar to above but using new facilities at sites other than SRS.
• New Ceramic Immobilization Facilities	• Collocated pit disassembly/Pu conversion, and immobilization facilities. • Use of either Cs-137 from capsules or HLW as a radiation barrier. • Wet or dry feed preparation technologies. • A can-in-canister approach at SRS in which the Pu is immobilized without highly radioactive radionuclides in a ceramic matrix and then placed in the DWPF canisters that are then filled with borosilicate glass containing HLW (See Appendix O of the Final PEIS). • A can-in-canister approach similar to above but using new facilities at sites other than SRS.
• Electrometallurgical Treatment (glass-bonded zeolite form)	• Immobilize Pu into metal ingot form. • Locate at DOE sites other than ANL-W at INEL.
• Existing LWR With New MOX Facilities	• Pressurized or Boiling Water Reactors. • Different numbers of reactors. • European MOX fuel fabrication. • Modification/completion of existing facilities for MOX fabrication. • Collocated pit disassembly/conversion, Pu conversion, and MOX facilities. • Reactors with different core management schemes (Pu loadings, refueling intervals).
• Partially Completed LWR With New MOX Facilities	• Same as for existing LWR (except that MOX fuel would not be fabricated in Europe).
• New Evolutionary LWR With New MOX Facilities	• Same as for partially completed LWR.
• Existing CANDU Reactor With New MOX Facilities	• Different numbers of reactors. • Modification/completion of existing facilities for MOX fabrication. • Collocated pit disassembly/conversion, Pu conversion, and MOX facilities. • Reactors with different core management schemes (Pu loadings, refueling intervals).

pellets would be mixed with ceramic pellets containing no Pu and fixed with grout during emplacement. The deep borehole would be sealed to isolate the Pu from the accessible environment. Long-term performance of the deep borehole would depend on the stability of the geologic system.

Although a generic site is used for the borehole complex in this alternative, the ceramic immobilization facility is assumed to be built at a DOE site. Therefore, the six candidate sites for long-term storage were used to evaluate the environmental impact of the facility.

Immobilization Category

Under this category of alternatives, surplus Pu would be immobilized to create a chemically stable form for disposal in a geologic repository pursuant to the *Nuclear Waste Policy Act* (NWPA).[14] The Pu material may be mixed with HLW or other radioactive isotopes and immobilized to create a radiation field that could serve as a proliferation deterrent, along with safeguards and security comparable to those of commercial spent nuclear fuel, thereby achieving the Spent Fuel Standard. All immobilized Pu would be encased in stainless steel canisters and would remain in onsite vault-type storage until a separate geologic repository pursuant to the NWPA is operational.

Vitrification

Under the Vitrification Alternative, surplus Pu would be removed from storage, processed, packaged, and transported to the vitrification facility. In this facility, the Pu would be mixed with glass frit and the highly radioactive isotope cesium-137 (Cs-137) or HLW to produce borosilicate glass logs (a slightly different process, using HLW, would be used for the can-in-canister variant discussed in Appendix O of the Final PEIS). The Cs-137 isotope could come from the cesium chloride (CsCl) capsules currently stored at Hanford or from existing HLW if the site selected for vitrification already manages HLW. Each glass log produced from the vitrification facility would contain about 84 kilograms (kg) (185 pounds [lb]) of Pu.

The vitrification facility is assumed to be built at a DOE site. Therefore, the six candidate sites for long-term storage were used to evaluate the environmental impact of this alternative.

Ceramic Immobilization

Under the Ceramic Immobilization Alternative, surplus Pu would be removed from storage, processed, packaged, and transported to a ceramic immobilization facility. In this facility, the Pu would be mixed with nonradioactive ceramic materials and Cs-137 or HLW to produce ceramic disks (a slightly different process, using HLW, would be used for the can-in-canister variant). Each disk would be approximately 30 cm (12 in) in diameter and 10 cm (4 in) thick, and would contain approximately 4 kg (9 lb) of Pu. The Cs-137 or HLW would be provided as previously described.

The ceramic immobilization facility is assumed to be built at a DOE site. Therefore, the six candidate sites for long-term storage were used to evaluate the environmental impact of this alternative.

Electrometallurgical Treatment

Under the Electrometallurgical Treatment Alternative, surplus Pu would be removed from storage, processed, packaged, and transported to new or modified facilities for electrometallurgical treatment. This process could immobilize surplus fissile materials into a glass-bonded zeolite (GBZ) form. With the GBZ material, the Pu is in the form of a stable, leach-resistant mineral that is incorporated in durable glass materials.[15]

[14] Also referred in the PEIS as a geologic, permanent, or HLW repository.

[Text deleted.]

Reactor Category

The reactor alternatives considered in the Storage and Disposition PEIS would utilize surplus Pu in MOX fuel for use in non-defense reactors. The irradiated MOX fuel would meet the Spent Fuel Standard to reduce the proliferation risks of the Pu material, and the reactors would also generate revenues through the sale of electricity. MOX fuel would be used in a once-through fuel cycle, with no reprocessing or subsequent reuse of spent fuel. The spent nuclear fuel generated by the reactors would then be sent to a geologic repository pursuant to the NWPA.

Because the United States does not have a MOX fuel fabrication facility or capability, a dedicated facility would likely have to be constructed or modified at a U.S. Government or existing commercial fuel fabricator's site. The surplus Pu from storage would be processed, converted to PuO_2, and transferred to the MOX fuel fabrication facility. In this facility, PuO_2 and UO_2 (from existing domestic sources) would be blended and fabricated into MOX pellets, loaded into fuel rods, and assembled into fuel bundles suitable for use in the reactor alternatives under consideration. The PEIS evaluates the potential environmental impacts of the MOX fuel fabrication facility at the six DOE sites and at a generic commercial site. MOX fuel fabrication at existing European facilities would be a viable option in the near-term to meet the initial fuel needs of the Existing LWR Alternative, pending availability of a domestic MOX fuel fabrication facility.[16]

Existing Light Water Reactor

Under the Existing LWR Alternative, the MOX fuel containing surplus Pu would be fabricated and transported to existing commercial LWRs in the United States, where the MOX fuel would be used instead of conventional UO_2 fuel. The LWRs employed for domestic electric power generation are pressurized water reactors (PWRs) and boiling water reactors (BWRs). Both types of reactors use the heat produced from nuclear fission reactions to generate steam that drives the turbines and generates electricity. The Storage and Disposition PEIS assumes a throughput of 3 to 5 t/year (yr) (3.3 to 5.5 tons/yr) for disposition of surplus Pu; three to five LWRs would be used. A sample of operating reactors (eight PWRs and four BWRs built after 1975) was compiled to obtain generic operating characteristics for environmental analysis of this alternative.

It is possible that an existing LWR can be configured to produce tritium, consume Pu as fuel, and generate revenue through the production of electricity. This configuration is called a multipurpose reactor. Environmental analysis of the multipurpose reactor is included in Chapter 4 of the *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (TSR PEIS) (DOE/EIS-0161, October 1995). In the TSR PEIS ROD (December 1995), the multipurpose reactor was preserved as an option for future consideration. Information on the Fast Flux Test Facility (FFTF) at Hanford and the costs and benefits of the multipurpose reactor is presented in Appendix N of the Final PEIS.

Partially Completed Light Water Reactor

Under the Partially Completed LWR Alternative, commercial LWRs on which construction has been halted would be completed. The completed reactors would use MOX fuel containing surplus Pu. The characteristics of

[15] The Department has recently issued a FONSI (61 FR 25647) and decision to proceed with the limited demonstration of the electrometallurgical treatment process at Argonne National Laboratory-West (ANL-W) at INEL for processing up to 125 spent fuel assemblies from the Experimental Breeder Reactor II (100 driver and 25 blanket assemblies). Although this alternative could be conducted at other DOE sites, ANL-W is described in the PEIS as the representative site for analysis. The National Research Council prepared a report called *An Evaluation of the Electrometallurgical Approach for Treatment of Excess Weapons Plutonium* (National Academy Press, Washington, DC, 1996). The results of this evaluation will be considered in DOE's decision-making process for Pu disposition.

[16] European MOX fuel fabrication would only be available in the near-term, and is not a part of the Preferred Alternative.

these LWRs would be essentially the same as those of the existing LWRs discussed in the Existing LWR Alternative. The Bellefonte Nuclear Plant located along the west bank of the Tennessee River in Alabama is used as a representative site for the environmental analysis of this alternative. Two reactor units (such as those at the Bellefonte Nuclear Plant) would be needed to implement this alternative.

Evolutionary Light Water Reactor

The evolutionary LWRs are improved versions of existing commercial LWRs. Two design approaches are considered in the Storage and Disposition PEIS. The first is a large PWR or BWR similar to the size of the existing PWR and BWR. The second is a small PWR approximately one-half the size of the large PWR. Two large or four small evolutionary LWRs would be needed to implement this alternative.

Under each design approach for this alternative, evolutionary LWRs would be built at a DOE site. Therefore, the six candidate sites for long-term storage were used to evaluate the environmental impact of this alternative.

Canadian Deuterium Uranium Reactor

Under the CANDU Reactor Alternative, the MOX fuel containing surplus Pu would be fabricated in a U.S. facility, then transported for use in a commercial heavy water reactor in Canada. The Ontario Hydro Nuclear Bruce-A Generating Station identified by the Canadians is used as a representative site for evaluation of this alternative. This station is located on Lake Huron about 300 km (186 mi) northeast of Detroit, Michigan. Environmental analysis of domestic activities up to the U.S./Canadian border is presented in the PEIS. The use of CANDU reactors would be subject to the policies, regulations, and approval of the Federal and Provincial Canadian Governments. Pursuant to Section 123 of the *Atomic Energy Act*, any export of MOX fuel from the United States to Canada must be made under an agreement for cooperation between the two countries. Spent fuel generated by a CANDU reactor would be accommodated within the Canadian spent fuel program.

S.5 APPROACH TO ENVIRONMENTAL IMPACT ANALYSIS

The environmental impact assessment addresses the full range of natural and human resource, and issue areas pertinent to the sites considered for the long-term storage and disposition alternatives. The resource/issue areas are land resources, site infrastructure, air quality and noise, water resources, geology and soils, biological resources, cultural and paleontological resources, socioeconomics, public and occupational health and safety, waste management, intersite transportation, and environmental justice.

A region of influence (ROI) for each resource/issue area is identified and analyzed for each candidate site for long-term storage and each analysis site for disposition. Land resources address land use; land-use compatibility with existing land-use plans, controls, and policies; and the potential for visual resource impacts. Site infrastructure impacts are assessed by comparing the electrical power, fuel, and transportation network requirements against the existing capacities at each candidate site. Air quality and noise impacts focus on air pollutants and noise emissions and their compliance with the National Ambient Air Quality Standards, State air quality standards, and local government standards for noise.

For water resources, the water consumption requirements of each alternative were compared to the availability of surface and groundwater sources at each site, the potential effects of wastewater discharges on surface and groundwater quality are evaluated, and the site's location relative to floodplains assessed. Similarly, geology and soils are evaluated in terms of site suitability and soil erosion potential. Biological resources are evaluated in terms of the potential for impacts to terrestrial and aquatic resources, wetlands, and threatened and endangered species. Cultural and paleontological resources addresses the potential for disturbance to prehistoric, historic, Native American, and paleontological resources. The employment and income effects of new job creation and the attendant demands on community services and local transportation are analyzed for socioeconomics.

Both the public and onsite worker exposure to ionizing radiation and hazardous chemicals and the resultant increase in cancer fatality risk to public and occupational health and safety are assessed for normal operations and accident conditions. The analysis of radiation impacts includes consideration of National Emission Standards for Hazardous Air Pollutants (NESHAPs). The widely used algorithms for estimating the risk of latent cancers from radiation are based on high dose rates, and impacts are then extrapolated to low rates by presumed linear response models. These models are known to overestimate the risk for low dose rates. For the purposes of presentation in the PEIS, the impacts calculated from the linear model are treated as an upper bound case, consistent with the widely used methodologies for quantifying radiogenic health impacts. This does not imply that health effects are expected. Moreover, in cases where the upper bound estimates predict a number of latent cancer deaths that is greater that 1, this does not imply that the latent cancer death(s) are identifiable to any individual.

The additional wastes generated by each alternative are compared to existing and planned treatment, storage, and disposal capacities for potential impacts to waste management. Waste management assumptions are based on current site practices and are contingent upon decisions to be made following completion of the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE/EIS-0200).

The increased number of potential fatalities from truck accidents during the transportation of weapons-usable fissile materials among the various DOE sites and proposed facilities is evaluated for intersite transportation. Environmental justice addresses the potential for disproportionately high and adverse impacts to minority and low-income populations within 80 km (50 mi) of the sites.

The Storage and Disposition PEIS analyzes six candidate sites for the long-term storage of weapons-usable fissile materials. These sites are Hanford, NTS, INEL, Pantex, ORR, and SRS. These same sites were also used to evaluate the construction and operation of various facilities required for the disposition alternatives. These facilities include the pit disassembly/conversion and the Pu conversion facilities common to all disposition alternatives, the MOX fuel fabrication facility common to all reactor alternatives, the ceramic immobilization facility for the deep borehole alternative, the glass vitrification and ceramic immobilization facilities, and the Evolutionary LWR Alternative.

Other sites analyzed for Pu disposition are the ANL-W site at INEL for the Electrometallurgical Treatment Alternative and the Bellefonte Nuclear Plant for the Partially Completed LWR Alternative. These sites are used for analysis only and do not represent a DOE proposal or preference. Alternative sites may be analyzed in subsequent NEPA documents. A generic borehole site is evaluated for the alternatives in the Deep Borehole Category.[17] The Existing LWR Alternative analysis uses generic operating characteristics developed from 12 operating LWRs within the United States, and impacts are assessed using a generic site that was developed based on a composite of existing sites.

S.6 PREFERRED ALTERNATIVE SUMMARY OF IMPACTS

This section summarizes the maximum site impacts that would result at Hanford, INEL, Pantex, and SRS from combining the Preferred Alternative for storage with the Preferred Alternative for disposition at each of these sites. The Preferred Alternative identifies these sites as possible locations for all or some Pu disposition activities. The siting, construction, and operation of disposition facilities and variants would be covered in future tiered NEPA analyses. To the extent practical, DOE would use modified existing buildings and facilities for portions of the disposition activities. The use of existing buildings would reduce the environmental impacts and resource usages identified in this section.

[17] If either Borehole Alternative were selected, DOE would prepare a siting study and tiered NEPA documentation to identify and assess impacts of potential alternative borehole sites. DOE would analyze and compare existing and new buildings and facilities for the technologies chosen as part of the Preferred Alternative in subsequent, tiered NEPA review.

The preferred strategy for disposition is a combination of alternatives which includes operating existing reactors with MOX fuel and immobilization of some of the surplus Pu. The impacts from the operation of most of the existing domestic LWRs would not affect DOE sites. For purposes of analysis, approximately 70 percent of the surplus Pu, which is high purity material, could be readily converted into MOX fuel for use in nuclear reactors. The Preferred Alternative is to use existing reactors. DOE would retain using CANDU reactors in the event of a multilateral agreement among Russia, Canada, and the United States. For purposes of analysis, approximately 30 percent (low purity Pu) would be immobilized in glass or ceramic forms although much of it could be purified with chemical processing and used as MOX fuel in reactors. Disposition by use in reactors would require the construction of a MOX fuel fabrication facility and a pit disassembly/conversion facility at DOE sites. Disposition by immobilization would require the construction of a Pu conversion facility and an immobilization facility (either ceramic immobilization or vitrification) at a DOE site. Four DOE sites (Hanford, INEL, Pantex, and SRS) would be potential locations for MOX fuel fabrication and pit disassembly/conversion facilities, and two sites (Hanford and SRS) for the Pu conversion and immobilization facilities.

The following sections describe the total life cycle impacts that would result from the implementation of the Preferred Alternative at the DOE sites identified for potential placement of the disposition facilities. The analysis conservatively assumed a maximum impact scenario where two or four new disposition facilities could be built at the same DOE site. For immobilization, the analysis conservatively uses impacts from the ceramic immobilization facility since they are generally larger than the impacts from the vitrification facility. If existing facilities (such as the DWPF at SRS and the FMEF at Hanford) were used for some of the disposition activities, the impacts would be reduced.

Land Resources

Collocating disposition facilities at Hanford, INEL, Pantex, or SRS would likely minimize land-use impacts due to the sharing of land resources. In addition, optimal use of existing buildings and facilities would occur where possible. All four sites would have adequate land area to accommodate the facilities. Most disposition facilities would be separated from the site boundary by a 1.6-km (1-mi) buffer zone. For all four DOE sites, construction and operation would not affect other onsite or offsite land uses. No prime farmlands exist onsite. Construction and operation would be compatible with site, State, and local land-use plans, policies, and controls. This section describes the impacts to land resources from constructing and operating the Preferred Alternative storage and disposition facilities for each site.

Hanford Site. Plutonium materials would continue to be stored at the Plutonium Finishing Plant (PFP) in the 200 West Area, pending decisions on their disposition. The potential pit disassembly/conversion, Pu conversion, ceramic immobilization, and MOX facilities would be located on vacant land in the 200 Area adjacent to 200 East. The total area disturbed during construction would be approximately 191 hectares (ha) (472 acres); operation would require approximately 133 ha (329 acres). Construction and operation of the facilities would conform to existing and future land use plans as described in the current *Hanford Site Development Plan* and ongoing discussions in the comprehensive land-use planning process.

Construction and operation of these facilities would also be consistent with the industrialized landscape character of the 200 Area and with the current Visual Resource Management (VRM) Class 5 designation. The ceramic immobilization facility or MOX facility could have stack plumes that could be visible from public viewpoints with high sensitivity levels, including State Highways 24 and 240 and the city of Richland; however, the proposal would be compatible with the existing industrial character of the Hanford area.

Idaho National Engineering Laboratory. Plutonium materials would continue to be stored at the Idaho Chemical Processing Plant (ICPP) and at ANL-W in the Zero Power Physics Reactor (ZPPR) and Fuel Manufacturing Facility (FMF) vaults, pending decisions on their disposition. The potential pit disassembly/conversion and MOX facilities would be located on undeveloped land within or near the ICPP security area. The total area disturbed during construction would be approximately 135 ha (334 acres);

operation would require approximately 93 ha (230 acres). Construction and operation would be consistent with the *Idaho National Engineering Laboratory Site Development Plan*, which designates the ICPP as situated within the Central Core Area/Prime Development Zone at INEL.

Construction and operation of these facilities would also be consistent with the industrialized landscape character of the ICPP and with the current VRM Class 5 designation. The MOX facility may have stack plumes that could be visible from off-site public viewpoints; however, the proposal would be compatible with the existing industrial character of the area.

Pantex Plant. Buildings 12-66 and 12-82 in Zone 12 South would be modified to accommodate the long-term storage of Pantex pits and RFETS pits under the Preferred Alternative. Construction and operation would require less than 1 ha (2.5 acres) and conform with the current *Pantex Site Development Plan*, which includes as part of its master plan the Fissile Material Storage Facility in Zone 12. Zone 12 is also the potential location for the pit disassembly/conversion facility. Construction and operation would require less than 14 ha (35 acres) and conform with the Pantex Site Development Plan, which designates Zone 12 for weapon assembly/disassembly. The total area disturbed during construction would be approximately 135 ha (334 acres); operation would require approximately 93 ha (230 acres). When completed, the potential MOX fuel fabrication facility would be located on previously undeveloped land in Zone 11, which is currently designated for applied technology. However, Pantex could revise the site development plan to accommodate the potential MOX facility.

The existing Zone 12 VRM Class 5 designation would not change due to the Preferred Alternative. The MOX facility in Zone 11 may have stack plumes that could be visible from off-site viewpoints; however, the proposal would be compatible with the existing site industrial character of the area.

Savannah River Site. The APSF in F-Area would be modified to accommodate the long-term storage of SRS non-pit Pu material and RFETS non-pit Pu material for the Preferred Alternative. Approximately 191 ha (472 acres) of vacant land in the F-Area would be disturbed during construction of the pit disassembly/conversion, Pu conversion, MOX fuel fabrication, and ceramic immobilization facilities. The completed facilities would occupy approximately 133 ha (329 acres). Construction and operation would conform with existing and future land use as designated by the current *Savannah River Site Development Plan*. According to the Plan, current F-Area land use is designated industrial operations, while the future land-use category is primary industrial mission. Although the proposal would convert undeveloped land, forested land, and a very small portion of National Environmental Research Park lands, the action would conform with site land-use plans.

Construction and operation of the upgrade storage, pit disassembly/conversion, Pu conversion, and ceramic immobilization facilities would be consistent with the industrial landscape character and current VRM Class 5 designation of the F-Area. Construction and operation of the MOX facility would change the current VRM Class 4 designation of the proposed site north of the P-Reactor Area to Class 5. The ceramic immobilization and MOX facilities may have stack plumes; however, because of hilly terrain, visual effects to public access roads with high sensitivity levels would not be apparent.

Site Infrastructure

The resource requirements for the construction of the proposed facilities are not expected to exceed site capabilities for any of the sites evaluated. At Hanford, the planned facilities use natural gas as the primary utility fuel, and the total requirement for natural gas (13,609,000 cubic meters [m^3]/yr [17,800,000 cubic yds {yd^3}/yr]) would be larger than currently available. Since INEL and SRS use fuel oil as the primary utility fuel, use of natural gas in lieu of fuel oil would require additional infrastructure. Final designs for facilities under the Preferred Alternative at INEL and SRS would be adapted to use fuel oil. At SRS the oil requirement would exceed the site availability by 277,750 liters (l)/yr (73,370 gallons [gal]/yr). Additional oil

and natural gas requirements could be met by increasing procurement at all sites. Locating the Preferred Alternative disposition actions at any of the analyzed sites would require the construction of additional onsite roads and rail spurs.

Air Quality and Noise

Construction and operation of the proposed facilities under the Preferred Alternative would generate criteria and toxic/hazardous air pollutants. To evaluate air quality impacts at Hanford, INEL, Pantex, and SRS, potential concentrations from the facilities have been compared to Federal and State guidelines.

Concentrations of particulate matter less than or equal to 10 microns in diameter (PM_{10}) and total suspended particulates (TSP) are expected to increase during construction of the facilities. Simultaneous construction of the facilities could result in elevated levels of these pollutants. However, appropriate control measures would be implemented to maintain fugitive emissions within applicable Federal and State ambient air quality standards during construction.

The Prevention of Significant Deterioration (PSD) regulations, which are designed to protect ambient air quality in attainment areas, apply to new sources and major modifications to existing sources. Based on estimated emission rates, PSD permits may be required at all of the sites under consideration for the Preferred Alternative facilities. PSD permits may require inclusion of "offsets" (reductions of existing emissions) for any additional or new emission source.

Noise sources associated with the Preferred Alternative facilities may include construction equipment, increased traffic, ventilation equipment, cooling systems, and emergency diesel generators. The contribution to offsite noise levels would continue to be small at all of the sites because the facilities associated with the Preferred Alternative would be a sufficient distance away from the site boundary and sensitive receptors. Due to the large size of the sites, noise emissions from construction and operation activities would not be expected to cause annoyance to the public.

Water Resources

The construction and operation of the proposed facilities under the Preferred Alternative at Hanford, INEL, Pantex, and SRS would affect water resources. All facilities would be constructed outside of the 100-year, 500-year, and probable maximum flood; although the 500-year floodplain is not completely mapped at SRS, the facilities would likely be located outside the 500-year floodplain. Flooding from dam failures and flooding from a landslide resulting in river blockage would only be potentially possible at Hanford or INEL, but are not expected to occur. Wastewater discharges at all sites are expected to continue to meet National Pollutant Discharge Elimination System (NPDES) limits and reporting requirements at all sites.

Hanford Site. Surface water obtained from the Columbia River would be used as the water source for operation of the proposed facilities. The total water requirement for the Preferred Alternative at Hanford would be less than 1 percent of the Columbia River's average annual flow (3,360 m^3/s [118,700 ft^3/s]). The withdrawals are negligible in comparison with the average flow of the river and would not noticeably affect the local or regional water supply.

The wastewater discharge would account for a 98-percent increase over the No Action Alternative projected discharge. The wastewater would be treated in newly constructed sanitary, utility, and process wastewater treatment systems prior to disposal.

Idaho National Engineering Laboratory. Water requirements for the operation of the Preferred Alternative at INEL would be obtained from groundwater sources. The water requirements for the site over the projected No

Action Alternative water usage would be less than a 0.05-percent increase for construction (approximately 0.24 percent of the groundwater allotment) and a 2-percent increase for operations (approximately 9.6 percent of the groundwater allotment).

The wastewater discharged during operations would represent a 24-percent increase over the projected No Action Alternative discharge. Existing INEL treatment facilities could accommodate all the new Preferred Alternative processes and wastewater streams. If necessary, new sanitary, utility, and process wastewater treatment systems would be constructed to accommodate the increase.

Pantex Plant. Water requirements for the operation of technologies identified in the Preferred Alternative for Pantex would be obtained from groundwater resources or, if feasible, from the City of Amarillo Hollywood Road Wastewater Treatment Plant. Should only groundwater be used, the total annual site groundwater withdrawal, including that required for the Preferred Alternative in the year 2005 (the No Action base year), would be 428 million l/yr (113 million gal/yr). This represents a 72-percent increase in the projected No Action Alternative water usage. Because the projected No Action Alternative water usage reflects reductions in water use due to planned downsizing over the next few years, this quantity (No Action plus the Preferred Alternative) is considerably less than what is currently being withdrawn at Pantex (836 million l/yr [221 million gal/yr]). Pantex's groundwater usage would still contribute to the overall declining water levels of the Ogallala Aquifer.

Total estimated wastewater discharge for the Preferred Alternative (283 million l/yr [74.8 million gal/yr]) at Pantex would result in a 100-percent increase in the projected No Action Alternative discharge. If necessary, new sanitary, utility, and process wastewater treatment systems would be constructed to accommodate the increase.

Savannah River Site. Water requirements during operation of the Preferred Alternative would be obtained from existing or new well fields at SRS. The Preferred Alternative water requirements for the site would be a 3.7-percent increase over projected No Action Alternative groundwater usage. Suitable groundwater from the deep aquifers at the site is abundant, and aquifer depletion is not a problem.

The Preferred Alternative wastewater discharge to the river would be less than 5 percent of the minimum flow of Fourmile Branch (0.16 m^3/s [5.7 ft^3/s]), and less than 0.003 percent of the Savannah River average flow (283 m^3/s [9,990 ft^3/s]). SRS treatment facilities could accommodate all the new processes and wastewater streams if a new facility is built for tritium supply and recycling operations as planned. If necessary, new sanitary, utility, and process wastewater treatment systems would be constructed to accommodate the increase.

Geology and Soils

The construction of the potential facilities under the Preferred Alternative would involve some ground disturbing activities at Hanford, INEL, Pantex, and SRS (see discussion under Land Resources). Ground disturbance increases the potential for soil erosion. The key factors affecting the erosion potential of a site are the amount of disturbed land and the amount of annual precipitation. The potential for soil erosion at Hanford, INEL, and Pantex is slight because of low precipitation. Since SRS receives more precipitation, the potential for erosion is considered moderate. The amount of soil loss would depend on factors such as the frequency and severity of precipitation events; wind velocities; and the area, location, and duration of soil disturbance.

During operation, improvements to buildings, roads, and landscaping would considerably reduce the erosion potential. Erosion from stormwater runoff and wind could occasionally occur during operation of the facilities. Beyond increased erosion potential, no direct or indirect effects on geologic resources are anticipated.

Biological Resources

Hanford Site. Plutonium materials would continue to be stored at the PFP in the 200 West Area. Construction of the pit disassembly/conversion, Pu conversion, ceramic immobilization, and MOX facilities would be located on vacant land in the 200 Area adjacent to 200 East and would affect animal populations. Less mobile animals within the project area, such as reptiles and small mammals, would not be expected to survive. Noise from construction and operation activities would cause larger mammals and birds in the construction area and adjacent areas to move to similar habitat nearby. Nests and young animals living within the assumed sites may not survive. The sites would be surveyed as necessary for the nests of migratory birds before construction. Areas disturbed by construction, but not occupied by facility structures, would be of minimal value to wildlife because they would be maintained as landscaped areas.

Wetlands or aquatic resources would not be affected since no wetlands or surface water bodies exist near the assumed facilities locations. During both construction and operation, water would be withdrawn from the Columbia River through an existing intake structure, and wastewater would be discharged to evaporation/infiltration ponds. Wetlands or aquatic resources bordering the river would not be affected because the volume of water required represents a small percentage of the flow of the river.

It is unlikely that federally listed threatened and endangered species would be affected by construction and operation of the four disposition facilities, but sagebrush habitat would be disturbed. The sagebrush community is an important nesting/breeding and foraging habitat for several State-listed and candidate species, such as the ferruginous hawk, loggerhead shrike, western burrowing owl, pygmy rabbit, western sage grouse, and sage thrasher. Pre-activity surveys would be conducted as appropriate before construction to determine the occurrence of plant species or animal species and habitat in the area to be disturbed. DOE would also consult with Federal and State agencies pursuant to the *Endangered Species Act* (ESA) and other statutes as appropriate.

Idaho National Engineering Laboratory. Plutonium materials would continue to be stored at the ICPP and at ANL-W in the ZPPR and FMF vaults. Construction of the pit disassembly/conversion and MOX facilities on undeveloped land within or near the ICPP security area would affect animal populations. Less mobile animals within the project area, such as reptiles and small mammals, would be expected not to survive. Noise from construction and operation activities would cause larger mammals and birds in the construction area and adjacent areas to move to similar habitat nearby. Nests and young animals living with the assumed sites may not survive. The sites would be surveyed as necessary for the nests of migratory birds before construction. Areas disturbed by construction, but not occupied by facility structures, would be of minimal value to wildlife because they would be maintained as landscaped areas.

Wetlands and aquatic resources associated with the nearest surface water body, the Big Lost River, are located 1.6 km (1 mi) from the facility location. Due to the lack of wetlands or aquatic resources at the assumed facility locations, these resources would not be affected by construction or operation of the two facilities.

It is unlikely that federally threatened or endangered species would be affected by construction of the two disposition facilities, but several State-listed species may be affected. Burrows and foraging habitat for the pygmy rabbit would be lost. Bat species such as the Townsend's western big-eared bat may roost in caves and forage through the assumed site. One State-listed sensitive plant species could potentially be affected by construction of the facility. The plant species, tree-like oxytheca, has been collected at eight sites on INEL and at only two other sites in Idaho. If present, individual plants of this species could be destroyed during land clearing activities. Preactivity surveys would be conducted as appropriate before construction to determine the occurrence of these species and habitat in the area to be disturbed. DOE would also consult with Federal and State agencies pursuant to the ESA and other statutes as appropriate. No impacts to threatened and endangered species are expected due to facility operation.

Pantex Plant. Upgrading the existing storage Pu storage facility at Pantex would cause minimal disturbance to biological resources because all activities, including some new construction, would take place within the developed area. Noise associated with construction could cause some temporary disturbance to wildlife, but this impact would be minimal since animals living adjacent to the developed area have already adapted to its presence. Impacts to wetlands and aquatic resources would not occur since these resources do not exist in the upgrade area. Since the upgrade would take place within a developed area, impacts to threatened and endangered species would not be expected.

Both the pit disassembly/conversion facility location in Zone 12 and the MOX fuel fabrication facility location in Zone 11 lack natural vegetation. Disturbance of wildlife would be limited due to the existing disturbed nature of the assumed locations; however, small mammals and some birds and reptiles could be displaced by construction. Since the area around both locations does not contain any wetlands or aquatic resources, these resources would not be affected by construction of the facility. During operation, wastewater would be discharged to site playas through NPDES-regulated outfalls. The additional wastewater could lead to minor increases in open water near the outfalls, as well as changes in plant species composition. It is unlikely that federally listed threatened or endangered species would be affected by construction or operation of the facilities. Although the assumed sites have been disturbed, it is possible that the State-listed Texas horned lizard could be present. Before construction, preactivity surveys would be conducted, as appropriate to determine the presence of any special status species and habitat on the proposed site; DOE would also consult with Federal and State agencies pursuant to the ESA and other statutes as appropriate.

Savannah River Site. No additional impacts on biological resources are expected from modifying the APSF in F-Area to accommodate the storage of RFETS non-pit Pu material in addition to SRS non-pit Pu material because the modification would only use previously disturbed land.

For the pit disassembly/conversion, Pu conversion, and ceramic immobilization facilities, impacts to terrestrial resources would be minimal because the F-Area is one of the highly developed industrial areas of the SRS. Noise associated with construction could cause some temporary disturbance to wildlife, but this impact would be minimal since animals living adjacent to the F-Area have already adapted to similar disturbances. There would be no direct impacts to wetlands or aquatic resources from construction of the facility. Secondary impacts from stormwater runoff would be controlled by implementation of a soil erosion and sediment control plan. Operational impacts to wetlands and aquatic resources would be minimal since there would be relatively small increases in treated wastewater and storm water that would be discharged via NPDES-permitted outflows. Impacts from construction and operation of the three disposition facilities would not be expected to affect threatened and endangered species due to the developed nature of the assumed facility locations. Although suitable foraging habitat for the red-cockaded woodpecker exists in the area, the woodpecker colonies are located far enough from the facilities so that this species would not be directly affected by these facilities. Before committing construction resources, DOE would consult with Federal and State agencies pursuant to the ESA and other statutes as appropriate.

Construction of the MOX facility north of the P-Reactor Area on the east side of SRS Route F would affect animal populations. Less mobile animals within the project area, such as reptiles and small mammals, would not be expected to survive. Noise from construction and operation activities would cause larger mammals and birds in the construction area and adjacent areas to move to similar habitat nearby. Nests and young animals living with the assumed sites may not survive. The sites would be surveyed as necessary for the nests of migratory birds before construction. Areas disturbed by construction, but not occupied by facility structures, would be of minimal value to wildlife because they would be maintained as landscaped areas.

Since the majority of the assumed MOX fuel fabrication facility site is upland, the facility could be located to avoid direct impacts to wetlands. Wastewater discharge from construction and operation would be minimal and would not be expected to affect wetlands associated with the receiving stream. Stormwater runoff during construction could cause temporary water quality changes in local tributaries to Par Pond. During operation,

nonhazardous wastewater flow increases are not expected to impact stream hydrology or aquatic resources. All discharges would be required to meet NPDES permit regulations.

It is unlikely that federally listed threatened or endangered species would be affected by construction or operation of a MOX fuel fabrication facility. Although bald eagles have been sighted in the vicinity of the assumed facility location, it is highly unlikely that construction and operation of the MOX fuel fabrication facility would affect this species. Although suitable foraging habitat for the red-cockaded woodpecker exists in the area, the woodpecker colonies are located far enough from the facilities so that this species would not be directly affected by the MOX facility. Before construction, preactivity surveys would be conducted as appropriate to determine the presence of any special status species and habitat on the proposed site; DOE would consult with Federal and State agencies pursuant to the ESA and other statutes as appropriate.

Cultural and Paleontological Resources

The impacts to cultural and paleontological resources are closely related to the amount of land disturbed. The land-use impacts associated with construction and operation of the Preferred Alternative actions at Hanford, INEL, Pantex, and SRS are discussed under Land Resources. Because most of the locations proposed have been previously disturbed, it is unlikely that they would contain subsurface prehistoric or historic archaeological deposits. Some paleontological remains may be encountered during construction. Operations would not have additional impacts on historic, prehistoric, or paleontological resources, but there may be visual or auditory intrusions to Native American resources.

Hanford Site. Plutonium materials would continue to be stored at the PFP in the 200 West Area. The pit disassembly/conversion, Pu conversion, ceramic immobilization, and MOX facilities would be located on vacant land in the 200 Area adjacent to 200 East. Although no archeological resources have been identified during surveys conducted in the adjacent 200 Areas, some may exist in the facility locations. Any such sites would be identified through compliance with Sections 106 and 110 of the *National Historic Preservation Act* of 1966 (NHPA). Any identified sites may be affected by facility construction. Operation would not result in additional impacts.

Although all of Hanford is considered sacred land by some Native American groups, no areas of great cultural significance have been identified close to the 200 Area. Resources may be identified through facility-specific consultation. Impacts from construction and operation may include reduced access to traditional use areas or visual or auditory intrusion into sacred or ceremonial space.

Pliocene and Pleistocene fossil remains have been discovered at Hanford. Although none have been recorded in the facility locations, they may exist. These resources may be affected by ground disturbing construction. Operations would not have additional impacts on paleontological resources.

Idaho National Engineering Laboratory. Plutonium materials would continue to be stored at the ICPP and the ZPPR and FMF vaults in ANL-W. The pit disassembly/conversion and MOX facilities would be located on undeveloped land within or near the ICPP security area. The pit disassembly/conversion facility would be sited in a location previously approved for the construction of the Special Isotope Separation Project. A surface survey of this area identified no prehistoric or historic sites. Although it is possible, the ICPP is unlikely to contain intact subsurface cultural deposits, due to prior ground disturbance and environmental setting. INEL has a contingency plan in place should any archeological remains be discovered during construction. Two historic sites exist adjacent to the ICPP, one historic can scatter lies across the Big Lost River to the northeast, and one abandoned homestead is to the east. The can scatter is not considered eligible for National Register of Historic Places (NRHP) listing, and the homestead has been fenced off for protection. Construction and operation are not expected to affect either site.

Native American resources may be affected by the proposed facilities. Facility construction and operation may have visual or auditory impacts on traditional use areas or sacred sites. Resources may be identified through consultation with the interested tribes.

Some paleontological remains may be encountered during construction. The ICPP lies on alluvial gravels associated with the Big Lost River floodplain, which have produced fossilized remains. Operation would not have an effect on paleontological resources.

Pantex Plant. Modifications of Buildings 12-66 and 12-82 in Zone 12 South to accommodate the long-term storage of Pantex pits and RFETS pits are not considered NRHP eligible based on an evaluation of World War II Era structures at Pantex. However determinations of NRHP-eligible Cold War Era structures have not been completed, and some structures in Zone 12 may be determined eligible on that basis. Zone 12 is also the potential location for the pit disassembly/conversion facility. Because Zone 12 South is developed, disturbed, and removed from water sources, it is unlikely to contain subsurface prehistoric or historic archeological deposits, even on lands used for equipment laydown or construction parking. No impacts to prehistoric or historic resources are expected to result from the construction or operation of these facilities.

Areas that would be disturbed in Zone 11 for the MOX fuel fabrication facility have not been systemically surveyed for archaeological or paleontological resources. Before construction, additional survey work may be necessary under Section 106 of the NHPA. Because Zone 11 is disturbed, it is unlikely to contain subsurface prehistoric or historic archeological deposits. Should any subsurface remains be discovered during construction, appropriate mitigation, documentation, and/or preservation measures would be conducted as necessary. Operations would not have additional impacts to archeological resources as it does not result in additional ground disturbance. Facility construction may have an impact on historic structures at Pantex. The original buildings in Zone 11 were constructed between 1942 and 1945 to produce general purpose bombs. Zone 11 contains buildings, ramps, and landscape features that clearly illustrate the historic layout of a World War II bomb manufacturing line. Only two buildings within Zone 11 have been determined ineligible for listing on the NRHP. Construction may obscure the spatial relationship between these buildings, thereby compromising their historic significance. Operation of the facility is not expected to affect historic structures.

The Department has recently initiated consultation with Native American groups that have expressed interest in Pantex lands. To date, no Native American resources have been identified within Zones 11 and 12. Resources may be identified through additional consultation. Although no mortuary remains have been discovered at Pantex to date, it is possible that some exist within land to be disturbed by development. Burials are considered important Native American resources. Construction and operation could affect traditionally used plant and animal species.

The surficial geology of the Pantex area consists of silts, clays, and sands of the Blackwater Draw Formation. In other areas of the High Plains, this formation has produced Late Pleistocene vertebrate remains including woolly mammoth, bison, and camel, sometimes in context with archaeological remains. The land to be disturbed during construction may contain some fossilized remains. Operation would not have an affect on paleontological resources.

Savannah River Site. The Actinide Packaging and Storage Facility in F-Area would be modified to accommodate the storage of SRS non-pit Pu material and RFETS non-pit Pu material for the storage Preferred Alternative. Vacant land in the F-Area would be used for the pit disassembly/conversion, Pu conversion, and ceramic immobilization facilities. Portions of the F-Area have been surveyed and contain sites potentially eligible for the NRHP. Additional surveys would be conducted in any unsurveyed areas to be disturbed by construction. Site types known to occur at SRS include remains of prehistoric base camps, quarries, and workshops. Historic resources include remains of farmsteads, cemeteries, churches, and schools. Resources such as these may be affected by new facility construction, but not operation.

The MOX fuel fabrication facility would be located on undeveloped land approximately 1.6 km (1 mi) north of the P-Reactor Area on the east side of SRS Route F. To date, seven prehistoric sites have been located within 0.5 km (0.3 mi) of this area, so the potential for archaeological sites is moderate to high, and some NRHP-eligible resources may occur within the acreages that would be disturbed by construction. Prehistoric site types that may occur at SRS include villages, base camps, limited activity sites, quarries, and workshops. Historic site types that may occur at SRS include farmsteads, tenant dwellings, mills, plantations and slave quarters, rice farming dikes, cattle pens, dams, towns, churches, cemeteries, trash scatters, and roads.

Some Native American resources may be affected by construction and operation of the facilities. Resources such as prehistoric sites, cemeteries, isolated burials, and traditional plants could be affected by construction. Facility operation could result in reduced access to traditional use areas or sacred space. Visual or auditory intrusions to the areas may also result from the proposed facilities. These resources would be identified through consultation with the potentially affected tribes.

Some paleontological remains may occur on this acreage, but impacts during construction would be considered negligible because fossil assemblages known to occur at SRS are of low research value. No additional impacts are expected to paleontological resources during operation since no additional ground disturbance is expected.

Socioeconomics

At Hanford, INEL, Pantex, and SRS the primary impact of the Preferred Alternative would be to increase regional employment and income. There would be some increase in demand for community services and housing at each of the sites as a result of in-migrating population. However, the available housing and existing community infrastructure would be able to accommodate these small population increases. Construction and operation of the proposed facilities would increase traffic flow and cause a potential decline in the level of service on some road segments at all sites except Hanford. At RFETS, phaseout of Pu storage would result in the loss of approximately 2,200 direct jobs. Compared to the total employment in the area, the loss of these jobs and the impacts to the regional economy would not be severe.

Hanford Site. Plutonium materials would continue to be stored at the PFP in the 200 West Area, and there would be no impact on the site workforce. Construction of the pit disassembly/conversion, Pu conversion, ceramic immobilization, and MOX facilities would continue through the year 2013, and there would be sufficient available labor within the region to fulfill construction workforce requirements. Economic impacts from construction would peak in 2010, during construction of the ceramic immobilization facility. Total regional economic area (REA) employment would increase by 2001 due to construction of the ceramic immobilization facility. However, during this same period, the other three disposition facilities would already be fully operational, generating approximately 7,500 additional jobs in the REA.

In the year 2003, the pit disassembly/conversion and MOX facilities would be the first disposition alternative facilities to become fully operational. Pu conversion would begin in 2006, and the ceramic immobilization operations would begin in 2013. The operational workforce would increase beginning in the year 2003 and peak in the year 2013 when all of the disposition facilities would become fully operational. Total direct employment would reach approximately 3,100 in 2013. Total REA employment would increase by approximately 10,400, and unemployment would decrease from 9.1 to 7.1 percent. The per capita income would increase by 2 percent.

In-migration to fulfill specialized direct job requirements would lead to a population increase of about 1 percent in the ROI. The additional population would increase the demand for community services by approximately 1 percent. Demand for housing would also increase, but the impact on the local markets would be minimal.

Construction and operation workers at Hanford would generate 1,920 and 5,900 additional vehicle trips per day on the local roads, respectively. The level of service would not change due to the additional traffic generated

during construction. Operations would cause a drop in level of service from B to C on Washington State Route 240 from Washington State Route 24 to Washington State Route 224.

Idaho National Engineering Laboratory. Plutonium materials would continue to be stored at ICPP and ZPPR, and in FMF vaults at ANL-W. No additional workforce would be required for continuation of the storage mission at INEL. Construction of the pit disassembly/conversion and MOX facilities would take place concurrently and continue through the year 2003. Some in-migration would take place both during construction and operation to fill specialized job requirements. Direct employment during peak construction would reach 660 in 1999 and total 1,330 during the first year of full operation in 2003. Total REA employment would increase by approximately 1,200 during construction and by approximately 6,000 during operations. Unemployment would decrease from 5.4 percent to 4.8 percent during peak construction and fall further to 2.4 percent during operation. The per capita income would increase by less than 0.4 percent during construction and by about 1.4 percent during operations.

In-migration to fulfill direct job requirements for both construction and operations would lead to a population increase of less than 1 percent in the ROI. The additional population would increase demand for community services by less than 1 percent during both construction and operations. Demand for housing would also increase, but, the impact on the local markets would be minimal.

Construction and operation workers at INEL would generate 1,267 and 2,554 additional vehicle trips per day on local roads, respectively. The level of service would not change due to additional traffic generated during construction. Operations would cause a drop in level of service from D to E on US 20 from US 26/91 at Idaho Falls to US 26 East. Operations would also cause a drop in level of service from B to C on US 20/26 from US 26 East to Idaho State Route 22/33.

Pantex Plant. Buildings 12-66 and 12-82 would be modified to accommodate the long-term storage of Pantex pits and RFETS pits for the storage Preferred Alternative. Additional workers would be required for construction and operation of the modified storage facilities. Construction of the pit disassembly/conversion and MOX fabrication facilities would take place concurrently and continue through 2003, when full operations would commence. Because the construction of the disposition facilities would require a larger workforce than would modification of the storage facilities, peak construction impacts would occur in 1999. Peak operation impacts would occur in 2005, when all three facilities would be fully operational. Total direct construction employment during peak construction would reach 660 in 1999, and direct operation employment would reach 1,420 in 2005, when all three facilities would be fully operational. Total REA employment would increase by 1,192 during peak construction and by 6,404 during operations. Unemployment would decrease from 4.8 percent to 4.3 percent during peak construction and fall further to 3.0 percent during operations. The per capita income would increase about 0.3 percent during construction and by 0.5 percent during operations.

In-migration to fulfill direct job requirements for both construction and operations would lead to a population increase of 0.1 percent during construction and about 2 percent during operation. The increase in demand for community services during construction and operation would be minimal. Demand for housing would also increase, but, the impact on the local markets would be minimal.

Construction and operation workers at Pantex would generate 1,267 and 2,726 additional vehicle trips per day on local roads, respectively. The level of service would not change due to additional traffic generated during construction. Operations would cause a drop in level of service from A to B on Farm-to-Market 683 from US 60 to Farm-to-Market 293 and on Farm-to-Market 2373 from I-40 to US 60.

Savannah River Site. Under the Preferred Alternative, the Actinide Packaging and Storage Facility in the F-area would be modified to accommodate the long-term storage of the SRS non-pit Pu material and RFETS non-pit Pu material. The modification activities would employ workers from the current workforce, while operation of the expanded storage facility would require some additional workers. Construction of the pit

disassembly/conversion, Pu conversion, MOX fuel fabrication, and the ceramic immobilization facilities would continue until 2013, when all of the facilities would become operational. There would be sufficient available labor in the region to fulfill the construction workforce requirements. Economic impacts from construction would peak in 2010, during construction of the ceramic immobilization facility. Total REA employment would increase by 1,793 due to construction of the ceramic immobilization facility. However, during this same period, the other three disposition facilities would already be operating and generating an additional 6,936 jobs in the REA. Peak economic impacts would occur in 2013, when all of the storage and disposition facilities would be fully operational. Total employment in the region would increase by 9,482, and unemployment would decrease to 4.5 percent. Regional per capita income would increase by about 1.6 percent.

Because of the demand for in-migrating workers to fill specialized employment requirements, the ROI population would increase by 0.9 percent. Demand for community services would increase about 1 percent or less. The increase in demand for housing would be too small to affect the market.

Construction and operation workers at SRS would generate 1,920 and 6,150 additional vehicle trips per day on local roads, respectively. Construction would cause a drop in level of service from E to F on South Carolina State Route 19 from US 1/78 at Aiken to US 278. Operations would not significantly impact local roads.

Public and Occupational Health and Safety

Normal Operations. The human health impacts from the radiological and hazardous chemical releases during facility normal operations associated with the storage and disposition Preferred Alternative actions were analyzed at each of the DOE sites. The impact of the Preferred Alternative actions were then combined to obtain the "total impact." Total impact for each receptor/impact parameter is the summation of each facility, action, process, or technology for each of the operational campaigns (the number of years required to complete Pu disposition). Under normal radiological operations, the annual incremental dose to the maximally exposed individual (MEI) ranges from 2.7×10^{-4} millirem (mrem)/yr at INEL to 4.1×10^{-3} mrem/yr at SRS. All doses, when added to No Action, are within the radiological limits specified in NESHAPS (40 CFR 61, Subpart H) and DOE Order 5400.5. The annual incremental dose to the population within 80 km (50 mi) from the Preferred Alternative ranges from 4.2×10^{-3} person-rem/yr at INEL to 0.22 person-rem/yr at SRS. For DOE activities, proposed 10 CFR 834 (See 58 FR 1628) would generally limit the potential annual population dose to 100 person-rem from all pathways combined, and would require an As Low As Reasonably Achievable Program. When the contribution from the Preferred Alternative is combined with the No Action population dose for each of the sites, the total dose is well within the proposed 10 CFR 834. The dose assessments of the involved worker for storage and disposition facilities are within DOE radiological limits and administrative control levels. The incremental latent cancer fatalities to the involved workforce statistically estimated from these doses attributed to the Preferred Alternative range from 0.48 at INEL to 1.32 at SRS for the entire campaign (estimates based on the *1990 Recommendations of the International Commission of Radiological Protection*).

Facility Accidents. A set of potential accidents was postulated for each component of the Preferred Alternative. For each DOE site subject to multiple storage and disposition actions (Hanford, INEL, Pantex, and SRS), this includes a set of accidents for the storage option coupled with the combination of preferred disposition technologies assumed for the analysis. For the Existing LWR Alternative, a Probabilistic Risk Assessment (PRA) approach was applied to determine the effects of operating an existing LWR with a MOX core. The incremental effects are described below.

One measure of impact calculated from modeled accident scenarios is expected risk, the summation of risk (the product of accident occurrence probability and consequence) for the accident spectrum modeled for each component of the Preferred Alternative. These expected risks were aggregated for the Preferred Alternative for the following impact receptors: a worker located 1,000 m (3,280 ft) from the accident release point; the maximum hypothetical offsite individual located at the site boundary; and the population located within 80 km

(50 mi) of the accident release point. Aggregated expected risk estimates of cancer fatality(s) for each assumed campaign under the Preferred Alternative range from: 1.3×10^{-6} at INEL to 1.5×10^{-5} at Pantex; 1.4×10^{-8} at INEL to 6.0×10^{-6} at Pantex; and 3.0×10^{-5} at INEL to 9.1×10^{-4} at Pantex; respectively for these impact receptors. The Y–12 upgrade at ORR under the Preferred Alternative could reduce the expected risk of cancer fatalities for the design basis accidents analyzed in the Y–12 EA to 5.1×10^{-7}, 7.4×10^{-6}, and 5.7×10^{-8} per year for the 80-km (50-mi) offsite population, MEI, and noninvolved worker, respectively by meeting the performance goal for a moderate hazard facility of Performance Category 3 as prescribed in DOE Order 5480.28, *Natural Phenomena Hazards Mitigation*.

The evaluated accident scenario with the highest risk to the public at the DOE sites under the Preferred Alternative (a fire on the loading dock of the MOX fuel fabrication facility) would result in an estimated risk of 5.2×10^{-5}, 1.6×10^{-5}, 1.8×10^{-5}, and 5.2×10^{-5} cancer fatalities over the assumed MOX fuel fabrication campaign at Hanford, INEL, Pantex, and SRS, respectively.

Under the Preferred Alternative, the use of existing LWRs is being pursed for the disposition of surplus plutonium through the use of MOX fuel in place of UO_2. An important question is whether the use of MOX fuel changes the safety envelope of UO_2 fueled reactors documented in Safety Analysis Reports, PRAs, and NUREG-1150 (*Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants*). Related reactor safety issues are addressed in a recent report by the National Academy of Sciences (*Management and Disposition of Excess Weapons Plutonium Reactor-Related Options*). The report indicates that the potential influences on safety of the use of MOX fuel in LWRs has been extensively studied in the United States in the 1970s (*Final Generic Environmental Impact Statement on the Use of Recycled Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors*, NUREG-0002). These influences have also been extensively studied in Europe, Japan and Russia. Regarding effects of MOX on accident probabilities, the National Academy of Sciences report states, "... no important overall adverse impact of MOX use on the accident probabilities of the LWRs involved will occur; if there are adequate reactivity and thermal margins in the fuel, as licensing review should ensure, the main remaining determinants of accident probabilities will involve factors not related to fuel composition and hence unaffected by the use of MOX rather than LEU fuel." Regarding the effects of MOX on accident consequences, the report states, "... it seems unlikely that the switch from uranium-based fuel could worsen the consequences of a postulated (and very improbable) severe accident in a LWR by more than 10 to 20 percent. The influence on the consequences of less severe accidents, which probably dominate the spectrum value of population exposure per reactor-year of operation would be even smaller, because less severe accidents are unlikely to mobilize any significant quantity of plutonium at all."

The incremental effects of utilizing MOX fuel in a commercial reactor in place of UO_2 were derived from a quantitative analysis of several typical severe accident scenarios for MOX and UO_2 using the MACCS computer code and generic population and meteorology data. The analysis only considers highly unlikely severe accidents where sufficient damage would occur to cause the release of Pu or uranium. The risks of severe accidents were found to be in the range of plus 8 to minus 7 percent, compared to UO_2 fuel, depending on the accident release scenario. The incremental risk of cancer fatalities to a generic offsite population located within 80 km (50 mi) of the severe accident release point would range from -2.0×10^{-4} to 3.0×10^{-5} per year for the accident release scenarios analyzed.[18] These preliminary results would be re-examined for licensing purposes and subsequent NEPA review. More detailed safety analyses would be performed using both up-to-date calculations of radionuclide inventories for different fuel compositions and irradiation histories, and population-exposure models for sensitivity changes in those inventories resulting from the use of weapons-grade Pu in the fuel.

[18] Accidents severe enough to cause a release of Pu or HEU involve combinations of events that are highly unlikely. Estimates and analyses presented in Chapter 4 and summarized in Table 2.5–3 indicate a range of latent cancer fatalities of 5.9×10^3 to 7.3×10^3 and risk per year of 0.15 to 0.16.

Natural Phenomena. Under the Preferred Alternative, HEU would continue to be stored at the Y–12 Plant at ORR in existing facilities that would be upgraded. The majority of the HEU would be housed in upgraded facilities currently used for HEU storage. The remaining HEU would be stored in facilities that were formerly used for material processing but are currently being modified and converted into storage areas. Modifications to existing buildings would make the facilities suitable for long-term storage and consist primarily of those upgrades required to meet natural phenomena requirements (including earthquakes and tornadoes) as documented in *Natural Phenomena Upgrade of the Downsized/Consolidated Oak Ridge Uranium/Lithium Plant Facilities* (Y/EN-5080, 1994). The Y–12 storage buildings would be upgraded to meet the performance goal for a moderate hazard facility of Performance Category 3 in DOE Order 5480.28, *Natural Phenomena Hazards Mitigation*. In a Performance Category 3 facility, radioactive or toxic materials are present in significant quantities. Design considerations for this category are to limit facility damage so that hazardous materials can be controlled and confined, occupants can be protected, and functions of the facility can continue without interruption. A performance goal for Performance Category 3 is a hazard exceedance frequency of $1.0x10^{-4}$ per year (DOE Order 5480.28). Meeting this performance goal would reduce the expected risk for the design basis accidents analyzed in the Y–12 EA (for example, Building 9212) by approximately 80 percent, resulting in a latent cancer fatality risk of $5.1x10^{-7}$ to the MEI and $5.7x10^{-8}$ to a noninvolved worker, and potential latent cancer fatalities of $7.4x10^{-6}$ for the 80-km (50-mi) offsite population.

At SRS, F-Canyon facilities could be used for the immobilization of surplus Pu using the can-in-canister variant under the Preferred Alternative. The earthquake accident analysis in the IMNM EIS determined that the F-Canyon facilities are structurally sound. Since that time, DOE has prepared a *Supplemental Analysis of Seismic Activity on F-Canyon* (August 1996). Based on the evaluation, an earthquake that could occur about once every 8,000 years could cause a level of structural damage to F-Canyon similar to the level of damage attributed to the earthquake considered in the IMNM EIS. Thus, the capability of F-Canyon to survive an earthquake more severe than that evaluated in the EIS, in combination with the fact that the likelihood of this level of damage was less than assumed in the EIS (1 per 8,000 years compared to 1 per 5,000 years), indicates that F-Canyon is seismically safe, or safer, than indicated in the IMNM EIS.

Waste Management

There is no spent nuclear fuel or HLW associated with construction or operation of Preferred Alternative facilities, but the ceramic immobilization facility would generate as its product output a stabilized ceramic form spiked with cesium radionuclides. (For immobilization using vitrification, a stable glass form of Pu and HLW would be generated.) Storage of this immobilized product would be provided until disposal in a geologic repository pursuant to the NWPA.[19] Each of the facilities under the Preferred Alternative have as part of their conceptual design waste management facilities that would treat and package all waste generated into forms that would enable long-term storage and/or disposal in accordance with the regulatory requirements of *Resource Conservation and Recovery Act* (RCRA), and other applicable statutes. Under the Preferred Alternative, the waste management infrastructure of the individual facilities would be integrated into a single waste management infrastructure to include maximum use of existing and planned site waste management facilities. Depending in part on decisions in the waste-type specific RODs for the Waste Management PEIS, wastes could be treated, and (depending on the type of waste) disposed of, onsite or at regionalized or centralized DOE sites. The treatment level and potential disposal of TRU and mixed TRU waste at the Waste Isolation Pilot Plant (WIPP) will depend on decisions in the ROD for the *Supplemental Environmental Impact Statement for the Waste Isolation Pilot Plant Disposal Phase*. For the purposes of analyses only, this PEIS assumes that transuranic (TRU) and TRU mixed waste would be treated onsite to the current planning-basis Waste Isolation Pilot Plant (WIPP) Waste

[19] Pursuant to the *Nuclear Waste Policy Act*, DOE is currently characterizing the Yucca Mountain Site as a potential repository for spent nuclear fuel and HLW. Legislative clarification, or a determination by the Nuclear Regulatory Commission that the immobilized Pu should be isolated as HLW, may be required before the material could be placed in Yucca Mountain should DOE and the President recommend, and Congress approve, its operation. No radionuclides that are RCRA wastes would be used for immobilization so the immobilized product would be consistent with the repository's waste acceptance criteria.

Acceptance Criteria, and shipped to WIPP for disposal. This PEIS also assumes that hazardous waste, low-level waste (LLW), and mixed LLW would be treated and disposed of in accordance with current site practice.

Construction and operation of the proposed facilities would affect existing waste management activities at each of the sites analyzed, increasing the generation of TRU, low-level, mixed, hazardous, and nonhazardous wastes. Wastes generated during construction would consist of wastewater and hazardous and solid nonhazardous wastes. Wastewater and solid nonhazardous wastes would be disposed of as part of the construction project by the contractor, and the hazardous wastes would be treated onsite or shipped offsite, to a commercial RCRA-permitted treatment facility. After treatment, the waste would be disposed of off-site in a commercial RCRA-permitted disposal facility. No radioactive or hazardous soil contamination is expected to be generated during construction. However, if any were generated, it would be managed in accordance with site practice and all applicable Federal and State regulations.

Hanford Site. Under the Preferred Alternative approximately 78.2 m^3 (20,660 gal) of liquid and 750 m^3 (981 yd^3) of solid TRU waste would require treatment, and packaging to meet the current planning-basis WIPP Waste Acceptance Criteria or an alternate treatment level. An estimated 200 m^3 (262 yd^3) of solid mixed TRU waste would be managed and treated as necessary in accordance with the Hanford Tri-Party Agreement to meet the WIPP Waste Acceptance Criteria or an alternate treatment level. Depending on decisions made in the ROD for the *Supplemental Environmental Impact Statement for the Waste Isolation Pilot Plant Disposal Phase*, 109 additional truck shipments per year or, if applicable, 54 regular train shipments per year, or 18 dedicated train shipments per year would be required to transport the TRU and mixed TRU waste to WIPP.

Approximately 70.4 m^3 (18,590 gal) of liquid and 2,010 m^3 (2,630 yd^3) of solid LLW would require treatment, processing, and packaging to meet the waste acceptance criteria of the 200-Area LLW Burial Grounds. After treatment and volume reduction, 2,010 m^3 (2,630 yd^3) of solid LLW would require disposal. Assuming a land usage of factor of 3,400 m^3/ha (1,800 yd^3/acre), this would require 0.6 ha/yr (1.5 acres/yr) of LLW disposal area. The ultimate disposal of LLW will be in accordance with the ROD for the Waste Management PEIS.

Roughly 1.2 m^3 (320 gal) of liquid and 231 m^3 (302 yd^3) of solid mixed LLW would be treated and disposed of in accordance with the Hanford Tri-Party Agreement. The 46 m^3 (12,150 gal) of liquid and 184 m^3 (241 yd^3) of solid hazardous wastes would be collected, treated on- or off-site, and shipped in Department of Transportation (DOT)-approved containers to an offsite commercial RCRA-permitted treatment facility. After treatment, the waste would be disposed of off-site in commercial RCRA-permitted disposal facilities.

Approximately 177,000 m^3 (46.8 million gal) of liquid nonhazardous sanitary and industrial wastewater and 170,000 m^3 (45.0 million gal) of steam plant and cooling blowdown and estimated stormwater runoff would require treatment in accordance with site practice. Depending on actual site location, expansion of existing or construction of new sanitary, utility, and process wastewater treatment facilities may be required. The 3,240 m^3 (4,240 yd^3) of solid nonhazardous wastes that is not recycled or salvageable would be shipped to the City of Richland landfill per current site practice.

Idaho National Engineering Laboratory. Under the Preferred Alternative approximately 373 m^3 (488 yd^3) of solid TRU waste would require treatment and packaging to meet the current planning-basis WIPP Waste Acceptance Criteria or an alternate treatment level. An estimated 8 m^3 (11 yd^3) of solid mixed TRU waste would be managed and treated as necessary in accordance with the INEL Site Treatment Plan to meet the current planning-basis WIPP Waste Acceptance Criteria or an alternate treatment level. Depending on decisions made in the ROD for the *Supplemental Environmental Impact Statement for the Waste Isolation Pilot Plant Disposal Phase*, 44 additional truck shipments per year or, if applicable, 22 regular train shipments per year, or 7 dedicated train shipments per year would be required to transport the TRU and mixed TRU waste to WIPP.

Approximately 8 m^3 (2,100 gal) of liquid and 255 m^3 (333 yd^3) of solid LLW would require treatment, processing, and packaging to meet the waste acceptance criteria of the Radioactive Waste Management

Complex (RWMC). Assuming a land usage of factor of 6,200 m^3/ha (3,300 yd^3/acre), the disposal of LLW would require 0.04 ha/yr (0.1 acres/yr) of LLW disposal area. The ultimate disposal of LLW will be in accordance with the ROD for the Waste Management PEIS.

Roughly 1.1 m^3 (290 gal) of liquid and 40 m^3 (52 yd^3) of solid mixed LLW would be treated and disposed of in accordance with the INEL Site Treatment Plan. The 6 m^3 (1,500 gal) of liquid and 154 m^3 (201 yd^3) of solid hazardous wastes would be collected, treated on- or off-site, and shipped in DOT-approved containers to an offsite commercial RCRA-permitted treatment facility. After treatment, the waste would be disposed of off-site in commercial RCRA-permitted disposal facilities.

Approximately 129,000 m^3 (34.0 million gal) of liquid nonhazardous sanitary, industrial, and other process wastewater would require treatment in accordance with site practice. Depending on actual site location, expansion of existing or construction of new sanitary, utility, and process wastewater treatment facilities may be required. The 253 m^3 (331 yd^3) of solid nonhazardous wastes that is not recycled or salvageable would be shipped to the onsite landfill per current site practice.

Pantex Plant. Under the Preferred Alternative approximately 374 m^3 (489 yd^3) of solid TRU waste would require treatment and packaging to meet the current planning-basis WIPP Waste Acceptance Criteria or an alternate treatment level. An estimated 8 m^3 (11 yd^3) of solid mixed TRU waste would be managed and treated as necessary in accordance with the *Pantex Plant Federal Facility Compliance Act Site Treatment Plan/Compliance Plan* to meet the WIPP Waste Acceptance Criteria or an alternate treatment level. Depending on decisions made in the ROD for the *Supplemental Environmental Impact Statement for the Waste Isolation Pilot Plant Disposal Phase*, 44 additional truck shipments per year or, if applicable, 22 regular train shipments per year, or 7 dedicated train shipments per year would be required to transport the TRU and mixed TRU waste to WIPP.

Approximately 8 m^3 (2,100 gal) of liquid and 392 m^3 (513 yd^3) of solid LLW would require treatment, processing, and packaging to meet the waste acceptance criteria of the NTS Area 5 Radioactive Waste Management Site Waste Acceptance Criteria. After treatment and volume reduction, 324 m^3 (424 yd^3) of solid LLW would require disposal. Assuming a land usage of factor of 6,000 m^3/ha (3,200 yd^3/acre), the disposal of LLW would require 0.05 ha/yr (0.13 acres/yr) of LLW disposal area at NTS. Assuming 16.6 m^3 (21.7 yd^3) of LLW per shipment, 20 additional LLW shipments per year from Pantex to NTS would be required. The ultimate disposal of LLW will be in accordance with the ROD for the Waste Management PEIS.

Roughly 1.3 m^3 (350 gal) of liquid and 48 m^3 (63 yd^3) of solid mixed LLW would be treated and disposed of in accordance with the *Pantex Plant Federal Facility Compliance Act Site Treatment Plan/Compliance Plan*. The 7 m^3 (1,760 gal) of liquid and 155 m^3 (203 yd^3) of solid hazardous wastes would be collected, treated on- or off-site, and shipped in DOT-approved containers to an offsite commercial RCRA-permitted treatment facility. After treatment, the waste would be disposed of off-site in commercial RCRA-permitted disposal facilities.

Approximately 141,000 m^3 (37.2 million gal) of liquid nonhazardous sanitary, industrial, and other process wastewater would require treatment in accordance with site practice. Depending on site location, expansion of existing or construction of new utility and process wastewater treatment facilities may be required. The existing sanitary wastewater treatment system has adequate excess capacity to treat the additional quantity of sanitary wastewater. The 391 m^3 (511 yd^3) of solid nonhazardous wastes that is not recycled or salvageable would be shipped to the City of Amarillo landfill per current site practice.

Savannah River Site. Under the Preferred Alternative approximately 78.2 m^3 (20,660 gal) of liquid and 750 m^3 (981 yd^3) of solid TRU waste would require treatment and packaging to meet the current planning-basis WIPP Waste Acceptance Criteria or an alternate treatment level. An estimated 200 m^3 (262 yd^3) of solid mixed TRU waste would be managed and treated as necessary in accordance with the SRS Treatment Plan to meet the

current planning-basis WIPP Waste Acceptance Criteria or an alternate treatment level. Depending on decisions made in the ROD for the *Supplemental Environmental Impact Statement for the Waste Isolation Pilot Plant Disposal Phase*, 109 additional truck shipments per year or, if applicable, 54 regular train shipments per year, or 18 dedicated train shipments per year would be required to transport the TRU and mixed TRU waste to WIPP.

Approximately 70.4 m^3 (18,600 gal) of liquid and 2,010 m^3 (2,630 yd^3) of solid LLW would require treatment, processing, and packaging to meet the waste acceptance criteria of the SRS E-Area Low-Level Radioactive Disposal Facility. After treatment and volume reduction, 2,010 m^3 (2,630 yd^3) of solid LLW would require disposal. Assuming a land usage of factor of 8,600 m^3/ha (4,600 yd^3/acre), this would require 0.2 ha/yr (0.5 acres/yr) of LLW disposal area. The ultimate disposal of LLW will be in accordance with the ROD for the Waste Management PEIS.

Roughly 1.2 m^3 (311 gal) of liquid and 231 m^3 (302 yd^3) of solid mixed LLW would be treated and disposed of in accordance with the SRS Site Treatment Plan. The 46 m^3 (12,070 gal) of liquid and 184 m^3 (241 yd^3) of solid hazardous wastes would be collected, treated on- or off-site, and shipped in DOT-approved containers to an offsite commercial RCRA-permitted treatment facility. After treatment, the waste would be disposed of off-site in commercial RCRA-permitted disposal facilities.

Approximately 179,000 m^3 (47.3 million gal) of liquid nonhazardous sanitary and industrial wastewater and 170,000 m^3 (45 million gal) of steam plant and cooling blowdown and estimated stormwater runoff would require treatment in accordance with site practice. Depending on actual site location, expansion of existing or construction of new utility and process wastewater treatment facilities may be required. The centralized sanitary wastewater treatment system is adequate to treat the sanitary portion. The 3,250 m^3 (4,250 yd^3) of solid nonhazardous wastes that is not recycled or salvageable would be shipped to an offsite landfill per current site practice.

Intersite Transportation

The estimated health effects from transportation of radiological materials for the Preferred Alternative actions at Hanford, INEL, Pantex, and SRS for the life of the project range from 0.193 fatalities for Pantex to 1.87 fatalities for SRS.

In addition to the activities at the DOE sites, there would be transportation of the MOX fuel from the DOE fuel fabrication site to existing LWRs. The location of the LWRs and the destination of the MOX fuel could be either the eastern or western United States. For 4,000 km (2,486 mi) there could be an additional 3.61 potential fatalities. The 3.61 potential fatalities assumes that 100 percent of the surplus Pu would be used in commercial reactors. For analysis purposes, approximately 70 percent of the surplus Pu would be used in commercial reactors under the Preferred Alternative, therefore potential fatalities could be lower.

Environmental Justice

There would be no high and adverse health or environmental impacts to any population around the sites, including low-income and minority populations, from normal operation of the Preferred Alternative actions. The alternatives would confer socioeconomic benefits to each site where storage or disposition activities would occur (except RFETS), and therefore would not lead to any environmental justice concerns.

For environmental justice impacts to occur, there must be high and adverse human health or environmental impacts that disproportionately affect minority populations or low-income populations. The public health and safety analysis shows that air emissions and hazardous chemical and radiological releases from normal operations for all storage and disposition alternatives would be within regulatory limits and that no latent cancer fatalities would result.

The public health and safety analyses also indicate that radiological releases from accidents would not result in significant adverse human health or environmental impacts. Therefore, such accidents would not have disproportionately high and adverse impacts on minority or low-income populations. For the Preferred Alternative, for accidents associated with existing LWRs using MOX fuel, the maximum risk (which includes accident probability) of latent cancer fatalities to the public within 80 km (50 mi) would be 0.10 for the 11-year Pu disposition campaign. Therefore, it is unlikely that there would be disproportionately high and adverse impacts to minority populations or low-income populations surrounding the LWRs. Any potential transportation accidents would be random events that would not disproportionately affect minority or low-income populations.

S.7 CUMULATIVE IMPACTS

Cumulative impacts are those that could result from the incremental impact of the proposed action and alternatives identified above when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such actions. The reference condition is the No Action Alternative, which addresses the impacts of past, present, and ongoing programs. In particular, for alternatives that are proposed for DOE sites, the analysis focuses on the potential for cumulative impacts at each candidate site where other programs are reasonably anticipated.

The reasonably foreseeable future actions that have the potential to be implemented at some of the DOE sites under consideration, in addition to the long-term storage and disposition alternatives considered in the Storage and Disposition PEIS, include the following DOE programs: Waste Management (at Hanford, NTS, INEL, Pantex, ORR, SRS, RFETS, and LANL); Stockpile Stewardship and Management (at NTS, Pantex, ORR, SRS, and LANL); Tritium Supply and Recycling (at SRS); HEU Disposition (at ORR and SRS); Foreign Research Reactor Spent Nuclear Fuel (at INEL and SRS); and Spent Nuclear Fuel Management (at Hanford, INEL, and SRS).

[Text deleted.]

LONG-TERM STORAGE

Long-Term Storage Alternatives

The cumulative impact analysis, including the long-term storage alternatives and the six other reasonably foreseeable DOE programs, identified the following resource areas and issues at each site as having the potential to result in cumulative impacts:

- At Hanford, potential cumulative impacts from the maximum case alternative (Collocation) were identified for land resources, air quality, biological resources, and waste management.
- At NTS, potential cumulative impacts from the maximum case alternative (Collocation) were identified for land resources, site infrastructure, air quality, biological resources, cultural and paleontological resources, and waste management.
- At INEL, potential cumulative impacts from the maximum case alternative (Collocation) were identified for land resources, air quality, biological resources, socioeconomics (local transportation), and waste management.
- At Pantex, potential cumulative impacts from the maximum case alternative (Collocation) were identified for land resources, site infrastructure, air quality, water resources, and waste management.

- At ORR, potential cumulative impacts from the maximum case alternative (Collocation) were identified for land resources (visual quality), air quality, biological resources, cultural and paleontological resources, socioeconomics (local transportation), and waste management.

- At SRS, potential cumulative impacts from the maximum case alternative (Collocation) were identified for land resources, site infrastructure, air quality, biological resources, cultural and paleontological resources, socioeconomics (local transportation), public and occupational health and safety, and waste management.

- At RFETS, potential cumulative impacts from the maximum case alternative (Phaseout) were identified for socioeconomics.

- At LANL, no potential cumulative impacts were identified.

Preferred Alternative

The contribution to long-term storage cumulative impacts from the Preferred Alternative would be lower than the impacts identified above for the maximum case alternative at any one DOE site. Based on the cumulative impact analysis for long-term storage described above, the following resource and issue areas were identified at each site as having the potential to result in cumulative impacts:

- At Pantex, potential cumulative impacts were identified for land resources, site infrastructure, air quality, water resources, and waste management.

- At ORR, potential cumulative impacts were identified for air quality, cultural resources, local transportation, and waste management.

- At SRS, potential cumulative impacts were identified for air quality, public and occupational health and safety, and waste management.

- At RFETS, potential cumulative impacts were identified for socioeconomics.

Because the Preferred Alternative for storage at Hanford, NTS, INEL, and LANL is No Action, the storage program would not contribute to the cumulative impacts at these sites.

DISPOSITION

Disposition Alternatives

A site-specific cumulative impact analysis was not performed for all of the disposition alternatives because many of the facilities (for example, deep borehole complex and existing LWRs) do not allow site-specific cumulative impact analysis. Instead, a generic analysis that is applicable to all DOE sites was developed for these disposition alternatives. This representative scenario includes all of the common activities that would be needed for all of the disposition alternatives (construction and operation of pit disassembly/conversion and Pu conversion facilities), the common activity that would be required for the reactor alternatives (construction and operation of a MOX fuel fabrication facility), and the immobilization alternative that would generally have the largest impacts (ceramic immobilization facility). The scenario assumes that all four of the facilities would be constructed and operated concurrently at the same DOE site. Potential cumulative impacts could result from constructing and operating the pit disassembly/conversion, Pu conversion, MOX fuel fabrication, and immobilization facilities at a single DOE site.

For land resources, the construction of all four of the disposition facilities would disturb up to 191 ha (472 acres) of land during construction, of which up to 133 ha (330 acres) would be used during operations. If all four of the facilities were located at the same site, there would likely be a reduced area of disturbed land due to the sharing of land resources. Construction and operation of the disposition facilities could also result in the direct disturbance of terrestrial resources, wetlands, and threatened and endangered species.

The construction and operation of the disposition facilities could affect cultural and paleontological resources by disturbing Native American and buried paleontological materials. Constructing and operating the disposition facilities would generate employment and income increases in the region.

During normal operations of the disposition facilities, there would be both radiological and chemical releases to the environment and direct in-plant worker exposures. However, exposures are expected to be within regulated limits. To the extent possible, existing treatment systems would be used for the waste streams from the disposition facilities. If the capacity or appropriate treatment technology are not available, new treatment facilities would be built to handle the waste from the new facilities.

Preferred Alternative

Under the Preferred Alternative for disposition, Hanford and SRS are potential sites for four facilities (pit disassembly/conversion, Pu conversion, MOX fuel fabrication, and immobilization), therefore, the maximum contribution to cumulative impacts would result at these sites if all four facilities were constructed. INEL and Pantex are potential sites for two facilities (pit disassembly/conversion and MOX fuel fabrication), therefore, the maximum contribution to cumulative impacts at these sites would result if both of these facilities were constructed. Based on the cumulative impact analysis for the disposition alternatives described above, the following resource areas and issues were identified as having the potential to result in cumulative impacts:

- At Hanford, potential cumulative impacts were identified for land resources, site infrastructure, air quality, biological resources, cultural and paleontological resources, socioeconomics (local transportation), and waste management.
- At INEL, potential cumulative impacts were identified for land resources, site infrastructure, air quality, biological resources, cultural and paleontological resources, socioeconomics (local transportation), and waste management.
- At Pantex, potential cumulative impacts were identified for land resources, site infrastructure, air quality, water resources, cultural and paleontological resources, socioeconomics (local transportation), and waste management.
- At SRS, potential cumulative impacts were identified for land resources, site infrastructure, air quality, biological resources, cultural and paleontological resources, socioeconomics (local transportation), public and occupational health and safety, and waste management.

S.8 COMPARISON OF ALTERNATIVES

The environmental impacts of the storage and disposition alternatives, including the Preferred Alternative, are compared in this section. The emphasis is on those environmental resources and issues that discriminate between the alternatives and are of interest to the public. Detailed comparison tables, including each alternative and each resource and issue, are contained in Chapter 2 of the PEIS. Within this Chapter, Table 2.5–1 provides a summary of environmental impacts for the Preferred Alternative for storage; Table 2.5–2 provides a comparison of environmental impacts for the No Action and long-term storage alternatives; and Table 2.5–3 provides a comparison of environmental impacts for disposition alternatives (including the Preferred Alternative).

LONG-TERM STORAGE

Tables S.8–1 through S.8–6 present a comparison of the key environmental impacts for the long-term storage alternatives and the Preferred Alternative for storage. As discussed in Section S.2, the Preferred Alternative for storage is a combination of No Action and Upgrade Alternatives for the various DOE sites, and phaseout of Pu storage at RFETS.

For all of the storage sites, the No Action Alternative is used as a baseline from which incremental impacts of the storage alternatives are compared. The phaseout associated with these storage alternatives could reduce human health and waste generation impacts and increase the number of lost jobs at some sites.

Site Infrastructure. For the Upgrade Alternatives, all requirements would be within existing site capacities for all sites except for coal at ORR and SRS. Under the Preferred Alternative, coal consumption at ORR and SRS would exceed site storage capacities by less than 1 percent; all other requirements would be within existing site capacities. In those cases where site capacity for fuel storage does not adequately support increased requirements, more frequent deliveries would be scheduled. Increases in resource requirements would be within the following ranges over No Action: electrical energy, 0 to 104 percent (maximum for Pantex); peak electric load, 0 to 90 percent (maximum for Pantex); oil, 0 to 13 percent (maximum for INEL for the Upgrade Alternative); natural gas, 0 to 71 percent (maximum for Pantex); and coal, 0 to 1 percent (maximum for ORR).

For the Consolidation Alteratives, all requirements would be within existing site capacities at all sites except for the following: electrical energy (12 percent over existing capacity), oil (1 percent over existing capacity), and natural gas (no existing capacity) at NTS; coal at INEL (97 percent over existing capacity); and oil (1 percent over existing capacity) and coal (2 percent over existing capacity) at SRS. In these cases where site capacity for fuel storage does not adequately support increased requirements, more frequent deliveries would be scheduled. Increases in resource requirements would be within the following ranges over No Action: electrical energy, 8 to 104 percent (maximum for Pantex); peak electric load, 9 to 90 percent (maximum for Pantex); oil, 1 to 5 percent (maximum for Pantex); natural gas, 0 percent (no existing capacity at NTS); and coal, 0 to 97 percent (maximum for INEL). All infrastructure requirements could be met by increasing procurement or, in the case of NTS, by using a different energy source.

For the Collocation Alternatives, all requirements would be within existing site capacities at all sites except for the following: electrical energy (21 percent over existing capacity), oil (1 percent over existing capacity), and natural gas (no existing capacity) at NTS; coal at INEL (124 percent over existing capacity); oil (3 percent over existing capacity), and coal (35 percent over existing capacity) at ORR; and oil (1 percent over existing capacity) and coal (3 percent over existing capacity) at SRS. In these cases where site capacity for fuel storage does not adequately support increased requirements, more frequent deliveries would be scheduled. Increases in resource requirements would be within the following ranges over No Action: electrical energy, 8 to 126 percent (maximum for Pantex); peak electric load, 9 to 100 percent (maximum for Pantex); oil, 1 to 14 percent (maximum for ORR); natural gas, 0 percent (no existing capacity at NTS); and coal, 0 to 124 percent (maximum for INEL).

Soil, Cultural, and Paleontological. Ground disturbance during construction activities would potentially impact soil; cultural resources (including historic, prehistoric, and Native American); and paleontological resources. The Upgrade Alternatives and the Preferred Alternative would have fewer impacts because they use existing facilities or involve only small areas of ground disturbance. The Consolidation and Collocation Alternatives would have more impacts because they involve more ground disturbance due to the construction of new facilities.

Land Use and Visual Resources. For land use, the larger facilities associated with Consolidation and Collocation Alternatives would use more land (56 to 87 ha [138 to 215 acres]) than the facilities associated with Upgrade and Preferred Alternatives (0 to 0.1 ha [0 to 0.25 acres]). The Collocation Alternative at ORR would

change the current VRM Class 4 designation of the Bear Creek Road/Route 95 intersection to Class 5. Visual resources at the other DOE sites would not be affected by the storage alternatives because the facilities would be located near other similar structures.

Air Quality and Noise. Since the Collocation and Consolidation Alternatives would result in more air emission sources (exhaust from delivery trucks, generators, and boilers), slightly greater air quality impacts would occur than with the Upgrade and Preferred Alternatives. The more extensive ground disturbance during construction associated with the Consolidation and Collocation Alternatives would also result in higher levels of PM_{10} and TSP than for the Upgrade and Preferred Alternatives. Potential air emissions for all of the alternatives are within applicable Federal, State, and local air quality standards and guidelines. Minimal noise impacts would be expected from the storage alternatives because of the remote location of the facilities that would be modified or constructed.

Socioeconomics. Beneficial impacts to regional employment would be expected from all storage alternatives at all storage sites (Table S.8–1) except for the site (or sites depending on the alternative) where storage would be phased out. Collocation would generate the largest employment, followed by the Consolidation, Upgrade, and Preferred Alternatives. However, the phaseout at RFETS associated with the Preferred Alternative would result in the loss of approximately 2,200 direct jobs. Due to the small number of the new jobs created by the alternatives relative to the size of the regional economies at all of the DOE sites, community services would not be affected by the long-term storage alternatives. Short-term local transportation impacts may result at all sites from the construction of the facilities associated with the storage alternatives. The larger construction projects (Collocation and Consolidation Alternatives) would have a greater potential to cause short-term congestion on local roads than the smaller construction projects (the Upgrade and Preferred Alternatives).

Table S.8–1. Maximum Incremental Direct Employment Over No Action Generated During Operations at Each Candidate Site

Site	Total Site Employment in 2005	Upgrade	Consolidation	Collocation	Preferred Alternative
Hanford	14,586	252[a]	443	572	0
NTS	3,800	NA	527[b]	641[b]	0
INEL	6,911	116[a]	432	561	0
Pantex	3,559	90[c]	509[d]	601	90[e]
ORR	18,010	111	[f]	566[g]	111
SRS	16,562	30[h]	485	614	30[h,i]

[a] Upgrade with RFETS and LANL materials.
[b] Modify P-Tunnel.
[c] Upgrade with RFETS and LANL materials. Actual number of employees during operation could be higher.
[d] Construct new and modify existing storage facilities.
[e] Upgrade with pits from RFETS.
[f] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
[g] Construct new Pu and HEU facilities.
[h] Workers would be supplied from existing site workforce.
[i] Upgrade with non-pit materials from RFETS.
Note: NA=not applicable.

Water Resources. The water resource impacts for the Consolidation and Collocation Alternatives are greater than for the Upgrade and Preferred Alternatives, both in water requirements and wastewater discharges. Wastewater discharge is dependent on the number of employees, which is greatest for the Consolidation and Collocation Alternatives due to the larger facilities. As shown in Table S.8–2, water resource requirements are the greatest for the Collocation Alternative at all DOE sites because collocation includes the maximum amount of Pu and HEU in the PEIS. Water resource requirements for all the alternatives would impact groundwater

availability at Pantex because the additional groundwater withdrawal would contribute to the existing overall decline in water levels of the Ogallala Aquifer. However, there should be minimal impacts to regional groundwater levels from this additional withdrawal. At all other sites, water requirements would have minimal impact on water resources because of the abundance of surface water or groundwater.

Table S.8–2. Maximum Annual Net Incremental Water Usage Over No Action During Operation at Each Candidate Site

Site	No Action in 2005 (MLY)	Upgrade (MLY)	Consolidation (MLY)	Collocation (MLY)	Preferred Alternative (MLY)
Hanford	195	8.9[a]	110	150	0
NTS	2,400	NA	130[b]	190[b]	0
INEL	7,570	22[a]	66	87	0
Pantex	249	110[a]	110[c]	130	27.5[d]
ORR	14,760	0.24	[e]	360[f]	0.24
SRS	13,247	7.1[a]	360	460	5.7[g]

[a] Upgrade with RFETS and LANL materials.
[b] Modify P-Tunnel.
[c] Construct new and modify existing storage facility.
[d] Upgrade with pits from RFETS.
[e] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
[f] Construct new Pu and HEU facilities.
[g] Upgrade with non-pit materials from RFETS.
Note: MLY=million liters per year; NA=not applicable.

Biological Resources. The Preferred Alternative would have no incremental biological resource impacts at INEL and Hanford, and minimal impacts at Pantex and potentially at SRS because of ground disturbance for upgrades. The Consolidation and Collocation Alternatives would have the potential to impact biological resources at all DOE sites because they would involve ground disturbance. At Pantex, previously disturbed land would be used for consolidation and collocation facilities. Threatened and endangered species at NTS and SRS may be affected by the storage alternatives at these sites.

Environmental Justice. All six DOE storage sites have, within an 80-km (50-mi) radius, census tracts with greater than 25 percent minority or low-income populations. However, the public health and safety analyses show that air emissions and hazardous chemical and radiological releases from normal operations for all storage alternatives would be within regulatory limits and that no latent cancer fatalities would result. The public health and safety analyses also indicate that radiological releases from accidents would not result in disproportionate and adverse human health or environmental impacts. Potential transportation accidents would be random events along transportation corridors. Therefore, none of the storage alternatives would have disproportionately high or adverse impacts on minority or low-income populations.

Waste Management. All of the storage alternatives would impact existing waste management practices at the DOE sites by increasing the amount of waste that must be treated, stored, and disposed. Depending on decisions in the waste-type-specific RODs for the Waste Management PEIS, wastes would be treated and disposed of onsite or at regionalized or centralized DOE sites. Generally, the Consolidation and Collocation Alternatives would generate more wastes than the Upgrade and Preferred Alternatives. Tables S.8–3 through S.8–5 show the maximum incremental waste generation rates for solid TRU, solid low-level, and solid hazardous wastes at the six candidate sites.

Public and Occupational Health and Safety. Table S.8–6 shows the differences between the long-term storage alternatives for radiological exposures to the public. The maximum potential latent cancer fatalities over No

Action for the MEI over 50 years from normal operations ranges from 4.5×10^{-13} for the Upgrade and Preferred Alternatives at Pantex to 1.1×10^{-9} for the Collocation Upgrade Alternative at ORR. This means that the chance of a latent cancer fatality occurring ranges from about 1 in 1 billion to 5 in 10 trillion. The risk varies because of site parameters including the distance from the facility to the MEI (small sites vs. large sites); local meteorological conditions (windspeed, direction, and stability); and the type of material being stored (metals and oxides vs. residues).

Table S.8–3. Maximum Annual Net Incremental Volume of Solid Low-Level Waste Over No Action Generated During Operations at Each Candidate Site

Site	Waste Generated in 2005 (m^3)	Upgrade (m^3)	Consolidation (m^3)	Collocation (m^3)	Preferred Alternative (m^3)
Hanford	3,390	89[a]	1,260	1,300	0
NTS	15,000	NA	1,260	1,300	0
INEL	7,200	500[a]	1,260	1,300	0
Pantex	32	1,260[a]	1,260	1,300	138[b]
ORR	7,320	3	[c]	1,300[d]	3
SRS	16,400	0	1,220[e]	1,260[e]	0

[a] Upgrade with RFETS and LANL materials.
[b] Upgrade with pits from RFETS.
[c] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
[d] Construct new Pu and HEU facilities.
[e] Net waste from new facility and from phaseout of existing facility.
Note: NA=not applicable.

Table S.8–4. Maximum Annual Net Incremental Volume of Solid Transuranic Waste Over No Action Generated During Operations at Each Candidate Site

Site	Waste Generated in 2005 (m^3)	Upgrade (m^3)	Consolidation (m^3)	Collocation (m^3)	Preferred Alternative (m^3)
Hanford	271	21[a]	10	10	0
NTS	0	NA	10	10	0
INEL	3.5	2[a]	10	10	0
Pantex	0	10[a]	10	10	0.8[b]
ORR	119	0	[c]	10[d]	0
SRS	338	0	2[e]	2[e]	0

[a] Upgrade with RFETS and LANL materials.
[b] Upgrade with pits from RFETS.
[c] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
[d] Construct new Pu and HEU facilities.
[e] Net waste from new facility and from phaseout of existing facility.
Note: NA=not applicable.

Table S.8–5. Maximum Annual Net Incremental Volume of Solid Hazardous Waste Over No Action Generated During Operations at Each Candidate Site

Site	Waste Generated in 2005 (m^3)	Upgrade (m^3)	Consolidation (m^3)	Collocation (m^3)	Preferred Alternative (m^3)
Hanford	560	4	2	2	0
NTS	212	NA	2	2	0
INEL	1,200	1	2	2	0
Pantex	31	2[a]	2	2	1.5[b]
ORR	26	0.8[c]	[d]	2[e]	0.8
SRS	15,100	0.8[a]	2	2	0.6[f]

[a] Upgrade with RFETS and LANL materials.
[b] Upgrade with pits from RFETS.
[c] Total of mixed LLW and hazardous waste because hazardous waste is included in mixed LLW.
[d] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
[e] Construct new Pu and HEU facilities.
[f] Upgrade with non-pit materials from RFETS.
Note: NA=not applicable.

Table S.8–6. Maximum Latent Cancer Fatalities Over No Action for Maximally Exposed Individual for 50 Years From Normal Operations at Each Candidate Site

Site	No Action in 2005	Upgrade	Consolidation	Collocation	Preferred Alternative
Hanford	$1.0x10^{-8}$	$4.5x10^{-11}$	$6.2x10^{-11}$	$6.2x10^{-11}$	0
NTS	$1.0x10^{-7}$	NA	$1.4x10^{-10}$	$1.4x10^{-10}$	0
INEL	$4.4x10^{-7}$	$1.3x10^{-11}$	$4.0x10^{-11}$	$4.0x10^{-11}$	0
Pantex	$1.5x10^{-9}$	$4.5x10^{-13}$	$2.4x10^{-10}$	$2.4x10^{-10}$	$4.5x10^{-13}$
ORR	$3.5x10^{-8}$	$5.5x10^{-13}$	[a]	$1.1x10^{-9}$	$5.5x10^{-13}$
SRS	$2.0x10^{-5}$	$2.1x10^{-10}$	$3.5x10^{-10}$	$3.5x10^{-10}$	$2.1x10^{-10}$

[a] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
Note: NA=not applicable.

Potential accidents were postulated for each of the long-term storage alternatives. The risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for the accident scenario evaluated with the highest risk (PCV penetration by corrosion) for the Upgrade Alternative would be: $4.3x10^{-4}$ at Hanford; $1.6x10^{-3}$ at INEL; $8.8x10^{-4}$ at Pantex (Preferred Alternative); $3.0x10^{-5}$ at ORR (Preferred Alternative); and $4.6x10^{-4}$ at SRS. For both the Consolidation and Collocation Alternatives, the highest risk to the population located within 80 km (50 mi) of the accident release point associated with the accident scenarios evaluated (PCV penetration by corrosion) would be: $4.2x10^{-3}$ at Hanford; $5.1x10^{-5}/9.4x10^{-5}$ at NTS (P-Tunnel/New Pu and HEU Facility); $1.2x10^{-3}$ at INEL; $1.4x10^{-3}$ at Pantex; and $1.7x10^{-2}$ at ORR; and $4.6x10^{-3}$ at SRS. Since Pu accidents dominate the accident spectrum, the risks would be higher for the Consolidation and Collocation Alternatives because these alternatives would require more Pu at a single DOE site than the Upgrade Alternative.

Intersite Transportation. For intersite transportation, the Upgrade and Preferred Alternatives would have lower potential for fatalities. For the Preferred Alternative, the number of potential fatalities ranges from 0 at Hanford and INEL (since there is no transport of material) to 0.06 at SRS. The Consolidation and Collocation Alternatives would have the higher potential for intersite transportation fatalities because they would move the greatest amount of material between sites. The number of potential fatalities ranges from 0.079 (Consolidated Storage Alternative at Pantex) to 1.07 (Collocated Storage Alternative at Hanford). Intersite transportation impacts would primarily result from nonradiological sources, such as fatalities from nonradiological traffic accidents.

DISPOSITION ALTERNATIVES

Table S.8–7 depicts total campaign data for the disposition alternatives including the Preferred Alternative for disposition. A total of approximately 50 t (55.1 tons) of surplus Pu is assumed to be processed over the life of the campaign. In preparation for disposition under any alternative, surplus Pu must be processed through either the pit disassembly/conversion facility or the Pu conversion facility. Approximately 32.5 t (35.8 tons) are assumed to be processed at the pit disassembly/conversion facility, and approximately 17.5 t (19.3 tons) at the Pu conversion facility. Since these two facilities produce the input material for the other disposition facilities, actions at these two facilities would be the first to occur for the campaign. The operating period for these two facilities for each disposition alternative, including the Preferred Alternative, is 10 years.

Table S.8–7. Total Campaign Data (Approximate) for Disposition Alternatives and the Preferred Alternative

Action	Disposition Alternatives			Preferred Alternative		
	Total Pu (t)	Throughput (t/yr)	Years In Operation	Total Pu (t)	Throughput (t/yr)	Years In Operation
Pit disassembly/ conversion	32.5	3.25	10	32.5	3.25	10
Pu conversion	17.5	1.75	10	17.5	1.75	10
Direct to borehole	50	5	10	NA	NA	NA
Immobilized to borehole	50	5	10	NA	NA	NA
Vitrification	50	5	10	17.5[a]	5[a]	3.5[a]
Ceramic immobilization	50	5	10	17.5[a]	5[a]	3.5[a]
Electrometallurgical treatment	50	5	10	NA	NA	NA
MOX fuel fabrication	50	3	17	32.5	3	11
5 Existing LWRs[b]	50	3	17	32.5	3	11
2 Partially completed LWRs[c]	50	3	17	NA	NA	NA
2 Large or 4 small evolutionary LWRs	50	3	17	NA	NA	NA
CANDU reactors[d]	50	3.8	13	NA	NA	NA

[a] Either vitrification or ceramic immobilization would be implemented for immobilization of surplus Pu under the Preferred Alternative, but not both.

[b] Three to five existing LWRs would be used depending upon the amount of MOX fuel in the reactor core.

[c] If the partially completed LWRs were to be completed by other parties, they would be considered existing LWRs and could compete for the surplus Pu disposition mission under the Preferred Alternative.

[d] The CANDU reactor is retained in the event a multilateral agreement is made among Russia, Canada, and the United States to use CANDU reactors.

Note: NA=not applicable.

The operation of the disposition facilities for a single disposition alternative would require between 10 and 17 years to accomplish the disposition mission. However, the Preferred Alternative may result in fewer years of operation for the disposition facilities, since the 50 t (55.1 tons) of surplus Pu would be dispositioned under two different technologies. For purposes of analysis, it is assumed that approximately 17.5 t (19.3 tons) of surplus Pu would be immobilized through vitrification or ceramic immobilization, and approximately 32.5 t (35.8 tons) would be converted to MOX fuel for use in reactors,[20] under the Preferred Alternative. The number of years in

[20] The actual amount dispositioned under each disposition technology would depend on subsequent NEPA analysis, costs, test and demonstration results, international agreements, and the procurement process among other things.

operation for each disposition technology may be less than that required to process the full 50 t (55.1 tons) with any single disposition alternative.

Actual years of operation and Pu throughput rates for any of the reactor disposition alternatives would not exceed 17 years and 3.8 t/yr (4.2 tons/yr), respectively, but could be less depending upon the final reactor core design. Variables such as the amount of MOX fuel included in each core have not yet been determined and would affect the years required to complete the mission using the reactor alternatives. Conservative estimates for throughput and years in operation are presented for comparing the Reactor Alternatives with the Preferred Alternative.

Table S.8–8 presents a comparison of the total campaign impacts from the disposition of 50 t (55.1 tons) of surplus Pu for key environmental resources for the individual disposition alternatives and the Preferred Alternative. Since the ceramic immobilization facility generally has greater impacts than the vitrification facility, it was used in the calculation of the total campaign impacts for the Preferred Alternative. A comparison of impacts is not included for community services, environmental justice, and noise since the impacts are highly site-specific.

Biological, Geology and Soil, Land Use, and Cultural and Paleontological Resources. Ground disturbance during construction activities would potentially impact soil; biological; cultural resources (including historic, prehistoric, and Native American); and paleontological resources for all of the disposition alternatives. The immobilization alternatives would disturb the least amount of land while the Evolutionary LWR Alternative would disturb the most land area because it would require the most new construction. However, when considering operational land area, the two Deep Borehole Alternatives would require the most land because of the 1.6-km (1-mi) radius buffer zone. Depending upon location, all of the alternatives could result in visual resource impacts by changing the visual resource management classification of an area. The Deep Borehole Alternatives would impact geologic resources because the borehole operations would render the site perpetually unusable.

Site Infrastructure and Water Resources. The evolutionary LWR would require the largest electrical load during operations. The Evolutionary LWR and the Partially Completed LWR Alternatives would require the most additional water for operations. The rest of the alternatives would require nearly the same amount of water, with the exception of the Electrometallurgical Treatment Alternative, which would require the least amount of water.

Air Quality and Socioeconomics. Potential construction-related impacts on air quality and local transportation would be minor for all of the disposition alternatives and the Preferred Alternative. The Evolutionary LWR and Partially Completed LWR Alternatives would generate the most employment and income among the alternatives. For local transportation, the Evolutionary LWR Alternative would have the greatest potential of reducing the level of service on local roads during construction and/or operations. Some reduction in level of service would also be expected for the Vitrification, Ceramic Immobilization, and the Preferred Alternatives.

Public and Occupational Health and Safety. There would be potential for impacts to public and occupational health and safety from the radiological and hazardous chemical doses during operations of all the disposition alternatives, including the Preferred Alternative; however, the annual radiological doses to onsite workers and the public would be within regulatory limits for all alternatives. For hazardous chemicals, potential impacts to the public and onsite workers would not be expected to cause adverse health affects.

A set of potential accidents was postulated for each of the disposition technology alternatives. The risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for the front-end disposition process campaign would range from 4.5×10^{-16} to 1.7×10^{-4} for pit disassembly/conversion (for the highest accident risk scenario [fire on loading dock] at the potential disposition sites: 4.6×10^{-5} at Hanford; 1.4×10^{-5} at INEL; 1.6×10^{-5} at Pantex; and 5.0×10^{-5} at SRS) and from 1.5×10^{-16} to 1.3×10^{-4} for Pu conversion

Table S.8–8. Comparison of Resource Use and Impacts From the Total Campaign for the Operation of Disposition Alternatives[a]

Alternatives	Total Number of Worker-Years	Water Usage (million l)	Latent Cancer Fatalities for MEI from Lifetime Accident-Free Operation	Solid TRU Waste Generated (m^3)	Solid Low-Level Waste Generated (m^3)	Solid Hazardous Waste Generated (m^3)
Direct to borehole	20,550	3,405	$1.2x10^{-9}$ to $1.2x10^{-7}$	3,452	18,500	287
Immobilized to borehole	29,550	6,605	$1.2x10^{-9}$ to $1.2x10^{-7}$	4,955	18,740	497
Vitrification	24,810	4,251	$1.2x10^{-9}$ to $1.2x10^{-7}$	4,440	18,590	307
Ceramic immobilization	25,730	4,251	$1.2x10^{-9}$ to $1.2x10^{-7}$	4,440	18,590	307
Electrometallurgical treatment	17,960	1,751	$1.2x10^{-9}$ to $1.3x10^{-7}$	3,510	19,000	125
5 Existing LWRs[b]	29,030	2,717	$1.3x10^{-6}$ to $2.6x10^{-6}$	8,652	21,051	2,718
2 Partially completed LWRs[c]	47,305	2,352,000	$9.8x10^{-6}$ to $9.9x10^{-6}$	8,652	22,955 to 42,709	3,636
2 Evolutionary large LWRs[d]	53,850	2,062,000	$5.8x10^{-7}$ to $8.2x10^{-5}$	8,652	38,051	3,636
4 Evolutionary small LWRs[e]	59,630	1,856,000	$8.4x10^{-7}$ to $9.6x10^{-5}$	8,652	39,411	4,554
CANDU reactors[f]	25,630	2,717	$1.8x10^{-9}$ to $1.2x10^{-7}$	8,652	21,051	2,718
Preferred Alternative[g]	16,140	3,253	$9.0x10^{-7}$ to $1.7x10^{-6}$	7,163	20,182	1,866

[a] Data includes all front-end processes (Pu conversion, pit disassembly/conversion, and MOX fuel fabrication) that would be needed for the individual alternatives. The total campaign impacts were calculated by multiplying the annual impacts times the number of years of operation, as identified in Table S.8–7.
[b] The table reflects the use of 5 existing LWRs. Three to five existing LWRs would be used depending upon the amount of MOX fuel in the reactor core.
[c] The table reflects the use of 2 partially completed LWRs.
[d] The table reflects the use of 2 evolutionary large LWRs.
[e] The table reflects the use of 4 evolutionary small LWRs.
[f] The table reflects impacts from pit disassembly/conversion and MOX fuel fabrication in the United States.
[g] Ceramic immobilization and 5 existing LWRs are the assumed technologies for the Preferred Alternative for comparative purposes only.

(for the highest accident risk scenario [fire on loading dock] at the potential disposition sites: $3.5x10^{-5}$ at Hanford and $3.2x10^{-5}$ at SRS). Within the borehole category, the risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for direct disposition campaign would range from $8.4x10^{-16}$ to $6.3x10^{-8}$. For both the ceramic immobilization front-end process prior to immobilized disposal, and ultimate disposition in the deep borehole complex, the risks would range from $9.3x10^{-18}$ to $6.3x10^{-8}$ and $9.3x10^{-19}$ to $6.3x10^{-9}$, respectively for the disposition campaign. The risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for the immobilization category would range from $2.8x10^{-14}$ to $1.8x10^{-5}$ for the vitrification alternative and from $7.0x10^{-16}$ to $1.9x10^{-7}$ for the ceramic

immobilization alternative over the disposition campaign (for the highest accident scenario [criticality] at the potential disposition sites and 30 percent immobilization campaign: 1.7×10^{-8} at Hanford and 2.1×10^{-8} at SRS). For the immobilization of Pu through electrometallurgical treatment of spent fuels, the projected campaign risk to the population would be 3.5×10^{-7} for the accident scenario evaluated with the highest risk (a breach in the argon cell initiated by a design basis earthquake).

For the reactor alternative, the risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for the MOX fuel fabrication facility would range from 4.6×10^{-16} to 4.3×10^{-4} for the campaign (for the highest accident scenario [fire on loading dock] at the potential disposition sites using for analysis purposes, approximately 70 percent disposition campaign: 5.2×10^{-5} at Hanford; 1.6×10^{-5} at INEL; 1.8×10^{-5} at Pantex; and 5.2×10^{-5} at SRS). The risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for the MOX-fueled evolutionary LWR would range from 9.6×10^{-11} to 6.9×10^{-6}. Under the Preferred Alternative, DOE would pursue the use of MOX-fueled LWRs. The incremental effects of utilizing MOX fuel in a reactor in place of UO_2 were derived from a quantitative analysis of severe accident release scenarios for MOX and UO_2 using the MACCS computer code and generic population and meteorology data. The analysis only considers severe accidents where sufficient damage would occur to cause the release of Pu or uranium. The risks of severe accidents were found to be in the range of plus 8 to minus 7 percent, compared to UO_2 fuel, depending on the accident release scenario. The incremental risk of cancer fatalities to a generic population located within 80 km (50 mi) of the severe accident release point would range from -2.0×10^{-4} to 3.0×10^{-5} per year.

Waste Management. The reactor alternatives and the Preferred Alternative would be the only alternatives that would generate spent nuclear fuel. The Partially Completed LWR Alternative would generate the largest incremental increase in spent nuclear fuel. The Preferred Alternative would generate the lowest incremental increase of spent nuclear fuel among the reactor alternatives because the combination of disposition technologies would require less Pu to go through reactors. The reactor alternatives and the Preferred Alternative would also generate the most solid TRU, solid low-level, and solid hazardous waste among the alternatives.

Intersite Transportation. The Evolutionary LWR and Partially Completed LWR Alternatives would have the highest potential fatalities over the total campaign because they would require the most material transport. The Preferred Alternative and Electrometallurgical Treatment Alternative would have the lowest potential fatalities from transportation. Intersite transportation impacts would primarily be the result of nonradiological impacts such as fatalities from nonradiological highway accidents.

S.9 SUMMARY OF MAJOR ISSUES IDENTIFIED DURING THE COMMENT PERIOD AND CHANGES TO THE DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

S.9.1 ISSUES IDENTIFIED AND RESOLVED

The Department initially issued the Storage and Disposition PEIS as a draft for public comment for the period from March 8 through May 7, 1996. In response to public requests, DOE extended the comment period deadline to June 7, 1996. Public meetings on the Draft PEIS were held in March and April 1996 at the following locations:

Denver, CO	March 26, 1996
Las Vegas, NV	March 28–29, 1996
Oak Ridge, TN	April 2, 1996
Richland, WA	April 11, 1996

Idaho Falls, ID	April 15, 1996
Washington, DC	April 17–18, 1996
Amarillo, TX	April 22–23, 1996
North Augusta, SC	April 30, 1996

During the 92-day public comment period on the Storage and Disposition Draft PEIS, DOE received comments on the document by mail, fax, telephone recording, electronic mail, and orally at the public meetings. Altogether, DOE received approximately 8,700 written and recorded comments from individuals and organizations. All comments are presented in Volume IV of the Storage and Disposition Final PEIS, the *Comment Response Document.*

Approximately 80 percent of the comments received consisted of mail-in letter and postcard campaigns which expressed either support of or opposition to the use of various sites or alternatives. Many commentors encouraged DOE and the United States to become the world leader in the safe, secure, and timely disposition of Pu, and favored worldwide nonproliferation efforts for surplus Pu. The following highlights recurring comments, DOE's response, and the PEIS revisions in response to these comments.

A number of commentors expressed the opinion that the surplus Pu should remain in present locations for future energy or weapons use, or until new technologies are available for disposition. In response to these concerns, DOE expanded the discussion on the need for the proposed Pu disposition action in the PEIS. Disposition is necessary to implement the President's *Nonproliferation and Export Control Policy* in a safe, reliable, cost-effective, and timely manner.

Some commentors also stated that DOE should consider additional disposition alternatives, including the use of FFTF, deep burn reactors, and mononitride reactors. The use of advanced reactors such as deep burn reactors and mononitride reactors was considered but eliminated due to the technical immaturity, attendant costs, and lengthy development and demonstration efforts required to bring the technologies to a viable, practical status and enable disposition options to be initiated with certainty. The FFTF would be considered for Pu disposition if first selected for tritium production. The FFTF is not a reasonable, stand-alone alternative because it is in a standby status awaiting shutdown and because it could not satisfy the criterion of completing the disposition mission within 25 years. A discussion of FFTF for this purpose is included in Appendix N. In all, thirty-seven different alternative options were considered by DOE for disposition of Pu. DOE has made revisions to the Summary and Chapter 2 of the PEIS to clarify how the screening process was used for selection of reasonable alternatives.

Commentors noted that transportation of fissile materials is one of their major concerns with the Program. The ground transportation between sites, in the event a consolidation alternative was selected, could increase the potential for traffic accidents. International transportation for specific border crossings for the shipment of MOX fuel to Canada for the CANDU Reactor Alternative was also identified as a concern. DOE acknowledges the public's concern, and in response, the transportation analysis in Section 4.4 and Appendix G of the Draft PEIS was expanded. The revisions address security measures for land and sea transport, emergency preparedness, and clarify the results of analyses performed.

One frequently recurring comment presented by the public relates to the technical, cost, schedule, and nonproliferation analyses to support DOE's ROD. Many of the commentors suggested that DOE should make information available for public review. Since issuance of the Draft PEIS, DOE has prepared both the *Technical Summary Report for Long-Term Storage of Weapons-Usable Fissile Materials* (DOE/MD-0004 Rev. 1) and the *Technical Summary Report for Surplus Weapons-Usable Plutonium Disposition* (DOE/MD-0003 Rev. 1). These two reports summarize representative technical, cost, and schedule data for the reasonable alternatives being

considered for long-term storage and surplus Pu disposition, respectively. In July and August 1996, these documents were initially distributed for public review and comment. After taking the public's comments into consideration, DOE revised and re-issued both reports in November and December 1996. In October 1996, DOE issued the *Draft Nonproliferation and Arms Control Assessment of Weapons-Usable Fissile Material Storage and Plutonium Disposition Alternatives*, which analyzes the nonproliferation and arms reduction implications of the alternatives addressed in the PEIS for Pu and HEU storage and the disposition of surplus Pu. From October through early November 1996, the public was asked to review and comment on the draft nonproliferation document; this process included a series of 10 public meetings held nationwide. Public comments received are being taken into consideration in revising the report, which is scheduled for re-issue in late 1996. This report, in conjunction with the Final PEIS, the technical summary reports previously described, and public input, will form the basis for DOE's decisions, which will be discussed in a ROD to be issued no sooner than 30 days after publication of the Environmental Protection Agency's Notice of Availability of the Final PEIS.

Commentors also stated that the U.S. Nonproliferation Policy does not encourage the civil use of Pu or Pu processing for either nuclear power or nuclear explosive purposes. The commentors requested that the PEIS address the possibility that the MOX option would have an adverse effect on U.S. nonproliferation policy by encouraging its use in civil nuclear power programs and by encouraging Pu reprocessing and recycling. DOE acknowledges the public concern for nonproliferation. As discussed in the PEIS, the reactor option would utilize a once-through fuel cycle. Spent fuel from disposition would be disposed of with other commercial reactor spent fuel. This is consistent with U.S. policy since no Pu in the spent fuel would be recycled. Revisions to the Summary and Chapter 1 of the PEIS were made to expand and clarify this issue.

Commentors indicated that the isotopic composition of the residual Pu in the final waste forms is an inappropriate criterion by which to assess proliferation risks because it perpetuates a myth that reactor-grade Pu cannot be used to make workable weapons. In the opinion of these commentors, isotopic degradation does not constitute a compelling argument in favor of the MOX option. DOE acknowledges that, although it may be possible to make a nuclear weapon from spent commercial reactor fuel, this can only be done with extreme difficulty by individuals with a great deal of experience in handling and processing nuclear materials. DOE believes that the disposition of weapons Pu through the use of MOX fuel in reactors would meet the Spent Fuel Standard in creating a radiological barrier that makes the Pu as difficult to retrieve and reuse in weapons as Pu in spent commercial fuel. The use of this technology would allow for the Pu to be disposed in a geologic repository, the same as for spent commercial fuel. Revisions to Chapter 1 of the PEIS were made to clarify this issue.

S.9.2 CHANGES MADE TO THE DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

This section identifies changes made since the issuance of the Draft PEIS. The Final PEIS includes the Preferred Alternative, which is a combination of other alternatives and is described in Section S.2 and Section 1.6. Other changes, after considering public comments, are described below.

Appendix N, which in the Draft PEIS summarized the operational aspects of the multipurpose reactor, has been revised for the Final PEIS to provide information on the costs and benefits of conducting separate tritium production and Pu disposition missions versus the costs and benefits of carrying out one multipurpose mission. Included in Appendix N is a cost comparison of using new Advanced LWRs or Modular Helium Reactors, and a discussion of issues regarding the use of the FFTF (a liquid metal reactor at Hanford) for tritium production and Pu disposition.

Appendices O, P, Q, and R were added to the Final PEIS to help clarify alternative issues as they relate to the Preferred Alternative. Appendix O describes two can-in-canister technology concepts at SRS, which are variants of the Vitrification and Ceramic Immobilization Disposition Alternatives described in Chapter 2. This

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Penalty for Private Use $300

information was added based on public interest in these concepts during the Draft PEIS comment period, and also because of DOE's reconsideration of this technology as being a viable approach for Pu disposition through immobilization.

Appendix P provides a description of using the Manzano Weapons Storage Area (WSA) near Albuquerque, NM to store Pu pits. This appendix was added because DOE's Preferred Alternative separates the storage of pits from non-pit materials, in which case Manzano WSA no longer appears unreasonable under the Preferred Alternative for pit storage. However, since DOE's preferred site for interim storage of pits is Pantex (as described in the Pantex EIS) and since the majority of pits are already located in storage at Pantex, the Preferred Alternative proposes the long-term storage of Pu pits at Pantex. Weapons assembly/disassembly would continue at Pantex in any case. Construction of a new storage facility at Manzano would create needless expense and transportation risk.

Appendix Q describes the operations and human (radiological) health impacts associated with Pu pits being transferred from RFETS to Pantex, repackaged in Zone 12 South, and placed in storage in Zone 4 West at Pantex, as part of the Preferred Alternative for long-term storage. The information presented in this appendix is based on the Pantex EIS analysis of storing the Pu pits already at Pantex.

Appendix R discusses aircraft crash and radioactive release probabilities for proposed storage and disposition facilities at Pantex.

Section 1.2 of the Final PEIS has been revised to reflect the cooperative effort between the United States and Russia to study different options for managing excess Pu (including secure storage, conversion of Pu weapons components to other forms, and stabilization of unstable forms of Pu), and options for disposition of excess Pu (deep borehole, immobilization, and reactors). The results of this study have been documented in the *Joint United States/Russian Plutonium Disposition Study* report, completed in September 1996. This study and the options considered will provide decisionmakers from both countries with a set of jointly evaluated alternatives for Pu disposition and help build further trust and cooperation in the area of fissile material disposition.

Office of
Fissile Materials Disposition

United States Department of Energy

Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement

Volume I

December 1996

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Final Programmatic Environmental Impact Statement/Volume I

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DOE/EIS-0229

Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement

Volume I

United States Department of Energy
Office of Fissile Materials Disposition

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ABSTRACT: This document analyzes the potential environmental consequences of alternatives for the long-term storage (up to 50 years), including storage until disposition, and disposition of weapons-usable fissile materials from U.S. nuclear weapon dismantlements under the responsibility of the DOE. Long-term storage of nonsurplus inventories of weapons-usable plutonium (Pu) and highly enriched uranium (HEU) are required for national defense purposes, while the disposition of surplus weapons-usable Pu is necessary in order to implement our national nonproliferation policy. In addition to the No Action Alternative, this PEIS assesses three storage alternatives (that is, upgrade at multiple sites, consolidation of Pu, and collocation of Pu and HEU) at six DOE candidate sites located across the country. These sites are Hanford Site, Nevada Test Site, Idaho National Engineering Laboratory, Pantex Plant, Oak Ridge Reservation, and Savannah River Site. Although they are not candidate sites for storage, Rocky Flats Environmental Technology Site (RFETS) and Los Alamos National Laboratory are assessed for the No Action Alternative. For the disposition of surplus Pu, three alternative categories (that is, deep borehole, immobilization, and reactor) with nine primary alternatives are assessed at several DOE and representative sites for analysis purposes. Evaluations of impacts on site infrastructure, water resources, air quality and noise, socioeconomics, waste management, public and occupational health and safety, and environmental justice are included in the assessment. The intersite transportation of nuclear and hazardous materials is also assessed. DOE's Preferred Alternative is identified in this Final PEIS. The Preferred Alternative for storage is a combination of No Action and Upgrade Alternatives for the various DOE sites, and phaseout of Pu storage at RFETS. The Preferred Alternative for disposition of surplus Pu is to pursue a disposition strategy involving a combination of immobilization and reactor alternatives, including vitrification, ceramic immobilization, and existing reactors.

PUBLIC INVOLVEMENT: The DOE issued a Draft PEIS on March 8, 1996, and held a formal public comment period on the Draft through June 7, 1996. In preparing the Final PEIS, DOE considered comments received via mail, fax, electronic bulletin board (Internet), and transcripts of messages recorded by telephone. In addition, comments and concerns were recorded by notetakers during interactive public meetings held during March and April 1996 in Denver, CO, Las Vegas, NV, Oak Ridge, TN, Richland, WA, Idaho Falls, ID, Washington, DC, Amarillo, TX, and North Augusta, SC. Comments received and DOE's responses to those comments are found in Volume IV of the Final PEIS.

FOREWORD

This is the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (PEIS), prepared by the U.S. Department of Energy, Office of Fissile Materials Disposition. The document is composed of four volumes and a separate Summary. Changes made since the Draft PEIS are shown by change bar notation (vertical lines adjacent to the changes) in this Final PEIS for both text and tables. Deletion of one or more sentences is indicated by the phrase "Text deleted." in brackets. This Final PEIS includes the Preferred Alternative, which is a combination of alternatives. The Preferred Alternative is described in Section 1.6 and Chapter 2 of Volume I, and analyzed in Chapter 4 of Volume II. For all the alternatives, including the Preferred Alternative, a comparison of alternatives is presented in Section 2.5 of Volume I and a summary of impacts is presented in Section 4.6 of Volume II (Part B). Information from these sections is also presented in the Summary.

Volume I contains Chapters 1 through 3 of the PEIS. Chapter 1 includes a description of the history and background of the fissile materials disposition program, the purpose of and need for the proposed action, a summary of changes made to the Draft PEIS, and the Preferred Alternative. Chapter 2 gives a description of the proposed long-term storage and disposition alternatives, a description of how the alternatives were selected and why others were eliminated from further consideration, and a comparison of the alternatives in terms of their potential environmental impacts. Chapter 3 describes the affected environment at candidate long-term storage locations, and at sites and environmental settings for the disposition alternatives.

Volume II (Parts A and B) contains Chapters 4 through 10 of the PEIS. Chapter 4 describes the potential environmental impacts resulting from construction and operation of the proposed long-term storage and disposition alternatives, including the Preferred Alternative. Also contained in this chapter are intersite transportation impacts, a discussion of environmental justice issues, cumulative impacts due to the implementation of the proposed alternatives in addition to other actions at a site, avoided environmental impacts, and a summary of impacts. Chapter 5 provides a list of references used in the preparation of this document. Chapter 6 provides an index to the main text of the PEIS. Chapter 7 is a glossary of key terms used in the document. Chapter 8 is a list of preparers. Chapter 9 lists government agencies and organizations contacted during the preparation of this PEIS. Chapter 10 provides a distribution list for the document.

Volume III contains the appendices to this PEIS. Appendix A contains the fact sheet on the President's *Nonproliferation and Export Control Policy*, and the Joint Statement Between the United States and Russia on Nonproliferation. Appendix B provides specifications for key buildings within each facility complex analyzed in this PEIS. Appendix C describes requirements for construction and operation of the various facilities required to accomplish the storage and disposition activities essential to the alternatives described in this PEIS. Appendix D provides information on overall water usage for the storage and disposition facilities discussed in this PEIS. Appendix E gives a general overview of the Department of Energy (DOE) environmental restoration and waste management program, baseline waste management at DOE sites, and project-specific waste management activities associated with the proposed long-term storage and disposition alternatives. Appendix F provides detailed data supporting the air quality and noise analyses. Appendix G describes the methodology used for intersite transportation risk analysis and provides a summary of hazardous materials shipped to and from DOE sites, plus information on shipping containers. Appendix H evaluates various plutonium waste forms for potential disposal in a high-level waste repository. Appendix I describes operations of a Canadian Deuterium Uranium Reactor. Appendix J identifies the compliance requirements associated with the Proposed Action, as specified by the major Federal and State environmental, safety, and health statutes, regulations, and orders. Appendix K lists the scientific names of common nonthreatened and nonendangered animal and plant species identified in Chapters 3 and 4. Appendix L includes the supporting data used for assessing the No Action

Alternative in the socioeconomics sections of this PEIS. Appendix M presents detailed information on the potential health risks associated with releases of radioactivity and hazardous chemicals from the proposed storage and disposition alternatives during normal operations and from postulated accidents. Appendix N describes different concepts for, and provides cost and benefit information on, the multipurpose reactor. Appendix O provides a description of facilities and operations for a can-in-canister approach to plutonium immobilization at the Savannah River Site in South Carolina. Appendix P describes the potential environmental impacts of using the Manzano Weapons Storage Area in New Mexico for the long-term storage of plutonium pits. Appendix Q identifies the potential health impacts from the storage of Rocky Flats Environmental Technology Site plutonium pits at the Pantex Plant in Texas. Appendix R discusses the aircraft crash and radioactive release probabilities for proposed storage and disposition facilities at Pantex Plant in Texas. A separate Classified Appendix was also prepared, which provides detailed analysis results for intersite transportation risks based on classified inventories of materials stored at DOE sites.

Volume IV (Parts A and B) is the Comment Response Document. It contains an overview of the public comment process, the comments received on the Draft PEIS during the public review period, and the DOE responses to those comments, including identifying changes made to the Draft PEIS in response to public comments.

The Summary provides a brief overview of the PEIS. It includes the purpose of and need for the Proposed Action, a description of the storage and disposition alternatives including the Preferred Alternative, and the potential environmental impacts resulting from these alternatives.

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LIST OF ACRONYMS AND ABBREVIATIONS

AADT	Average Annual Daily Traffic
ACEC	Area of Critical Environmental Concern
ACGIH	American Conference of Governmental Industrial Hygienists
AEA	*Atomic Energy Act*
AEC	Atomic Energy Commission
AGV	automated guided vehicle
ALARA	as low as reasonably achievable
ALE	Arid Lands Ecology Reserve
ANL-W	Argonne National Laboratory-West
APSF	Actinide Packaging and Storage Facility
AQCR	Air Quality Control Region
ARA	Auxiliary Reactor Area
ARIES	Advanced Recovery and Integrated Extraction System
BEA	Bureau of Economic Analysis
BEIR	biological effects of ionizing radiation
BLM	Bureau of Land Management
BOP	balance-of-plant
BPA	Bonneville Power Administration
BWR	boiling water reactor
CAA	*Clean Air Act*
CANDU	Canadian deuterium uranium
CAS	Chemical Abstracts Service
CCDF	complimentary cumulative distribution function
CEQ	Council on Environmental Quality
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CGTO	Consolidated Group of Tribes and Organizations
CI	confidence interval
CIC	can-in-canister
CLUP	Comprehensive Land-Use Plan
CMR	Chemistry and Metallurgy Research

COE	Corps of Engineers
Complex	Nuclear Weapons Complex
CRD	Comment Response Document
CRT	Cargo Restraint Transporters
CWA	*Clean Water Act*
D&D	decontamination and decommissioning
DAF	Device Assembly Facility
DCG	derived concentration guide
DHLW	defense high-level waste
DNB	departure of nucleate boiling
DNFSB	Defense Nuclear Facilities Safety Board
DNL	day and night average sound levels
DNWR	Desert National Wildlife Range
DoD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DP	Office of Defense Programs
DRCOG	Denver Regional Council of Governments
DWPF	Defense Waste Processing Facility
EA	environmental assessment
EBR	Experimental Breeder Reactor
EDNA	Environmental Design for Noise Abatement
EIA	Energy Information Administration
EIS	environmental impact statement
EM	Office of Environmental Management
EPA	Environmental Protection Agency
ERR	excess relative risk
ES&H	Office of Environment, Safety, and Health
ESA	*Endangered Species Act*
ETF	effluent treatment facility
FAIR	Forest, Agriculture, Industry, and Research
FCF	Fuel Cycle Facility
FEMA	Federal Emergency Management Agency
FFCA	Federal Facility Compliance Agreement
FFTF	Fast Flux Test Facility

FLPMA	*Federal Land Planning Management Act*
FMEF	Fuels and Materials Examination Facility
FMF	Fuel Manufacturing Facility
FONSI	Finding of No Significant Impact
FR	Federal Register
FSAR	Final Safety Analysis Report
GBZ	Glass-bonded zeolite
GESMO	Generic Environmental Statement on Mixed Oxide
GIS	Geographical Information System
GMA	*Growth Management Act*
GMODS	Glass Material Oxidation Dissolution System
HAD	hazard analysis document
Hanford	Hanford Site
HE	high explosives
HEAST	Health Effects Summary Table
HEPA	high-efficiency particulate air
HEU	highly enriched uranium
HEU EIS	*Disposition of Surplus Highly Enriched Uranium Environmental Impact Statement*
HFEF	Hot Fuel Examination Facility
HI	Hazard Index
HLW	high-level waste
HQ	Hazard Quotient
HRA EIS	*Hanford Remedial Action Environmental Impact Statement and Comprehensive Land Use Plan*
HVAC	Heating Ventilation and Air Conditioning
HWR	Heavy Water Reactor
IAEA	International Atomic Energy Agency
ICPP	Idaho Chemical Processing Plant
ICRP	International Commission of Radiological Protection
INEL	Idaho National Engineering Laboratory
IRIS	Integrated Risk Information System
ISCST2	Industrial Source Complex Short-Term Model Version 2
ISO	International Standards Organization
IWG	Interagency Working Group
K-25	K-25 Site

L/ER	Energy Research Program Office
LA	Limited Area
LAA	Limited Access Area
LANL	Los Alamos National Laboratory
LANSCE	Los Alamos Neutron Scattering Center
LCF	latent cancer fatalities
LDR	Land Disposal Restriction
LEU	low-enriched uranium
LIGO	Laser Interferometer Gravitational-Wave Observatory
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
LOB	Laboratory Office Building
LWR	Light Water Reactor
MAA	Material Access Area
MACCS	Melcor Accident Consequence Code System
MC&A	Material Control and Accountability
MD	Office of Fissile Materials Disposition
MEI	maximally exposed individual
MHR	Modular Helium Reactor
MMI	Modified Mercalli Intensity
MOX	mixed oxide
MSL	mean sea level
NAAQS	National Ambient Air Quality Standards
NAGPRA	*Native American Graves Protection and Repatriation Act*
NAS	National Academy of Sciences
NCDC	National Climatic Data Center
NCRP	National Commission of Radiological Protection
NEIC	National Earthquake Information Center
NEPA	*National Environmental Policy Act*
NERP	National Environmental Research Park
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFS	Nuclear Fuel Services Fuel Fabrication Plant
NHPA	*National Historic Preservation Act*
NIOSH	National Institute of Occupational Safety and Health
NMSF	Nuclear Material Storage Facility

NMSM	Nuclear Materials and Stockpile Management
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
NRF	Naval Reactors Facility
NRHP	National Register of Historic Places
NTS	Nevada Test Site
NTS EIS	*Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada*
NWI	National Wetlands Inventory
NWPA	*Nuclear Waste Policy Act*
NWS	National Weather Service
OCRWM	Office of Civilian Radioactive Waste Management
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Administration
PA	Protected Area
Pantex	Pantex Plant
Pantex EIS	*Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components*
PBF	Power Burst Facility
PCV	Primary Containment Vessel
PEIS	programmatic environmental impact statement
PEL	Permissible Exposure Level
PFP	Plutonium Finishing Plant
PFP EIS	*Plutonium Finishing Plant Stabilization Environmental Impact Statement*
PIDAS	Perimeter Intrusion Detection and Alarm System
PNNL	Pacific Northwest National Laboratory
PPA	Property Protection Area
PRA	probabilistic risk assessment
PSAR	Preliminary Safety Analysis Report
PSD	Prevention of Significant Deterioration

PUREX	Plutonium-Uranium Extraction Plant
PWR	pressurized water reactor
R&D	Research and Development
RCRA	*Resource Conservation and Recovery Act*
REA	regional economic area
RIA	reactivity insertion accident
RFETS	Rocky Flats Environmental Technology Site
RIMS II	Regional Input-Output Modeling System
RL	Richland Operations Office
ROD	Record of Decision
ROI	region of influence
RSWF	Radioactive Scrap and Waste Facility
RWMC	Radioactive Waste Management Complex
RWMS	Radioactive Waste Management Site
SAR	Safety Analysis Report
SARA	*Superfund Amendments and Reauthorization Act*
sd	standard deviation
SDWA	*Safe Drinking Water Act*
SEB	Security Equipment Building
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SISMP	Site Integrated Stabilization and Management Plan
SMR	Standardized Mortality Ratio
SNF	spent nuclear fuel
SNL	Sandia National Laboratories
SRR	standardize rate ratio
SRS	Savannah River Site
Stockpile Stewardship and Management PEIS	*Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*
Storage and Disposition PEIS	*Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmenta Impact Statement*
SST	safe secure trailer
START	Strategic Arms Reduction Talks

TA	Technical Area
TAN	Test Area North
TCLP	toxicity characteristic leaching procedure
TDEC	Tennessee Department of Environmental Conservation
TDS	total dissolved solids
TI	transport index
TLV	Threshold Limit Values
TNRCC	Texas Natural Resources Conservation Commission
TRA	Test Reactor Area
TRU	transuranic
TSCA	*Toxic Substance Control Act*
TSD	Transportation Safeguards Division
TSP	total suspended particulates
TSR PEIS	*Tritium Supply and Recycling Programmatic Environmental Impact Statement*
TVA	Tennessee Valley Authority
USFWS	United States Fish and Wildlife Services
USGS	United States Geological Survey
VOC	volatile organic compound
VRM	Visual Resource Management
WAC	Waste Acceptance Criteria
Waste Management PEIS	*Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*
WIPP	Waste Isolation Pilot Plant
WMIS	Waste Management Information System
WNP	Washington Nuclear Power
WPPSS	Washington Public Power Supply System
WSA	Weapons Storage Area
WSCC	Western Systems Coordinating Council
WSCF	Waste Sampling and Characterization Facility
Y–12	Y–12 Plant
Y–12 EA	*Environmental Assessment for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Level at the Y–12 Plant, Oak Ridge, Tennessee*
YMSCO	Yucca Mountain Site Characterization Office
ZPPR	Zero Power Physics Reactor

Chemicals and Units of Measure

^{o}C	degrees Celsius
Ci	curie
cm	centimeter
CO	carbon monoxide
CO_2	carbon dioxide
Co-60	cobalt-60
Cs	cesium
Cs-137	cesium-137
CsCl	cesium chloride
Cu	copper
dB	decibel
dBA	decibel A-weighted
^{o}F	degrees Fahrenheit
ft	feet
ft^2	square feet
ft^3	cubic feet
g	gram
G	gravitational acceleration
gal	gallon
Gd	gadolinium
GWd	gigawatt-days
ha	hectare
H_2	hydrogen
HF	hydrogen fluoride
HNO_3	nitric acid
hr	hour
I-129	iodine-129
in	inch
k_{eff}	effective neutron multiplication factor
kg	kilogram
km	kilometer
km^2	square kilometer

Kr	krypton
kV	kilovolt
l	liter
lb	pound
m	meter
m^2	square meter
m^3	cubic meter
mCi	millicurie
mg	milligram
mi	mile
mi^2	square miles
min	minute
mph	miles per hour
mrem	millirem (one thousandth of a rem)
MW	megawatt
MWe	megawatt electric
N_2	nitrogen
nCi	nanocurie (one-billionth of a Curie)
Ni	nickel
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
O_3	ozone
oz	ounce
Pb	lead
PCB	polychlorinated biphenyl
pCi	picocurie (one-trillionth of a Curie)
PM_{10}	particulate matter less than or equal to 10 microns
ppm	parts per million
Pu	plutonium
PuCl	plutonium chloride
PuO_2	plutonium dioxide
rad	radiation absorbed dose
rem	roentgen equivalent man
RfC	Reference Concentration
RfD	Reference Dose

s	second
SO_2	sulfur dioxide
Sr-90	strontium-90
t	metric ton
Tc-99	technetium-99
ton	short ton
U	uranium
U-233	uranium-233
U-234	uranium-234
U-235	uranium-235
U-236	uranium-236
U-238	uranium-238
UF_6	uranium hexafluoride
UNH	uranyl nitrate hexahydrate
UO_2	uranium dioxide
U_3O_8	triuranium octaoxide
VOC	volatile organic compound
yd	yard
yr	year
μg	microgram (one-millionth of a gram)

METRIC CONVERSION CHART

To Convert Into Metric			To Convert Out of Metric		
If You Know	**Multiply By**	**To Get**	**If You Know**	**Multiply By**	**To Get**
Length					
inches	2.54	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.0328	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.0936	yards
miles	1.60934	kilometers	kilometers	0.6214	miles
Area					
sq. inches	6.4516	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.092903	sq. meters	sq. meters	10.7639	sq. feet
sq. yards	0.8361	sq. meters	sq. meters	1.196	sq. yards
acres	0.40469	hectares	hectares	2.471	acres
sq. miles	2.58999	sq. kilometers	sq. kilometers	0.3861	sq. miles
Volume					
fluid ounces	29.574	milliliters	milliliters	0.0338	fluid ounces
gallons	3.7854	liters	liters	0.26417	gallons
cubic feet	0.028317	cubic meters	cubic meters	35.315	cubic feet
cubic yards	0.76455	cubic meters	cubic meters	1.308	cubic yards
Weight					
ounces	28.3495	grams	grams	0.03527	ounces
pounds	0.45360	kilograms	kilograms	2.2046	pounds
short tons	0.90718	metric tons	metric tons	1.1023	short tons
Temperature					
Fahrenheit	Subtract 32 then multiply by 5/9ths	Celsius	Celsius	Multiply by 9/5ths, then add 32	Fahrenheit

METRIC PREFIXES

Prefix	Symbol	Multiplication Factor
exa-	E	1 000 000 000 000 000 000 = 10^{18}
peta-	P	1 000 000 000 000 000 = 10^{15}
tera-	T	1 000 000 000 000 = 10^{12}
giga-	G	1 000 000 000 = 10^{9}
mega-	M	1 000 000 = 10^{6}
kilo-	k	1 000 = 10^{3}
hecto-	h	100 = 10^{2}
deka-	da	10 = 10^{1}
deci-	d	0.1 = 10^{-1}
centi-	c	0.01 = 10^{-2}
milli-	m	0.001 = 10^{-3}
micro-	μ	0.000 001 = 10^{-6}
nano-	n	0.000 000 001 = 10^{-9}
pico-	p	0.000 000 000 001 = 10^{-12}
femto-	f	0.000 000 000 000 001 = 10^{-15}
atto-	a	0.000 000 000 000 000 001 = 10^{-18}

Chapter 1
Background, Purpose of, and Need for the Proposed Action

1.1 INTRODUCTION

At the end of the Cold War, the need for nuclear materials used in weapons in the United States was significantly reduced. Substantial quantities of weapons-usable fissile materials that had previously been intended for use in warheads remain in Department of Energy (DOE) facilities. The President has declared that some quantities of fissile materials are surplus to national defense and defense-related program needs. Other materials are being retained for defense and defense-related program needs. Additional fissile materials may be declared surplus in the future. As a result, DOE is developing an integrated strategy for storage and disposition of weapons-usable fissile materials.

As the number of weapons in the stockpile is reduced, DOE is faced with the challenge of effectively managing weapons-usable fissile materials in existing inventories and those resulting from the dismantlement of nuclear weapons and weapon components. Declaration of fissile materials as surplus by the President is resulting in an inventory of fissile materials that includes all isotopes of plutonium (Pu) except Pu-238 (used in space and industrial applications), uranium-233 (U-233), and highly enriched uranium (HEU), which is uranium with a U-235 isotopic content of 20 percent or more. If not properly managed, these fissile materials could pose a danger to national and international security. DOE must manage the storage and disposition of these materials to prevent the potential for proliferation of nuclear weapons and adverse environmental, safety, and health consequences.

This *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (Storage and Disposition PEIS) analyzes the potential direct, indirect, and cumulative environmental effects of reasonable alternatives for the long-term storage of nonsurplus Pu and HEU, storage of surplus Pu and HEU pending disposition, and disposition of surplus weapons-usable Pu. [Text deleted.] A separate document, *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (DOE/EIS-0240 [HEU EIS]), addresses the disposition of surplus HEU. The HEU EIS Record of Decision (ROD) was published on August 5, 1996 (61 FR 40619).

A key element of DOE's decisionmaking is a thorough understanding of the environmental impacts that may occur during the implementation of the proposed action. The *National Environmental Policy Act* of 1969 (NEPA), as amended, provides Federal agency decisionmakers with a process to consider potential environmental consequences (both positive and negative) of proposed actions before making decisions. In following this process, DOE has prepared this Storage and Disposition Final PEIS to analyze various long-term storage and disposition alternatives and to provide the necessary background, data, and analyses to help decisionmakers and the public understand the potential environmental impacts of each alternative. The results of the environmental analyses, together with information from technical and economic studies, the nonproliferation analysis, and public input, will form the basis for DOE's decisions, which will be discussed in an ROD to be issued no sooner than 30 days after publication of this Storage and Disposition Final PEIS.

1.1.1 WEAPONS-USABLE FISSILE MATERIALS

Locations in the United States. The Department's inventories of Pu and HEU are located at a number of DOE sites, including the Hanford Site (Hanford), Idaho National Engineering Laboratory (INEL), Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL), Oak Ridge Reservation (ORR), the Pantex Plant (Pantex), Rocky Flats Environmental Technology Site (RFETS), and Savannah River

Site (SRS). [Text deleted.] The weapons-usable Pu materials are those that can be readily converted for use in nuclear weapons, including weapons-grade, fuel-grade, and power reactor-grade Pu. Inventories and locations of currently declared surplus weapon-grade Pu and surplus HEU, as stated in DOE's Openness Initiative of February 6, 1996, are presented in Figures 1.1.1–1 and 1.1.1–2, respectively. These materials, currently declared excess to national security needs, total approximately 38.2 metric tons (t) (42.1 short tons [tons]) of weapons-grade Pu and 174.3 t (192.1 tons) of HEU. As of September 1994, the total U.S. inventory of Pu is composed of 85 t (93.7 tons) of weapons-grade material,[1] 13.2 t (14.6 tons) of fuel grade, and 1.3 t (1.4 tons) of power reactor grade (DOE 1996p:17). [Text deleted.]

Materials Covered in This Programmatic Environmental Impact Statement. All Pu (except for Pu-238 and Department of Defense [DoD] weapons program materials in use) and nonsurplus HEU (except DoD weapons program materials in use) are being considered for the various long-term storage alternatives. The Pu materials being considered for disposition in this PEIS are those the President has declared surplus or may declare surplus to national defense needs in the future in response to recommendations from the Nuclear Weapons Council (made up of representatives from DOE, DoD, and the Joint Chiefs of Staff). For the purposes of analysis, this PEIS analyzes the disposition of a nominal 50 t (55.1 tons) of Pu. The Pu materials covered in this PEIS are primarily in the form of pits (Pu-bearing weapons components), metals, and oxides.

The Department is currently in the process of stabilizing and repackaging weapons-usable fissile materials and placing them in safe, secure interim storage awaiting decisions on long-term storage and disposition. For Pu, this is being accomplished in accordance with the corrective actions identified in DOE's *Plutonium Vulnerability Management Plan* (DOE/EM-0199). This plan was developed in response to an assessment in DOE's *Plutonium Working Group Report* (DOE/EH-0415) and recommendations by the Defense Nuclear Facilities Safety Board (DNFSB) to improve the schedule for interim safe storage at those sites where Pu is currently stored (DNFSB 94-1). These corrective actions include material packaging upgrades and standardized packaging to facilitate cost-effective management of materials well into the future. This will be the base condition and storage configuration from which decisions will be made on future storage. In addition, the Pu materials will also meet the *Criteria for Safe Storage of Plutonium Metals and Oxides* (DOE-STD-3013-94), a DOE standard for long-term storage (at least 50 years) of these materials. Fissile materials present in spent nuclear fuel or irradiated targets[2] from reactors are not covered in this PEIS; they are not considered weapons-usable because separation of the relevant isotopes from these highly radioactive materials requires significant remote chemical processing. Any subsequent reprocessing and extraction of Pu from spent fuel is beyond the scope and the fundamental nonproliferation purpose of the program covered by this PEIS.

Following the discontinuance of nuclear weapons material production, large quantities of residues remained as a result of the chemical and thermal processes applied to separate and purify Pu. Examples of residue forms include some impure oxides and metals, halide salts, combustibles, ash, sludges, and contaminated glass. To meet requirements of DOE's *Plutonium Vulnerability Management Plan*, as well as various compliance agreements with State and local regulatory agencies, some Pu residues must be stabilized. As a result of the stabilization process, portions of the residues will potentially be concentrated and stored. These concentrates may be in a form and concentration (greater than 50 percent Pu by weight) that is weapons-usable and are therefore included in this PEIS.[3]

The stabilization, concentration, and storage of Pu residues, as well as disposal of non-weapons-usable waste, is covered in other existing and future environmental documents as appropriate, including the *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (at SRS) and ROD; the *Plutonium*

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[1] Weapons-grade Pu contains less than 7 percent Pu-240, fuel grade Pu contains from 7 to less than 19 percent Pu-240, and power reactor grade Pu contains 19 percent and greater Pu-240.

[2] These materials are not directly subject to disposition pursuant to this PEIS unless the irradiated fuel or targets were first processed to separate the Pu under another program. Currently, DOE is not proposing such an action.

[3] As a result of the stabilization process, there will also be nonweapons-usable Pu or HEU contaminated wastes or residues (less than 50 percent Pu by weight) that would not be within the scope of this PEIS.

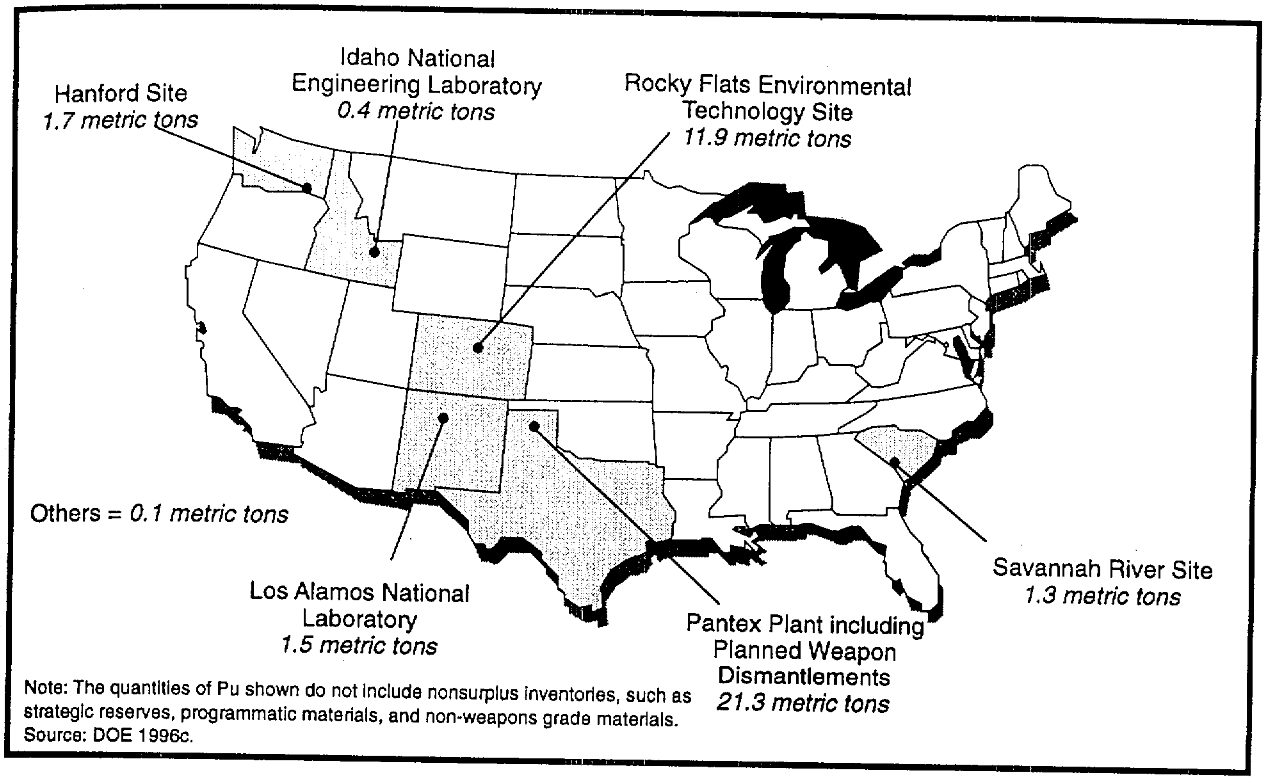

Figure 1.1.1–1. Department of Energy Locations With Surplus Weapons-Grade Plutonium Inventories in September 1994.

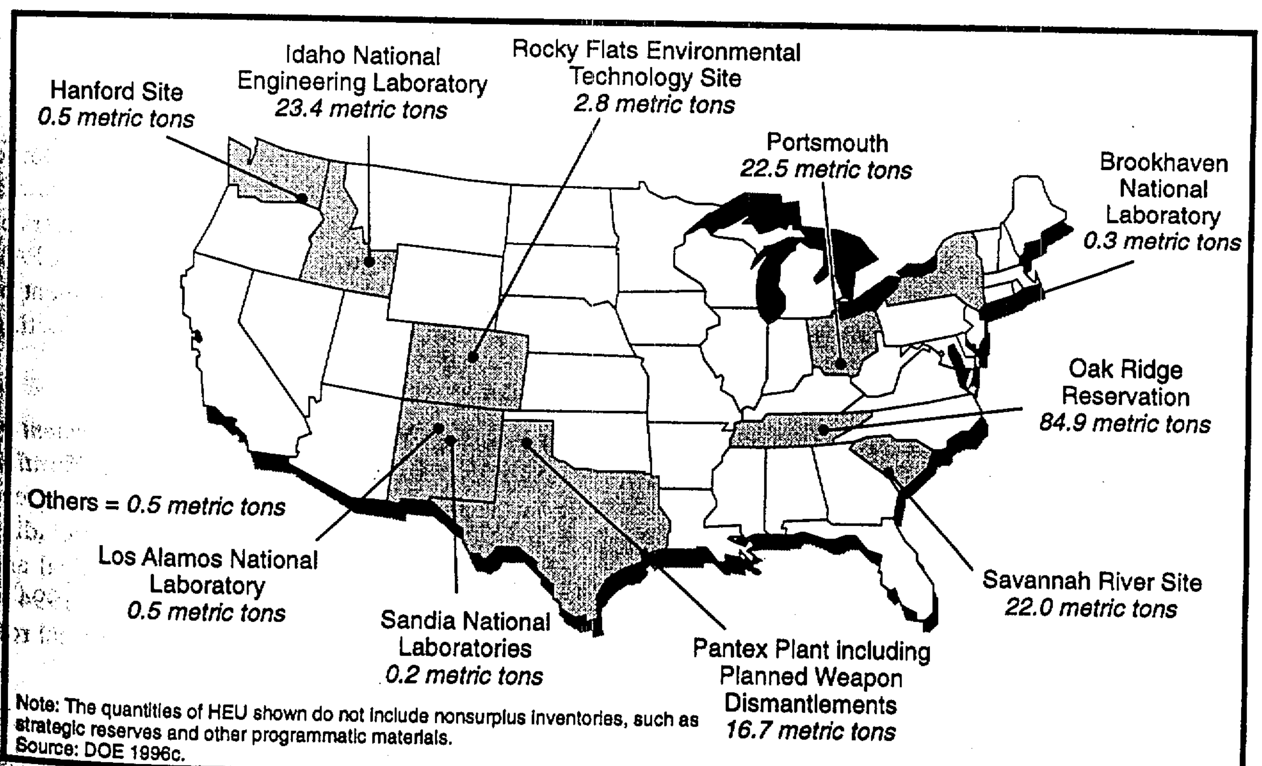

Figure 1.1.1–2. Department of Energy Locations With Surplus Highly Enriched Uranium Inventories on February 6, 1996.

Finishing Plant Stabilization Final Environmental Impact Statement (at Hanford) and ROD; the *Environmental Assessment for Solid Residue Treatment, Repackaging, and Storage (at RFETS)* and Finding of No Significant Impact (FONSI); and an EIS on the *Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site* (in preparation), as discussed in Section 1.4. [Text deleted.]

The nonsurplus HEU materials covered in this PEIS are primarily in the form of metals and oxides. These materials include naval nuclear fuel feed stock, strategic reserves, and programmatic materials. Storage of surplus HEU, pending disposition under the HEU EIS and ROD, is also analyzed.[4] The HEU materials for long-term storage will meet long-term storage criteria for safe storage of HEU metals and oxides, which are under development at this time. Appropriate environmental review will be prepared for stabilizing and repackaging the HEU materials to meet respective long-term storage criteria.

1.2 BACKGROUND

The arms race between the superpowers was brought to a close at the end of the Cold War, causing increases in stockpiles of surplus weapons-usable fissile materials. Continued implementation of arms reduction agreements may lead to additional quantities being declared surplus in the future. With the collapse of the Soviet Union and the economic and social challenges faced by newly formed states, there is a serious risk of nuclear proliferation from those growing stockpiles. The United States has taken steps to address this risk of nuclear proliferation. In September 1993, President Clinton announced the *Nonproliferation and Export Control Policy* (see Appendix A), which included the commitment that the United States will do the following:

- Seek to eliminate, where possible, the accumulation of stockpiles of HEU or Pu, and to ensure that, where these materials already exist, they are subject to the highest standards of safety, security, and international accountability.

- Initiate a comprehensive review of long-term options for Pu disposition, taking into account technical, nonproliferation, environmental, budgetary, and economic considerations. Russia and other nations with relevant interests and experience will be invited to participate in the study.

Following the President's policy announcement, the National Security Council, together with the White House Office of Science & Technology Policy, established an Interagency Working Group (IWG) to initiate a comprehensive review of the options for disposition of surplus Pu from nuclear weapons activities. Members of the IWG include the Arms Control and Disarmament Agency, Environmental Protection Agency (EPA), DNFSB, Nuclear Regulatory Commission (NRC), Office of Management and Budget, DOE, Department of State, and DoD. DOE has the lead role within the IWG for evaluating technical options and conducting economic, schedule, and environmental analyses.

At the Moscow Summit in January 1994, President Clinton and President Yeltsin issued the *Joint Statement by the President of the Russian Federation and the President of the United States of America on Non-Proliferation of Weapons of Mass Destruction and the Means of Their Delivery* (see Appendix A). The two Presidents agreed to task their technical experts to study options for the disposition of weapons-usable fissile materials, including Pu, taking into account the issues of nonproliferation, environmental protection, safety, and technical and economic factors. Under the leadership of the IWG, an initial meeting was held in Moscow in May 1994 to establish the framework for this effort. DOE and its national laboratories have assumed the lead technical role in supporting this joint effort.

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[4] This Storage and Disposition PEIS covers long-term storage of nonsurplus HEU and storage of surplus HEU pending disposition. Until storage decisions are implemented, surplus HEU that has not gone to disposition will continue to be stored pursuant to, and not to exceed the 10-year interim storage time period evaluated in the *Environmental Assessment for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant, Oak Ridge, Tennessee* (DOE/EA-0929, September 1994) and Finding of No Significant Impact. [Text deleted.]

At the end of January 1995, specialists from the United States and Russia met at LANL for a 2-day exchange of technical presentations on scientific research that had been conducted on potential Pu disposition alternatives and on promising prospective investigations. During this meeting, the United States and Russia reviewed various long-term storage and disposition options. Both sides agreed to conduct consistent comparisons of alternatives for the disposition of Pu, taking into account the factors noted in the Summit statement of the two Presidents.

In addition, DOE sponsored a National Academy of Sciences (NAS) study on the management and disposition of surplus weapons Pu. In its report, *Management and Disposition of Excess Weapons Plutonium* of March 1994, the NAS stated that the existence of surplus weapons-usable fissile materials was a "clear and present danger to national and international security" and then identified proposed standards for managing the risks associated with surplus weapons-usable fissile materials (NAS 1994a:vii,31-34). The following standards, although not regulatory requirements, were identified by the NAS and modified by DOE:

- *The Stored Weapons Standard.* The high standards of security and accounting for the storage of intact nuclear weapons should be maintained, to the extent practical, for weapons-usable fissile materials throughout dismantlement, storage, and disposition. [Text deleted.]

- *The Spent Fuel Standard.* The surplus weapons-usable Pu should be made as inaccessible and unattractive for weapons use as the much larger and growing quantity of Pu that exists in spent nuclear fuel from commercial power reactors.

The NAS also identified several disposition options that meet these standards, including immobilization of Pu for disposal and the use of Pu in mixed oxide (MOX) fuel for commercial (non-defense) nuclear reactors. Material forms resulting from the immobilization and reactor options would be disposed of in a high-level waste (HLW) repository. The NAS also identified the deep borehole as a possible disposition option, where ultimate disposal is accomplished by emplacing the Pu material several kilometers below the water table into ancient, geologically stable rock formations. DOE used the NAS report as the starting point for developing the proposed action for disposition of surplus Pu.

More recently, through the ongoing efforts of the joint U.S./Russia study, the *Joint United States/Russian Plutonium Disposition Study* on technical options for the disposition of surplus Pu was issued in late September 1996. This study was undertaken to provide a consistent comparison of deep borehole, immobilization, and reactor alternatives by the two countries using criteria related to nuclear nonproliferation, safety, environmental protection, and technical and economic factors. Joint technical demonstrations are planned by the United States and Russia to support implementation of disposition decisions. The study and options will provide decisionmakers from both countries with a set of jointly evaluated alternatives for Pu disposition and help build further trust and cooperation in the area of fissile materials disposition.

1.3 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

The Department proposes to take the following actions for U.S. weapons-usable fissile materials:

- Storage—provide a long-term storage system (for up to 50 years) for nonsurplus Pu and HEU that meets the Stored Weapons Standard and applicable environmental, safety, and health standards while reducing storage and infrastructure[5] costs

- Storage Pending Disposition—provide storage that meets the Stored Weapons Standard for inventories of weapons-usable Pu and HEU that have been or may be declared surplus

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[5] Includes electrical power, fuel, transportation network requirements, and safeguards/security.

- Disposition—convert surplus Pu and Pu that may be declared surplus in the future to forms that meet the Spent Fuel Standard, thereby providing evidence of irreversible disarmament and setting a model for proliferation resistance

[Text deleted.]

The purpose of the proposed action is to implement the President's *Nonproliferation and Export Control Polic* in a safe, reliable, cost-effective, and timely manner. DOE is proposing a comprehensive program to accomplisl this purpose by providing an exemplary long-term storage system for weapons-usable fissile materials eliminating the stockpile of surplus weapons-usable Pu, and establishing the technical and progran infrastructure that will enable the United States to dispose of surplus weapons-usable Pu.

A portion of the materials covered in this Storage and Disposition Final PEIS may be subject to internationa and/or bilateral inspection. Consistent with the President's *Nonproliferation and Export Control Policy*, surplu fissile materials will be subject to international inspections, including inspections by the International Atomi Energy Agency (IAEA), with the imperative that there would be no disclosure of sensitive/classified informatio to unauthorized parties. Furthermore, in an effort to increase transparency between the United States and Russi on nuclear disarmament, some nonsurplus materials may be made available for bilateral inspections with th Russians, once an agreement is reached between the two countries. Facilities for long-term storage an disposition would be designed or modified, as needed, to accommodate inspection requirements. Othe modifications to those facility designs might be needed should new treaties come into effect.

In March 1995, the President declared 200 t (220 tons) of fissile materials to be surplus to national defens needs. These materials are in various compositions and forms. A long-term storage plan is needed to provid continued and adequate control of these surplus materials and any that may be declared surplus in the future from now through disposition. Disposition of surplus Pu is needed to reduce the reliance on institutional control and to provide visible evidence of irreversible disarmament. A comprehensive long-term storage and dispositio action is needed to ensure that weapons-usable fissile materials are properly managed and to prevent the increas of potential environmental, health, and safety risks. This includes achieving nonproliferation goals through th disposition of surplus Pu, providing long-term storage for nonsurplus Pu and HEU, and providing storage fo surplus Pu and HEU that cannot go directly from current storage to disposition. DOE also recognizes the nee to strengthen national and international arms control efforts by providing a storage and disposition model fo the international community. This action will enhance U.S. credibility and flexibility in negotiations on bilatera or multilateral reductions of surplus weapons-usable fissile materials inventories.

1.4 RELATED *NATIONAL ENVIRONMENTAL POLICY ACT* REVIEWS

Weapons-usable fissile materials are divided into two categories—surplus and nonsurplus. The nonsurplus categor includes naval nuclear fuel, strategic reserves, programmatic materials (non-weapons research and developmen [R&D], weapons R&D, and other programmatic materials), and weapons program materials in use (as shown in Figur 1.4–1). Weapons program materials in use will not go into long-term storage. These materials are primarily located i weapons and operational storage vaults at current DoD weapons complex sites. For this reason, these materials are nc analyzed for long-term storage. The ongoing and completed environmental reviews related to the storage an disposition of weapons-usable fissile materials, both Pu and HEU, are summarized in Table 1.4–1. A description o these and other related environmental reviews is given below.

Current or Interim Storage. The *Final Environmental Impact Statement for the Continued Operation of th Pantex Plant and Associated Storage of Nuclear Weapon Components* (Pantex EIS, DOE/EIS-0225, Novembe 1996), is a sitewide EIS that covers current and proposed facilities and activities at Pantex in Amarillo, Texas where Pu pits are currently stored. The Pantex EIS analyzes the alternatives and environmental impact associated with conducting nuclear weapons operations at Pantex for approximately 10 years. Included in th

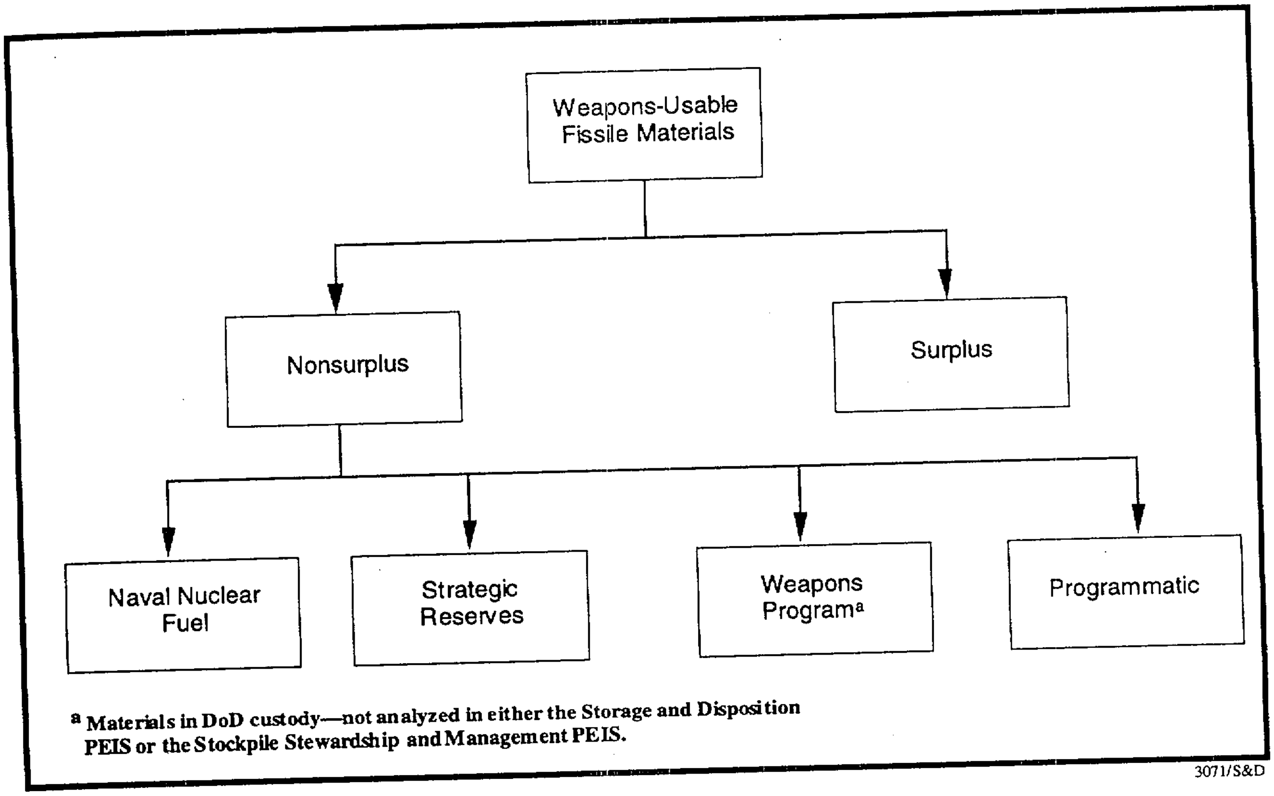

Figure 1.4–1. Weapons-Usable Fissile Material Categories.

Pantex EIS is an analysis to increase the interim storage of Pu pits from 12,000 pits to 20,000 pits. The Pantex EIS also analyzes alternate locations to Pantex for interim pit storage operations.

In May 1994, when DOE announced its intention to prepare the Pantex EIS, DOE believed that the Pantex EIS ROD would precede decisionmaking on the long-term storage of pits. Accordingly, the Pantex EIS was scoped to address alternate locations for interim pit storage (that is, until the long-term decisions are made and implemented).

The *Environmental Assessment for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y–12 Plant, Oak Ridge, Tennessee* (Y–12 EA) (DOE/EA-0929) evaluates the continued receipt, prestorage processing, and interim storage of enriched uranium for up to 10 years in quantities that would exceed the historical maximum storage level. The Y–12 EA was issued in September 1994 and was followed by a FONSI in September 1995. In the FONSI, DOE determined that the Y–12 Plant (Y–12) would store no more than 500 t (550 tons) of HEU and no more than 6 t (6.6 tons) of low-enriched uranium (LEU).

The *Interim Storage of Plutonium at the Rocky Flats Environmental Technology Site Environmental Impact Statement*, announced for preparation by DOE on July 17, 1996 (61 FR 37247), will evaluate reasonable alternatives for the safe interim storage of Pu at RFETS, including current and additional inventory from future processing of Pu residues into more stable forms, pending implementation of upcoming long-term storage and disposition decisions, and waste management decisions.

The *Environmental Assessment for Solid Residue Treatment, Repackaging, and Storage* (DOE/EA-1120, April 1996) describes and analyzes the environmental effects of the proposed action to treat, repackage, and provide interim storage of solid residues at RFETS. It also analyzes the alternatives of taking no action, shipping the

*Table 1.4–1. **Environmental Reviews for Storage and Disposition of Weapons-Usable Fissile Materials***

Action	Pu	HEU
Current/Interim Storage	Pantex EIS[a] and other site-specific NEPA documents (see Table 1.4–2)	Y–12 EA[b]
Long-Term Storage	Storage and Disposition PEIS Stockpile Stewardship and Management PEIS[c]	Storage and Disposition PEIS Stockpile Stewardship and Management PEIS[c]
Disposition	Storage and Disposition PEIS	HEU EIS[d]
[Text deleted.]		

[a] *Final Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components* (DOE/EIS-0225, November 1996).
[b] *Environmental Assessment for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y–12 Plant, Oak Ridge, Tennessee* (DOE/EA-0929, September 1994).
[c] *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE/EIS-0236, September 1996).
[Text deleted.]
[d] *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (DOE/EIS-0240, June 1996).

residues offsite for treatment, and shipping the residues offsite for storage. A FONSI to the environmental assessment (EA) was signed by DOE in April 1996.

On November 19, 1996, DOE announced its intention to prepare an EIS on the *Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site* (61 FR 58866). This EIS will evaluate the potential environmental impacts associated with reasonable management alternatives for certain Pu residues and all scrub alloy currently being stored at RFETS. The management alternatives include treatment of these materials to enable them to be disposed of as waste or, in the case of separated surplus weapons-usable Pu, stored and dispositioned in accordance to the decisions to be made in the Storage and Disposition PEIS ROD. Activities analyzed in this EIS would be in addition to certain activities evaluated in the *Environmental Assessment for Solid Residue Treatment, Repackaging, and Storage*, previously described, in which a portion of the residues would undergo further treatment prior to waste disposal or other disposition.

Long-Term Storage. With the exception of those materials in weapons programs, the Storage and Disposition PEIS analyzes the environmental impacts of reasonable alternatives for long-term storage of various materials in all categories shown in Figure 1.4–1, including the long-term storage of all Pu pits (strategic reserves and surplus) and the approach for dispositioning pits that are surplus to national security requirements.

Another DOE NEPA document that addresses the storage of pits is the *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (Stockpile Stewardship and Management PEIS, DOE/EIS-0236, September 1996). The Stockpile Stewardship and Management PEIS supports decisions on the long-term storage of pits that will be needed for national security requirements (strategic reserve pits). The Preferred Alternative for strategic reserve storage is as follows: (1) HEU strategic reserve storage at Y–12 and (2) Pu pits strategic reserve storage in Zone 12 at Pantex. It also calls for the weapons R&D material (Pu-242), to be stabilized at SRS as a result of the ROD for the *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE/EIS-0220, October 1995), to be transported to LANL for storage.

Table 1.4–2. Additional Environmental Reviews Related to the Storage and Disposition Programmatic Environmental Impact Statement

Site	Document	Status
Argonne National Laboratory-West, Idaho Falls, ID	Electrometallurgical Treatment Research and Demonstration Project in the Fuel Conditioning Facility at ANL-West EA	Final 5/96
Hanford Site, Richland, WA	Plutonium Finishing Plant Stabilization EIS	Final 5/96
Los Alamos National Laboratory, Los Alamos, NM	Los Alamos National Laboratory Site-Wide EIS	In preparation
Multiple DOE sites	Waste Management PEIS	Draft 8/95 Final in preparation
Nevada Test Site, Mercury, NV	Nevada Test Site and Off-Site Locations in the State of Nevada EIS	Final 8/96
Rocky Flats Environmental Technology Site, Golden, CO	Interim Storage of Plutonium at the Rocky Flats Environmental Technology Site EIS	In Preparation
Rocky Flats Environmental Technology Site, Golden, CO	Solid Residue Treatment, Repackaging, and Storage EA	Final 4/96
Rocky Flats Environmental Technology Site, Golden, CO	Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site EIS	In preparation
Savannah River Site, Aiken, SC	Defense Waste Processing Facility, Supplemental EIS	Final 11/94
Savannah River Site, Aiken, SC	F-Canyon Plutonium Solutions EIS	Final 12/94
Savannah River Site, Aiken, SC	Savannah River Site Waste Management EIS	Final 7/95
Savannah River Site, Aiken, SC	Interim Management of Nuclear Materials EIS	Final 10/95
Savannah River Site, Aiken, SC	Tritium Supply and Recycling PEIS	Final 10/95

Since the Stockpile Stewardship and Management Program may store strategic materials and weapons R&D material, this Storage and Disposition Final PEIS separately analyzes, as a subpart of each alternative, the long-term storage of weapons-usable fissile materials without strategic reserves and weapons R&D material (under the programmatic category in Figure 1.4–1). Preparation of this Storage and Disposition Final PEIS and the Stockpile Stewardship and Management PEIS has been closely coordinated to ensure that all necessary information is available to the decisionmaker. Both of these PEISs have progressed to the point where they are scheduled to have their RODs issued in late 1996 or early 1997. Decisions on the long-term storage of pits would be made in the RODs of the PEISs. A decision relating to the interim storage of pits at Pantex would be made in the ROD of the Pantex EIS pending implementation of the selected long-term storage alternative(s).[6]

Disposition. The Storage and Disposition PEIS addresses the disposition of surplus Pu. In the *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (TSR PEIS, DOE/EIS-0161, October 1995), there is an option for a multipurpose reactor that could produce tritium, use Pu in reactor fuel, and generate revenue through the production of electricity. Environmental analysis of the multipurpose reactor

[6] If there is a delay in implementing the RODs for either of the PEISs (for example, delay due to availability and construction of upgrades for long-term storage facilities), then there would be a need to make a decision on the location of interim storage of pits. The Pantex EIS has been completed with the analysis of interim storage alternatives, including the issues and comments received from the public on that EIS, to support a decision relating to the storage of pits until a long-term storage decision is made and implemented.

is included in the TSR PEIS. On December 6, 1995, the Secretary of Energy made the decision that the future source of tritium would either be from a purchased reactor, from irradiation in a commercial reactor, or from the accelerator production of tritium. The multipurpose reactor was preserved as an option for future consideration. Therefore, the multipurpose reactor, as well as the Fast Flux Test Facility (FFTF) at Hanford, are discussed in Appendix N of this Storage and Disposition Final PEIS.

For the disposition of surplus HEU, DOE's decision, as identified in the HEU EIS ROD, is to gradually blend down a nominal 200 t (220 tons) of HEU[7] to LEU, containing less than 20 percent of the U-235 isotope, with the potential use of up to 85 percent of the resulting LEU as non-defense reactor fuel feed. The remaining LEU produced by blend-down would be disposed of as low-level waste (LLW). The blending down of the HEU will occur over an estimated 15- to 20-year period, with continued storage of the HEU until blend-down. The proposed action was analyzed separately in the HEU EIS from that of the Storage and Disposition PEIS because the disposition of surplus HEU can be accomplished at existing facilities and with existing technologies, and would involve different alternatives, timeframes, technologies, facilities, and personnel than those required for Pu disposition. The surplus HEU is part of the larger HEU inventory that was analyzed for interim storage in the Y–12 EA. [Text deleted.]

Other Related Environmental Reviews. The *Draft Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (Waste Management PEIS, DOE/EIS-0200D, August 1995) addresses management of the current and 20-year projected inventories of five types of waste (high-level, transuranic, low-level, low-level mixed, and hazardous waste) on a national basis. Among other things, it identifies impacts of consolidating or not consolidating waste management operations across sites where DOE manages wastes. [Text deleted.]

Waste management assumptions in this Storage and Disposition PEIS are based on current practice. These practices may be changed by the waste-type specific RODs from the Waste Management PEIS. However, none of the alternatives analyzed in this PEIS are expected to result in waste forms or produce "end product" materials that are not covered in the Waste Management PEIS.

Additional site-specific environmental reviews are currently being prepared by DOE. A listing of these reviews is included in Table 1.4–2. In particular, the site-specific, sitewide EISs being prepared cover continued operations for some of the sites evaluated in this Storage and Disposition PEIS. Some of the existing activities covered by these EISs are also similar to those of the No Action Alternative analyzed in this Storage and Disposition PEIS. Although the near-term analytical periods for these sitewide EIS analyses may be different from that of this Storage and Disposition PEIS, which is focused on longer-term activities, the preparation of these documents has been closely reviewed and coordinated within DOE.

As work on these and other potentially related NEPA documents proceeds, information from such future NEPA documents will be incorporated, as appropriate, in any supplements to, or documents tiered from, this Storage and Disposition Final PEIS.[8]

1.5 DECISIONS TO BE MADE

From March 8 through June 7, 1996, the Storage and Disposition Draft PEIS was circulated for written and oral comments from other Federal government agencies, State and local governments, Native American tribes,

[7] The nominal 200 t (220 tons) of HEU addressed in the HEU EIS consists of HEU already declared surplus, plus HEU that may be declared surplus in the future. This is different from and should not be confused with the 200 t (220 tons) of fissile material currently declared surplus by the President, which includes both HEU and Pu.

[8] The other ongoing or completed NEPA reviews referenced in Section 1.4 of this PEIS involve different purposes, needs, and alternative actions. They also involve, in whole or in part, different workers, locations, affected environments, and timing. As such, this PEIS is independently justified, and can and should proceed regardless of actions taken pursuant to other NEPA reviews. Except for tiered NEPA reviews, the decisions pursuant to this PEIS will not automatically trigger other actions requiring NEPA review.

special interest groups, and the public. Public meetings in the vicinity of the sites under consideration for the proposed action and in Washington, DC were held during the comment period. The comments received, along with DOE's responses, became a part of this Storage and Disposition Final PEIS. The Department also made available the results of the technical, cost, and schedule analyses[9,10] in July and November 1996, (DOE 1996o:ES-1–ES-14; DOE 1996r: ES-1–ES-8) and the nonproliferation analysis[11] in October 1996. Taken together, these analyses will support a formal ROD regarding Pu and HEU storage and Pu disposition. [Text deleted.] These decisions are as follows:

For storage:

- The strategy for long-term storage of nonsurplus weapons-usable Pu and nonsurplus HEU
- The strategy for storage of surplus Pu and surplus HEU until disposition
- The storage site(s) and (if appropriate) facilities

For disposition:

- The strategy and technologies for disposition of surplus weapons-usable Pu

The Department, with interagency coordination, will then issue the ROD. Following the ROD, subsequent tiered and project-specific NEPA documents will be prepared. The tiered NEPA reviews will analyze alternative locations for disposition activities.

1.6 PREFERRED ALTERNATIVE

STORAGE

The Department's Preferred Alternative for storage is to reduce, over time, the number of locations where the various forms of Pu are stored, through a combination of storage alternatives in conjunction with a combination of disposition alternatives. DOE would begin implementing this Preferred Alternative by moving surplus Pu from RFETS as soon as possible, transporting the pits to Pantex as early as 1997, and the non-pit Pu materials to SRS beginning in 2002. Over time, DOE would store Pu in upgraded facilities at Pantex and in an expanded, planned new facility at SRS, and store nonsurplus HEU and surplus HEU pending disposition in upgraded and consolidated facilities at ORR. Storage facilities would also be modified, as needed, to accommodate international inspection requirements consistent with the President's *Nonproliferation and Export Control Policy*. Accordingly, DOE's Preferred Alternative for storage would call for the following actions:

- **Phase out storage of all weapons-usable Pu at RFETS beginning in 1997; move pits to Pantex, and non-pit materials to SRS.** At Pantex, DOE would repackage pits from RFETS in Zone 12, then place them in existing storage facilities in Zone 4, pending completion of facility upgrades in Zone 12. At SRS, DOE would expand the planned new Actinide Packaging and Storage Facility (APSF), and move non-pit Pu materials from RFETS, after stabilization at RFETS, to the expanded APSF upon completion. The small number of pits currently at RFETS that are not in shippable form would be placed in a shippable condition in accordance with existing procedures prior to shipment to Pantex. Additionally, some pits and non-pit Pu materials from RFETS could be used at SRS, LANL, and LLNL for tests and demonstrations of aspects of disposition technologies (see Preferred

[9] *Technical Summary Report for Surplus Weapons-Usable Plutonium Disposition* (DOE/MD-0003, Rev. 1, October 31, 1996).
[10] *Technical Summary Report for Long-Term Storage of Weapons-Usable Fissile Materials* (DOE/MD-0004, Rev. 1, November 1996).
[11] *Nonproliferation and Arms Control Assessment of Weapons-Usable Fissile Material Storage and Plutonium Disposition Alternatives* (Draft, October 1996).

Alternative for disposition as discussed later in this section). All non-pit weapons-usable Pu materials currently stored at RFETS are surplus.

- **Upgrade storage facilities at Zone 12 South (to be completed by 2004) at Pantex to store those pits currently stored at Pantex, and pits from RFETS, pending disposition. Storage facilities at Zone 4 would continue to be used for these pits prior to completion of the upgrade.** This action would place pits at a central location where most pits already reside and where expertise and infrastructure exist to accommodate pit storage.

- **In accordance with the Preferred Alternative in the Stockpile Stewardship and Management PEIS, store Strategic Reserve pits at Pantex in the facilities discussed above. To the extent not reflected above, store Strategic Reserve materials in accordance with the Preferred Alternative in the Stockpile Stewardship and Management PEIS.**

- **Expand the APSF (Upgrade Alternative) at SRS to store those surplus, non-pit Pu materials currently at SRS and surplus non-pit Pu materials from RFETS, pending disposition** (see Preferred Alternative for disposition as discussed later in this section). The APSF would be built by 2001 pursuant to the *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE/EIS-0220) and ROD, and the expansion to accommodate RFETS material would be completed by 2002. The RFETS surplus non-pit Pu materials would be moved to SRS after stabilization is performed at RFETS under corrective actions in response to recommendation 94-1 by the DNFSB, and after completion of the APSF expansion. This action would place non-pit Pu materials in a new storage facility, in a location with existing expertise and Pu handling capabilities, and where potential disposition activities could occur (see Preferred Alternative for disposition as discussed later in this section). Strategic Reserve pits currently located at SRS would be stored in accordance with the Preferred Alternative in the Stockpile Stewardship and Management PEIS. There are no Strategic Reserve non-pit materials currently located at SRS.

- **Continue current storage (No Action) of surplus Pu at Hanford and INEL, pending disposition** (or movement to lag storage[12] at the disposition facilities). This action would allow surplus Pu to remain at the sites with existing expertise and Pu handling capabilities, and where potential disposition activities could occur (see Preferred Alternative for disposition as discussed later in this section). There are no nonsurplus weapons-usable Pu materials currently stored at either site.

- **Continue current storage (No Action) of surplus Pu at LANL, pending disposition** (or movement to lag storage at the disposition facilities). This Pu would be stored in stabilized form with the nonsurplus Pu in the upgraded Nuclear Material Storage Facility pursuant to the No Action Alternative for the site.

- **Take No Action at the Nevada Test Site (NTS).** DOE would not add Pu to sites that do not currently have Pu in storage.

- **Upgrade storage facilities at Y-12 (to be completed by 2004 or earlier) at ORR to store nonsurplus HEU and surplus HEU pending disposition.** Existing storage facilities at Y-12 would be modified to meet natural phenomena requirements, as documented in *Natural Phenomena Upgrade of the Downsized/Consolidated Oak Ridge Uranium/Lithium Plant Facilities* (Y/EN-5080, 1994). Storage facilities would be consolidated and the storage footprint would be reduced as surplus HEU is dispositioned and blended to LEU, pursuant to the HEU EIS. Consistent with the Preferred Alternative in the Stockpile Stewardship and Management PEIS, HEU strategic reserves would be stored at Y-12.

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[12] Lag storage is temporary storage at the applicable disposition facility.

DISPOSITION

The Department's Preferred Alternative for the disposition of surplus Pu is to pursue a disposition strategy that allows for immobilization of surplus weapons Pu in glass or ceramic forms and burning of the surplus Pu as MOX fuel in existing reactors. The disposition of the surplus Pu using these technological approaches would depend on the results of future technology development and demonstrations, site-specific environmental analyses, and detailed cost proposals as well as nonproliferation considerations. The results of these efforts and negotiations with Russia and other nations will ultimately determine the timing and extent to which either or both technologies are deployed.[13]

Under this Preferred Alternative, the U.S. policy not to encourage the civil use of Pu and, accordingly, not to itself engage in Pu reprocessing for either nuclear power or nuclear explosive purposes will not change. Although under the Preferred Alternative some Pu may ultimately be burned in existing reactors, every possible means will be pursued to ensure that Federal support for this unique disposition mission does not encourage other civil uses of Pu or Pu reprocessing. The United States, however, will maintain its commitments regarding the use of Pu in civil nuclear programs in Western Europe and Japan.

Proceeding with this strategy would provide increased flexibility to initiate Pu disposition promptly, and help assure disposition efforts could be accomplished in a timely manner. Establishing the means for expeditious Pu disposition would also help provide the basis for an international cooperative effort that can result in reciprocal, irreversible Pu disposition actions by Russia. DOE's preferred disposition strategy signals a strong U.S. commitment to reducing its stockpile of surplus Pu, thereby effectively meeting the purpose of and need for the Proposed Action.

To accomplish the Pu disposition mission, DOE would consider, to the extent practical, new as well as modified existing buildings and facilities for portions of the disposition activities. The PEIS analyzes new facilities for most disposition alternatives to obtain bounding environmental impacts. DOE would analyze and compare existing and new buildings and facilities for the technologies chosen as part of this strategy in subsequent, tiered NEPA review. In addition, all disposition facilities would be designed or modified, as needed, to accommodate international inspection requirements consistent with the President's *Nonproliferation and Export Control Policy*. Accordingly, DOE's Preferred Alternative for Pu disposition involves the following strategy and supporting actions:

- **Immobilize Pu materials using vitrification or ceramic immobilization.** The immobilization technology could be used for processing pure or impure forms of Pu. Vitrification or ceramic immobilization could include the can-in-canister variant, which could utilize the existing HLW and the Defense Waste Processing Facility (DWPF) at SRS, or new facilities at Hanford or SRS. DOE would continue the R&D leading to the demonstration of the can-in-canister variant at the DWPF using surplus Pu.

- **Convert Pu materials into MOX fuel for use in existing reactors.** Pure materials including pits, pure metal, and oxides could be converted without extensive processing into MOX fuel for use in existing commercial reactors. Other, already separated forms of surplus Pu would require additional cleanup (not reprocessing of spent nuclear fuel). The MOX fuel would be used in existing light water reactors (LWRs) with a once-through fuel cycle, with no reprocessing and subsequent reuse of the spent fuel. If partially completed LWRs were to be completed by other parties, they would be considered for this mission. The MOX fuel would be fabricated in a domestic, government-owned facility at a DOE site.

[13] Through these efforts, the President would be provided the basis and flexibility to initiate disposition efforts either multilaterally or bilaterally through negotiations or unilaterally as an example to Russia and other nations.

The Department would retain using MOX fuel in Canadian Deuterium Uranium (CANDU) reactors in Canada in the event that a multilateral agreement to use CANDU reactors is negotiated among Russia, Canada, and the United States. The DOE would engage in a test and demonstration for CANDU MOX fuel as appropriate and consistent with future cooperative efforts with Russia and Canada.

With regard to the above, for purposes of analysis of an approach involving a combination of both technologies, approximately 70 percent of the surplus Pu was identified to be in forms (metals and other pure forms) suitable for MOX fuel. The actual percentage and timing for disposition of the surplus Pu using either or a combination of both of the technological approaches would depend on the results of international agreements, future technology development and demonstrations, site-specific environmental assessments, and detailed cost proposals to be completed within the next 2 years. The results of these efforts, as well as nonproliferation considerations and negotiations with Russia and other nations, will ultimately determine the timing and extent to which either or both technologies are deployed for disposition of surplus Pu. In the event both technologies are deployed, and because the time required for Pu disposition using reactors would be longer than that for immobilization, it is probable that some surplus Pu would be immobilized initially, prior to completion of reactor irradiation for other surplus Pu. Deployment of this strategy would involve the following supporting actions:

- **Constructing and operating a Pu vitrification or ceramic immobilization facility at either Hanford or SRS.** DOE would analyze alternative locations at these two sites for constructing new or potentially using modified existing buildings in subsequent tiered NEPA review. SRS has existing facilities and infrastructure to support an immobilization mission, and Hanford has existing plans for constructing and operating immobilization facilities for the wastes in Hanford tanks. DOE would not create new infrastructure for immobilizing Pu with HLW or cesium (Cs) at INEL, NTS, ORR, or Pantex.

- **Constructing and operating a Pu conversion facility[14] at either Hanford or SRS.** DOE would collocate the Pu conversion facility with the vitrification or ceramic immobilization facility discussed above. In subsequent, tiered NEPA reviews, DOE would analyze alternative locations at Hanford and SRS, for constructing new or potentially using modified existing buildings.

- **Constructing and operating a pit disassembly/conversion facility[15] at Hanford, INEL, Pantex, or SRS.** DOE would not add Pu to sites that do not currently have Pu in storage. Therefore, two sites analyzed in the PEIS, NTS and ORR, would not be considered further for Pu disposition activities. DOE would analyze alternative locations at Hanford, INEL, Pantex, and SRS for constructing new or potentially using modified existing buildings in subsequent tiered NEPA review. DOE would demonstrate the Advanced Recovery and Integrated Extraction System (ARIES) concept at LANL for pit disassembly/conversion beginning in fiscal year 1997.

- **Constructing and operating a domestic, Government-owned, MOX fuel fabrication facility at Hanford, INEL, Pantex, or SRS.** DOE would not add Pu to sites that do not currently have Pu in storage. Therefore, two sites analyzed in the PEIS, NTS and ORR, would not be considered further for Pu disposition activities. The MOX fuel fabrication facility would serve only the finite mission of fabricating MOX fuel using surplus Pu for the purpose of Pu disposition. DOE would analyze alternative locations at Hanford, INEL, Pantex, and SRS, for constructing new or potentially using modified existing buildings in subsequent tiered NEPA review.

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[14] The Pu conversion facility would convert surplus non-pit Pu material (using a wet chemical process) into a metal or oxide form suitable for use at the next facility in the disposition process.

[15] The pit disassembly/conversion facility would disassemble, reshape, and convert surplus Pu pits (using a dry chemical process) into an unclassified metal or oxide form suitable for use at the next facility in the disposition process. In addition, some non-pit Pu material may also be processed in this facility.

Depending upon decisions in the ROD and pursuant to appropriate NEPA review(s), DOE would continue R&D and engage in further testing and demonstrations of Pu disposition technologies which may include: dissolution of small quantities of Pu in both glass and ceramic formulation; experiments with immobilization equipment and systems; fabrication of MOX fuel pellets for demonstrations of reactor irradiation at INEL; mechanical milling and mixing of Pu and feed forms; and testing of shipping and storage containers for certification, in addition to the testing and demonstrations previously described for the can-in-canister immobilization variant and the ARIES. These tests and demonstrations would slightly reduce the quantity of RFETS pit and non-pit materials to be stored at Pantex and SRS, respectively.

The storage and disposition actions proposed for various DOE sites by the Preferred Alternative are summarized in Table 1.6–1.

Table 1.6–1. Storage and Disposition Actions Proposed by the Preferred Alternative

Action	Hanford	NTS	INEL	Pantex	ORR	SRS	RFETS	LANL
Storage								
No Action	X[a]	X[b]	X[a]					X[a]
Upgrade				X[c]	X[d]	X[e]		
Phaseout							X	
Disposition[f]								
Pit Disassembly/Conversion	X		X	X		X		
MOX Fuel Fabrication	X		X	X		X		
Pu Conversion	X					X		
Immobilization	X					X		

[a] Pending subsequent tiered NEPA decisions for disposition of surplus Pu.
[b] NTS does not currently store either Pu or HEU.
[c] For storage of those pits currently at Pantex and pits from RFETS.
[d] For storage of HEU only.
[e] For storage of only those Pu materials currently at SRS and non-pit Pu materials from RFETS.
[f] "X" denotes potential sites for locating the disposition facilities pending subsequent tiered NEPA decisions. Only one of each facility is needed for accomplishing the disposition mission.

1.7 SCOPE OF THE PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

Public Scoping Process. During 1994, DOE conducted a phased scoping process to solicit comments on long-term storage and disposition of weapons-usable fissile materials. The initial phase of the scoping process consisted of a series of planning meetings attended by technical experts from DOE's National Laboratories, industry, and academia. These planning meetings helped introduce the objectives of the Fissile Materials Disposition Program to the public and to identify DOE and IWG's roles in implementing the President's *Nonproliferation and Export Control Policy.*

On May 4 and 5, 1994, DOE conducted the first public meeting in Washington, DC. Using the 1994 NAS study as a starting point, the public meeting served as a forum to solicit input on the scope of the Notice of Intent (NOI), which was published on June 21, 1994, in the *Federal Register* (59 FR 31985) to inform the public of the preparation of the Storage and Disposition PEIS.

During August, September, and October 1994, 12 workshops were held to solicit public comment on the scope of the program. Figure 1.7–1 shows the locations and dates of these public scoping workshops. Written comments on the scope of the Storage and Disposition PEIS were also requested from the public. The objective of the workshops was four-fold: comply with NEPA requirements; ensure that the PEIS addresses a range of

reasonable alternatives; solicit relevant, focused input from the public; and continue the ongoing public participation efforts of DOE with the goal of reaching all interested parties.

In addition to the 12 workshops, DOE conducted 2 other meetings in November and December 1994 to obtain public input on the NEPA review strategy and reasonable alternatives for disposition of surplus weapons-usable HEU and Pu. The meeting on November 10, 1994, in Oak Ridge, Tennessee, led to DOE's decision to proceed with a separate EIS to evaluate reasonable disposition alternatives for surplus HEU. A meeting on December 13 and 14, 1994, in Herndon, Virginia, provided preliminary feedback on Pu disposition alternatives from the scoping process and public input on additional concerns relative to the alternatives being considered.

Incorporating Input in the Screening Process. As part of the overall scoping process, a screening committee consisting of five DOE technical experts was formed to identify the reasonable alternatives to be evaluated in the Storage and Disposition PEIS. Using a screening evaluation process to compare potential alternatives against a set of screening criteria, the committee considered input from the general public and used technical reports and analyses from the national laboratories and industry to develop the final list of reasonable alternatives. The initial screening process and results were reviewed by the IWG and a senior technical review group of outside experts.

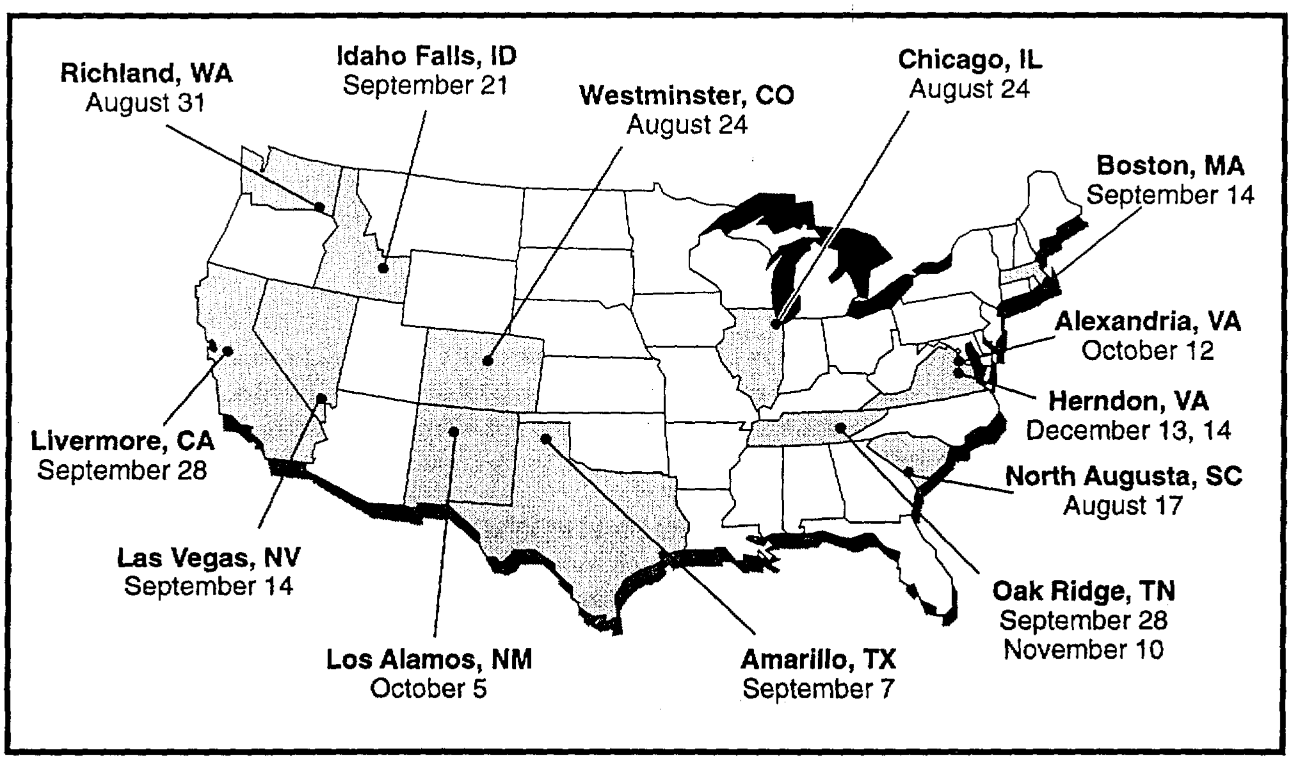


Figure 1.7–1. Public Scoping Workshop Locations, 1994.

The Department proposed criteria for screening reasonable Storage and Disposition PEIS alternatives and submitted them for public review and comment as part of the formal scoping process for the PEIS. During the scoping workshops, participants were given questionnaires to evaluate DOE's proposed screening criteria. The responses to these questionnaires, together with comments submitted by the public regarding the screening criteria, were reviewed by the screening committee. The input from the questionnaires resulted in several changes and clarifications of the criteria. The final criteria used for selecting alternatives are described in Chapter 2 of this PEIS.

Defining the Significant Issues. In the comment analysis process, written and oral public comments were reviewed and considered on their merits equally, regardless of the manner in which they were submitted. Each public comment was entered into a comment tracking system. A database was created with more than 3,000 individual records documented, and an analysis of similar comments was conducted to identify specific issues that the public felt DOE should address as part of the Storage and Disposition PEIS. The analysis of comments resulted in the identification of approximately 50 issues organized under the following 12 major issue categories:

- Overall scope of the proposed action and alternatives
- Storage alternatives
- Pu disposition
- HEU disposition
- Nonproliferation
- Surplus fissile materials declaration
- Spent Fuel Standard
- Environmental impacts
- Nonenvironmental impacts
- Relationship of the PEIS to other DOE actions
- Screening criteria
- Public participation

The resolution of many comments was described in the *Long-Term Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement Implementation Plan* (DOE/EIS-0229-IP, March 1995) for the Storage and Disposition PEIS. Issues regarding environmental impacts are addressed in this PEIS.

Organizing the Programmatic Environmental Impact Statement to Address Significant Issues. As mentioned in Section 1.3, DOE's proposed action involves evaluation of reasonable alternatives for long-term storage and disposition of weapons-usable Pu and HEU. These alternatives are as follows:

Storage:

- Storage Alternatives
  - Preferred Alternative (Combination)
  - Upgrade at Multiple Sites Alternative
  - Consolidation of Pu Alternative
  - Collocation of Pu and HEU Alternative
  - No Action Alternative
- Candidate Storage Sites

- Hanford
- NTS
- INEL
- Pantex
- ORR
- SRS

Environmental impacts of each long-term storage alternative and the No Action Alternative are analyzed for each of the six candidate storage sites to allow (1) the comparison of impacts by site for each alternative and (2) the comparison of impacts by alternative for each site. As a result, decisions can be made to select a single storage alternative for all sites or a combination of different alternatives for different sites.

Disposition:

- Preferred Alternative (Combination)
- Deep Borehole Category
  - Direct Disposition Alternative
  - Immobilized Disposition Alternative
- Immobilization Category
  - Vitrification Alternative
  - Ceramic Immobilization Alternative
  - Electrometallurgical Treatment Alternative
- Reactor Category
  - Existing LWR Alternative
  - Partially Completed LWR Alternative
  - Evolutionary LWR Alternative
  - CANDU Reactor Alternative
- No Disposition Action

Facilities under each alternative within the Immobilization and Deep Borehole Categories could be designed such that they could process all the surplus Pu over their operating lives. Each disposition alternative under the Reactor Category would consist of reactors that would use the MOX fuel produced from surplus; however, existing surplus Pu comes in various forms, and some of these forms may not be suitable for conversion to MOX fuel without specialized chemical processing.

[Text deleted.] In addition to the proposed storage and disposition alternatives, a No Action Alternative is analyzed. This alternative has two parts: (1) no change in current storage of Pu and HEU and (2) no disposition of surplus Pu. DOE may choose part one, part two, or both parts of this alternative. If only part one were chosen, no change in long-term storage would take place. Therefore, the current DOE storage sites would be used for continued storage of HEU and nonsurplus Pu (the No Action Alternative for these materials), while decisions

would be made for surplus Pu disposition. If only part two were chosen, disposition of surplus Pu would not occur, and this material would remain in storage. Therefore, decisions on long-term storage would become the "No Disposition Action" for surplus Pu. If both parts were chosen, no Pu disposition and no change in current storage of Pu and HEU would occur. This case is analyzed in the Storage and Disposition PEIS as the baseline case for the No Action Alternative. Disposition of surplus HEU is addressed in the HEU EIS.

Each of these alternatives, along with the screening process that led to the selection of these alternatives, is described in detail in Chapter 2. Definitions of the environmental resources and issue areas, and descriptions of the affected environments at each site, are presented in Chapter 3. The general approach and specific methods for assessing environmental consequences, along with estimated results and potential cumulative impacts, are presented in Chapter 4. The information and environmental analyses provided in this PEIS, together with separate cost, schedule, technical, and policy analyses, are intended to address all significant issues raised during the scoping process.

Changes in Scope. The original NOI to prepare the Storage and Disposition PEIS included the disposition of surplus HEU, long-term storage and disposition of surplus U-233, and long-term storage and disposition of minor actinides.

In the course of the public scoping process, it was deemed more appropriate to analyze the impact of surplus HEU disposition in a separate EIS. The decision to analyze HEU separately from the Storage and Disposition PEIS was made for a number of reasons, including the following:

- The disposition of surplus HEU could use existing technologies and facilities in the United States, in contrast to the disposition of surplus Pu.
- The disposition of surplus HEU would involve different alternatives, timeframes, technologies, facilities, and personnel than those required for the disposition of surplus Pu.
- Decisions on surplus HEU disposition are independently justified; would not affect, trigger, or preclude other decisions that may be made regarding the disposition of surplus Pu; and would not depend on actions taken or decisions made pursuant to the Storage and Disposition PEIS.
- Disposition is the most rapid path for neutralizing the proliferation threat of surplus HEU, is consistent with the President's *Nonproliferation and Export Control Policy*, would demonstrate U.S. nonproliferation commitment to other nations, and is consistent with the course of action now underway in Russia to reduce Russian HEU stockpiles.

Accordingly, DOE concluded that surplus HEU disposition should be treated separately, and published a notice in the *Federal Register* (60 FR 17344) in April 1995 to inform the public of its conclusion. The HEU Draft EIS was issued for public review in October 1995 (60 FR 54867), the HEU Final EIS was issued in June 1996 (61 FR 33719), and the resulting ROD was published on August 5, 1996 (61 FR 40619).

The long-term storage and disposition of surplus U-233 were also included in the original scope of the Storage and Disposition PEIS. Existing surplus U-233 is stored at two DOE sites in small quantities. Results of preliminary studies indicate that the only reasonable alternative for U-233 is to blend it down and dispose of it as waste. However, in contrast to Pu and HEU, U-233 is a high-energy radiation source, must be remotely handled, and involves additional worker and public radiation health and safety concerns that would need to be accommodated. In addition, if the U-233 is to be disposed of as waste, the requirements for its waste form must be established for existing or planned waste repositories or disposal sites. Further research on waste form requirements and the feasibility of blending the U-233 to meet these requirements is needed to assess the final disposition of this material. Finally, because U-233 emits high-energy radiation, it is inherently more proliferation-resistent than Pu.

Since U-233 disposition is not ready for decision, DOE is not currently proposing to take action on the disposition of surplus U-233, which will continue to be stored at current locations. Upon identification of disposition requirements and verification of the feasibility of accommodations to meet these requirements, DOE may propose disposition of surplus U-233 and would conduct appropriate environmental analyses under NEPA at that time. Any such disposition of surplus U-233, if proposed, would involve different alternatives, wastes, personnel, worker safety concerns, technologies, and proliferation concerns than disposition of Pu. Any disposition of surplus U-233, if proposed, would be independent of surplus Pu disposition, would be independently justified, would not trigger or affect Pu disposition, and could proceed regardless of any subsequent or prior Pu disposition actions.

The long-term storage and disposition of minor actinides, radioisotopes having atomic numbers of 95 and above, were included in the original scope of the Storage and Disposition PEIS. An assessment of these materials showed that they exist in small quantities, are in active program use, or are planned to be declared wastes. Consequently, there is no need to include minor actinides in the scope of this PEIS.

1.8 SUMMARY OF MAJOR ISSUES IDENTIFIED DURING THE COMMENT PERIOD AND CHANGES TO THE DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

1.8.1 ISSUES IDENTIFIED AND RESOLVED

The Department initially issued the Storage and Disposition PEIS as a draft for public comment for the period from March 8 through May 7, 1996 (61 FR 9443). In response to public requests, DOE extended the comment period deadline to June 7, 1996 (61 FR 22038). Public meetings on the Draft PEIS were held in March and April 1996 at the following locations:

Denver, CO	March 26, 1996
Las Vegas, NV	March 28–29, 1996
Oak Ridge, TN	April 2, 1996
Richland, WA	April 11, 1996
Idaho Falls, ID	April 15, 1996
Washington, DC	April 17–18, 1996
Amarillo, TX	April 22–23, 1996
North Augusta, SC	April 30, 1996

During the 92-day public comment period on the Storage and Disposition Draft PEIS, DOE received comments on the document by mail, fax, telephone recording, electronic mail, and orally at the public meetings. Altogether, DOE received approximately 8,700 written and recorded comments from individuals and organizations. All comments are presented in Volume IV of the Storage and Disposition Final PEIS, the *Comment Response Document* (CRD).

Approximately 80 percent of the comments received consisted of mail-in letter and postcard campaigns which expressed either support of or opposition to the use of various sites or alternatives. Many commentors encouraged DOE and the United States to become the world leader in the safe, secure, and timely disposition of

Pu, and favored worldwide nonproliferation efforts for surplus Pu. The following highlights some of the recurring comments, DOE's response, and the PEIS revisions in response to these comments.

A number of commentors expressed the opinion that the surplus Pu should remain in present locations for future energy or weapons use, or until new technologies are available for disposition. In response to these concerns, DOE expanded the discussion on the need for the proposed Pu disposition action in the PEIS. Disposition is necessary to implement the President's *Nonproliferation and Export Control Policy* in a safe, reliable, cost-effective, and timely manner.

Some commentors also stated that DOE should consider additional disposition alternatives, including the use of FFTF, deep burn reactors, and mononitride reactors. The use of advanced reactors such as deep burn reactors and mononitride reactors was considered but eliminated due to the technical immaturity, attendant costs, and lengthy development and demonstration efforts required to bring the technologies to a viable, practical status and enable disposition options to be initiated with certainty. The FFTF would be considered for Pu disposition if first selected for tritium production. The FFTF is not a reasonable, stand alone alternative because it is in a standby status awaiting shutdown and because it could not satisfy the criterion of completing the disposition mission within 25 years. A discussion of FFTF for this purpose is included in Appendix N. In all, 37 different alternative options were considered by DOE for disposition of Pu. DOE has made revisions to the Summary and Chapter 2 of the PEIS to clarify how the screening process was used for selection of reasonable alternatives.

Commentors noted that transportation of fissile materials is one of their major concerns with the Program. The ground transportation between sites, in the event a consolidation alternative was selected, could increase the potential for traffic accidents. International transportation for specific border crossings for the shipment of MOX fuel to Canada for the CANDU Reactor Alternative was also identified as a concern. DOE acknowledges the public's concern, and in response, the transportation analysis in Section 4.4 and Appendix G of the Draft PEIS was expanded. The revisions address security measures for land and sea transport, emergency preparedness, and clarify the results of analyses performed.

One frequently recurring comment presented by the public relates to the technical, cost, schedule, and nonproliferation analyses to support DOE's ROD. Many of the commentors suggested that DOE should make information available for public review. Since issuance of the Draft PEIS, DOE has prepared both the *Technical Summary Report for Long-Term Storage of Weapons-Usable Fissile Materials* (DOE/MD-0004 Rev. 1) and the *Technical Summary Report for Surplus Weapons-Usable Plutonium Disposition* (DOE/MD-0003 Rev. 1). These two reports summarize representative technical, cost, and schedule data for the reasonable alternatives being considered for long-term storage and surplus Pu disposition, respectively. In July and August 1996, these documents were initially distributed for public review and comment. After taking the public's comments into consideration, DOE revised and re-issued both reports in November and December 1996. In October 1996, DOE issued the *Draft Nonproliferation and Arms Control Assessment of Weapons-Usable Fissile Material Storage and Plutonium Disposition Alternatives*, which analyzes the nonproliferation and arms reduction implications of the alternatives addressed in the PEIS for Pu and HEU storage and the disposition of surplus Pu. From October through early November 1996, the public was asked to review and comment on the draft nonproliferation document; this process included a series of 10 public meetings held nationwide. Public comments received are being taken into consideration in revising the report, which is scheduled for re-issue in late 1996. This report, in conjunction with the Final PEIS, the technical summary reports previously described, and public input, will form the basis for DOE's decisions, which will be discussed in a ROD to be issued no sooner than 30 days after publication of the Environmental Protection Agency's Notice of Availability of the Storage and Disposition Final PEIS.

Commentors also stated that the U.S. Nonproliferation Policy does not encourage the civil use of Pu or Pu processing for either nuclear power or nuclear explosive purposes. The commentors requested that the PEIS address the possibility that the MOX option would have an adverse effect on U.S. nonproliferation policy by encouraging its use in civil nuclear power programs and by encouraging Pu reprocessing and recycling. DOE

acknowledges the public concern for nonproliferation. As discussed in the PEIS, the reactor option would utilize a once-through fuel cycle. Spent fuel from disposition would be disposed of with other commercial reactor spent fuel. This is consistent with U.S. policy since no Pu in the spent fuel would be recycled. Revisions to Chapter 1 of the PEIS were made to expand and clarify this issue.

Commentors indicated that the isotopic composition of the residual Pu in the final waste forms is an inappropriate criterion by which to assess proliferation risks because it perpetuates a myth that reactor-grade Pu cannot be used to make workable weapons. In the opinion of these commentors, isotopic degradation does not constitute a compelling argument in favor of the MOX option. DOE acknowledges that, although it may be possible to make a nuclear weapon from spent commercial reactor fuel, this can only be done with extreme difficulty by individuals with a great deal of experience in handling and processing nuclear materials. DOE believes that the disposition of weapons Pu through the use of MOX fuel in reactors would meet the Spent Fuel Standard in creating a radiological barrier that makes the Pu as difficult to retrieve and reuse in weapons as Pu in spent commercial fuel. The use of this technology would allow for the Pu to be disposed in a geologic repository pursuant to the *Nuclear Waste Policy Act,*[16] the same as for spent commercial fuel. Revisions to Chapter 1 of the PEIS were made to clarify this issue.

1.8.2 Changes Made to the Draft Programmatic Environmental Impact Statement

This section identifies changes made since the issuance of the Draft PEIS. The Final PEIS includes the Preferred Alternative, which is a combination of other alternatives and is described in Section 1.6. Other changes, after considering public comments, are described below.

Appendix N, which in the Draft PEIS summarized the operational aspects of the multipurpose reactor, has been revised for the Final PEIS to provide information on the costs and benefits of conducting separate tritium production and Pu disposition missions versus the costs and benefits of carrying out one multipurpose mission. Included in Appendix N is a cost comparison of using new Advanced LWRs or Modular Helium Reactors (MHR), and a discussion of issues regarding the use of the FFTF (a liquid metal reactor at Hanford) for tritium production and Pu disposition.

Appendices O, P, Q, and R were added to the Final PEIS to help clarify alternative issues as they relate to the Preferred Alternative. Appendix O describes two can-in-canister technology concepts at SRS, which are variants of the Vitrification and Ceramic Immobilization Disposition Alternatives described in Chapter 2. This information was added based on public interest in these concepts during the Draft PEIS comment period, and also because of DOE's reconsideration of this technology as being a viable approach for Pu disposition through immobilization.

Appendix P provides a description of using the Manzano Weapons Storage Area (WSA) near Albuquerque, NM to store Pu pits. This appendix was added because DOE's Preferred Alternative separates the storage of pits from non-pit materials, in which case Manzano WSA no longer appears unreasonable under the Preferred Alternative for pit storage. However, since DOE's preferred site for interim storage of pits is Pantex (as described in the Pantex EIS) and since the majority of pits are already located in storage at Pantex, the Preferred Alternative proposes the long-term storage of Pu pits at Pantex. Weapons assembly/disassembly would continue at Pantex in any case. Construction of a new storage facility at Manzano would create needless expense and transportation risk.

Appendix Q describes the operations and human (radiological) health impacts associated with Pu pits being transferred from RFETS to Pantex, repackaged in Zone 12 South, and placed in storage in Zone 4 West at Pantex, as part of the Preferred Alternative for storage. The information presented in this appendix is based on the Pantex EIS analysis of storing the Pu pits already at Pantex.

[16] Also referred in the PEIS as a geologic, permanent, or HLW repository.

Appendix R discusses aircraft crash and radioactive release probabilities for proposed storage and disposition facilities at Pantex.

Section 1.2 of the Final PEIS has been revised to reflect the cooperative effort between the United States and Russia to study different options for managing excess Pu (including secure storage, conversion of Pu weapons components to other forms, and stabilization of unstable forms of Pu), and options for disposition of excess Pu (deep borehole, immobilization, and reactors). The results of this study have been documented in the *Joint United States/Russian Plutonium Disposition Study* report, completed in September 1996. This study and the options considered will provide decisionmakers from both countries with a set of jointly evaluated alternatives for Pu disposition and help build further trust and cooperation in the area of fissile material disposition.

Chapter 2
Weapons-Usable Fissile Materials Long-Term Storage and Disposition Alternatives

2.1 DEVELOPMENT OF ALTERNATIVES

Alternatives analyzed in this PEIS were determined through a screening evaluation process in which a comprehensive set of screening criteria were used. From this process, reasonable alternatives for the following were identified:

- The strategy for long-term storage of weapons-usable Pu and HEU, including nonsurplus Pu and HEU, and surplus Pu and HEU pending disposition
- The strategy and technology for disposition of surplus weapons-usable Pu

In addition, a list of candidate sites for long-term storage of weapons-usable Pu and HEU was developed based on site-selection criteria established previously. The site selection process is described in Section 2.1.3. These reasonable alternatives and candidate sites are analyzed in this PEIS as part of the input for DOE's decisionmaking on the storage and disposition of weapons-usable fissile materials.

2.1.1 SCREENING CRITERIA

To determine reasonable alternatives for evaluation in this PEIS, DOE developed, for both long-term storage and disposition, screening criteria based on the policy objectives articulated in the President's *Nonproliferation and Export Control Policy* of September 1993 and the January 1994 *Joint Statement by the President of the Russian Federation and the President of the United States of America on Nonproliferation of Weapons of Mass Destruction and the Means of Their Delivery* (see Appendix A), as well as the analytical framework established by NAS in its 1994 report, *Management and Disposition of Excess Weapons Plutonium* study. Based on input from the public during the scoping process, the screening criteria were expanded and used for selecting reasonable alternatives. Descriptions of the screening criteria used for long-term storage and disposition alternatives are given in Sections 2.1.3 and 2.1.4, respectively.

2.1.2 SCREENING EVALUATION PROCESS

The screening evaluation was conducted by a committee of five DOE technical experts, DOE officials assisted by advisors from the National Laboratories, and other support staff. Based on a review of the NAS report, prior DOE-sponsored work on HLW disposal, and input from the public obtained during the scoping process, the screening committee identified an extensive set of options and developed potential disqualifiers for both long-term storage and disposition options. Each option represented a storage or disposition strategy that might be implemented in a systematic, cradle-to-grave manner. There were 5 long-term storage options, 37 Pu disposition options, 9 HEU disposition options, and 8 U-233 disposition options. As previously identified in Chapter 1, the disposition of surplus HEU and disposition of U-233 are not within the scope of this Storage and Disposition PEIS; disposition of surplus HEU is addressed in the HEU Final EIS and U-233 disposition will be addressed at the time it is proposed by DOE and found to be ready for decision.

The screening committee evaluated each option against potential disqualifiers to determine if any options had a "fatal flaw" in one or more of the screening criteria. For example, inability to meet the Stored Weapons Standard or the Spent Fuel Standard was considered a fatal flaw that resulted in the disqualification of an option. Options that survived this process were then ranked. Each option was rated high, medium, or low against each screening

criterion, relative to other options. This ranking process eliminated options that were rated low for multiple criteria or were clearly dominated by similar, more attractive options in the same category. Options that survived the ranking process emerged as reasonable alternatives for detailed evaluation in the Storage and Disposition PEIS. Details of the screening evaluation process can be found in the *Summary Report of the Screening Process* (DOE/MD-0002). After considering public comment on the Draft PEIS, as well as other public comments and internal DOE review following the Draft PEIS, DOE has for some of the disposition alternatives clarified and expanded explanations of the screening rationale and has added DoD's Manzano WSA Facility as a storage facility under consideration. A description of alternatives considered but eliminated for further analysis, along with reasons for elimination, is given in Section 2.1.3 for long-term storage and Section 2.1.4 for Pu disposition.

2.1.3 REASONABLE ALTERNATIVES FOR LONG-TERM STORAGE OF WEAPONS-USABLE FISSILE MATERIALS

Screening Criteria for Long-Term Storage Options

Resistance to Theft and Diversion by Unauthorized Parties. The site and facility must be capable of providing comprehensive protection and control of weapons-usable fissile materials (that is, meet the Stored Weapons Standard).

Technical Viability. There should be a high degree of confidence that the facility and site infrastructure can provide storage of nuclear components and materials for up to 50 years.

Environment, Safety and Health (ES&H) Compliance. High standards of public and worker health and safety and environmental protection must be met, and significant additional ES&H burdens should not be created.

Cost-Effectiveness. Long-term storage should be accomplished in a cost-effective manner and should be compatible with reasonable disposition alternatives.

Timeliness. Long-term storage should be implemented in a timely manner.

Fosters Progress and Cooperation With Russia and Other Countries. A facility must accommodate international inspections for surplus material in unclassified forms and must establish appropriate standards for storage and protection of international nuclear material inventories.

Public and Institutional Acceptance. An alternative should be able to muster a broad and sustainable consensus on the manner in which long-term storage is accomplished.

Results of the Screening Process: Reasonable Alternatives for Long-Term Storage

Options that were not disqualified or eliminated through the use of the screening criteria emerged from the screening process as reasonable options for further evaluation. As a result of the screening process, two options were identified as reasonable:

- Upgrade of storage facilities to make them suitable for long-term storage (upgrade existing storage capability at more than one site)
- Consolidation of the weapons-usable fissile materials at DOE sites (consolidate or collocate storage at one or two DOE sites)

Both options assumed that all nonsurplus HEU and surplus HEU pending disposition were located at ORR before initiating any action under this PEIS. The scope of the first option, upgrade existing storage capability

(referred to in the PEIS as Upgrade at Multiple Sites Alternative or Upgrade Alternative), has been expanded to include the possibility of upgrading through new construction where existing facilities cannot be economically modified to meet requirements and to account for the relocation of RFETS and/or LANL Pu to one or more Pu storage sites. The second option, consolidate storage at DOE sites, has been modified to separately address two alternative approaches: the Consolidation of Pu Alternative, and the Collocation of Pu and HEU Alternative. For each alternative (Upgrade at Multiple Sites Alternative, Consolidation of Pu Alternative, and the Collocation of Pu and HEU Alternative), a subalternative has also been added that would exclude the strategic reserve and weapons R&D material covered by the Stockpile Stewardship and Management PEIS. Finally, a Preferred Alternative was developed, representing a combination of alternatives. The PEIS alternatives are further described.

Upgrade at Multiple Sites Alternative: Modify Existing *and/or* Construct New Facilities at More Than One Site for Continued Storage of Plutonium and Highly Enriched Uranium; Relocate Rocky Flats Environmental Technology Site and Los Alamos National Laboratory Plutonium to Another Plutonium Storage Site. Under this alternative, DOE would modify certain existing facilities and/or build new facilities, depending on individual site requirements for meeting updated DOE standards for nuclear material storage facilities. The facilities would be designed to operate for up to 50 years. Pu material currently stored at Hanford, INEL, Pantex, and SRS would remain at those sites. Pu currently in storage at RFETS and LANL would be moved to a single long-term storage site or distributed for long-term storage at more than one site. HEU material stored at ORR would remain at that site in modified facilities.

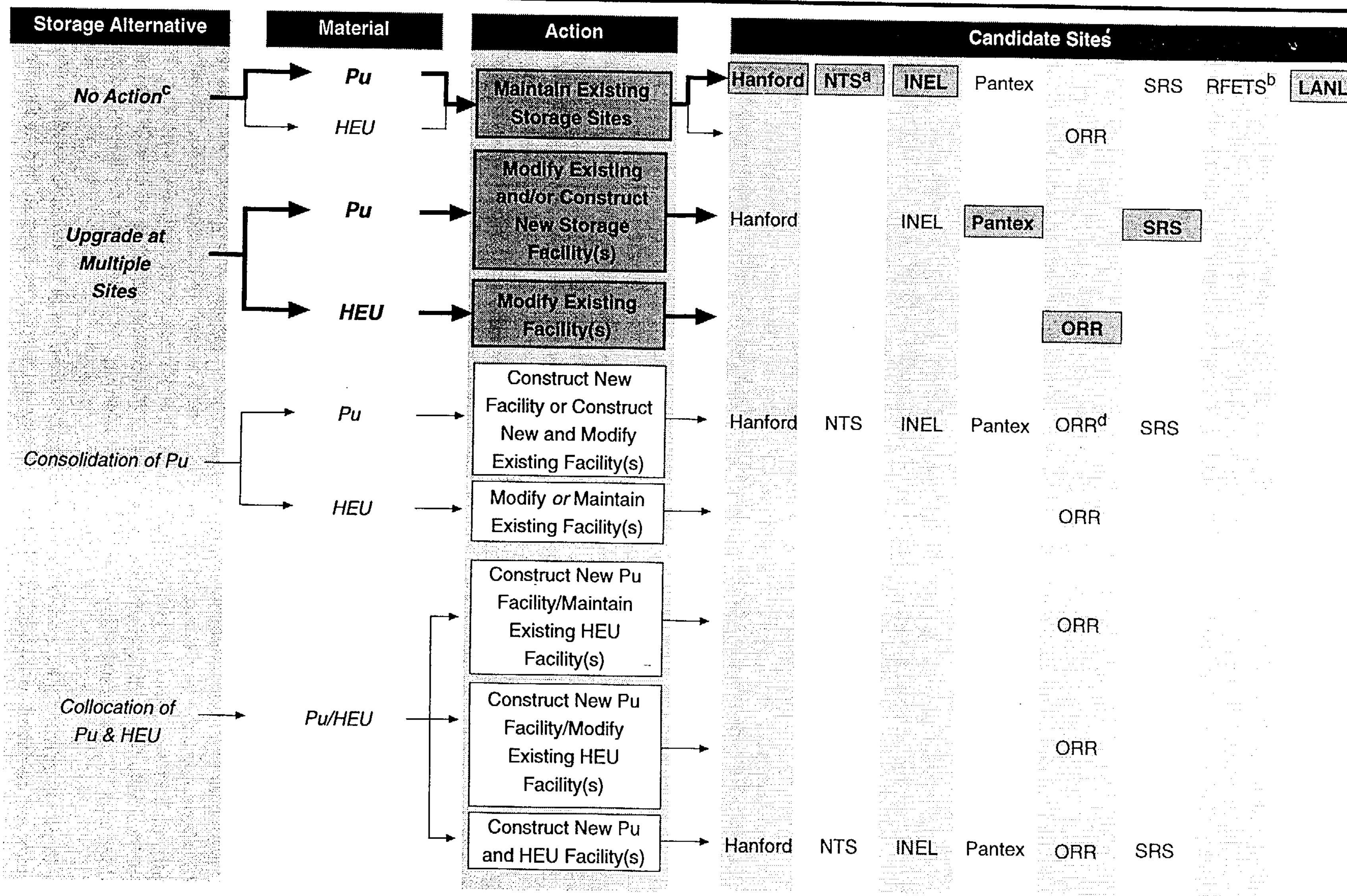
Consolidation of Plutonium Alternative: Construct New Facility *or* Construct New and Modify Existing Facilities at One Site for all Plutonium Materials; Maintain (and Modify as Necessary) Existing Highly Enriched Uranium Facilities at Oak Ridge Reservation. Under this alternative, a new consolidated Pu storage facility would be constructed alone or with modified existing facilities to store current and future DOE weapons-usable Pu inventories. Pu would be removed from existing storage facilities at Hanford, INEL, Pantex, SRS, RFETS, and LANL and transported to the consolidated storage facility. The facility would be designed to provide safe, secure, long-term storage of both nonsurplus Pu and surplus Pu (pending disposition) for up to 50 years. HEU material stored at ORR would remain at that site. DOE would maintain and, as necessary, modify and upgrade the ORR facilities to ensure continued safe, secure storage.

Collocation of Plutonium and Highly Enriched Uranium Alternative: Construct New Facility *or* Construct New and Modify or Maintain Existing Facilities at One Site for all Plutonium and Highly Enriched Uranium Materials. Under this alternative, a new consolidated Pu storage facility would be collocated with new or existing HEU facilities to store current and future DOE weapons-usable fissile material inventories. The facilities would be responsible for storing Pu as well as HEU. Pu would be moved from existing storage facilities at Hanford, INEL, Pantex, SRS, RFETS, and LANL. HEU would either stay at ORR, should ORR be selected, or be moved to the collocated storage facility. The facility would be designed to provide safe, secure, long-term storage for up to 50 years.

Preferred Alternative. Under the Preferred Alternative, existing facilities would be upgraded at Pantex, ORR,[1] and SRS. RFETS Pu pits would be relocated to Pantex, and RFETS surplus non-pit Pu materials would be relocated to SRS. Current storage would continue (No Action) at Hanford, INEL, and LANL for surplus Pu, pending disposition. Strategic Reserve pits would be stored at Pantex in accordance with the Preferred Alternative in the Stockpile Stewardship and Management PEIS. No Action would be taken at NTS; Pu storage would not be added to NTS, consistent with the site's current mission.

Figure 2.1.3–1 depicts the conceptual structure of the long-term storage alternatives and the Preferred Alternative for storage analyzed in this PEIS. Under each long-term storage alternative and the No Action

[1] DOE may subsequently propose to construct new HEU storage facilities at ORR; any such proposal would be assessed in subsequent site-specific NEPA documentation.



[a] Although NTS does not currently store either Pu or HEU, the No Action Alternative is included here as a basis against which other storage and disposition alternatives are analyzed.

[b] As part of the Preferred Alternative, Pu storage at RFETS would be phased out with pits sent to Pantex and non-pit materials sent to SRS.

[c] Under the No Action Alternative, DOE would not undertake any new construction projects except those that are considered part of ongoing site operations to ensure continued safe, secure storage. However, any new facility construction deemed necessary to maintain safe, secure storage would be addressed in appropriate, individual site-specific EISs and site development plans.

[d] If Pu is consolidated at ORR, the presence of the HEU material already residing at the Y-12 Plant would create an HEU collocation condition and is therefore portrayed as the Collocation Alternative.

Note: Bold text and shaded boxes indicate Preferred Alternative.

Alternative, Figure 2.1.3–1 describes the action that would be taken at the various candidate sites and locations for these materials.[2] For the No Action Alternative and upgrade, consolidation and collocation long-term storage alternatives, this PEIS analyzes the impact of storing all weapons-usable fissile materials. Under these alternatives, this PEIS also analyzes the impacts of storing weapons-usable fissile materials excluding those covered under the Stockpile Stewardship and Management PEIS (strategic reserves and some weapons R&D materials). [Text deleted.]

Candidate Sites for Long-Term Storage Alternatives

Six locations (Hanford, NTS, INEL, Pantex, ORR, and SRS) are being considered as candidate sites for the long-term storage of weapons-usable fissile materials. Each site is being considered for the location of upgraded, consolidated, or collocated storage facilities.

Site Screening Process

Concurrent with the publication of the NOI to prepare a PEIS for Reconfiguration of the Nuclear Weapons Complex in the *Federal Register* (56 FR 5590) on February 11, 1991, a *Notice of Availability of an Invitation for Site Proposals for the Nuclear Weapons Complex Reconfiguration Site* was also published (56 FR 5595). The invitation solicited proposals for consideration of non-DOE sites and listed five DOE sites that met the initial screening criteria (Hanford, INEL, Pantex, ORR, and SRS). No additional locations were identified as a result of this invitation.

The five initial sites were evaluated against the following siting criteria: (1) density and distribution of population, (2) ES&H, (3) socioeconomics, (4) site availability, (5) transportation, and (6) site flexibility. All sites were found by the Site Evaluation Panel to be fully qualified.

There have been significant changes in the world since publication of the *Nuclear Weapons Complex Reconfiguration Study* in January 1991, especially with regard to projected future requirements of the United States' nuclear weapons stockpile. As a result, the study no longer provides a suitable framework for determining the appropriate configuration of the future Nuclear Weapons Complex. Therefore, DOE decided to separate the Reconfiguration PEIS into two PEISs: a TSR PEIS and a Stockpile Stewardship and Management PEIS.

A Revised NOI to prepare a Reconfiguration PEIS was published in the *Federal Register* (58 FR 39528) on July 23, 1993. In this notice, DOE eliminated Hanford from further consideration as a candidate site, because all nuclear weapons production functions at that location had been terminated and the site was dedicated to environmental and waste management activities. NTS was evaluated using the siting criteria described above and was determined to be a reasonable site alternative for new tritium supply and recycling facilities. The resulting five sites—NTS, INEL, Pantex, ORR, and SRS—were evaluated in the TSR PEIS.

The long-term storage mission is a portion of the proposed action considered under the original reconfiguration proposal. Thus, sites meeting criteria for reconfiguration are considered reasonable for the long-term storage mission. Since the five TSR sites meet these criteria, they are being considered for long-term storage of weapons-usable fissile materials. In addition, Hanford is considered a reasonable site for the following reasons:

- It satisfies the original reconfiguration criteria
- Long-term storage is consistent with its current mission

[2] As of September 1994, LLNL stored 0.3 t (0.3 tons) of Pu, which are primarily R&D and operational feedstock materials not surplus to government needs. Adequate storage facilities for this material currently exist at LLNL; consequently, none of the Pu stored at LLNL falls within the scope of this Storage and Disposition PEIS.

- It has the infrastructure to support a long-term storage mission

The resulting sites—Hanford, NTS, INEL, Pantex, ORR, and SRS—are analyzed in the PEIS.

Long-Term Storage Alternatives Considered But Eliminated from Further Analysis

As a result of the screening process, two long-term storage options were eliminated: the utilization of existing facilities at non-DOE domestic sites for storage of non-pit Pu forms, and the utilization of non-domestic sites. The utilization of existing facilities at non-DOE sites for long-term storage as an option was rated but eliminated from further consideration. The Pantex EIS analyzes DoD's Manzano WSA near Albuquerque, NM, as a candidate non-DOE domestic site for temporary storage of Pu pits (58 FR 39528). [Text deleted.]

As in the case of temporary pit storage, the materials to be placed in long-term storage include Pu pits. However, they also include oxides and other dispersible material forms that may require treatment and repackaging not needed for pits. There are ES&H concerns associated with locating these operations in proximity to the metropolitan Albuquerque area. Furthermore, there is insufficient land area available to construct the necessary direct support facilities needed for analysis, repackaging, accounting, and waste management. Therefore, the Manzano WSA was considered in the Draft PEIS but eliminated as a reasonable alternative primarily because Manzano WSA could not accommodate storage of both pit and non-pit materials.

Since the issuance of the Draft PEIS, DOE has developed a Preferred Alternative for storage that would separate storage of most Pu pits from storage of non-pit Pu material. Specifically, the Preferred Alternative would store Pu pits from Pantex and RFETS at Pantex, and would store non-pit Pu at SRS, Hanford, and INEL. Since DOE's Preferred Alternative would separately locate storage of pits and non-pit Pu from RFETS, the option to store pits at Manzano WSA no longer appears unreasonable. Therefore, DOE has added Appendix P to the Final PEIS, which discusses potential storage of Pantex and RFETS pits at Manzano WSA.

For a number of reasons, the Preferred Alternative would store the pits from Pantex and RFETS at Pantex, rather than Manzano WSA. Pantex is the proposed site for interim storage of pits under the Preferred Alternative in the Pantex EIS.[3] The majority of the pits that require storage are surplus to U.S. defense needs and are already located at Pantex. The number of pits that would be relocated from RFETS would be small by comparison. Since the majority of pits are already in storage at Pantex, it would be prudent for DOE to consolidate all pits there for storage. Assembly and disassembly operations would continue at Pantex even if pit storage did not occur there. Selecting Manzano WSA would require DOE to create another site where Pu would be located with the risk of contamination and the associated costs for site infrastructure and security. In addition, other missions that could be added to Pantex (for example, pit disassembly/conversion or MOX fuel fabrication) could not be added to Manzano.

Storage at Manzano WSA would involve the transportation risk of moving these materials from Pantex to Manzano WSA. Furthermore, two shipment campaigns would be required for disposition for most of the pits (those already at Pantex) if Manzano WSA were chosen, whereas only one shipment campaign of those same pits would be required if the pits were stored at Pantex. For the Manzano case, pits at Pantex would require relocation to Manzano and then a second shipment campaign to a disposition site. Leaving the pits in storage at Pantex would result in only one shipment campaign from Pantex to the disposition site.[4]

The utilization of non-domestic sites for long-term storage was proposed, but was eliminated from further consideration because it was not able to address all of the long-term storage requirements. These requirements

[3] The disposition of these surplus pits would begin within the next 10 years and would be completed within the next 25 years. The time period required for the storage of the pits is therefore close to that considered in the Pantex EIS for pit storage and the reasons for not using Manzano WSA are the same.

[4] Two shipment campaigns of pits would be required for those pits currently stored at RFETS for both Pantex and Manzano.

include the storage of the materials set aside as strategic reserve for defense purposes, which are not appropriate to locate outside the United States. This option was disqualified in the screening process for non-strategic reserve material as well, because the risk of theft or diversion by unauthorized parties would be greater than those involved in the utilization of domestic sites. Safeguard and security of nuclear materials are also enhanced by the domestic law enforcement infrastructure, which would not be easily coordinated outside the United States. Figure 2.1.3–2 shows the long-term storage options that were considered and rated based on the seven screening criteria and the principal reasons for disqualification or elimination. The Preferred Alternative for storage at each DOE site was selected from among these storage options.

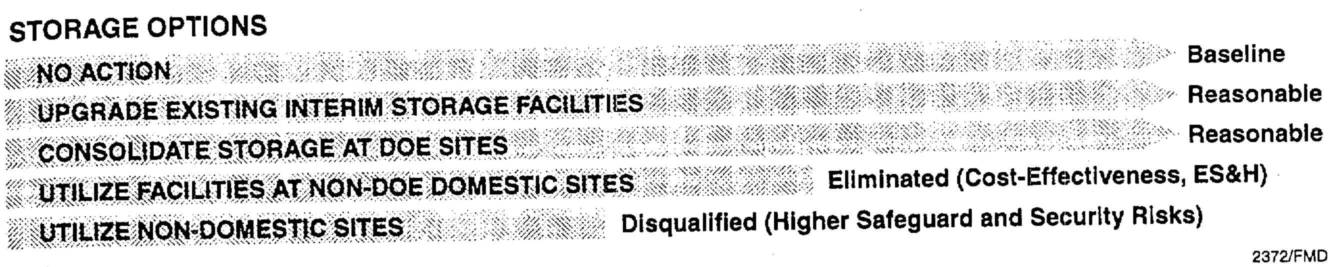


Figure 2.1.3–2. Results of the Screening Process—Long-Term Storage Options.

2.1.4 REASONABLE ALTERNATIVES FOR THE DISPOSITION OF SURPLUS PLUTONIUM

Screening Criteria for Disposition Options

Resistance to Theft and Diversion by Unauthorized Parties. Each step in the disposition process must be capable of providing for comprehensive protection and control of weapons-usable fissile materials.

Resistance to Retrieval, Extraction, and Reuse by Host Nation. The surplus material must be made highly resistant to potential use in weapons to reduce reliance on institutional controls and demonstrate that the arms reductions will not be easily reversed.

Technical Viability. There should be a high degree of confidence that the alternative will be technically successful.

Environmental, Safety and Health Compliance. High standards of public and worker health and safety, and environmental protection must be met, and significant additional ES&H burdens should not be created.

Cost-Effectiveness. Disposition should be accomplished in a cost-effective manner and be compatible with reasonable long-term storage alternatives.

Timeliness. There is an urgent need to begin Pu disposition and to minimize the time period that surplus fissile materials remain in weapons-usable form.

Fosters Progress and Cooperation With Russia and Other Countries. The alternative must establish appropriate standards for the disposition of surplus weapons-usable fissile material inventories and support negotiations for bilateral or multilateral reductions in these materials, and each step in the disposition process must allow international inspections.

Public and Institutional Acceptance. An alternative should be able to muster a broad and sustainable consensus on the manner in which disposition is accomplished.

Additional Benefits. The ability to leverage government investments for disposition of surplus materials to contribute to other national or international initiatives should be considered.

Results of the Screening Process: Reasonable Alternatives for Surplus Plutonium Disposition

As a result of the screening process for surplus Pu disposition, three alternative categories consisting of nine alternatives are considered reasonable. The alternative categories for further evaluation are the deep borehole category, the immobilization category, and the reactor category.

Deep Borehole Category. Within this category, surplus weapons-usable Pu would be emplaced in deep boreholes drilled several kilometers below the water table into ancient, geologically stable rock formations. The deep boreholes would be sealed to isolate the Pu from the environment.

Two Deep Borehole Alternatives were analyzed for this PEIS:

- Direct Disposition Alternative—direct emplacement of canisters containing Pu forms that have not been immobilized

- Immobilized Disposition Alternative—Pu immobilized in ceramic pellets (without the addition of high-energy, gamma-emitting radionuclides) would be emplaced in a borehole as part of a grout-pellet mixture

In the first borehole alternative, surplus weapons-usable Pu would be encapsulated directly in suitable canisters without any immobilization processing of Pu material and the canisters would be placed in a deep borehole. The deep borehole would then be plugged after completion of the emplacement. In the second deep borehole alternative, surplus weapons-usable Pu would be converted to an immobilized ceramic form. The immobilized Pu form then would be directly emplaced in a deep borehole without encapsulation in canisters, and the deep borehole would be plugged after completion of the emplacement. Under both alternatives, emplacement in a deep borehole would provide a geologic barrier to proliferation and Pu could not be recovered by the host nation undetected. Therefore, the Pu would not need to be mixed with HLW or other radioactive materials to provide a radiation barrier to recovery.

Immobilization Category. Within this category, surplus Pu would be immobilized in an acceptable matrix to create a chemically stable form for disposal. The immobilized material would be placed in lag storage prior to transfer to a repository constructed pursuant to the *Nuclear Waste Policy Act* (NWPA), as amended (see discussion in Section 2.4). The immobilized Pu would contain HLW or a radioactive isotope to create a radiation field that enhances proliferation resistance to meet the Spent Fuel Standard.

Three Immobilization Alternatives were included in this PEIS:

- **Vitrification Alternative.** This alternative would consist of building a new facility or modifying existing facilities to produce a glass waste form that embeds Pu and radioisotopes within the glass form. This PEIS analyzes the impacts associated with building and operating a new facility at any of six DOE sites (Hanford, NTS, INEL, Pantex, ORR, and SRS). As an example of a technology variant at existing facilities, Appendix O of this PEIS describes the can-in-canister variant at the DWPF at SRS.

- **Ceramic Immobilization Alternative.** This alternative would consist of building a new facility or modifying existing facilities to produce a ceramic waste form that embeds Pu and radioisotopes within the ceramic form. This PEIS analyzes the impacts associated with building a new facility at any of six DOE sites (Hanford, NTS, INEL, Pantex, ORR, and SRS). As an example of a technology

variant at existing facilities (with appropriate modifications), Appendix O of this PEIS describes the can-in-canister variant at the DWPF at SRS.

- **Electrometallurgical Treatment Alternative.** This alternative would utilize electrometallurgical treatment to produce a glass-bonded zeolite (GBZ) waste form that embeds Pu and radioisotopes within the GBZ form. Although this alternative could be conducted at other sites, the Argonne National Laboratory-West (ANL-W) site at INEL was used as an example site for evaluating potential environmental effects.

In all three alternatives, surplus weapons-usable Pu would be converted to an immobilized form (glass, ceramic, or GBZ). A radiation barrier for the immobilized surplus Pu would be required for nonproliferation purposes; the radioisotopes available to produce the barrier include radioactive Cs-137 (in storage at Hanford as cesium-chloride [CsCl] capsules in shippable form) or HLW (which would only be used if an immobilization facility were located at a site with quantities of this material). HLW would not be shipped between sites, thus avoiding additional risk in transportation.[5]

Reactor Category. Under this category, surplus Pu would be converted to MOX fuel for use in domestic or Canadian reactors. Using the MOX fuel would consume a portion of the Pu content of the fuel while embedding the rest in highly radioactive spent fuel similar to that now produced by uranium-fueled commercial power reactors. The resultant spent fuel then would be stored pending disposal in accordance with the applicable spent fuel program (U.S. or Canadian).

Analyses were conducted in this PEIS on four separate MOX fuel alternatives:

- Existing LWR Alternative—utilizing existing U.S. commercial reactors that would use MOX fuel instead of traditional LEU fuel
- Partially Completed LWR Alternative—completing construction of U.S. commercial reactors that are presently maintained in an extended interim state and utilize MOX fuel in these reactors
- Evolutionary LWR Alternative—building new reactors in the United States to use MOX fuel
- CANDU Reactor Alternative—utilizing existing Canadian reactors that would use MOX fuel instead of traditional natural uranium fuel

Because the United States does not have a MOX fuel fabrication facility or capability, a dedicated facility would likely have to be constructed or an existing facility be modified at a U.S. Government or existing commercial fuel fabricator's site. In the event MOX fuel is needed before a domestic fuel fabrication plant is available, existing facilities in Europe could be used on a short-term basis to provide initial lead test assemblies and other MOX fuel.

Preferred Alternative for Pu Disposition: A combination of Reactor and Immobilization Alternatives. The Preferred Alternative calls for (1) immobilizing at least those Pu materials not readily suitable for MOX fuel using vitrification or ceramic immobilization and (2) converting pure Pu metal, including pits and oxides into MOX fuel for use in existing reactors. Use of Canadian CANDU reactors would be retained in the event a multilateral agreement is made among Russia, Canada, and the United States to implement this.

The deployment of two disposition technologies would provide increased flexibility and assurance of mission accomplishment should technical problems develop with one technology as well as greater flexibility to deal

[5] Under the Immobilization Alternatives, DOE would not use CsCl or HLW that is a RCRA waste unless immobilization constituted sufficient RCRA treatment, or unless the CsCl or HLW first underwent RCRA treatment before immobilization with the surplus Pu.

with a wide range of Pu forms. The deployment of two technologies would signal a strong U.S. commitment to reducing the stockpiles of Pu and encourage Russia to reduce its stockpiles. The two disposition technologies that would allow an early start of Pu disposition have been determined to be the reactor and immobilization alternatives. The Preferred Alternative is a combination of reactor and immobilization alternatives.

Figure 2.1.4–1 depicts the alternative strategies and technologies for disposition of surplus Pu including the Preferred Alternative for disposition and how the material flows from the front-end process to the disposition categories.

Front-End Processes Common to Surplus Plutonium Disposition Alternatives

For the disposition of surplus Pu, a conversion process would be required to transform the various Pu forms into one suitable for further use in each of the disposition alternatives. Either pit disassembly/conversion (Section 2.4.1) or a Pu conversion process would be used (Section 2.4.2), depending on the current form of the surplus material.

Sites for the Analysis of Plutonium Disposition Alternatives

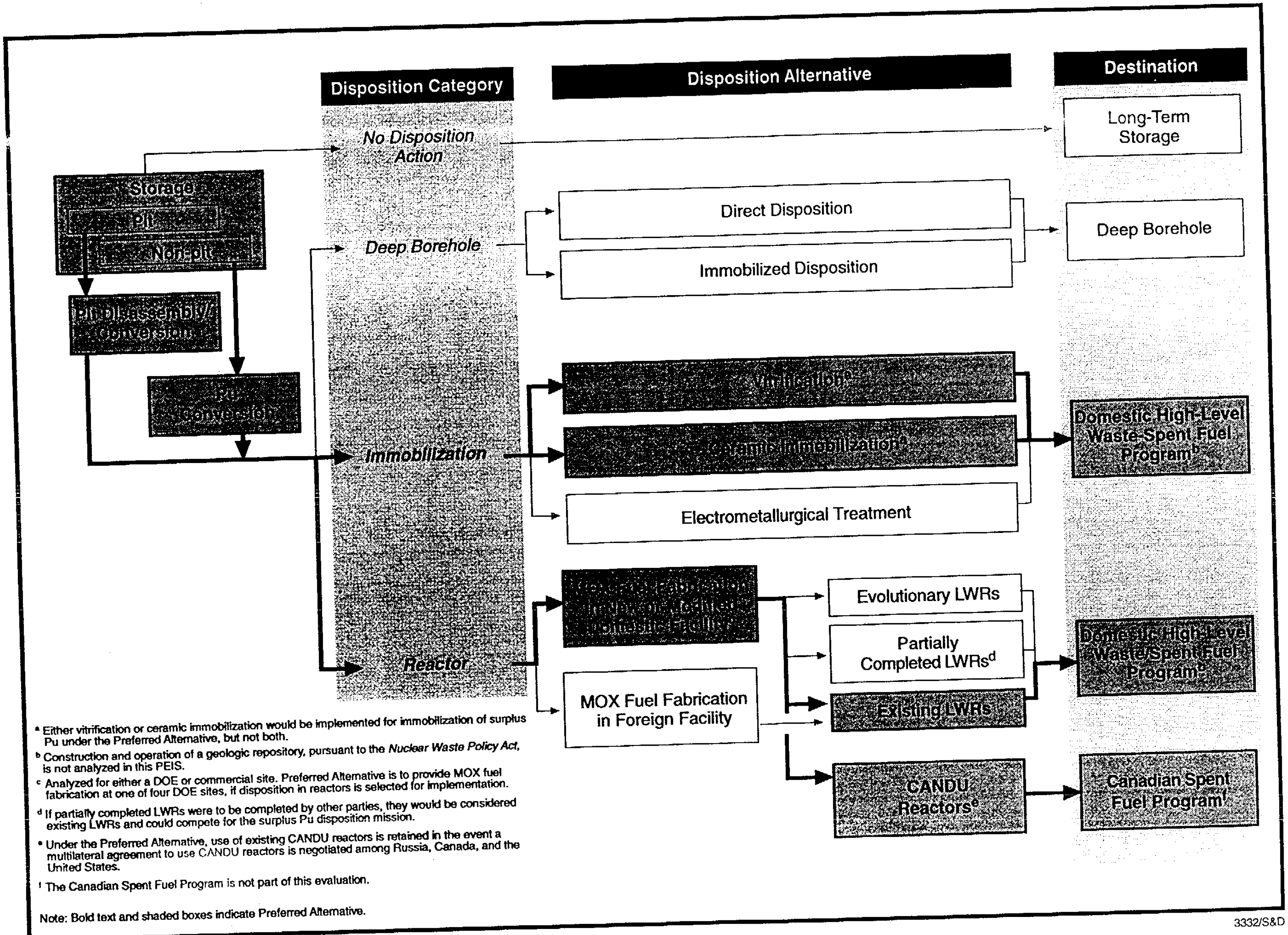
Six DOE sites and other generic and specific sites were used for assessing environmental impacts of various disposition techniques and strategies. The sites include Hanford, NTS, INEL, Pantex, ORR, and SRS. Additionally, some disposition facilities (specifically those involving the deep borehole complex, MOX fuel fabrication at a commercial facility [combination of five reactor fuel fabrication sites], and use of existing LWRs [combination of 12 existing LWRs at five sites]) have no representative sites, and so do not lend themselves to site-specific analysis at this time. Therefore, as explained more fully in Section 3.10 for the deep borehole, Section 3.11 for the MOX fuel fabrication site, and Section 3.12 for the existing LWR site, generic site characteristics have been developed for environmental evaluations of these facilities. Depending on programmatic decisions from this PEIS, DOE will conduct site-specific tiered NEPA analyses in the future. For the CANDU Reactor Alternative, a representative site (Bruce-A Nuclear Generating Station, Province of Ontario, Canada) is being considered for analysis. For the Partially Completed LWR Alternative, a representative site (Bellefonte Nuclear Plant, Alabama) is analyzed. The immobilization alternatives could be performed in new or existing, modified facilities, using technology variants identified in Table 2.4–1. For the Electrometallurgical Treatment Alternative, ANL-W at INEL is the representative site for analysis. If the Electrometallurgical Treatment Alternative is selected in the ROD, additional construction and operational impacts would result if this alternative were implemented at other sites, and additional tiered NEPA analyses and documentation would be developed. For the vitrification and ceramic immobilization alternatives, impacts of new facilities are analyzed for six DOE sites. As an example of a technology variant at an existing facility, the can-in-canister technology variant at the DWPF at SRS is described in Appendix O.

Disposition Alternatives Considered But Eliminated From Further Analysis

Twenty-seven Pu disposition options were eliminated as follows:

Radiation Barrier Alloy for Indefinite Storage. This option was eliminated because it did not have an endpoint destination comparable to options such as direct disposal, immobilization, or reactor burning. The Screening Committee noted the material (a Pu-beryllium compound) would be in a form unsuitable for a civilian HLW repository unless reconverted to remove the Pu and process it into a repository-compatible waste form.

Injection Into Continental Magma. This technology was eliminated because it is very immature. A licensing and regulatory regime for the technology is undefined and uncertain, and its use would present several ES&H concerns.



^a Either vitrification or ceramic immobilization would be implemented for immobilization of surplus Pu under the Preferred Alternative, but not both.

^b Construction and operation of a geologic repository, pursuant to the *Nuclear Waste Policy Act*, is not analyzed in this PEIS.

^c Analyzed for either a DOE or commercial site. Preferred Alternative is to provide MOX fuel fabrication at one of four DOE sites, if disposition in reactors is selected for implementation.

^d If partially completed LWRs were to be completed by other parties, they would be considered existing LWRs and could compete for the surplus Pu disposition mission.

^e Under the Preferred Alternative, use of existing CANDU reactors is retained in the event a multilateral agreement to use CANDU reactors is negotiated among Russia, Canada, and the United States.

^f The Canadian Spent Fuel Program is not part of this evaluation.

Note: Bold text and shaded boxes indicate Preferred Alternative.

Figure 2.1.4–1. Surplus Plutonium Disposition Alternatives, Including the Preferred Alternative for Disposition.

Emplacement in the Sub-Seabed. This option was eliminated because the technical approach is immature and because a licensing and regulatory regime is undefined and uncertain, which also makes the schedule uncertain. Extended operations at sea would enhance the opportunities for a transportation vessel accident in which material lost at sea could be available for retrieval. Public and international perceptions are also uncertain due to similar concerns as other ocean disposal options.

Launching to Deep Outer Space. This option was eliminated for a number of reasons. First, based on the U.S. experience to date, the risk of an explosion during launch and offsite dispersal of radioactive material would be much higher than the risks of accidents and dispersal of radioactive materials for other options. Second, if the space vehicle with its surplus fissile material payload failed to achieve orbit and reentered the atmosphere, the chances of other nations recovering the material would be enhanced and the chances of U.S. retrieval would be reduced. Also, this option would be more expensive and more time consuming to complete than many others.

Direct Immobilization With Radionuclides in Borosilicate Glass, Use of Retrofitted Defense Waste Processing Facility. This option was eliminated as unreasonable for reasons stated in the Screening Report.[6] Installing a specially designed melter for Pu immobilization remains unreasonable. However, it is reasonable to modify the DWPF for other variants of the vitrification and ceramic immobilization alternatives.

Reactor and Accelerator Options. Five new reactor and accelerator options requiring significant technology development, including three concepts with accelerators coupled to reactors, were eliminated primarily due to their technical immaturity and the attendant costly and lengthy development and demonstration effort that would be required to bring them to viable, practical status and enable disposition options to be initiated with certainty. Although these options hold promise of higher levels of Pu destruction than other reactor burning options, these alternatives involve significant time delay, increased cost, technical uncertainties, and are not as reasonable as the mature reactor burning options to achieve the Spent Fuel Standard. However, if some of these advanced concepts are developed and successfully demonstrated or operated (for commercial nuclear power) they may be considered for Pu disposition in supplemental NEPA documents.

These five options were as follows:

- Accelerator Conversion: Molten Salt Target
- Accelerator Conversion: Particle Bed Target
- Accelerator-Driven MHR
- Particle Bed Reactor
- Molten Salt Reactor

Consuming in Modular Helium Reactors. A reactor concept was evaluated that involves MHR coupled to closed cycle power conversion systems. This option is less technically mature than other available options using MOX fuel in operating water-cooled reactor plants. The MHR would use tested, but not fully demonstrated or proved, ceramic-coated plutonium dioxide (PuO_2) fuel particles in a graphite matrix. The power conversion system would use components that have neither been tested as a "system" themselves nor integrated with a

[6] In this option, the present DWPF at SRS would have a new, specially designed melter installed. Much of the supporting equipment would require major retrofitting for this application because DWPF was not designed for criticality control. Retrofitting the DWPF would create additional total personnel radiation exposure and would significantly interfere with its mission to stabilize and treat HLW, resulting in delays and cost escalation. Note that eliminating this "DWPF Upgrade" variant does not preclude other DWPF-related variants of the Vitrification and Ceramic Immobilization Alternatives (such as adding an adjunct melter adjacent to the DWPF, or the can-in-canister approach in the DWPF) if these other variants do not introduce increased radiation or Pu criticality concerns into the DWPF.

gas-cooled reactor system. The concept could achieve higher levels of Pu destruction than water-cooled reactors if this concept were developed and successfully operated. However, the technical uncertainty, cost, and time to develop, license, and successfully demonstrate or operate this new integrated reactor plant and power conversion system is not as reasonable as other reactor alternatives because Pu disposition can be accomplished using existing technologies. If this concept is developed and successfully demonstrated or operated for other missions, it may be considered for Pu disposition as well.

Advanced Liquid Metal Reactors with Pyroprocessing. Another reactor burning concept was evaluated that involves a variation of the integral fast reactor concept whereby an advanced liquid metal cooled reactor with a Pu alloy metal fuel would operate on a once-through cycle and then utilize pyroprocessing techniques to make a Pu-rich HLW form for potential disposal in a repository. This concept, which would use a reactor fuel cycle design still under development in a manner different from its intended purpose, would be more costly and more time-consuming than other reactor options. The development program was recently terminated by Executive and Congressional action. Since the Pu disposition can be accomplished using existing technologies, there is no justification for developing this advanced technology for the purpose of Pu disposition. However, if it is developed and successfully operated for other missions, it will be considered for Pu disposition.

Direct Emplacement (Without Immobilization) in a High-Level Waste Repository. It is highly unlikely that a determination of acceptability could be reached in a timely manner for this nonreference waste form for disposal in a HLW repository, should DOE decide to operate a HLW repository. Such a form would also require the safeguards and security requirements for weapons-usable material until the repository, currently planned to allow retrieval of spent fuel for about 100 years, is sealed.

Discard Surplus Plutonium in the Waste Isolation Pilot Plant. This option for surplus Pu would exceed capacity after meeting the needs for disposal of defense-related transuranic (TRU) waste, should DOE decide to proceed with the disposal phase of the Waste Isolation Pilot Plant (WIPP). This option would likely require amendment of the *Waste Isolation Pilot Plant Land Withdrawal Act*, associated regulations, and draft or pending regulatory compliance documents, and the planning-basis for WIPP Waste Acceptance Criteria (WAC), among other things.

Hydraulic Fracturing. This option (high-pressure injection of slurried materials into fractured shale formations) was previously tested and evaluated for civilian HLW disposal. The screening committee concluded that there was no assurance that the technical feasibility of this unproven option would be demonstrated in time for the option to be considered in the decision process. No engineered barrier would exist to prevent leakage into subsurface aquifers.

Injection of Slurry Into Deep Wells. This option, similar to the hydraulic fracturing, would not have an engineered barrier to prevent leakage into subsurface aquifers, would therefore pose unacceptable ES&H risks, and would be prohibited under current law.

Melting Into Crystalline Rock. Information previously developed in initially evaluating this approach for disposal of civilian HLW, which uses the heat from the fuel to melt into rock formations, was reviewed. It was concluded that the option is not technically viable for this disposition application because of major uncertainties. These include criticality concerns and difficulty in assuring that enough heat would be available from spent fuel (to be commingled with the surplus fissile materials) to melt the host rock.

Disposal Under Ice Caps. This option is not considered technically viable and poses unacceptable ES&H risks because ice caps in Greenland and Antarctica are not necessarily stable beyond a few hundred years. Reaching an agreement with Denmark to dispose of our nuclear materials on Greenland is not likely; a current treaty already prohibits leaving nuclear wastes in Antarctica.

Seabed Disposal and Controlled Dilution in Oceans. These options are unreasonable and were disqualified because they present ES&H concerns and are contrary to domestic and international laws, treaties, and policies. Because of increasing concerns about the pollution of marine environments with radioactive materials (ocean dumping of radioactive materials is prohibited), EPA has not issued any permits for ocean dumping or dispersal of radioactive materials in recent years. These options are inconsistent with the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, generally known as the London Dumping Convention, enacted in 1975 and amended in 1980 and 1993.

Underground Nuclear Detonation. This option is unreasonable and was disqualified because compliance with regulatory and licensing requirements is regarded as very uncertain, and compliance with ES&H regulations is unlikely for a new process of this type. In addition, the United States has a moratorium on underground nuclear testing and the President recently signed a Comprehensive Test Ban Treaty. The Screening Committee judges it unlikely that detonations for this application would be approved since such actions might undermine this national policy.

Naval Nuclear Fuel; Using Plutonium Fuel in Naval Reactor Plants. There is no design, testing, or demonstration experience with MOX fuel in naval reactors. Even if technical feasibility had been demonstrated, new classified fuel and reactor core fabrication plants would be required. Since these processes and facilities cannot be declassified, transparent confirmation of the process or final condition by international inspections would not be possible. Additionally, the number of new fuelings of naval reactor plants is so small that disposition of surplus Pu could not be accomplished in a reasonable timeframe.

Reprocessing: Using Plutonium Fuel in Existing or New Evolutionary/Advanced Light Water Reactors With Chemical Reprocessing of Spent Fuel. During reprocessing to separate Pu from spent fuel to fabricate more fuel, there are stages in the processing and handling when weapons-usable materials are more vulnerable to theft or diversion than the Stored Weapons Standard. Additionally, the time and cost required to design and construct reprocessing plants for this application are much greater than those for available, adequate options that meet the Spent Fuel Standard.

Advanced Liquid Metal Reactor With Recycle and Reuse of Metallic Alloy Fuel Elements. Based on recent DOE and Congressional action, development of the advanced liquid metal reactor/integral fast reactor concept is no longer being pursued due to a U.S. nonproliferation policy to not develop technologies that rely on Pu recycling. Since this is a relatively immature reactor concept that has not been demonstrated, and since Pu disposition can be accomplished using existing technologies, there is no justification for developing this advanced technology solely for the purpose of Pu disposition. [Text deleted.]

Glass Material Oxidation/Dissolution System. This option was eliminated due to timeliness and technical immaturity. The time required to complete the necessary R&D for this process is much longer than that for other alternatives and options.

Euratom Mixed Oxide Fuel Reactor Use. This option would involve the preparation of PuO_2 at a processing facility to be built in the United States, and transportation of the oxide to Europe where it would be fabricated into MOX reactor fuel assemblies and utilized as full-core MOX fuel loading in existing reactor facilities in one or more European countries. Final disposal of the spent fuel assemblies would be in Europe. Due to lack of capacity to complete the disposition mission, the institutional complexities such as transportation, security, and other geopolitical factors, this option was warranted unreasonable in light of the other alternatives considered.

Figure 2.1.4–2 shows the disposition options that were considered and rated based on the nine screening criteria and the principal reasons for disqualification or elimination.

Option		Result
STORAGE OPTIONS		
S1	NO DISPOSITION ACTION (CONTINUED STORAGE)	Baseline
S2	RADIATION BARRIER ALLOY (STORAGE)	Eliminated (Open-Ended, ES&H)
DIRECT DISPOSAL OPTIONS		
D1	DIRECT EMPLACEMENT IN HLW REPOSITORY	Disqualified (Retrievability, Timeliness)
D2	DEEP BOREHOLE (IMMOBILIZATION)	Reasonable
D3	DEEP BOREHOLE (DIRECT EMPLACEMENT)	Reasonable
D4	DISCARD TO WASTE ISOLATION PILOT PLANT	Disqualified (Capacity)
D5	HYDRAULIC FRACTURING	Disqualified (Technical Viability)
D6	DEEP WELL INJECTION	Disqualified (ES&H)
D7	INJECTION INTO CONTINENTAL MAGMA	Eliminated (Technical Viability, ES&H)
D8	MELTING IN CRYSTALLINE ROCK	Disqualified (Technical Viability)
D9	DISPOSAL UNDER ICE CAPS	Disqualified (Technical Viability, ES&H)
D10	SEABED (PLACEMENT ON OCEAN FLOOR)	Disqualified (ES&H)
D11	SUB-SEABED EMPLACEMENT	Eliminated (Technical Viability)
D12	OCEAN DILUTION	Disqualified (ES&H)
D13	DEEP SPACE LAUNCH	Eliminated (Retrievability, ES&H)
IMMOBILIZATION OPTIONS (WITH RADIONUCLIDES)		
I1	UNDERGROUND NUCLEAR DETONATION	Disqualified (ES&H, Licensing/Regulatory)
I2	BOROSILICATE GLASS IMMOBILIZATION (RETROFITTED DWPF)	Eliminated[a]
I3	VITRIFICATION (BOROSICLICATE GLASS IMMOBILIZATION [NEW FACILITY])	Reasonable
I4	CERAMIC IMMOBILIZATION	Reasonable
I5	ELECTROMETALLURGICAL TREATMENT	Reasonable
I6	GLASS MATERIAL OXIDATION/DISSOLUTION SYSTEM	Eliminated (Technical Maturity)
REACTOR AND ACCELERATOR OPTIONS		
R1	EURATOM MOX FABRICATION/REACTOR BURNING	Eliminated (Timeliness)
R2	EXISTING LWRs	Reasonable
R2A	PARTIALLY COMPLETED LWRs	Reasonable
R3	EVOLUTIONARY OR ADVANCED LWRs	Reasonable
R4	NAVAL PROPULSION REACTORS	Disqualified (Transparency)
R5	MODULAR HELIUM REACTORS	Eliminated (Technical Maturity)
R6	CANDU HEAVY WATER REACTORS	Reasonable
R7	ADVANCED LIQUID METAL REACTORS WITH PYROPROCESSING	Eliminated (Technical Maturity, ES&H)
R8	ACCELERATOR CONVERSION/MOLTEN SALT	Eliminated (Technical Maturity)
R9	ACCELERATOR CONVERSION/PARTICLE BED	Eliminated (Technical Maturity)
R10	EXISTING LWRs WITH REPROCESSING	Disqualified (Theft/Diversion, Policy)
R11	ADVANCED LWRs WITH REPROCESSING	Disqualified (Theft/Diversion, Policy)
R12	ACCELERATOR-DRIVEN MODULAR HELIUM REACTORS	Eliminated (Technical Maturity)
R13	ADVANCED LIQUID METAL REACTORS WITH RECYCLE	Disqualified (Technical Maturity, Policy)
R14	PARTICLE BED REACTORS	Eliminated (Technical Maturity)
R15	MOLTEN SALT REACTORS	Eliminated (Technical Maturity)

[a] In this option, the present DWPF at SRS would have a new, specially designed melter installed. Much of the supporting equipment would require major retrofitting for this application because DWPF was not designed for criticality control. Retrofitting the DWPF would create additional total personnel radiation exposure and would significantly interfere with its mission to stabilize and treat HLW, resulting in delays and cost escalation. Note that eliminating this "DWPF Upgrade" variant does not preclude other DWPF-related variants of the Vitrification and Ceramic Immobilization Alternatives (such as adding an adjunct melter adjacent to the DWPF or the can-in-canister approach in the DWPF) if these other variants do not introduce increased radiation or Pu criticality concerns into the DWPF. Can-in-canister at a retrofitted DWPF is discussed in Appendix O and would be examined along with other site-specific alternatives in subsequent NEPA review tiered from this PEIS.

Note: ES&H=Environmental Safety and Health.

Source: DOE 1995m.

2373/S&D

Figure 2.1.4–2 Results of the Screening Process—Surplus Plutonium Disposition Options.

2.2 NO ACTION ALTERNATIVE

The definition of the No Action Alternative as it relates to both surplus and nonsurplus Pu and HEU was discussed in Section 1.7. The baseline case for the No Action Alternative involves no disposition of surplus Pu and no change in the current storage sites for Pu and HEU. This case is analyzed and referred to as the No Action Alternative in this section. The Preferred Alternative for storage calls for continuing current storage (No Action) of surplus non-pit Pu materials at Hanford, INEL, and LANL, pending disposition.

The No Action Alternative for long-term storage would maintain storage of all weapons-usable fissile materials at existing storage sites using proven nuclear material safeguards and security procedures. This alternative assumes that the corrective actions necessary to ensure compliance with high-priority ES&H requirements identified in the *Plutonium Working Group Report on Environmental, Safety and Health Vulnerabilities Associated with the Department's Plutonium Storage* would be completed. Maintenance at these existing storage sites would be done as required to ensure safe facility operation for the balance of the facility's useful life. DOE would not undertake any new construction projects except those that are considered part of ongoing site operations as portrayed in individual site-specific EISs and site development plans.

Under the No Action Alternative, surplus and nonsurplus Pu materials would remain in place at LANL, RFETS, Hanford, INEL, Pantex, and SRS. HEU would continue to be stored in existing buildings at Y–12 at ORR. Under No Action, it is assumed that HEU from other sites in the DOE Complex would be relocated to Y–12. The Y–12 EA addresses the transportation of this material and the storage of the material for up to 10 years. Nonsurplus HEU would remain in storage at Y–12 under No Action. Nonsurplus HEU materials represent nuclear weapons, secondary components, naval nuclear fuel, and working material. Surplus HEU would be stored at Y–12 until the material is removed for disposition, as is described in the HEU Final EIS. As a result of the ROD from the HEU EIS, storage of some of this surplus HEU may extend past the 10 years specified in the Y–12 EA. Under No Action, the storage facilities would be maintained to ensure safe facility operation. Subsequent NEPA analysis would be performed for continued storage beyond the 10-year period analyzed in the Y–12 EA.

2.2.1 HANFORD SITE

Hanford Site, located in the State of Washington (Figure 2.2.1–1), had 11 t (12.1 tons) of Pu material in September 1994. Of this, approximately 4.0 t (4.4 tons) falls within the scope of this PEIS. This material is stored within the protected vaults and gloveboxes of the Plutonium Finishing Plant (PFP) complex located in the 200 West Area (Figure 2.2.1–2). The remaining Pu materials currently within the PFP consist of solutions and numerous solid compounds such as metals, oxides, fluorides, mixed (Pu and uranium) oxide residues containing less than 50 percent Pu such as ash, and other Pu-containing materials such as plastics and combustibles. Pu inventories associated with irradiated fuel, buried or retrievably stored solid waste, liquid tank and waste residues containing less than 50 percent Pu, are outside the scope of this PEIS.

Preferred Alternative: No Action. Under the No Action Alternative, Hanford would continue to store Pu-bearing materials in the storage vaults and approved vault-type rooms of the PFP that have been assessed in the *Plutonium Finishing Plant Stabilization Final Environmental Impact Statement* (PFP EIS) (DOE/ EIS-0244D).[7] The *DNFSB Recommendation 94-1 Hanford Site Integrated Stabilization Management Plan* (VHC-EP-0853) calls for transforming the Pu-bearing materials to a stable form that meets the DOE standard *Criteria for Safe Storage of Pu Metals and Oxides* (DOE-STD-3013-94) by 2002 for materials with greater than 50-percent Pu. Some PFP plant systems that provide basic facility services (such as power,

[7] All Pu materials (both greater than and less than 50-percent Pu) would be stabilized and repackaged, as necessary, to ensure safe storage. The cleanout, stabilization, and storage of readily retrievable Pu materials in the PFP have been assessed in the *Plutonium Finishing Plant Stabilization Final Environmental Impact Statement* (PFP-EIS) (DOE/EIS-0244D). Hanford would continue to store residues containing less than 50 percent, which are not within the scope of this PEIS.

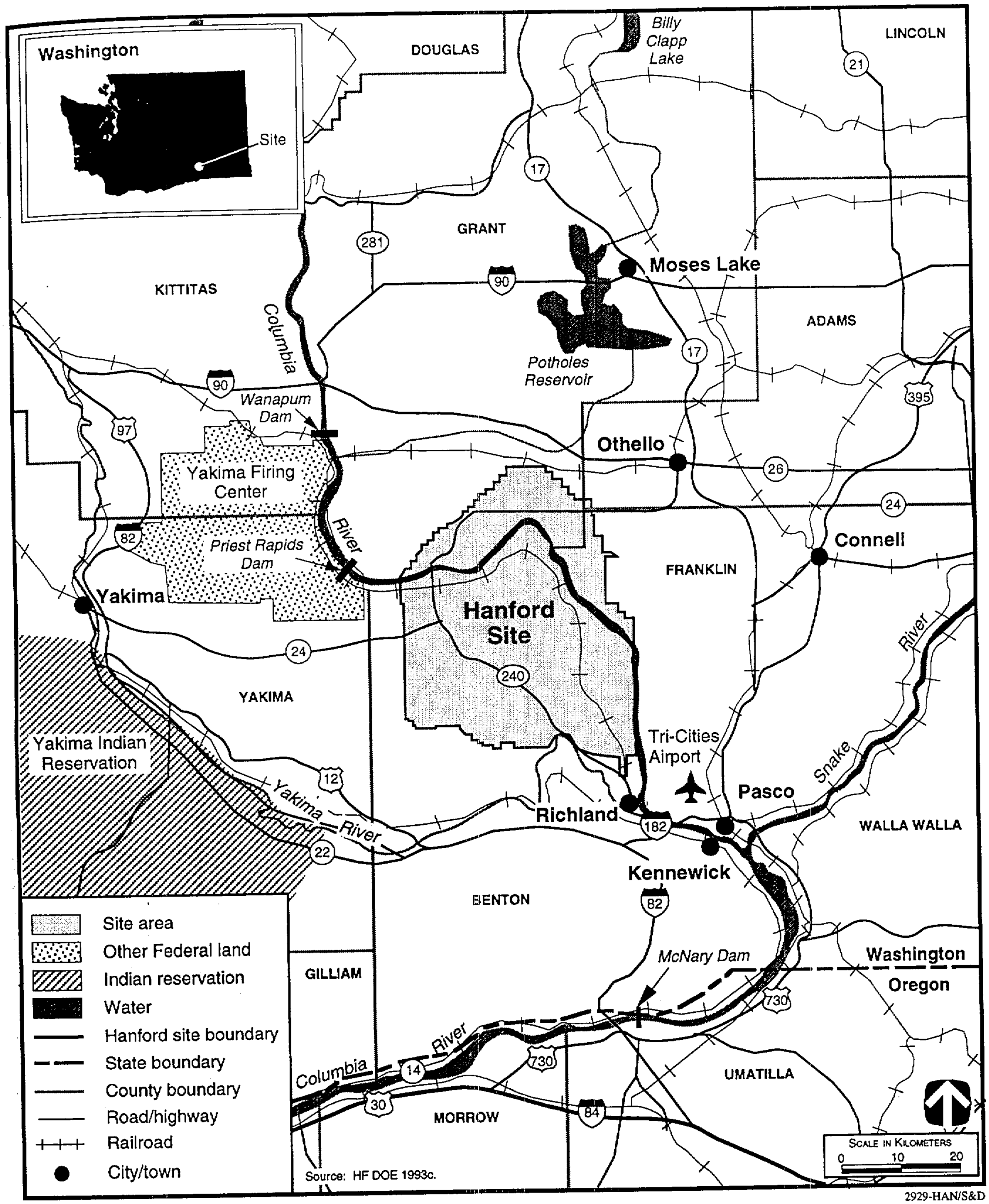


Figure 2.2.1–1. Hanford Site, Washington, and Region.

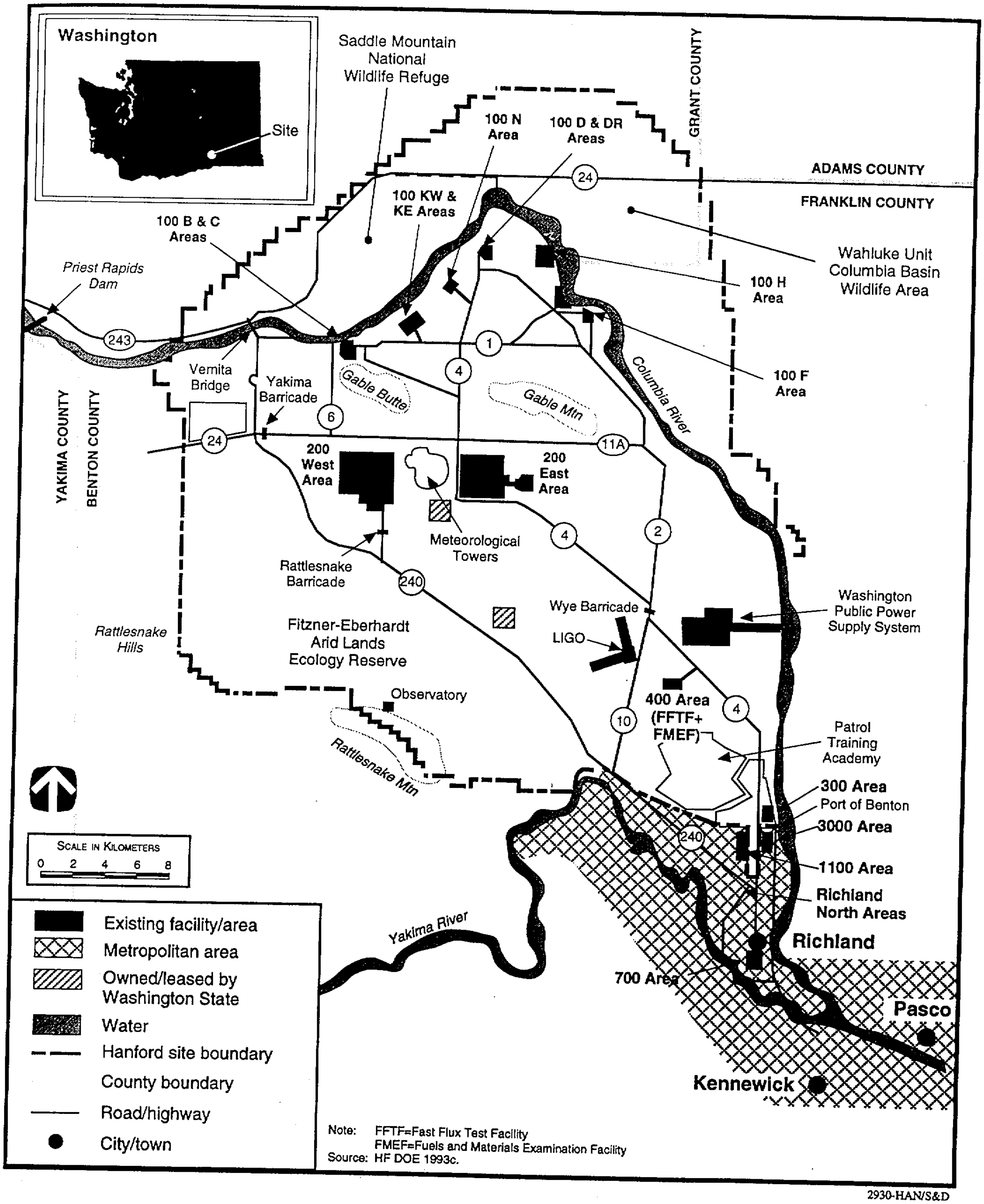


Figure 2.2.1–2. Site Designations and Principal Facilities at Hanford Site.

ventilation, and heat) would be upgraded for storage operations under the No Action Alternative. [Text deleted.] Hanford would continue to store residues containing less than 50 percent Pu. The unirradiated FFTF fuel pins and assemblies are acceptable "as is" for long-term storage. No further actions are envisioned for these unirradiated materials under the No Action Alternative.

[Text deleted.]

2.2.2 NEVADA TEST SITE

Nevada Test Site, located in the southern part of Nye County in southern Nevada (Figure 2.2.2–1), does not currently store any Pu or HEU within the scope of this PEIS. [Text deleted.] Due to existing available storage space within the P-Tunnel Facility, NTS is being considered for the long-term storage alternatives involving the consolidation of Pu and the collocation of Pu and HEU. These alternatives are described in Sections 2.3.2 and 2.3.3. Site designations and principal facilities at NTS are shown in Figure 2.2.2–2.

Preferred Alternative: No Action. DOE would not add Pu to sites that do not currently have Pu in storage. NTS does not store any Pu within the scope of this PEIS. Therefore, NTS would continue to carry out projected missions described in Chapter 3.

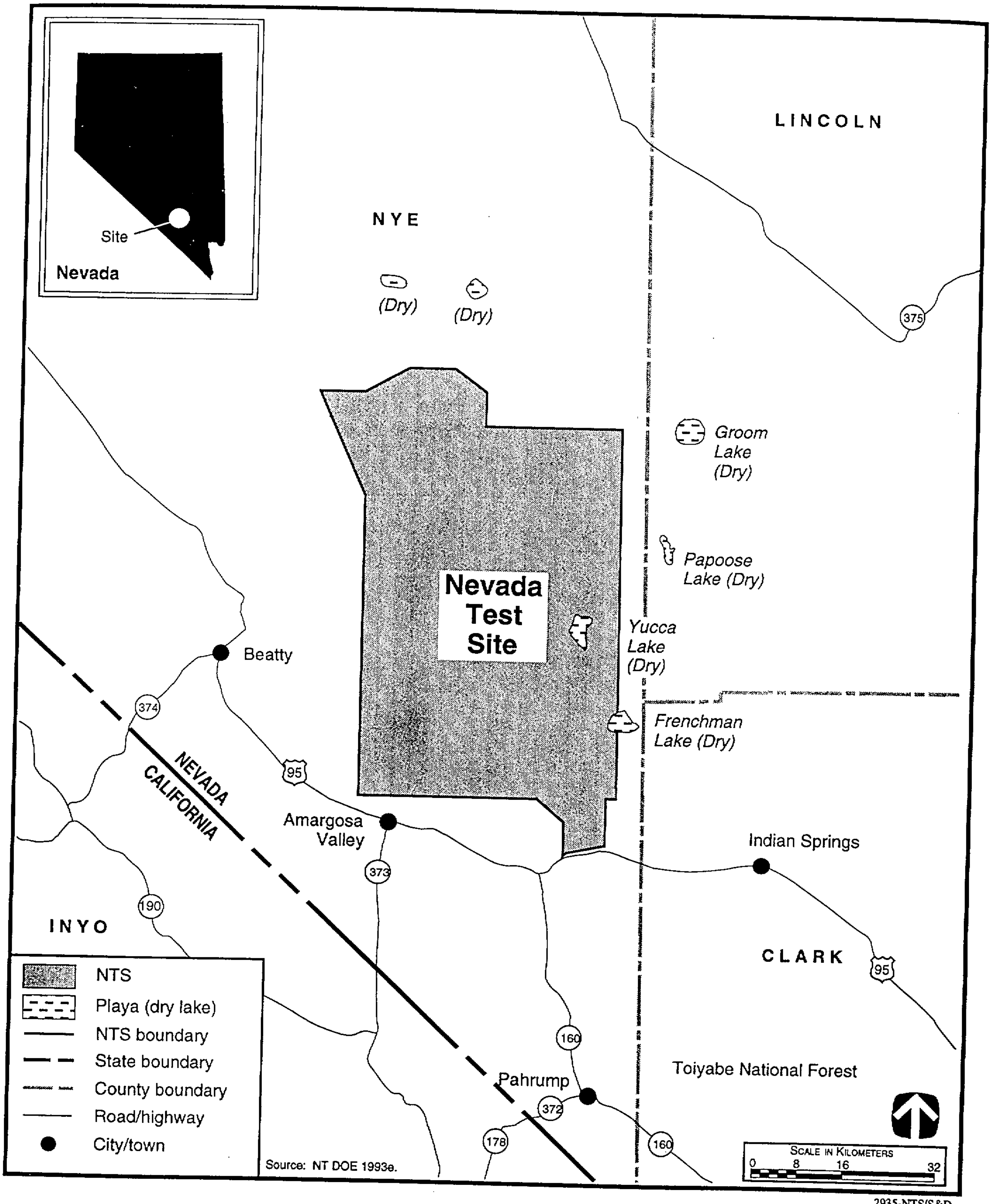


Figure 2.2.2–1. Nevada Test Site, Nevada, and Region.

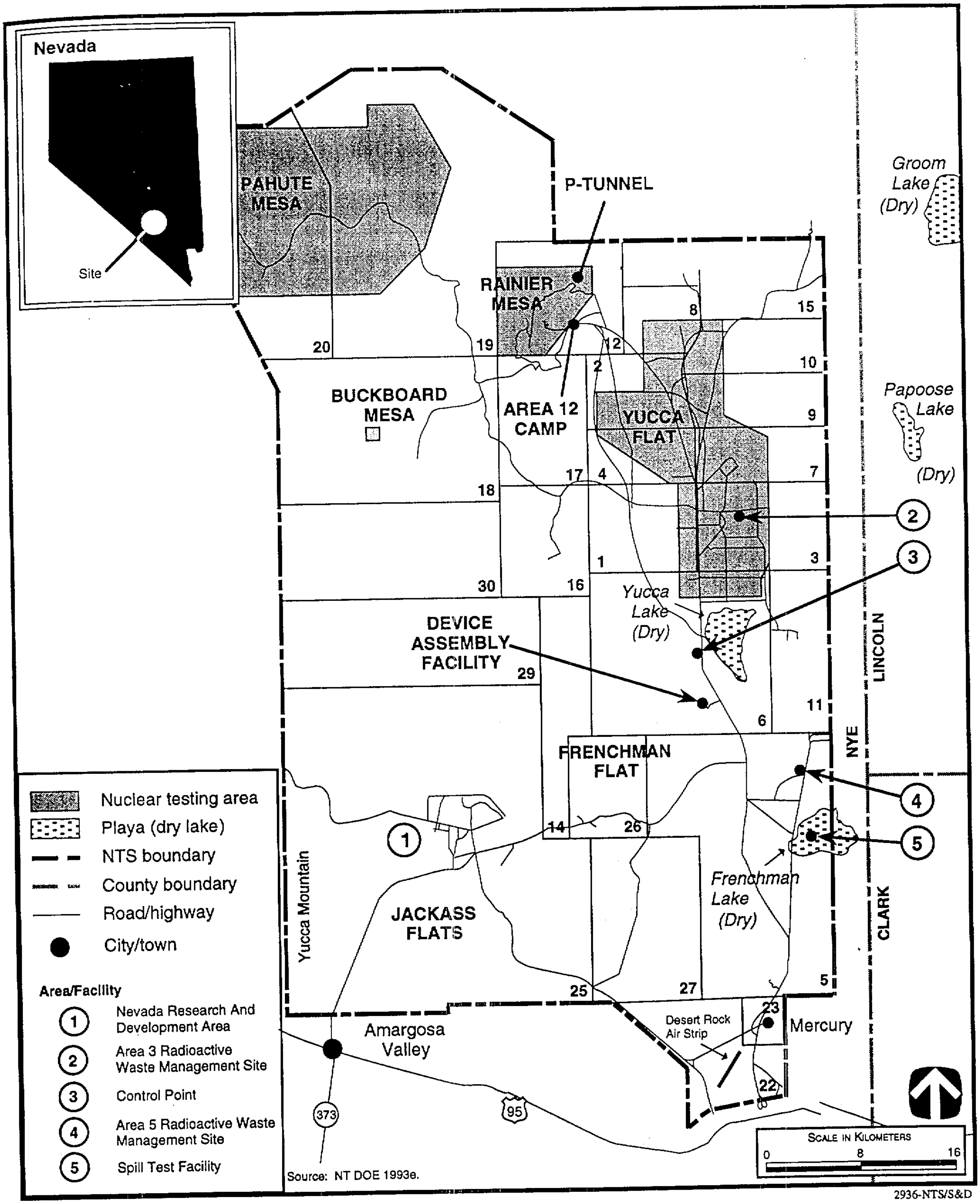


Figure 2.2.2–2. Site Designations and Principal Facilities at Nevada Test Site.

2.2.3 IDAHO NATIONAL ENGINEERING LABORATORY

Idaho National Engineering Laboratory is located near Idaho Falls in southern Idaho (Figure 2.2.3–1). As of February 6, 1996, there were approximately 4.0 t (4.4 tons) of Pu stored in the Zero Power Physics Reactor (ZPPR) and Fuel Manufacturing Facility (FMF) vaults at ANL-W and 0.5 t (0.55 tons) of Pu located in the Idaho Chemical Processing Plant (ICPP). All of this material falls within the scope of this PEIS. Site designations and principal facilities at INEL are shown in Figure 2.2.3–2.

Preferred Alternative: No Action. Under the No Action Alternative, weapons-usable Pu material at ANL-W would continue to be stored in the material forms deemed most stable according to the *ANL-W Plutonium ES&H Vulnerability Assessment Plan* (October 31,1994). The proposed *Corrective Action Plan* for vulnerability (ANL-W-I-4), involving almost all Pu onsite, calls for the site to store the material in the ZPPR and FMF vaults and maintain accountability pending disposal direction from DOE. Other site corrective action plans deal with the remaining INEL Pu which is in considerably smaller amounts, such as 13 kilograms (kg) (29 pounds [lbs]) requiring repackaging, 70 grams (g) (2.45 ounces [oz]) of surface oxides removed from stored Pu metal and alloys, and 2.7 g (0.095 oz) in sodium test loops.

2.2.4 PANTEX PLANT

Pantex is located in the Texas Panhandle in Carson County along U.S. Highway 60, as shown in Figure 2.2.4–1. Almost all Pu at Pantex is in the form of pits from disassembled nuclear weapons. The Pu inventory of 66.1 t (72.8 tons) at Pantex in September 1994 was the total amount actually at Pantex plus the amount in DoD custody. Currently, Pantex has the physical capacity to store up to 20,000 pits, but DOE has agreed to store no more than 12,000, pending completion of the Pantex EIS. Site designations and principal facilities at Pantex are shown in Figure 2.2.4–2.

Under the No Action Alternative, all site Pu holdings specific to the Storage and Disposition Program would continue to be stored in the Zone 4 facilities. However, if the Stockpile Stewardship and Management Final PEIS preferred alternative for downsizing assembly/disassembly actions is selected and implemented, the Pu pit strategic reserve storage would be moved to Zone 12 by 2005. Pu-bearing materials at Pantex would continue to reside in the material forms and facilities deemed most stable according to the DNFSB *Recommendation 94-1 Pantex Corrective Action Plan*. In accordance with this plan, Pantex will correct ES&H vulnerabilities by improving management and training within the plant and improving some operating structures to reduce the probability of dispersing hazardous material. In order to avoid or greatly reduce the possibility that Pu would be dispersed outside an assembly cell in case of an explosion, facility utility penetrations have been sealed and door seals have been improved. [Text deleted.] To mitigate the consequences of the possible collapse of the roof over Bay 27 in Building 12-26 due to natural phenomena, updated procedures and processes and modification of equipment and facilities would be accomplished.

In concert with its corrective action plan, Pantex is taking to reduce the probability of an operational accident, human error, or equipment failure that could cause failure of pit cladding, and to mitigate the effects of pit cladding failure due to these or other causes, such as aging. Pits would be repackaged in the more robust AT-400A containment vessel, and storage is being converted to a configuration that allows for remote handling and surveillance. To reduce the probability of accident or human error, a more robust weapons operations safety process has been instituted for B61, W56, and W69 weapons dismantlements and will be implemented for others in the near future.

2.2.5 OAK RIDGE RESERVATION

Oak Ridge Reservation is located near Knoxville, Tennessee, as shown in Figure 2.2.5–1. There are two ORR sites that currently store fissile materials within ORR. These sites are Oak Ridge National Laboratory (ORNL) and Y–12. The positions of these sites on ORR are shown in Figure 2.2.5–2.

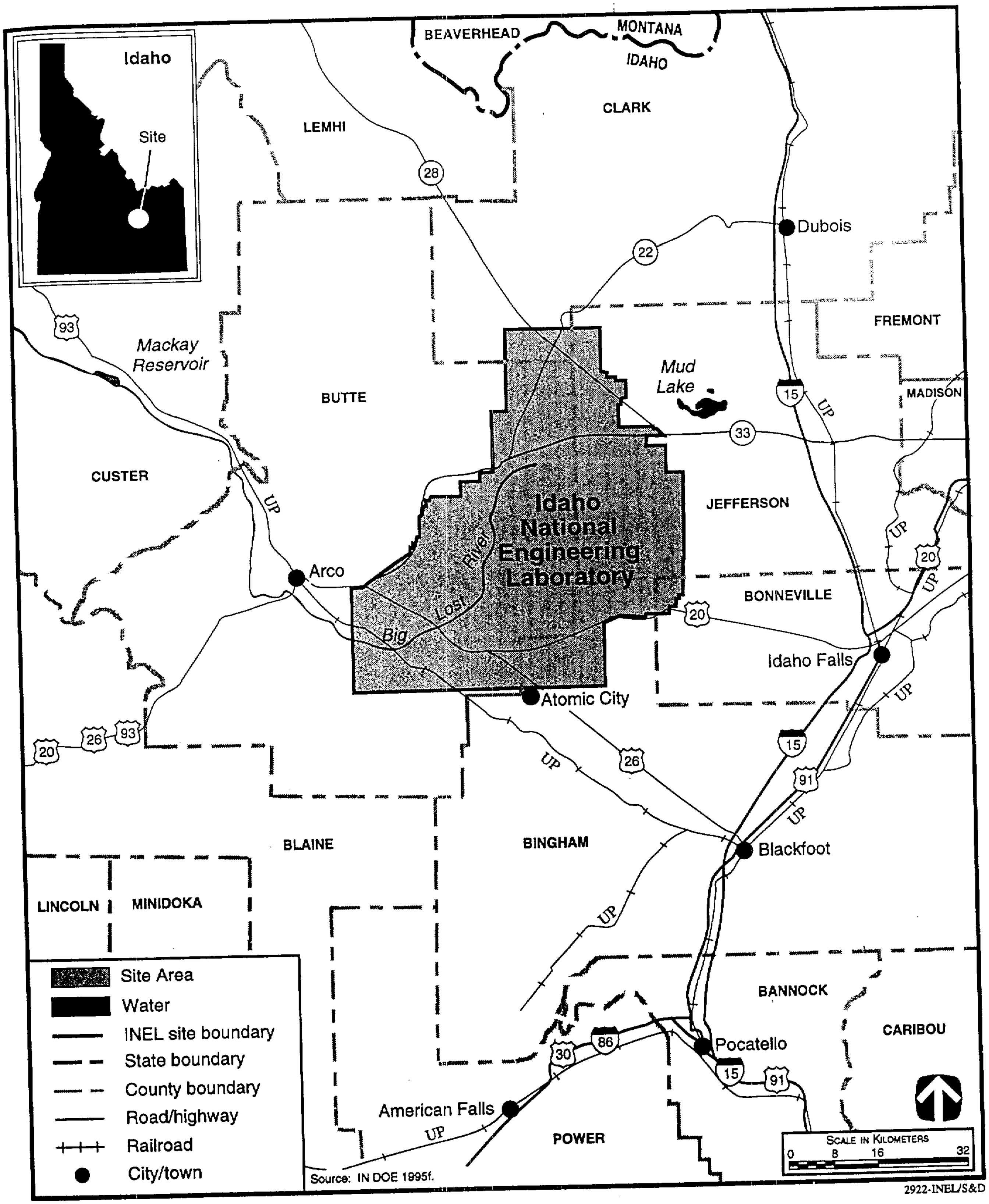


Figure 2.2.3–1. Idaho National Engineering Laboratory, Idaho, and Region.

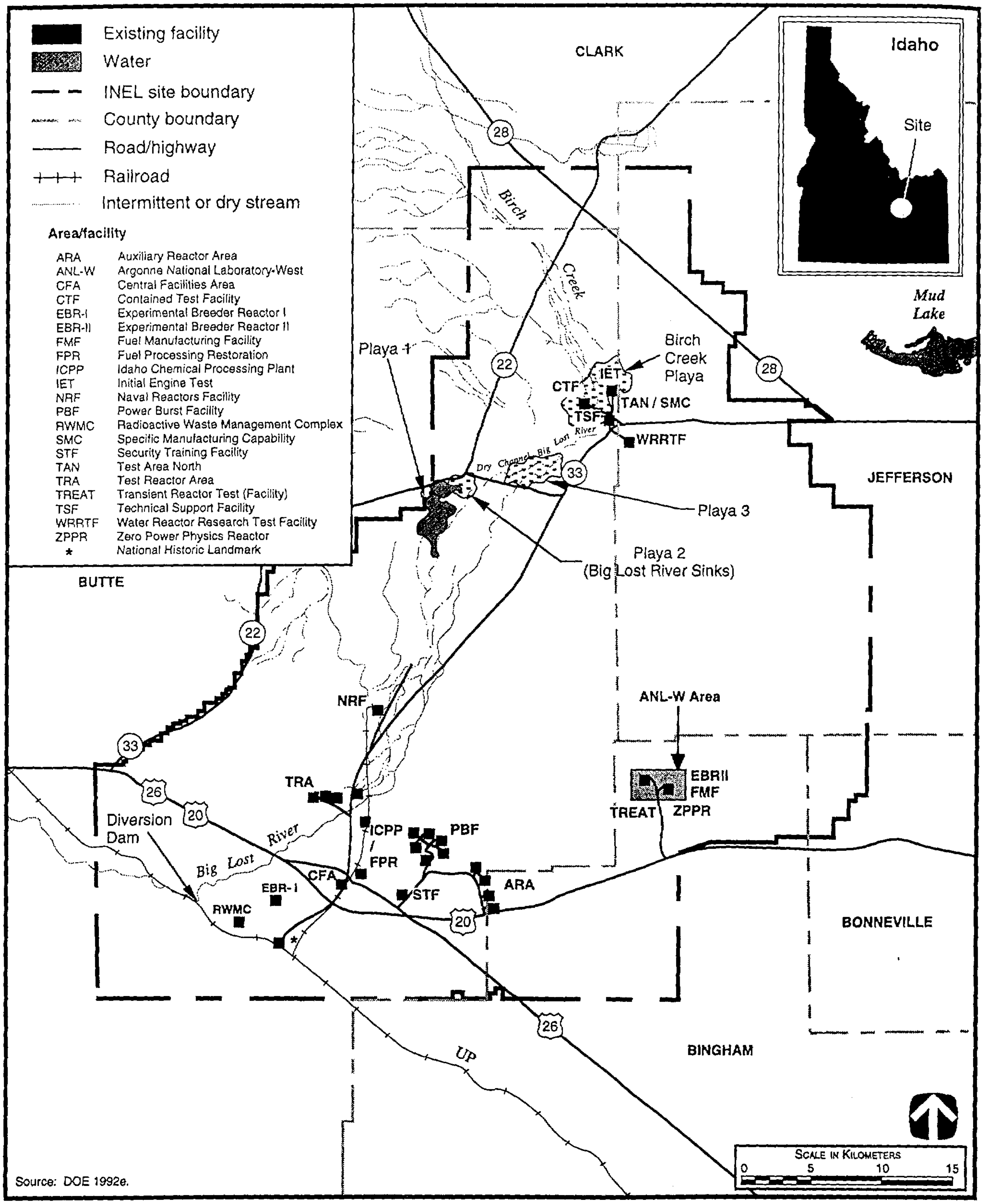


Figure 2.2.3–2. Site Designations and Principal Facilities at Idaho National Engineering Laboratory.

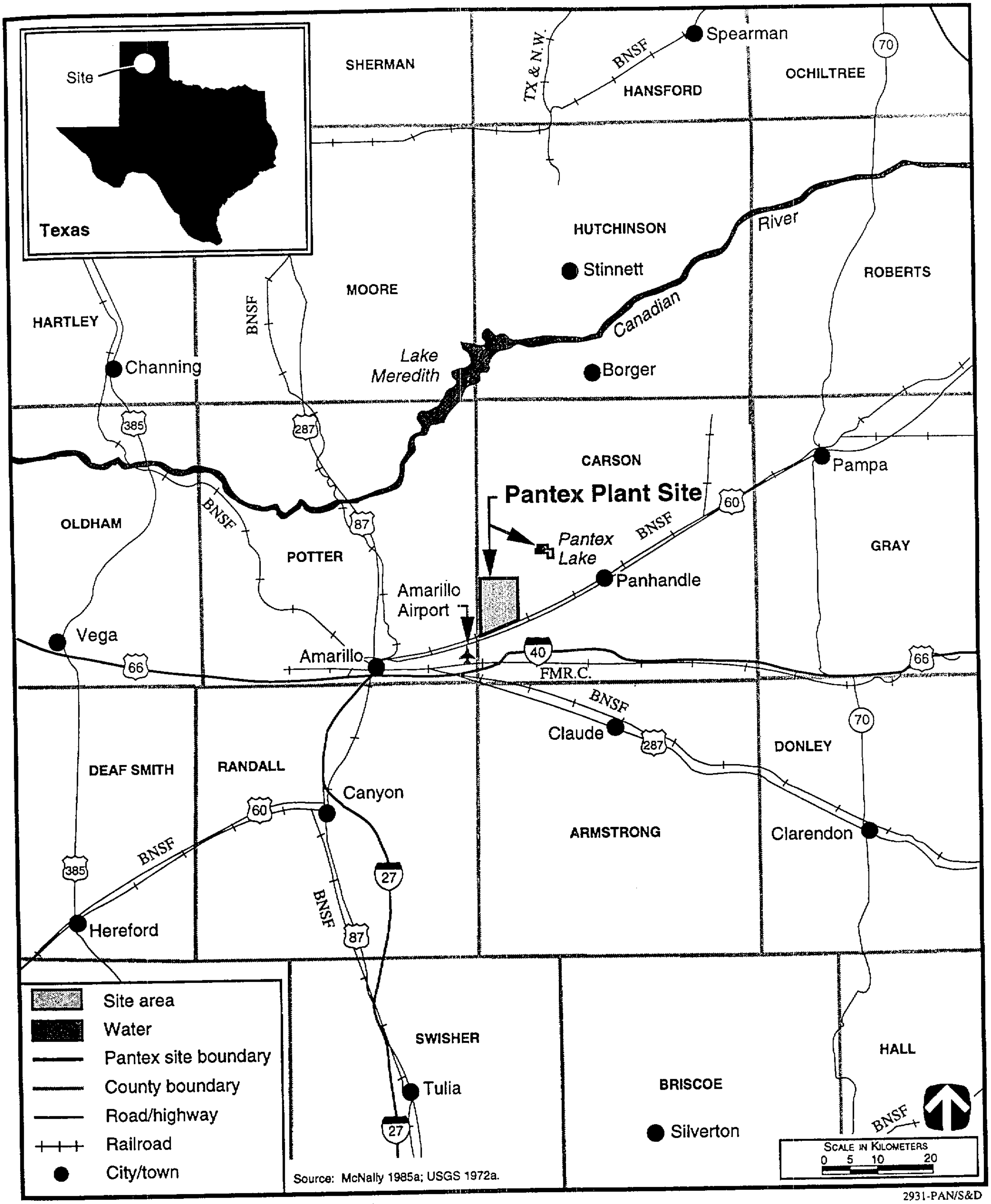


Figure 2.2.4–1. Pantex Plant, Texas, and Region.

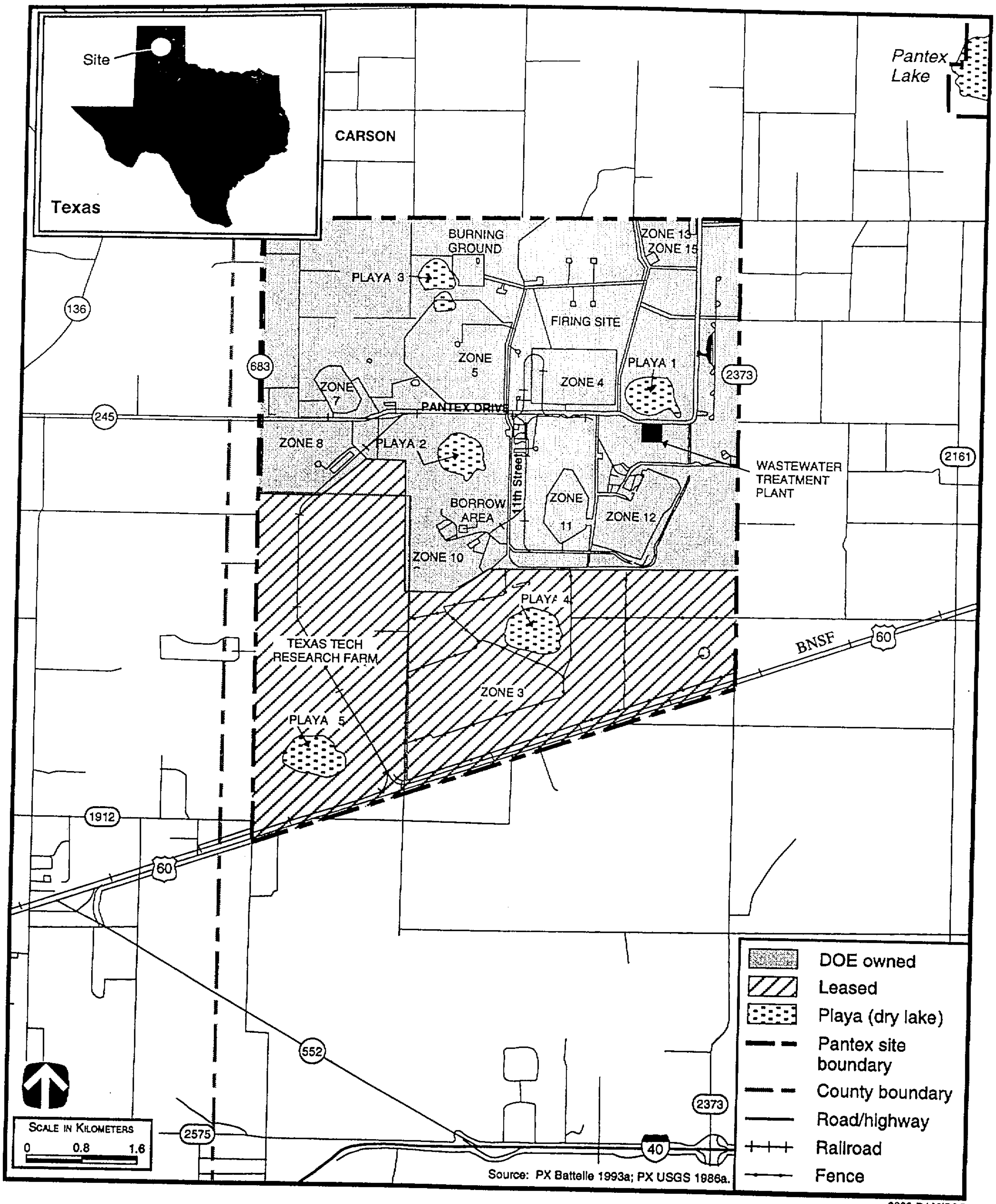


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Figure 2.2.4–2. Site Designations and Principal Facilities at Pantex Plant.

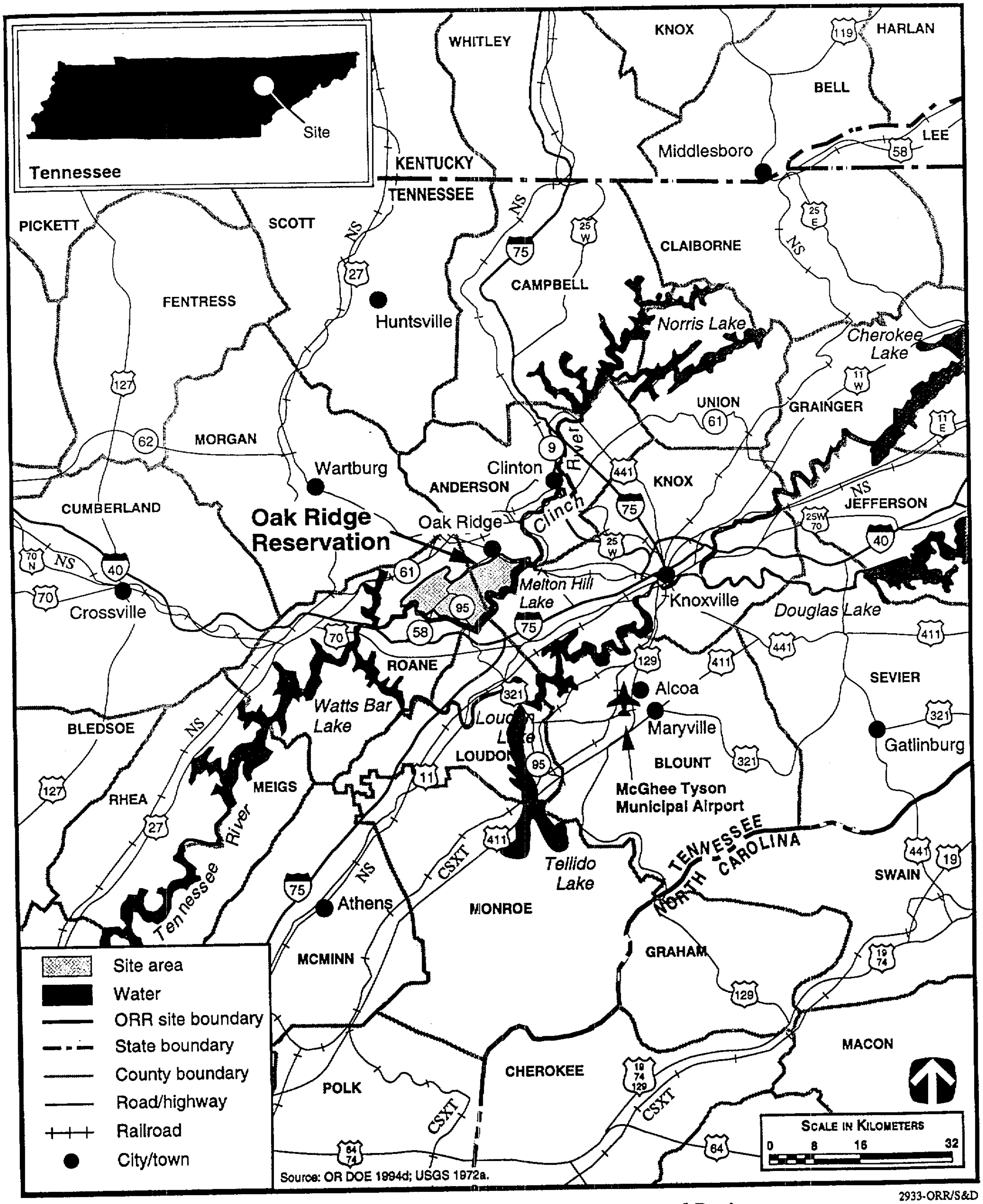
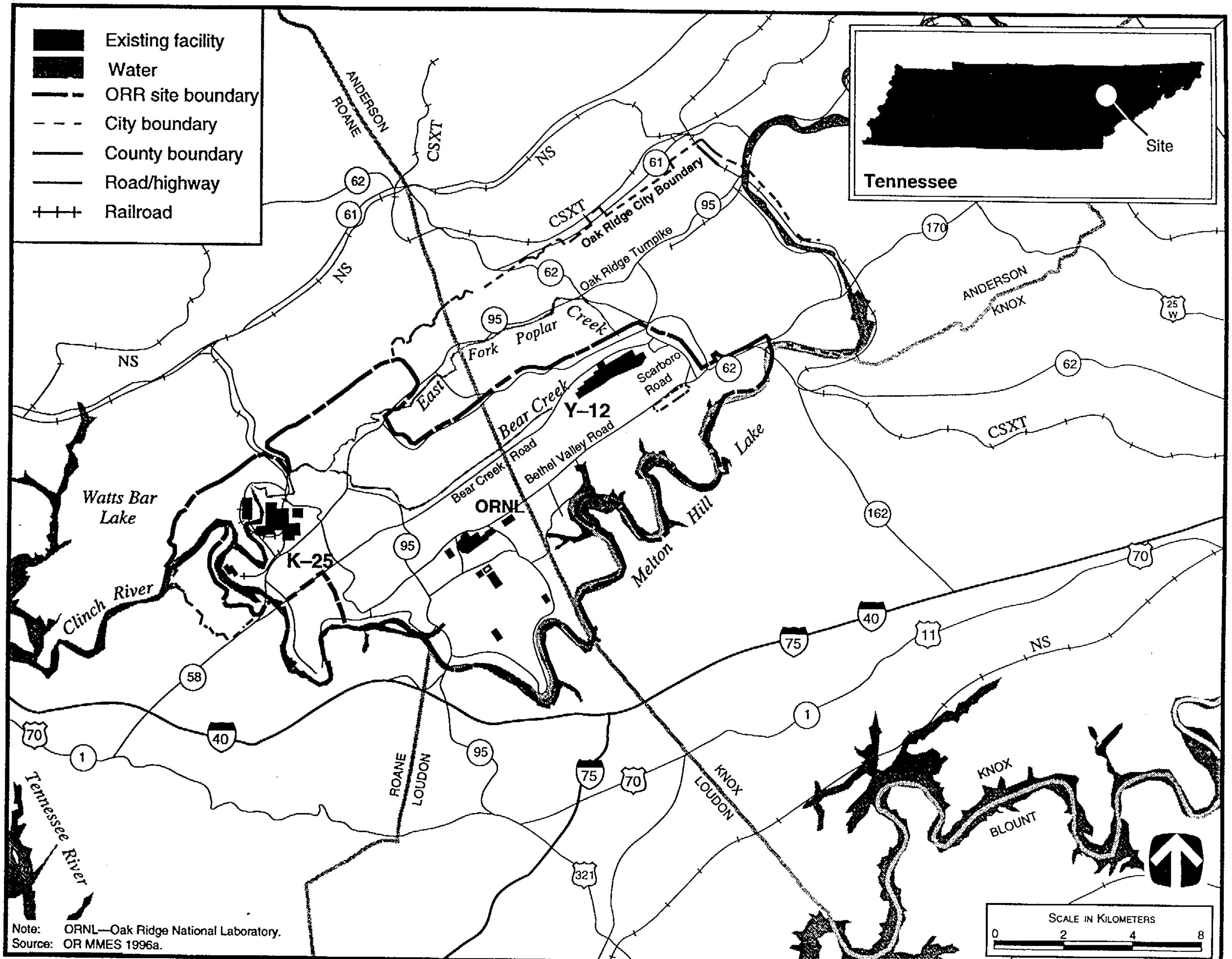


Figure 2.2.5–1.—Oak Ridge Reservation, Tennessee, and Region.



Note: ORNL—Oak Ridge National Laboratory.
Source: OR MMES 1996a.

2934-ORR/S&D

Figure 2.2.5–2. Site Designations and Principal Facilities at Oak Ridge Reservation.

As of September 1994, approximately 4.1 kg (9.0 lb) of Pu and 1 kg (2.2 lb) of collocated TRU waste was distributed among 19 facilities at ORNL and Y–12. This 5.1 kg (11.2 lb) is in various forms, including sealed sources, oxide, metal, solutions, and scrap/residues. Since the quantity of Pu stored at ORR is relatively insignificant compared to that located at other storage sites, and because it is in the form of waste, none of this material is within the scope of this PEIS.

All nonsurplus HEU currently stored at ORR is within the scope of this PEIS. Under the No Action Alternative, HEU would continue to be stored in existing buildings at Y–12. As of September 1994 the inventory at Y–12 consisted of 168.9 t (186.2 tons) of HEU. The bounding quantity (expected upper limit) of HEU that could be shipped to Y–12 from sites other than Pantex (whose quantity is classified) is an additional 98.4 t (108.5 tons).

Nonsurplus HEU would remain in storage at Y–12 under No Action. Nonsurplus HEU materials represent nuclear weapons, secondary components, naval nuclear fuel, and working material. Surplus HEU would be stored at Y–12 until the material is removed for disposition, as is described in the HEU Final EIS. As a result of the ROD from the HEU EIS, storage of some of this surplus HEU may extend past the 10 years specified in the Y–12 EA. Under No Action, the storage facilities would be maintained to ensure safe facility operation. Subsequent NEPA analysis would be performed for continued storage beyond the 10-year period analyzed in the Y–12 EA.[8]

2.2.6 SAVANNAH RIVER SITE

Savannah River Site, located south of Aiken, SC (Figure 2.2.6–1), had as of September 1994, 2.0 t (2.2 tons) of Pu material that falls within the scope of this PEIS, as well as other fissile materials in various forms which are outside the scope of this PEIS. The materials are in various forms, including Pu solutions, metal and oxides (more than 50-percent Pu), residues and oxides (less than 50-percent Pu), special isotopes, uranium, and spent nuclear fuel. Site designations and principal facilities are shown in Figure 2.2.6–2.

Under the No Action Alternative, SRS would continue to store Pu-bearing materials in the forms and facilities deemed most stable according to the *DNFSB Recommendation 94-1 Savannah River Site Integrated Stabilization Management Plan* (NMPP-PPLS95-0058) and in accordance with the *Spent Fuel Working Group Report on Inventory and Storage of the Department's Spent Nuclear Fuel and other Reactor Irradiated Nuclear Materials and Their Environmental Safety, and Health Vulnerabilities*, Volumes I, II, III, the *F-Canyon Plutonium Solutions Environmental Impact Statement* (DOE/EIS-0219, December 1994), the *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE/EIS-0220, October 1995), and the DOE standard *Criteria for Safe Storage of Plutonium Metals and Oxides* (DOE-STD-3013-94).

Under the No Action alternative, SRS would stabilize and store its various forms of Pu in accordance with the above listed plans for Pu materials as follows:

- *Pu-239 Solutions, F-Area.* The plan, supported by the *F-Canyon Plutonium Solutions Environmental Impact Statement* (DOE/EIS-0219) and the ROD dated February 1, 1995, was to convert this material to Pu metal. The conversion process in F-Canyon was completed in April 1996. The metal product will be stored temporarily in one of the F-Area vaults.
- *Pu-239 Solutions, H-Area.* In the *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE/EIS-0220) and the ROD dated December 12, 1995 (60 FR 65300), and supplemental ROD dated July 1996 (61 FR 6633), DOE determined procedures and processes for stabilizing stored nuclear materials, previously identified through independent reviews conducted by DOE and the DNFSB, that posed environmental, safety, or health vulnerabilities. A second

[8] Under No Action, DOE may, pursuant to appropriate NEPA review, propose to modify the Y–12 facilities or to build new facilities as necessary to ensure safe storage.

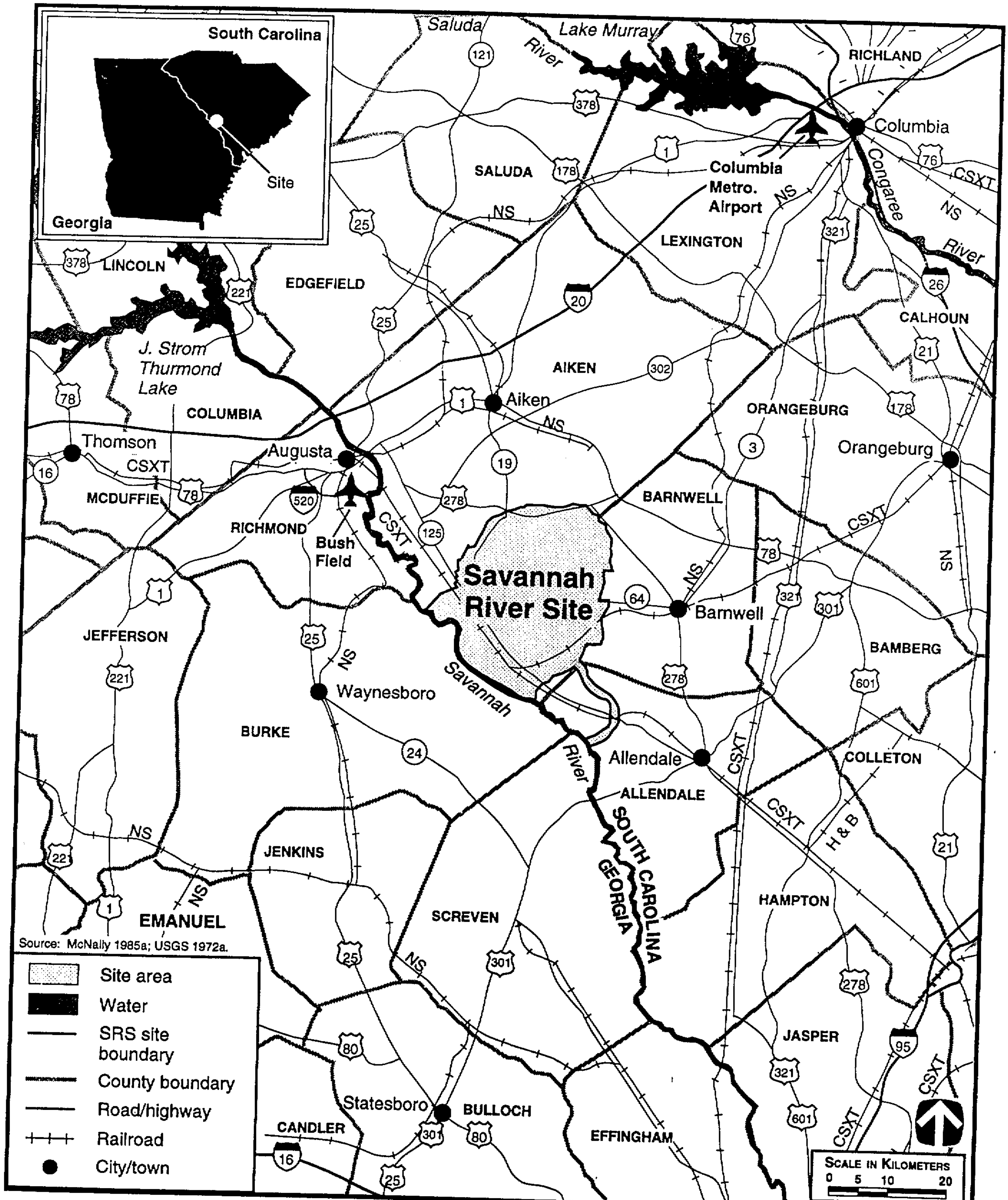


Figure 2.2.6–1. Savannah River Site, South Carolina, and Region.

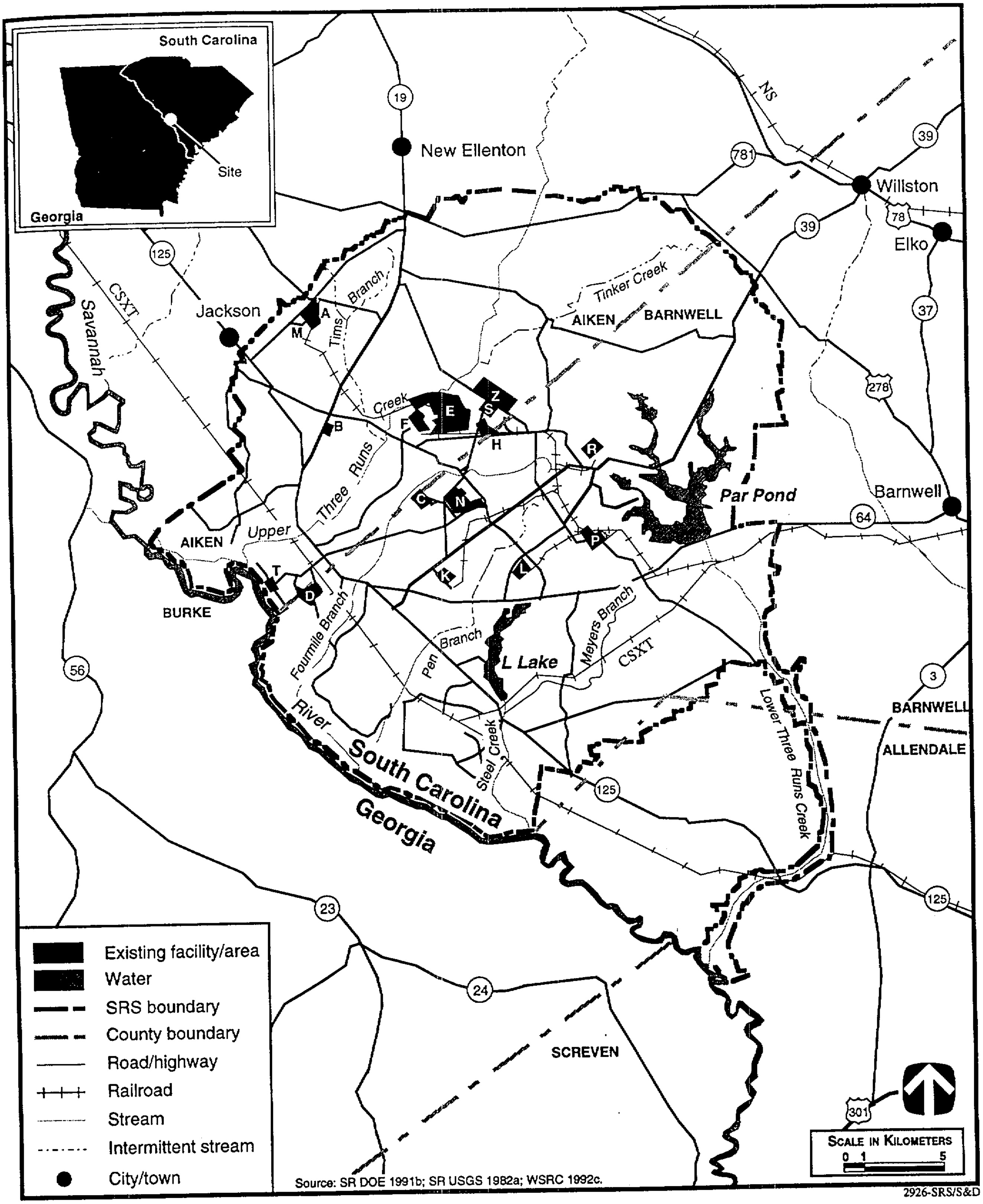


Figure 2.2.6–2. Site Designations and Principal Facilities at Savannah River Site.

supplemental ROD announcing DOE's decision for the stabilization of Pu-239 solutions by conversion to metal at F-Canyon and the FB-Line was published September 13, 1996 (61 FR 48474 through 61 FR 48479).

- *Pu-242. The Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE/EIS-0220) and the ROD dated December 12, 1995, categorized certain isotopes of Pu, neptunium, americium, and curium as programmatic. DOE has determined that the Pu-242 from SRS would be useful for future research and development activities.

- *Plutonium metal and oxide resulting from the stabilization actions at SRS.* This material would be stored in accordance with the DOE storage standard (DOE-STD-3013-94). In the ROD dated December 12, 1995, for the *Final Environmental Impact Statement, Interim Management of Nuclear Materials*, DOE decided to construct a new APSF in F-Area. This facility would enable SRS to stabilize and package Pu metals and oxides to meet storage criteria and also provide space for storage of all Pu and special actinide materials. The new facility is expected to be completed by 2001. In the interim, the Pu metals and oxides would be stored temporarily in one of the F-Area vaults.

[Text deleted.]

2.2.7 ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

Rocky Flats Environmental Technology Site, located in northern Jefferson County, Colorado (Figure 2.2.7–1), stored 12.9 t (14.2 tons) of Pu as of September 1994.[9] The Pu is in three basic forms: metals, oxides, and scrap/residues. The storage of the total Pu inventory at RFETS is within the scope of the storage portion of this PEIS. There are a small number of pits at RFETS that are surplus to national security needs but are still needed for ongoing, non-weapons-related R&D projects at LANL and LLNL. Therefore, these pits will not come within the scope of this PEIS until the R&D projects are completed. It is expected that this work will result in the transportation of these materials to LANL or LLNL, the conversion of the Pu into metal or oxide, and the return of the material to RFETS.[10] At that point, the materials will come within the scope of this PEIS and be stored and dispositioned in accordance with the decisions reached on the storage and disposition of surplus Pu in metal or oxide form. All Pu materials are stored in seven principal facilities: Buildings 371, 559, 707, 771, 776/777, 779, and 991. Site designations and principal facilities are shown in Figure 2.2.7–2.

In response to the DNFSB's Recommendation 94-1, and as addressed in the DOE *Plutonium Working Group Report on Environmental, Safety and Health Vulnerabilities Associated with the Department's Plutonium Storage*, the Pu metal and oxide at RFETS will be placed in a stable long-term (50-year) storage configuration. This storage configuration is in accordance with the DOE storage standard (DOE-STD-3013-94). DOE-STD-3013-94 does not apply to pits. In addition to the stabilization of this material, actions for resolving the Pu vulnerabilities have been identified as part of the RFETS *Site Integrated Stabilization and Management Plan*, and are being implemented.

Of the total amount of Pu in storage at RFETS, 11.9 t (13.1 tons) has been declared surplus to national security needs.[11] The amount of surplus in each of the basic forms is: metal 5.7 t (6.3 tons); oxides 1.6 t (1.8 tons); and scrap/residues 4.6 t (5.1 tons). Only a portion of the Pu is currently within the scope of this PEIS because the residues[12] are not in a weapons-usable form. Under proposed stabilization activities, all or portions of the non-weapons-usable material could be converted to a weapons-usable form.

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[9] Secretary of Energy's Openness Initiative, December 7, 1993.
[10] Under the Preferred Alternative, the RFETS material could be shipped directly from LANL or LLNL to Pantex.
[11] Secretary of Energy's Openness Initiative, February 6, 1996.
[12] Scrub alloy, ash, salts, dry residues, wet residues, and classified shapes.

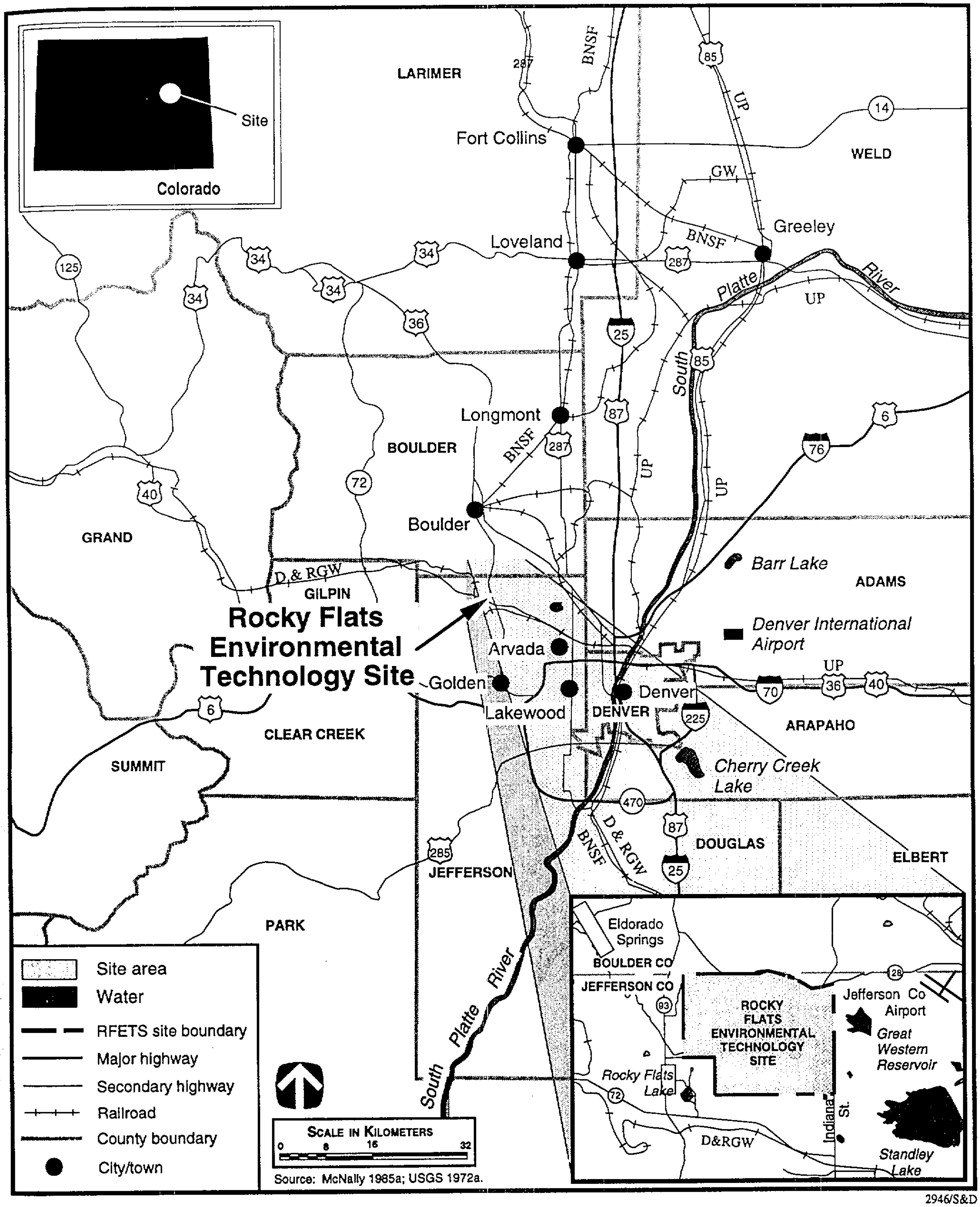

Figure 2.2.7–1. Rocky Flats Environmental Technology Site, Colorado, and Region.

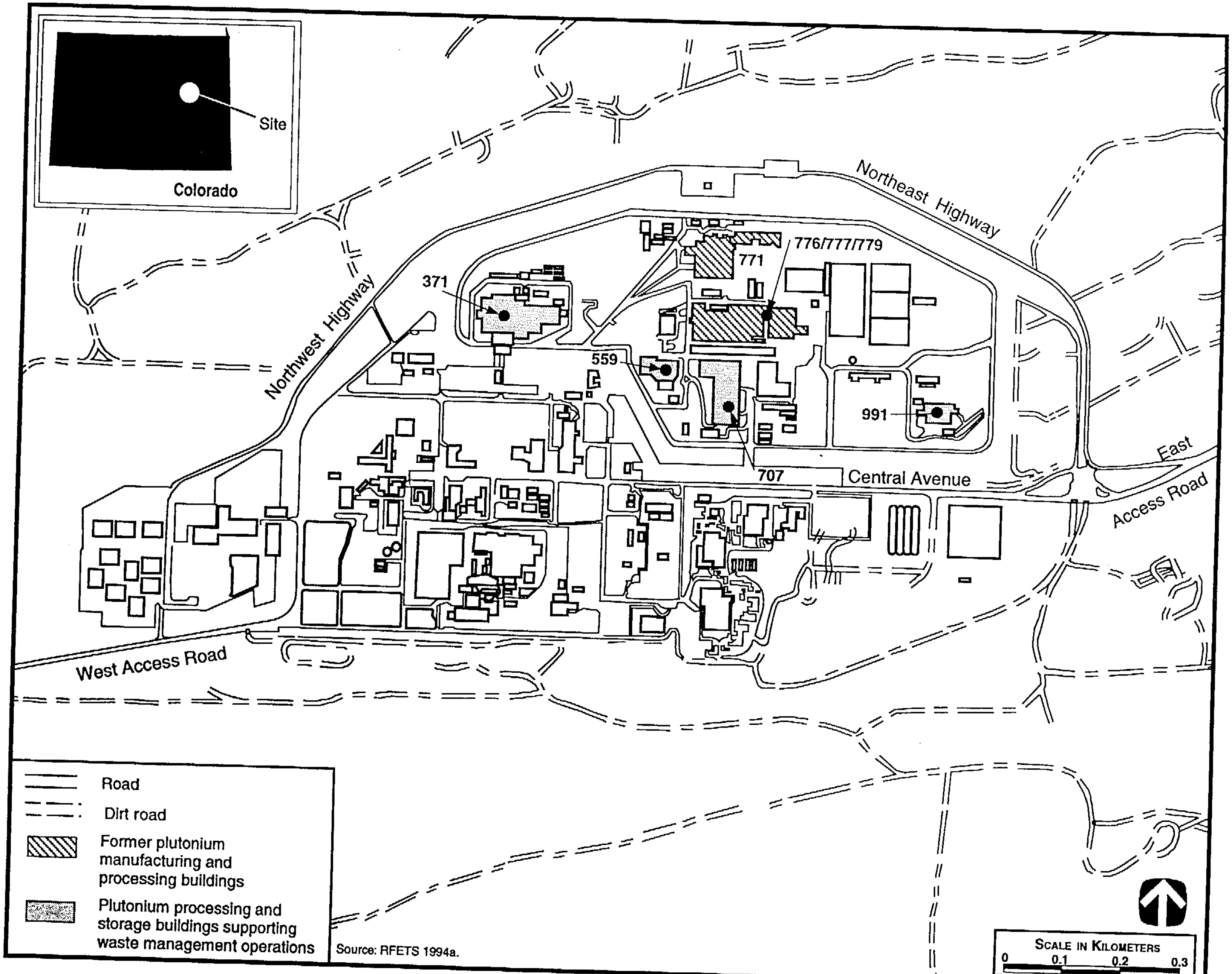

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Figure 2.2.7–2. *Site Designations and Principal Facilities at Rocky Flats Environmental Technology Site.*

Under the No Action Alternative, Pu-bearing materials at RFETS would be stabilized and converted to metal and/or oxide form and stored in existing, upgraded existing, or new facilities. Some Pu materials would be stabilized by conversion into a weapons-usable form and/or a waste form.

2.2.8 LOS ALAMOS NATIONAL LABORATORY

Los Alamos National Laboratory is located in north-central New Mexico adjacent to the town of Los Alamos, as shown in Figure 2.2.8–1. The Technical Areas (TAs) at LANL are shown in Figure 2.2.8–2. The inventory of Pu materials in storage at LANL as of September 1994, was 2.7 t (3.0 tons). This material is stored at 24 facilities and is in various physical and chemical forms, including metal, pits, fabricated weapons shapes, Pu compounds and alloys, and a broad range of scraps/residues (mostly solids). There are a number of sealed sources used for radiation instrument calibrations, neutron sources, and targets for experiments. In addition, small quantities of Pu exist in process equipment and at a few facilities within controlled access areas. Approximately 90 percent of the Pu at LANL is stored in packages located in TA-55. Of the total LANL Pu inventory, approximately 1.5 t (1.7 tons) falls within the scope of this PEIS.

Research at the TA-55 facility includes Pu recovery processes, Pu metal fabrication, Pu-238 general purpose heat source and radioisotope thermoelectric generation production, and advance fuel fabrication. Pu analytical operations are also conducted in the Chemistry and Metallurgy Research building, which has laboratories, hot cells, a waste assay facility, and a vault. The Los Alamos Critical Experiments Facility, remotely located in TA-18, uses Pu in nuclear criticality experiments.

Preferred Alternative: No Action. Under the No Action Alternative, weapons-usable Pu materials would continue to be stored in the upgraded Nuclear Material Storage Facility, in stabilized form pursuant to DNFSB Recommendation 94-1, within TA-55. Storage would be in accordance with LANL's proposed *Corrective Action Plan* for addressing ES&H vulnerabilities associated with Pu storage.

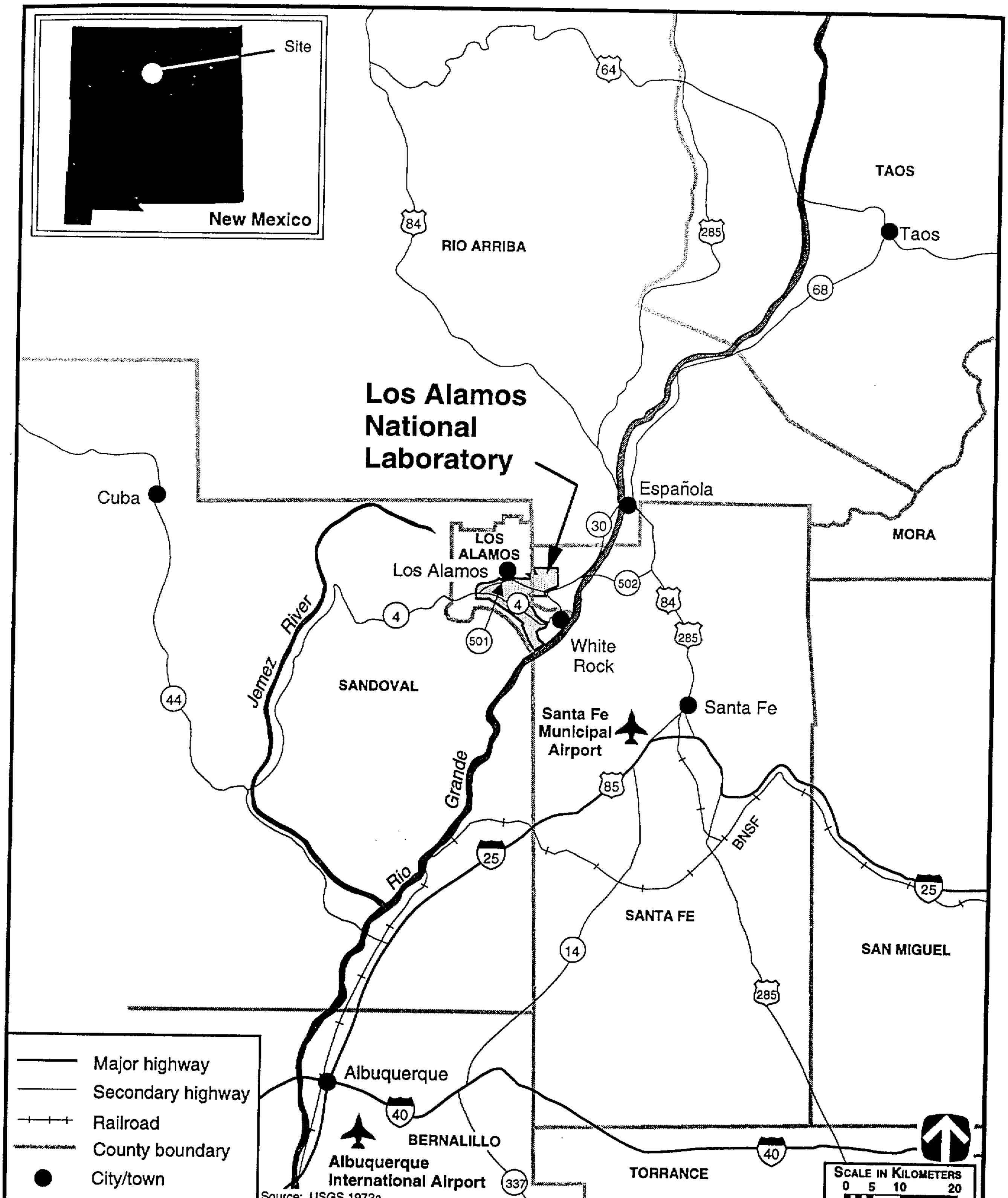

Figure 2.2.8–1. Los Alamos National Laboratory, New Mexico, and Region.

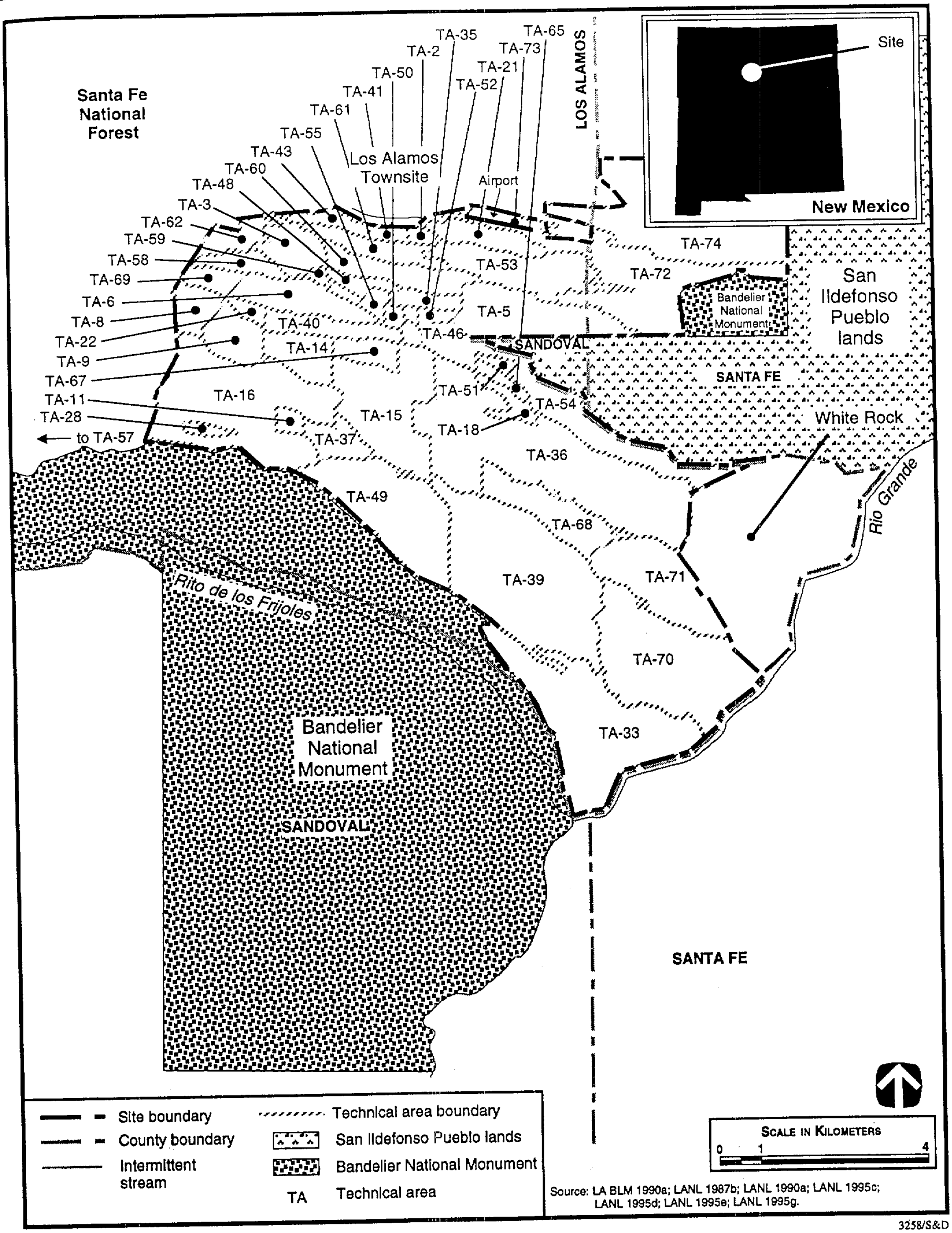

Figure 2.2.8–2. Site Designations and Principal Facilities at Los Alamos National Laboratory.

2.3 LONG-TERM STORAGE ALTERNATIVES AND RELATED ACTIVITIES

The long-term storage alternatives evaluated and discussed in this Storage and Disposition PEIS include the following:

- *Upgrade at Multiple Sites Alternative*—modify existing and/or construct new facilities at several DOE sites for continued storage of Pu and HEU; relocate all or some RFETS and LANL Pu to one or more of the Pu storage sites

- *Consolidation of Pu Alternative*—construct new facility, *or* construct new and modify existing facilities at one site for all Pu materials; modify or maintain existing HEU facilities at ORR

- *Collocation of Pu and HEU Alternative*—construct new facility, *or* construct new and modify or maintain existing facilities at one site for all Pu and HEU materials

Preferred Alternative for Storage: The Preferred Alternative for storage calls for (1) the upgrade of Zone 12 South facilities (to be completed by 2004) at Pantex to store strategic reserve pits, those surplus pits currently stored at Pantex, and pits from RFETS pending disposition; (2) the upgrade (expansion) of the APSF (planned to be built by 2001) at SRS to store those Pu materials currently at SRS, and surplus non-pit Pu materials from RFETS after stabilization is performed at RFETS; and (3) the upgrade of existing Y–12 facilities to store non-surplus HEU, and surplus HEU pending disposition.

Environmental impacts of each long-term storage alternative and the No Action Alternative are analyzed for each of the six candidate storage sites to allow the comparison of impacts by sites for each alternative and the comparison of impacts by alternatives for each site. As a result, decisions can be made to select a single storage alternative for all sites or a combination of different alternatives for different sites. In addition to the environmental analysis for storing all weapons-usable fissile materials under the scope of this PEIS under the No Action Alternative and the various long-term storage alternatives, an analysis of Pu storage without the nonsurplus materials covered under the Stockpile Stewardship and Management PEIS (strategic reserve and weapons R&D materials) is also presented. The impacts would generally be lower if these materials are not included.[13]

Conceptual facility locations for the long-term storage alternatives at Hanford, NTS, INEL, Pantex, ORR, and SRS are shown in Figures 2.3–1 through 2.3–6. [Text deleted.] Detailed descriptions of each long-term storage alternative are provided in the following sections. The descriptions, to the extent they describe new (not yet built) facilities or modifications, are based on conceptual designs and, depending on the strategy selected in the ROD, may be refined when more detailed designs become available.

2.3.1 UPGRADE AT MULTIPLE SITES ALTERNATIVE

The Upgrade at Multiple Sites Alternative includes four subalternatives. Under the first subalternative, Pu and HEU materials currently stored at five candidate DOE sites would remain in long-term storage at those sites in modified and/or new facilities. In addition, Pu material currently at RFETS and LANL, which are not candidate sites, would remain at those sites until decisions on the disposition alternatives are implemented.

The second subalternative includes relocating all or some of the Pu materials from RFETS and LANL to one or more of the upgraded long-term storage sites. For this second subalternative, all or some of the approximately 12.9 t (14.2 tons) of the Pu from RFETS Pu and 1.5 t (1.7 tons) of LANL surplus Pu material in storage would

[13] For the subalternatives that would not include strategic reserve and weapons R&D materials, a qualitative analysis for resources is presented.

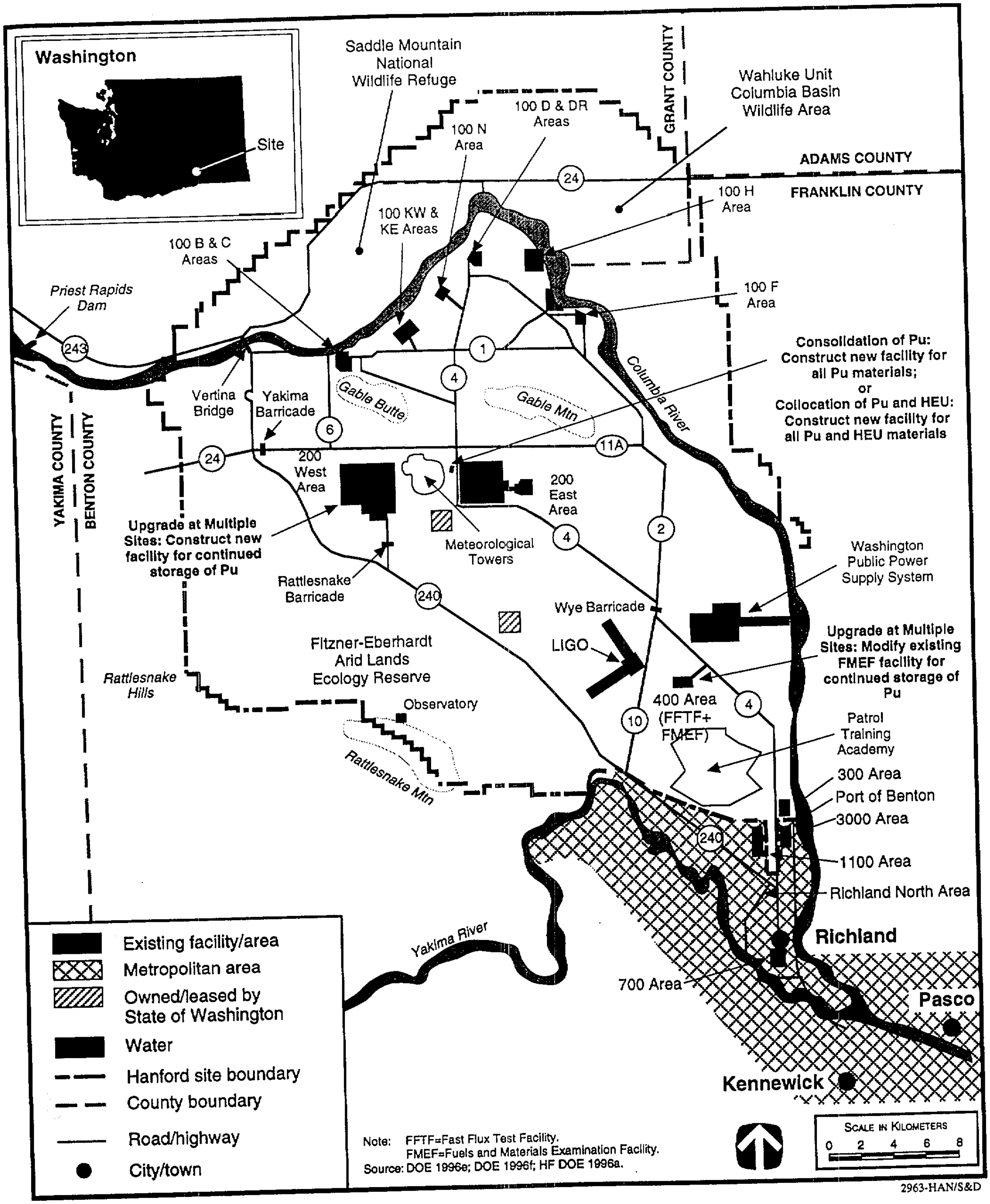

Figure 2.3–1. Conceptual Facility Locations for the Long-Term Storage Alternatives at Hanford Site.

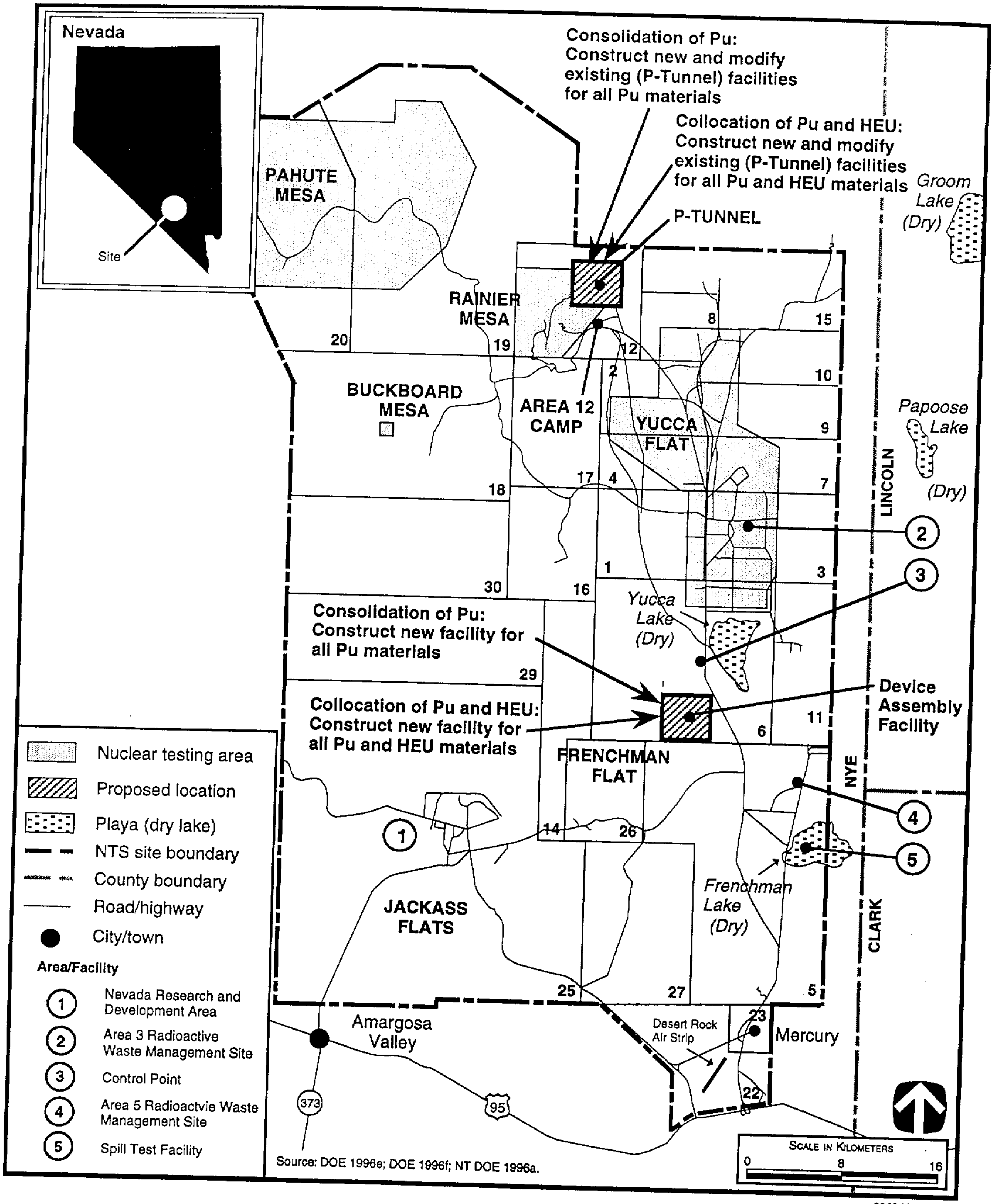

Figure 2.3–2. Conceptual Facility Locations for the Long-Term Storage Alternatives at Nevada Test Site.

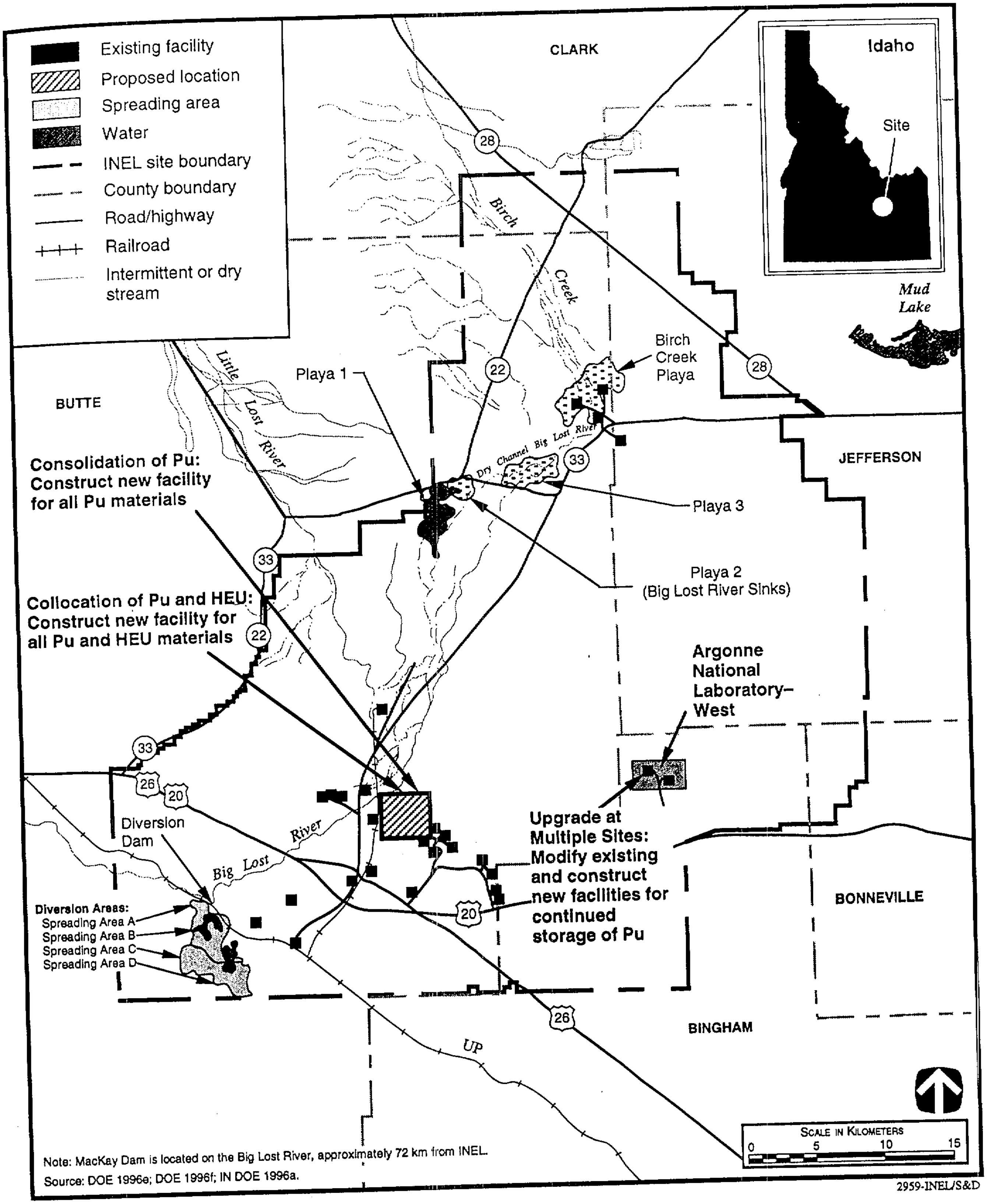

Figure 2.3–3. Conceptual Facility Locations for the Long-Term Storage Alternatives at Idaho National Engineering Laboratory.

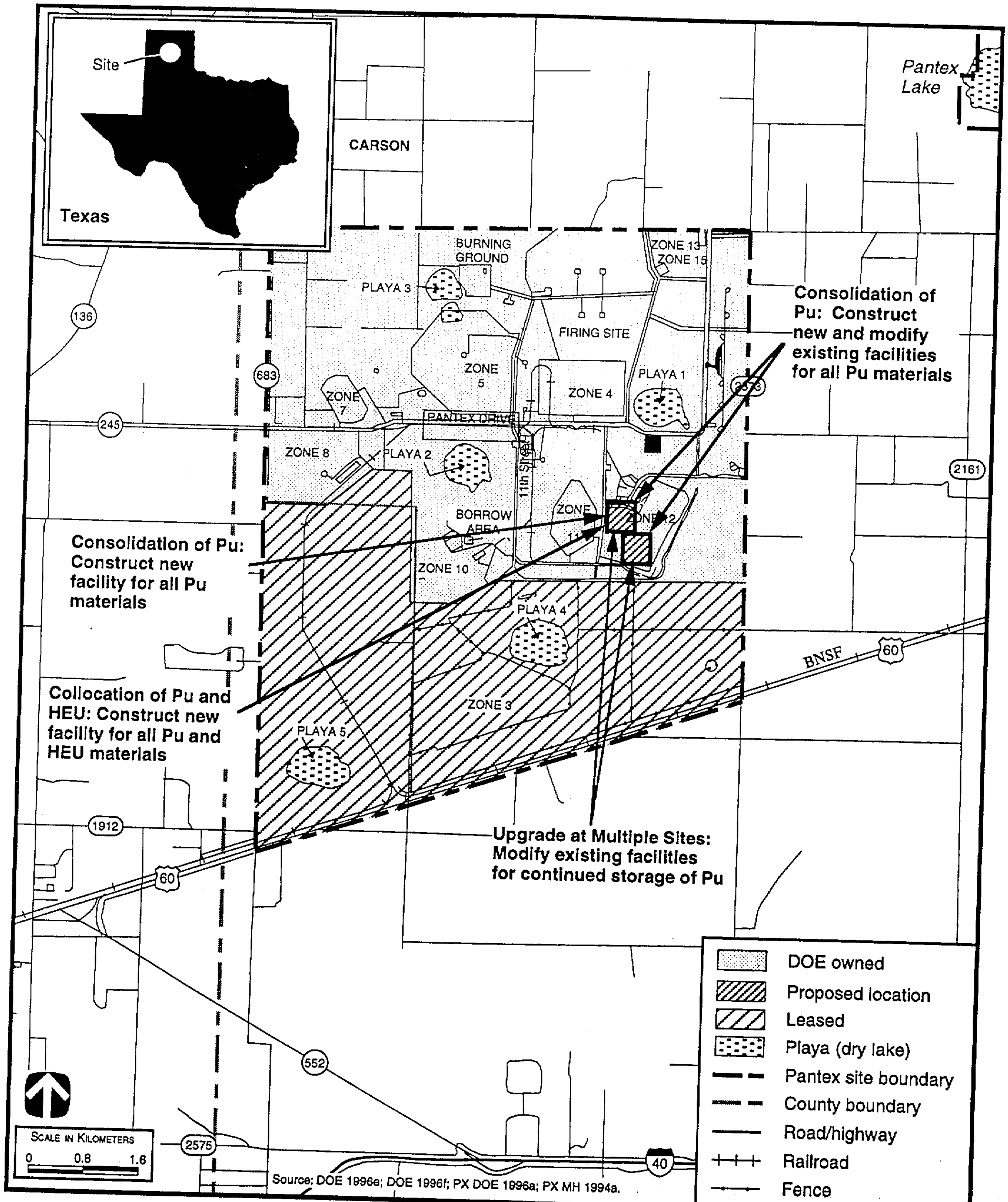

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Figure 2.3–4. Conceptual Facility Locations for the Long-Term Storage Alternatives at Pantex Plant.

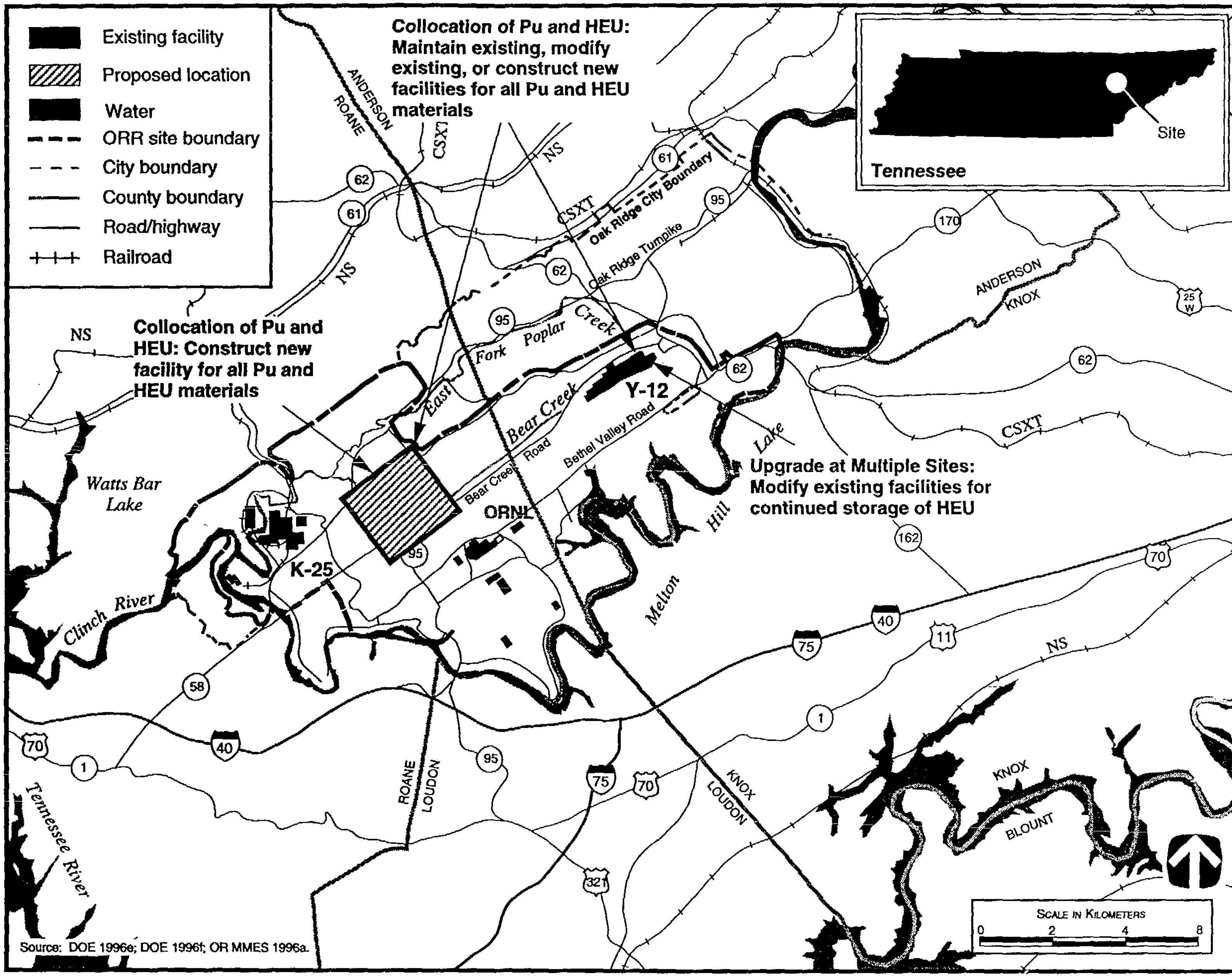

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Figure 2.3–5. Conceptual Facility Locations for the Long-Term Storage Alternatives at Oak Ridge Reservation.

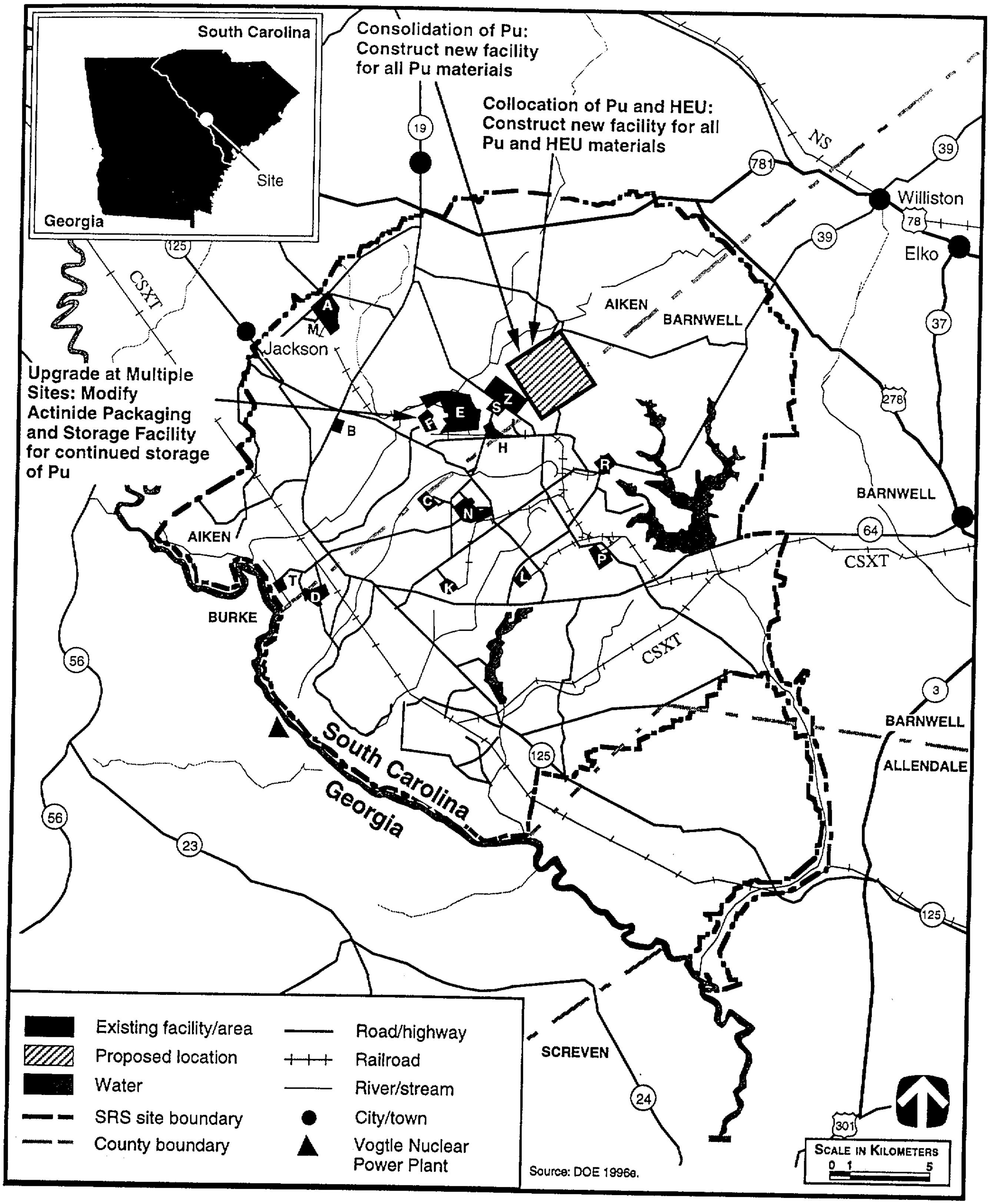


Figure 2.3–6. Conceptual Facility Locations for the Long-Term Storage Alternatives at Savannah River Site.

be relocated to one or more of the upgraded candidate sites. A summary of the long-term storage options (facility requirements) by candidate site is presented in Table 2.3.1–1 [Text deleted.]

The third subalternative includes relocating Pu pits from RFETS to Pantex with storage of surplus pits pending disposition. Transfer of pits from RFETS would begin in 1997. Pits from Pantex and RFETS would be stored in Zone 4 until the facilities in Zone 12 South have been upgraded. The fourth subalternative would include relocating non-pit Pu materials from RFETS to SRS. Facilities in the F-Area at SRS would be modified to accommodate non-pit Pu from RFETS. This subalternative involves a similar but smaller expansion of facilities in F-Area compared to the second subalternative, which includes all or some of the Pu materials from RFETS and LANL. Requirements presented in Appendices B, C, D, E, and F reflect the various Upgrade at Multiple Sites subalternatives.

Table 2.3.1–1. ***Long-Term Storage Options for the Upgrade at Multiple Sites Alternative***[a]

Candidate Site	Storage Option
Hanford	Modify Existing Fuels and Materials Examination Facility, or Construct New 200 West Area Facility for Continued Pu Storage
INEL	Modify Existing and Construct New ANL-W Facilities for Continued Pu Storage
Pantex (Preferred Alternative)	Modify Existing Zone 12 South Facilities for Continued Pu Storage
ORR (Preferred Alternative)	Modify Existing Y–12 Plant for Continued HEU Storage
SRS (Preferred Alternative)	Modify New Actinide Packaging and Storage Facility for Continued Pu Storage

[a] Proposed storage facility locations were primarily based on optimal use of existing facilities and are in accordance with current site development and utilization plans and proposals.

In addition to the environmental analysis performed for storing all weapons-usable fissile materials within the scope of this PEIS under this alternative, an analysis of the long-term storage of Pu and HEU without those nonsurplus materials covered under the Stockpile Stewardship and Management Final PEIS (strategic reserve and weapons R&D materials) is also presented as a subalternative to the Upgrade at Multiple Sites Alternative.

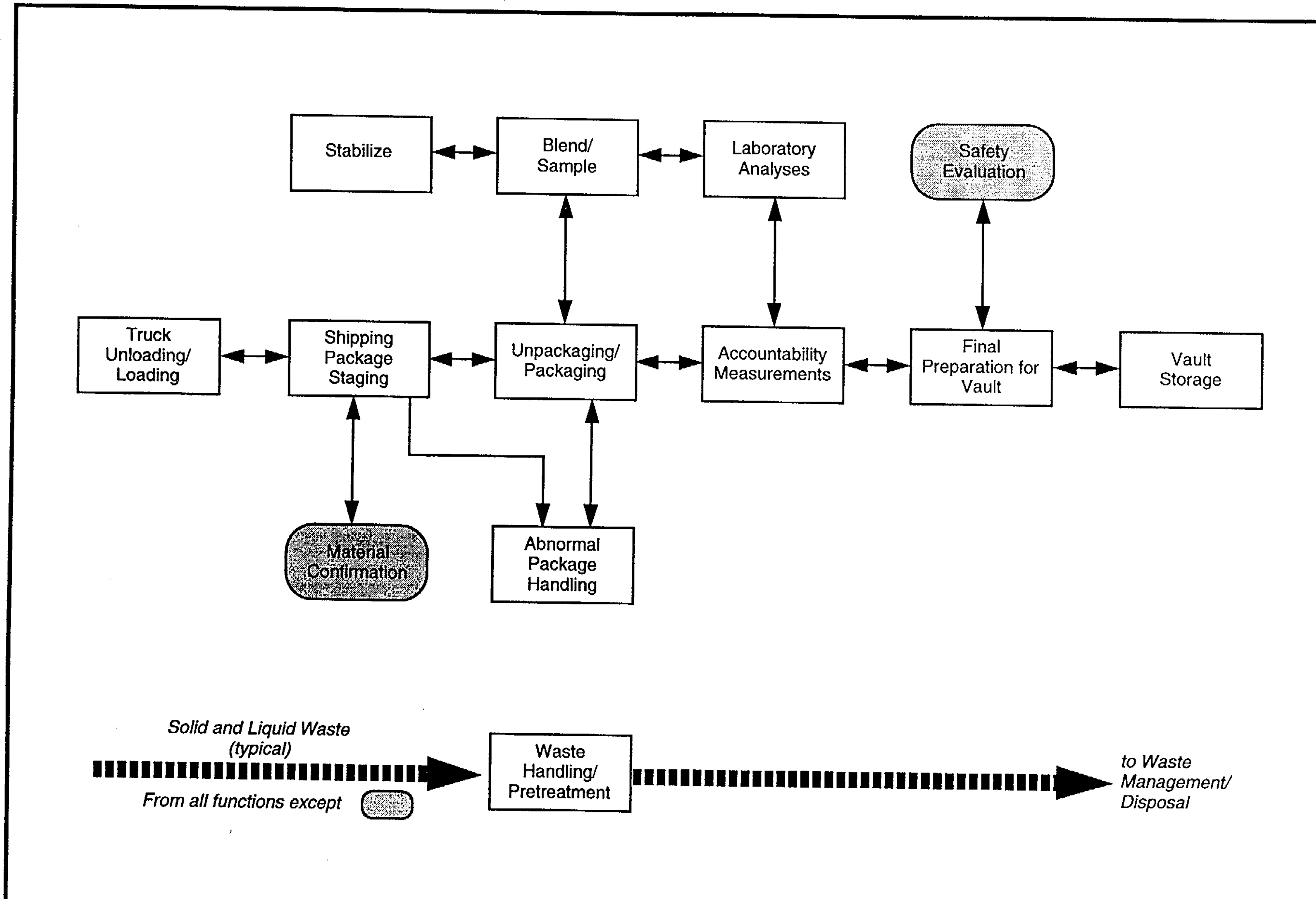
[Text deleted.]

Facility construction and operations data for the Upgrade at Multiple Sites Alternative at Hanford, INEL, Pantex, ORR, and SRS are listed in Appendix B, *Building and Facility Specifications*; Appendix C, *Materials, Resources, and Employment Requirements for Construction and Operations*; Appendix D, *Water Usage*; Appendix E, *Waste Management*; and Appendix F, *Air Quality and Noise*.

Hanford Site

Three options for onsite long-term storage of approximately 4 t (4.4 tons) of Pu materials were identified for the Hanford Site Upgrade Alternative. These include modifying current facilities at the PFP, modifying the as yet unused Fuels and Materials Examination Facility (FMEF), and constructing a new Pu storage facility. All three options appear realistically feasible and similar in total lifecycle cost. However, since lifecycle costs are similar, the PFP modification option was not specifically analyzed because of the potential difficulties associated with construction work within the PFP facility area and the risk of uncovering unexpected contamination during the modification activities. This leaves two options for consideration in this PEIS. The first option is to modify the existing FMEF. The second option is to upgrade Hanford's storage capability through new construction. The operational flow diagram is shown in Figure 2.3.1–1.

Modify Fuels and Materials Examination Facility. This option would utilize certain areas within the existing but as yet unused six-level, 18,600-square meter (m^2) (200,000-square foot [ft^2]) FMEF located in the 400 Area at Hanford (Figure 2.3–1). Figure 2.3.1–2 shows the plan view of the FMEF and surrounding buildings in the 400 Area. This location has a protected area with all required security features and necessary support utility



Note: Includes functions associated with Pu oxide.
Source: HF DOE 1996a.

3130/S&D

Figure 2.2.1-1. Operational Flow Diagram for the Upgrade Alternative at Hanford Site

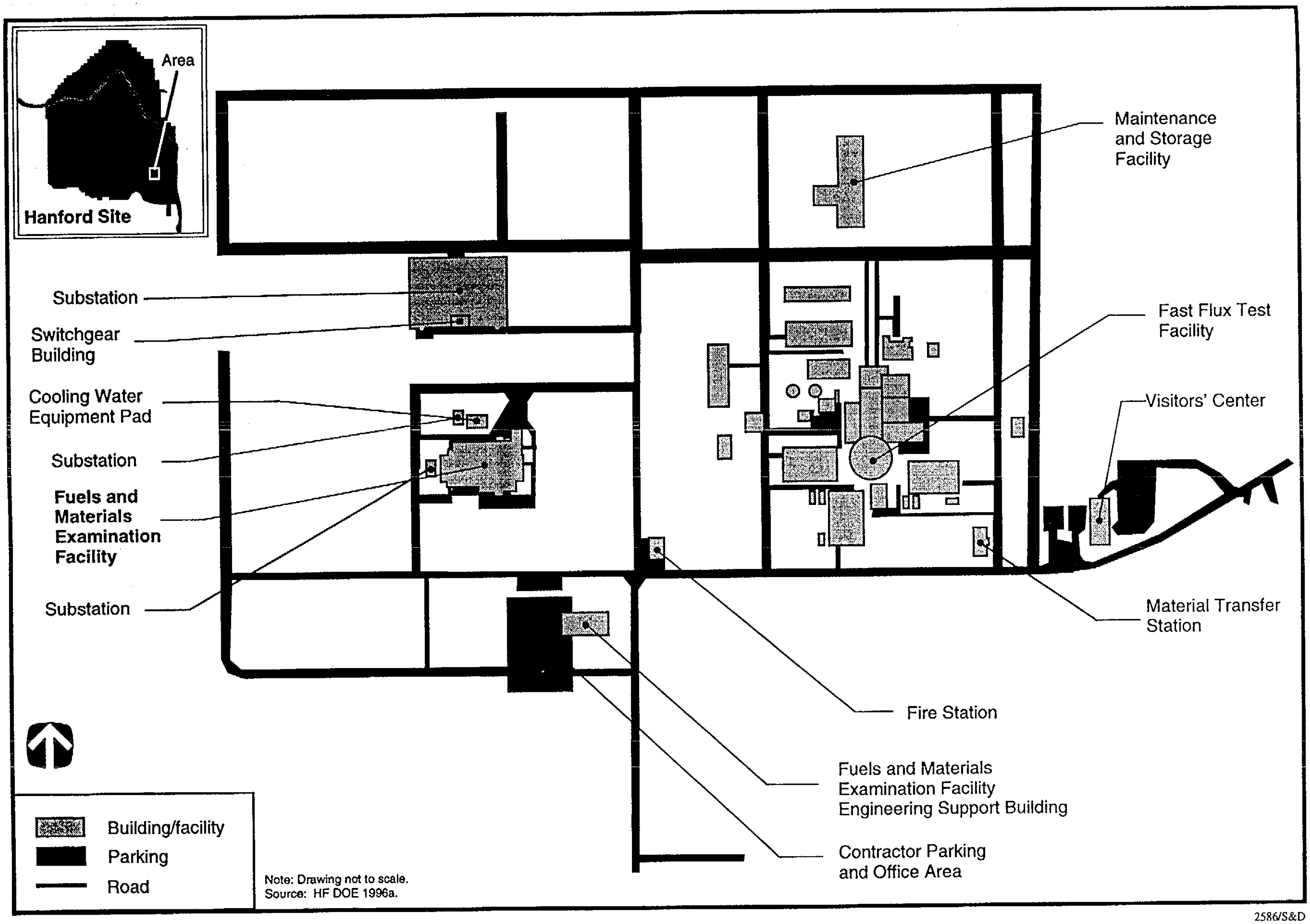


Figure 2.3.1–2. Location of Fuels and Materials Examination Facility in 400 Area at Hanford Site (Plan View).

services.The hardened outside walls of this facility are made of reinforced concrete and are designed to resist the forces of tornadoes and seismic events considered possible at Hanford. Modifying the FMEF would require minor demolition and stripping of some existing structures and utilities, and the possible addition of more radiation shielding. General renovation of laboratory areas would occur along with the addition of new equipment. Supporting office facilities would be provided in Buildings 4862 and 4706. A crane maintenance loft would be added, along with shielding and security hardening.

Secured storage vault space would utilize the FMEF main and decontamination cells within the 427 Building. The main cell would be modified to provide a vertical rack storage area. Shipping and receiving and other primary support functions would be housed in areas within the facility's hardened boundary. Utilization of the FMEF for the Upgrade Storage Alternative would not preclude its use to also support Pu disposition activities for either reactor or immobilization alternatives. This structure would meet all requirements of DOE O 430.1, *Life-Cycle Asset Management*, for Pu storage and handling. Pu handling capability would be accommodated by about 12 to 15 new gloveboxes in the hardened portion of the structure. These gloveboxes could also be used to directly support the Pu disposition operations. Modifications to the FMEF for storage would not preclude use of the FMEF for MOX fuel fabrication for the disposition alternatives.

Construct New Facility. Under this option, DOE would construct and operate a new two-story, stand-alone facility that would provide secured long-term vault storage as well as hardened and nonhardened long-term storage support space in a single building. The hardened portion of the facility walls and the vault walls would be made of reinforced concrete. Maintenance, utilities, process support, and access to the secured vault would be on the first floor. The second floor would house exhaust fans, filters, and the space for laboratory support.

The new long-term storage facility would be located adjacent to the current PFP protected area (PA) boundary in the 200 West Area at Hanford. Figure 2.3.1–3 shows the plan view of the proposed location for the new Hanford Pu storage facility in relation to surrounding buildings at the 200 West Area. This location has the advantage of allowing utilization of the existing secured PA, fences, and guards. In addition, movement of material from the present vaults into the facility would be more secure because of the collocation of vault facilities.

Support activities would be housed in the nonhardened portion of the new structure. These would include nonhardened utilities, offices for operations staff, and change areas. Existing Hanford facilities would be utilized for all required waste storage, handling, and disposal operations.

Nevada Test Site

This alternative does not apply at this site because neither Pu nor HEU is stored at existing facilities at NTS. Therefore, no facility is identified to be modified for continued storage of either material.

Idaho National Engineering Laboratory

The upgrade alternative at INEL would modify existing and construct new facilities for long-term storage of Pu located within the existing ANL-W facility at INEL as shown in Figure 2.3–3. The upgrade would be accomplished by constructing a new 2,650-m^2 (28,500-ft^2) material-handling building to augment existing buildings that would be modified for long-term storage and storage support. In addition, existing balance-of-plant (BOP) facilities at INEL would be used for support functions. The material handling, long-term storage, and storage support functions for the ANL-W upgrade would be provided by modifying Building 704 for long-term material storage, modifying Buildings 774 and 775 for storage support, and providing a new material handling building. The buildings would be interconnected by a new material transfer access corridor, with material handling lines and flow paths contained within one Materials Access Area (MAA). Figures 2.3.1–4 and 2.3.1–5 show the plan views of the ANL-W storage buildings in relation to the ZPPR building and other support buildings. The operational flow diagram is shown in Figure 2.3.1–6.

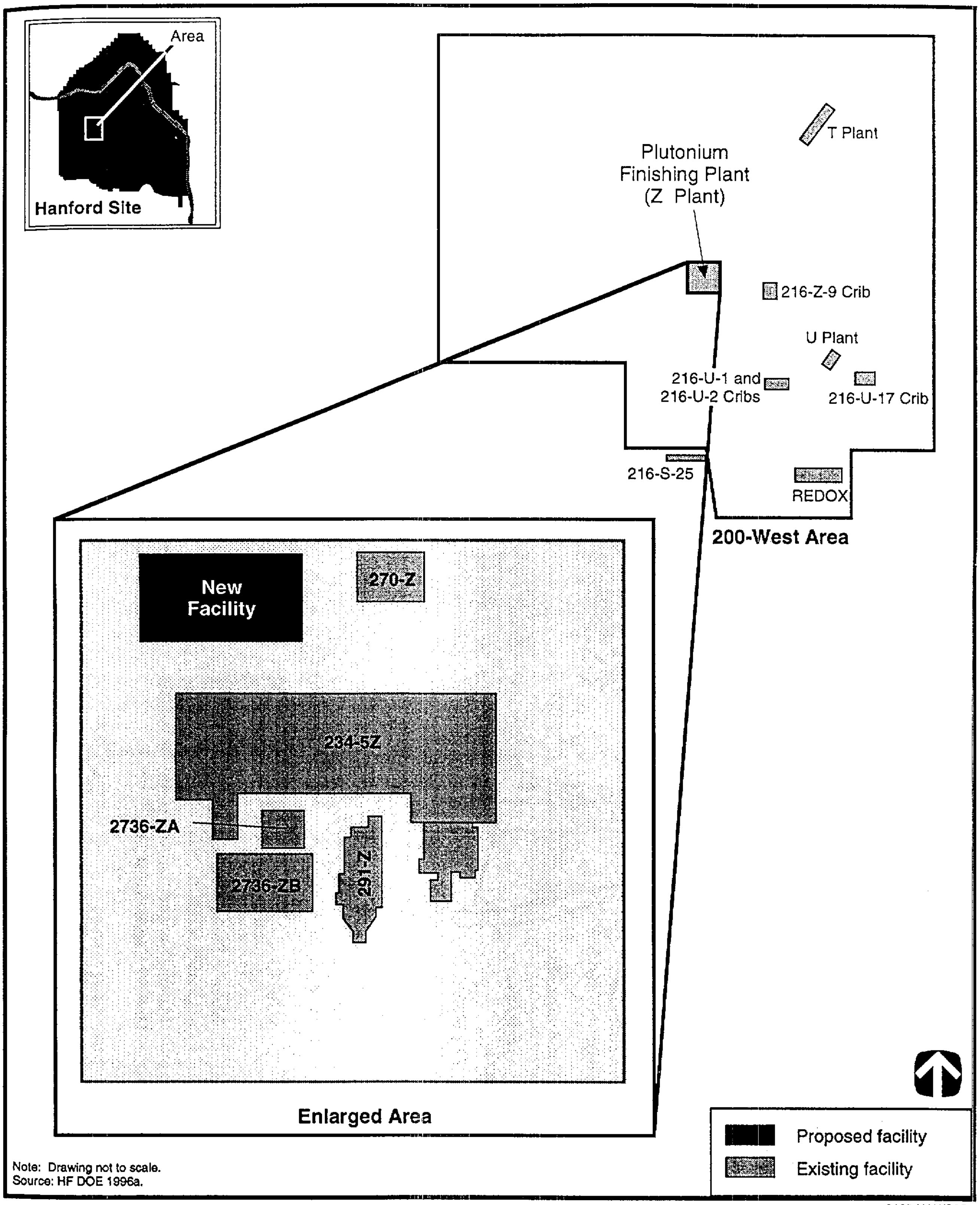


Figure 2.3.1–3. Proposed New Plutonium Storage Facility at Hanford Site (Plan View).

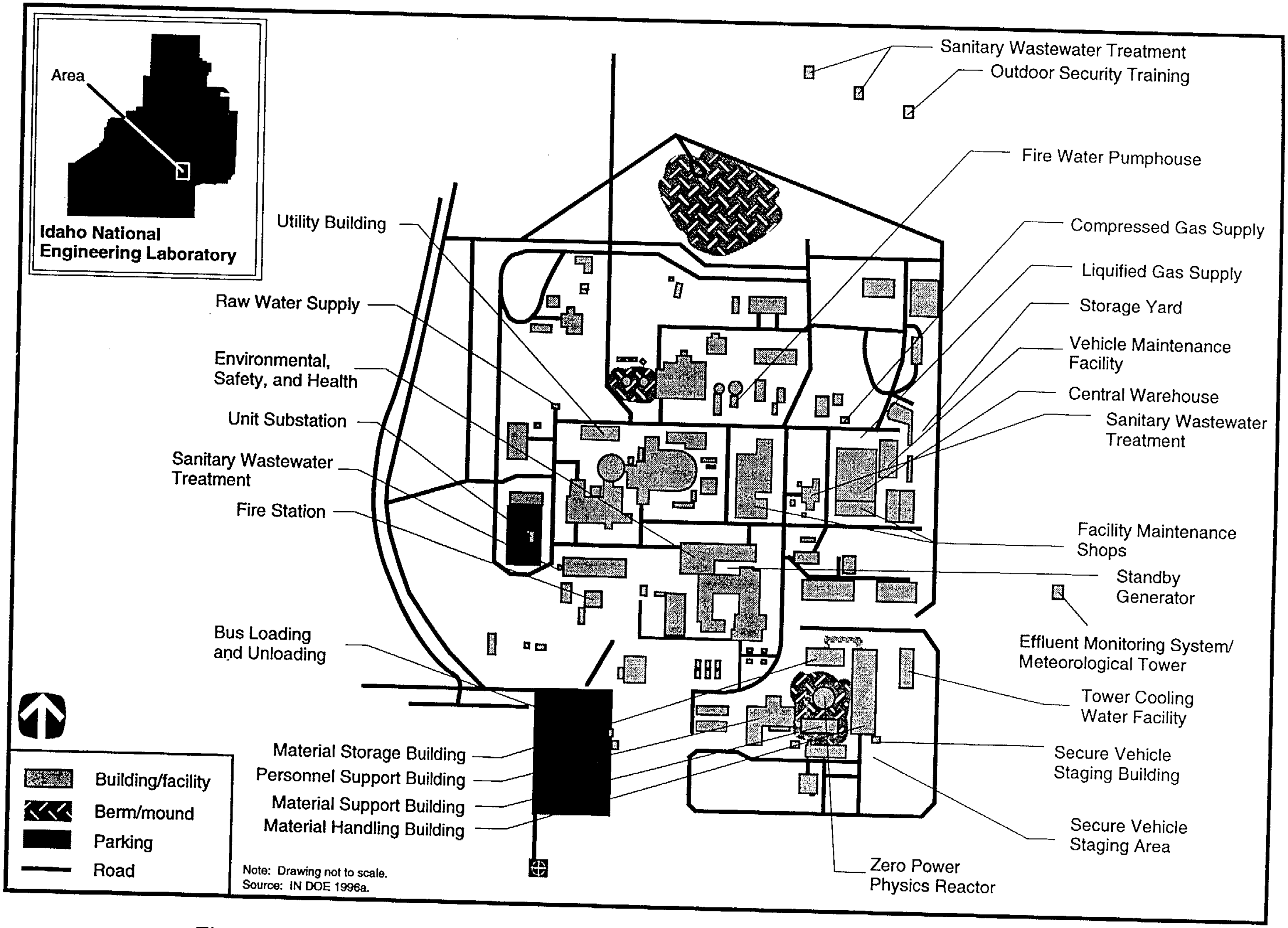


Figure 2.3.1–4. Proposed Plutonium Storage Upgrade at Idaho National Engineering Laboratory, Argonne National Laboratory-West (Plan View).

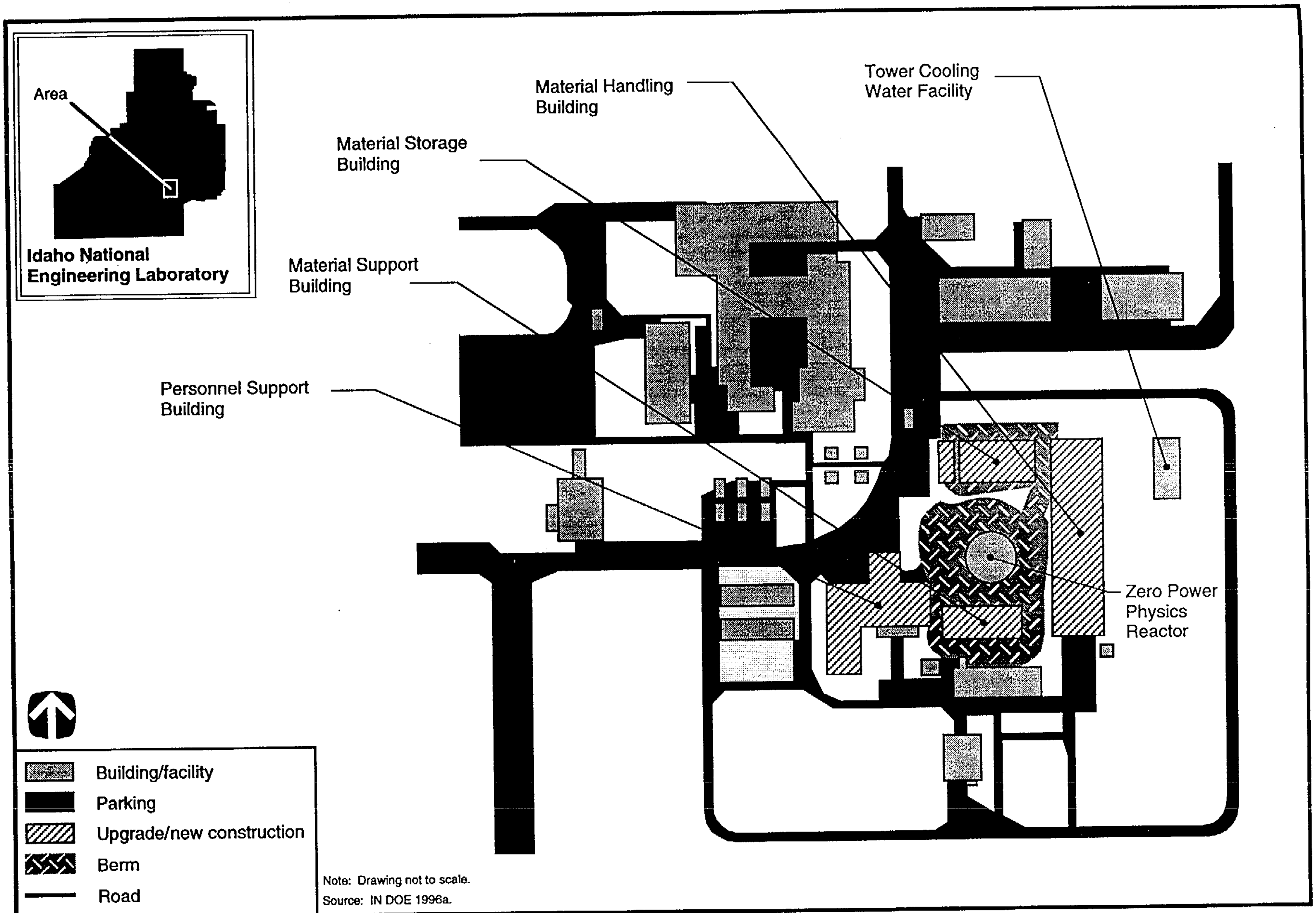
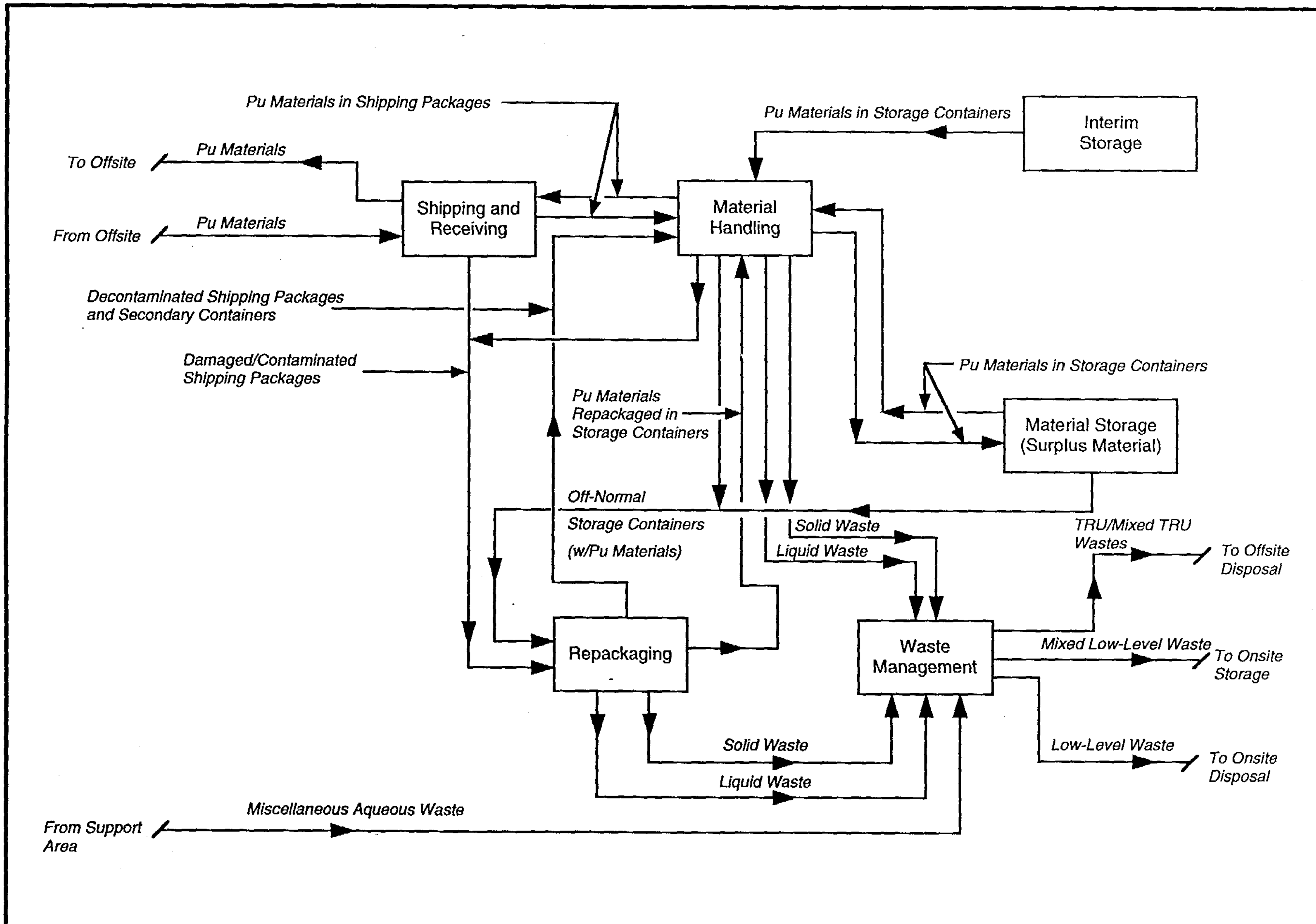


Figure 2.3.1–5. Large Scale View of the Proposed Plutonium Storage Upgrade at Idaho National Engineering Laboratory, Argonne National Laboratory-West (Plan View).



Source: IN DOE 1996a.

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Figure 2.3.1–6. Operational Flow Diagram for the Upgrade Alternative at Idaho National Engineering Laboratory, Argonne National Laboratory-West.

Pantex Plant

The upgrade alternative at Pantex would modify existing facilities in Zone 12 South. This alternative takes advantage of projected upgrade to support, security, and infrastructure systems for the assembly/disassembly operations at Pantex. The proposed location for this long-term storage option is shown in Figure 2.3–4. The modifications for long-term storage would be integrated into the Pantex infrastructure, security, waste, and assembly/disassembly operations systems. Upgrades of the Pantex assembly/disassembly operations include the upgrade of all support, security, and infrastructure systems needed for Pu storage operations. Therefore, the Pu storage upgrade is incremental to other planned upgrades at Pantex, and no additional upgrades of support systems beyond those identified for Pantex assembly/disassembly operations upgrade would be required. Figure 2.3.1–7 shows the plan view of the existing buildings in Zone 12 South (12-66 and 12-82 primarily) that would be modified for the Upgrade Alternative. The operational flow diagram is shown in Figure 2.3.1–8.

The modified facilities would provide staging capabilities to receive and ship approximately 3,000 shipping packages per year. The staging facility would include automated handling equipment to reduce radiation exposure. The long-term storage vault would be a modular design. It would incorporate remote operations to reduce the radiation exposure to personnel and enhance safeguards for the material. The vault would have a storage capacity of approximately 20,000 surplus material positions and approximately 5,000 nonsurplus material positions.[14]

In keeping with the primary objective to provide safe, secure, environmentally sound, and long-term storage of Pu pits from nuclear weapons, the upgrade would divide operations into three primary systems: a shipping/receiving and packaging system, a long-term storage vault system, and an abnormal package handling system. Currently, Pantex possesses the capability to overpack failed pit containers for offsite remediation. Under the preferred alternative, pits from RFETS would be stored similar to those currently stored at Pantex. No additional capability would be required to overpack failed pit containers since this capability already exists at Pantex. No capability exists for onsite remediation or overpacking of metal and oxide containers.

The majority of the pits at RFETS are already in a shippable form. For the small number of pits that are not currently in shippable condition, DOE would place these pits in a shippable condition prior to shipment to Pantex, in accordance with existing procedures. All of these pits are types which are currently stored at Pantex or have been stored there in the past. No capability exists for onsite remediation or overpacking of metal and oxide containers. If RFETS and/or LANL metal and oxide materials were moved to Pantex, processing equipment and space would be provided at Pantex to add the capability to either remediate or overpack any failed metal and oxide containers.

Preferred Alternative: Upgrade with RFETS Pu Pits Subalternative. The Upgrade with RFETS Pu Pits Subalternative would transfer Pu pits from RFETS to Pantex with storage of surplus pits continuing until disposition. Pits to be transferred would be packaged in FL (Type B) containers at RFETS before shipment and, upon receipt at Pantex, would be repackaged into AL-R8 containers in Zone 12 South and placed into storage in Zone 4 West pending availability of AT-400A containers and relocation to upgraded storage facilities in Zone 12 South. Storage of Pantex pits at Zone 4 West is analyzed in the Pantex EIS and storage and intrasite transportation of RFETS pits at Zone 4 West are described in Appendix Q. The intersite transportation analysis for shipment of the RFETS Pu to Pantex is given in Section 4.4 of this PEIS for both workers and the public. The transportation of existing Pantex pits between Zone 4 and Zone 12 and the repackaging of the pits from AL-R8 to AT-400A containers is analyzed in the Pantex EIS.

[14] A storage position is a volume defined by the dimensions 45.7 centimeters (cm) x 45.7 cm x 61 cm (18 inches [in] x 18 in x 24 in).

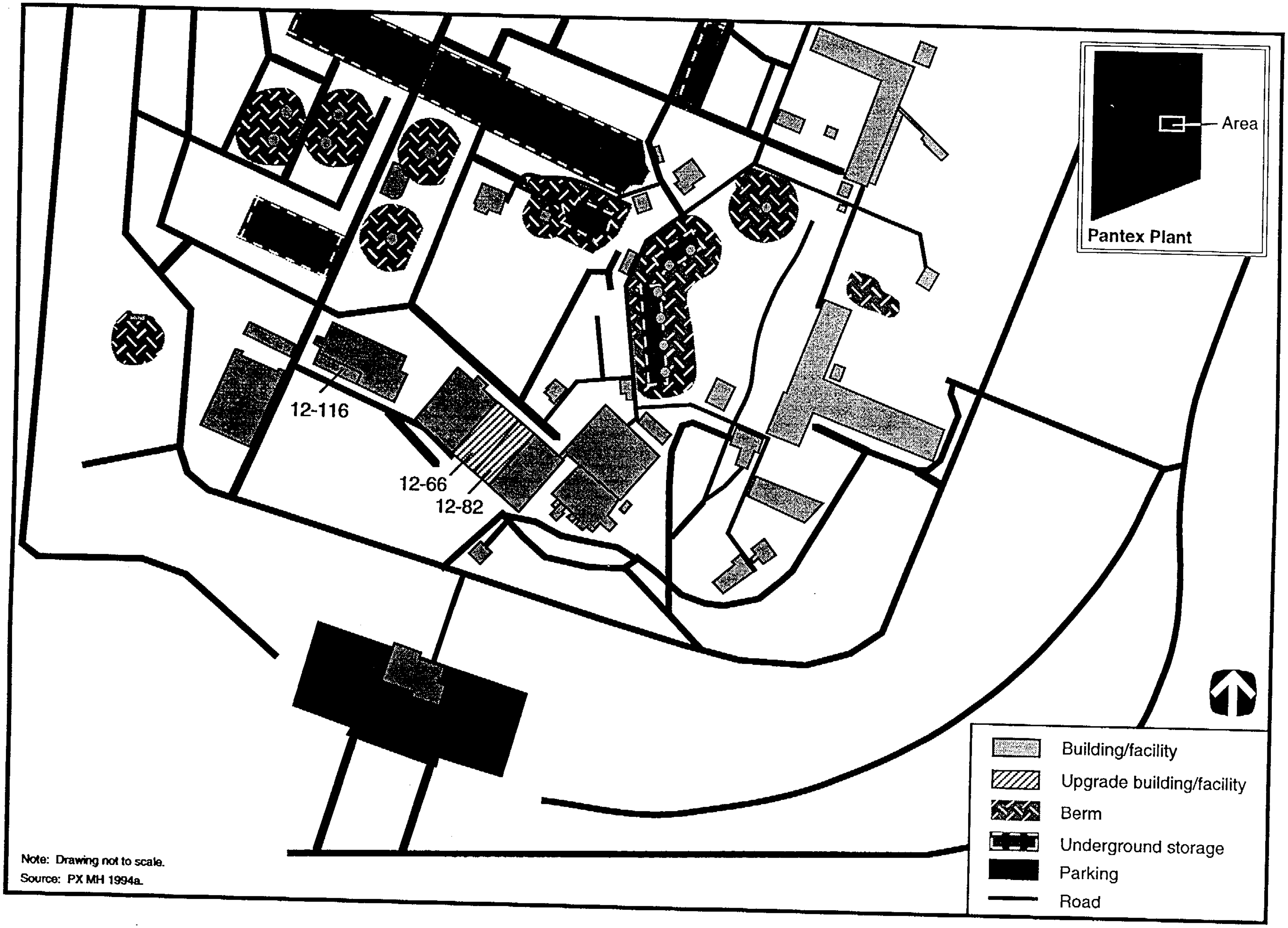


Figure 2.3.1–7. Proposed Plutonium Storage Upgrade at Pantex Plant, Zone 12 South (Plan View).

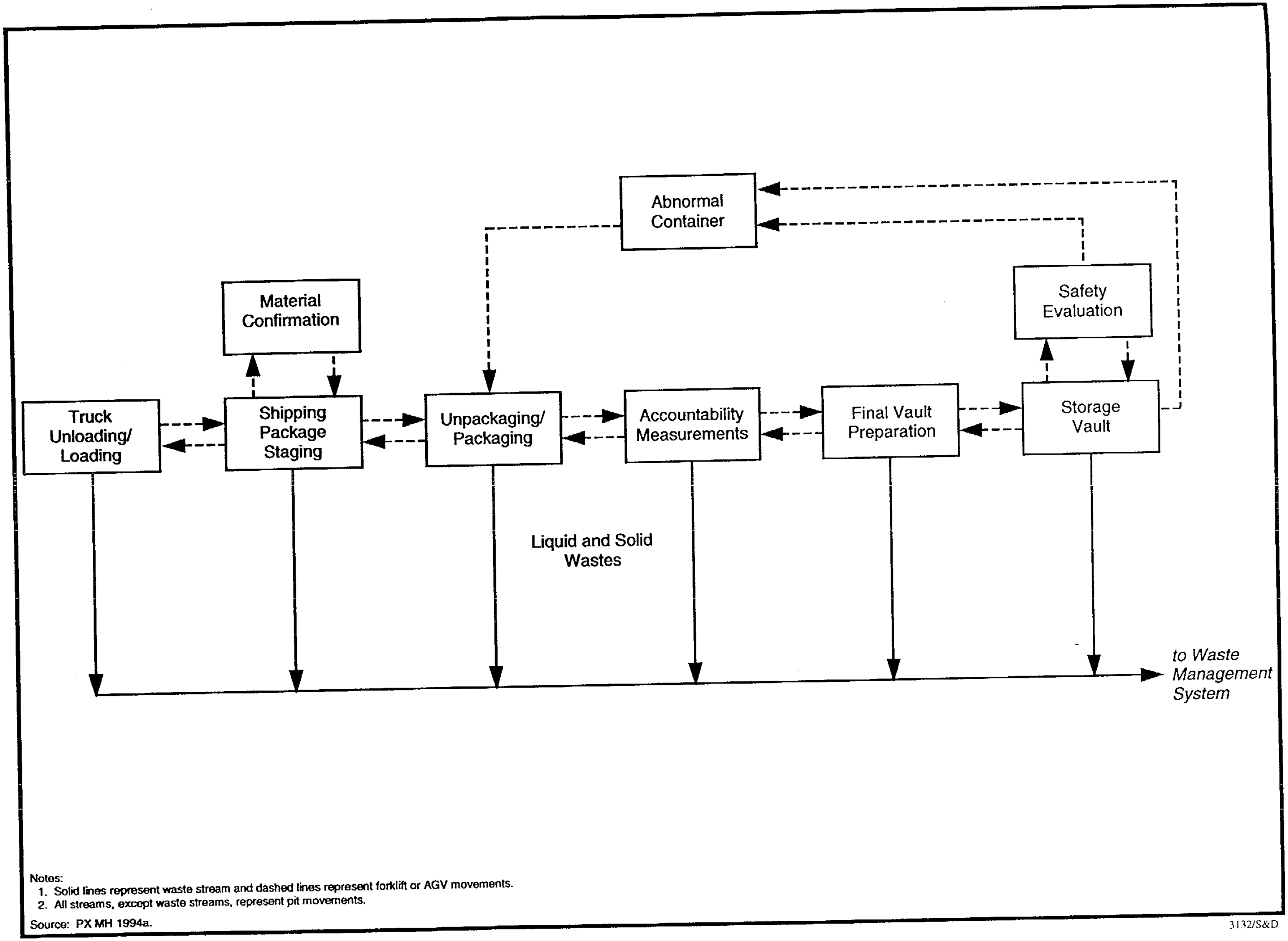


Figure 2.3.1–8. Operational Flow Diagram for the Upgrade Alternative at Pantex Plant.

Oak Ridge Reservation

Preferred Alternative: Upgrade. Under the Upgrade Alternative, the entire HEU inventory requiring long-term storage would be stored at Y–12 in modified existing facilities as shown in Figure 2.3–5; no new facilities would be built. The majority of the HEU would be housed in facilities currently used for HEU storage. The remaining HEU would be stored in facilities that were formerly used for material processing, but are currently being modified and converted into storage areas. Modifications to existing buildings that would be required to make the facilities suitable for long-term storage consist primarily of those upgrades required to meet natural phenomena requirements as documented in *Natural Phenomena Upgrade of the Downsized/ Consolidated Oak Ridge Uranium/Lithium Plant Facilities* (Y/EN-5080, 1994) and the Y–12 EA as follows:

- Building 9204-2: Seventeen concrete beams supporting the second floor need strengthening by the addition of steel beams. The steel beams would be placed directly below the existing columns, and grout packed between the concrete and the steel beams. All of the crane bay columns located on column lines J and K would be strengthened by adding concrete to the outside face of the columns. Shear walls to brace eight large columns between the first and second floors would also be provided.

- Building 9204-2E: The metal roof deck needs to be tack welded to existing purlins, and additional roof scuppers added.

- Building Complex 9212/9995: Modifications would be made to numerous columns, knee braces, and cross braces to provide proper stiffness and load distribution. Building 9995 in this Complex is structurally unique, and the structural frame needs to be strengthened with additional vertical braces; struts need to be welded to the roof beams and then bolted to the walls to provide out-of-plane support.

- Building Complex 9215/9998: Roof bracing would be added to the penthouse and columns and beams strengthened by adding steel plates to them. Also, the roof deck would be tack welded to existing purlins, and additional corners and scuppers provided.

Figure 2.3.1–9 shows existing buildings at Y–12 that are proposed to be converted to long-term storage space for HEU.[15]

The material arriving at Y–12 (pursuant to the Y–12 EA) includes both surplus and nonsurplus HEU. Under the Upgrade Alternative, nonsurplus HEU would be retained in long-term storage. Surplus HEU would remain in interim storage at Y–12 until removed for disposition, as addressed in the HEU Final EIS. As the surplus HEU material is dispositioned over time, the total amount remaining in interim storage at Y–12 would decrease. As a result, environmental impacts associated with storing HEU materials at ORR would decrease as well.

Savannah River Site

Under the Upgrade With All or Some RFETS Pu and LANL Pu Material Subalternative, SRS would expand the APSF, which will be located north of the 235-F Building and east of the 247-F Building in F-Area as shown in Figure 2.3–6. The APSF will be a new building planned for completion by 2001. Thus, the Draft PEIS described this Upgrade Alternative as "construct a new long-term storage facility." DOE decided to construct the APSF in the ROD associated with the *Interim Management of Nuclear Materials Final Environmental Impact Statement* (DOE/EIS-0220). Therefore, the Upgrade Alternative is more correctly described in this Final PEIS as an expansion of the APSF. The expansion would provide up to approximately 4,100 additional long-term storage

[15] The Department is pursuing the Stockpile Management Restructuring Initiative, which includes, among other things, the preparation of a Conceptual Design Report for these structural modifications. Approval of the Conceptual Design Report would result in budget funding request(s) for line item project(s) for some or all the structural upgrades described above.

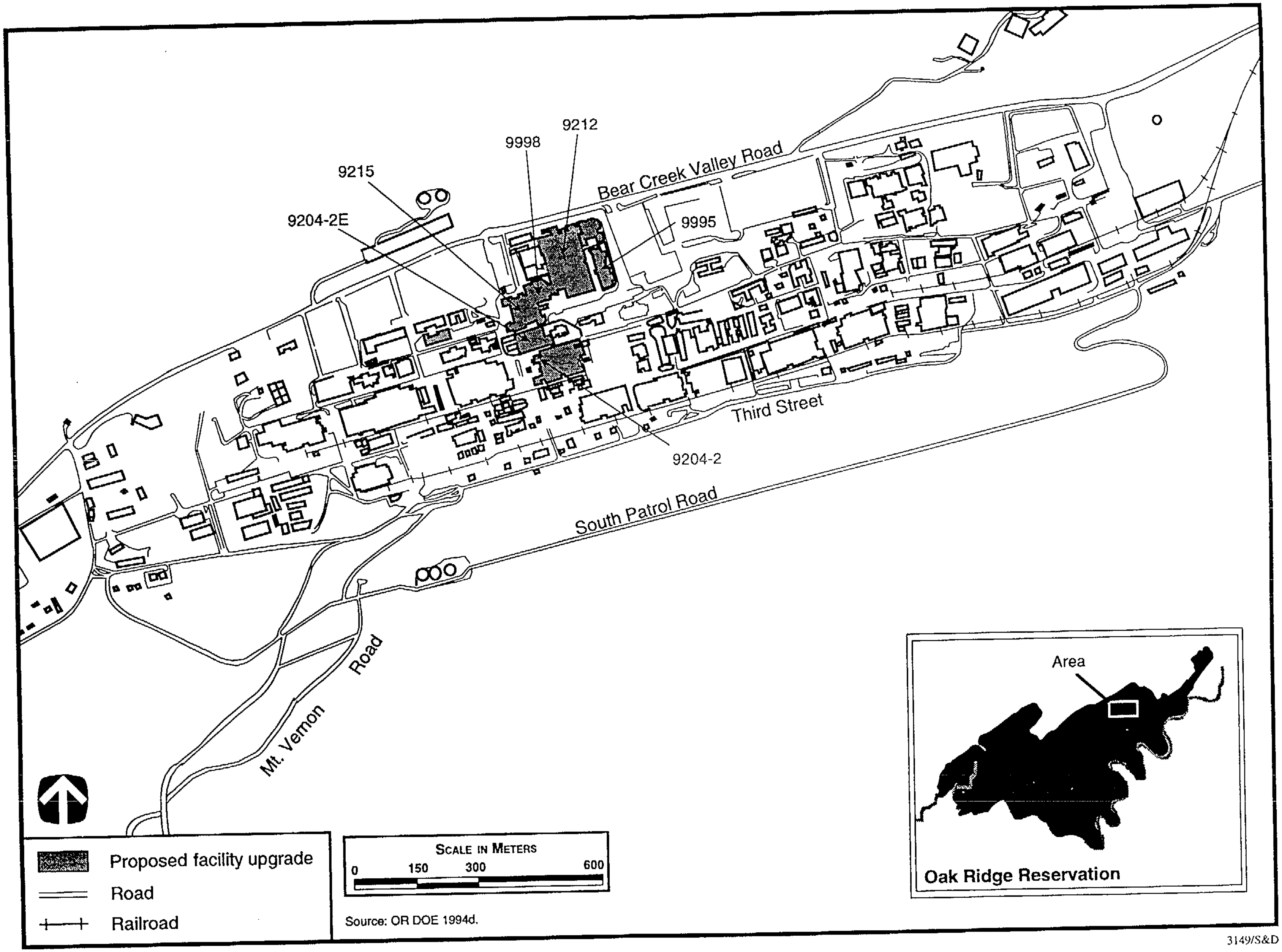


Figure 2.3.1–9. Proposed Highly Enriched Uranium Storage Upgrade at Oak Ridge Reservation, Y–12 Plant (Plan View).

positions for Pu material potentially relocated from RFETS and LANL. Figure 2.3.1–10 shows the plan view of the proposed location for the APSF expansion in relation to the surrounding buildings at the F-Area. The expansion site covers approximately 1,100 m^2 (11,900 ft^2), and would be protected by an appropriate security system with an entrance control facility and a central alarm station. The MAA portion of the Pu storage facility expansion would be a reinforced concrete structure. The staging operation would include confirmation measurement, packaging/unpackaging, abnormal package handling, and accountability measurement. Area would also be provided for safety evaluation systems and IAEA inspection. The operational flow diagram is shown in Figure 2.3.1–11.

Preferred Alternative: Upgrade with RFETS Non-Pit Pu Material Subalternative. The Preferred Alternative, a subalternative of the Upgrade Alternative, would involve a similar but smaller expansion of the APSF. The facility construction and operational data used for this subalternative is based on an APSF expansion sized to accommodate approximately 3,000 storage positions for the non-pit Pu to be relocated from RFETS.

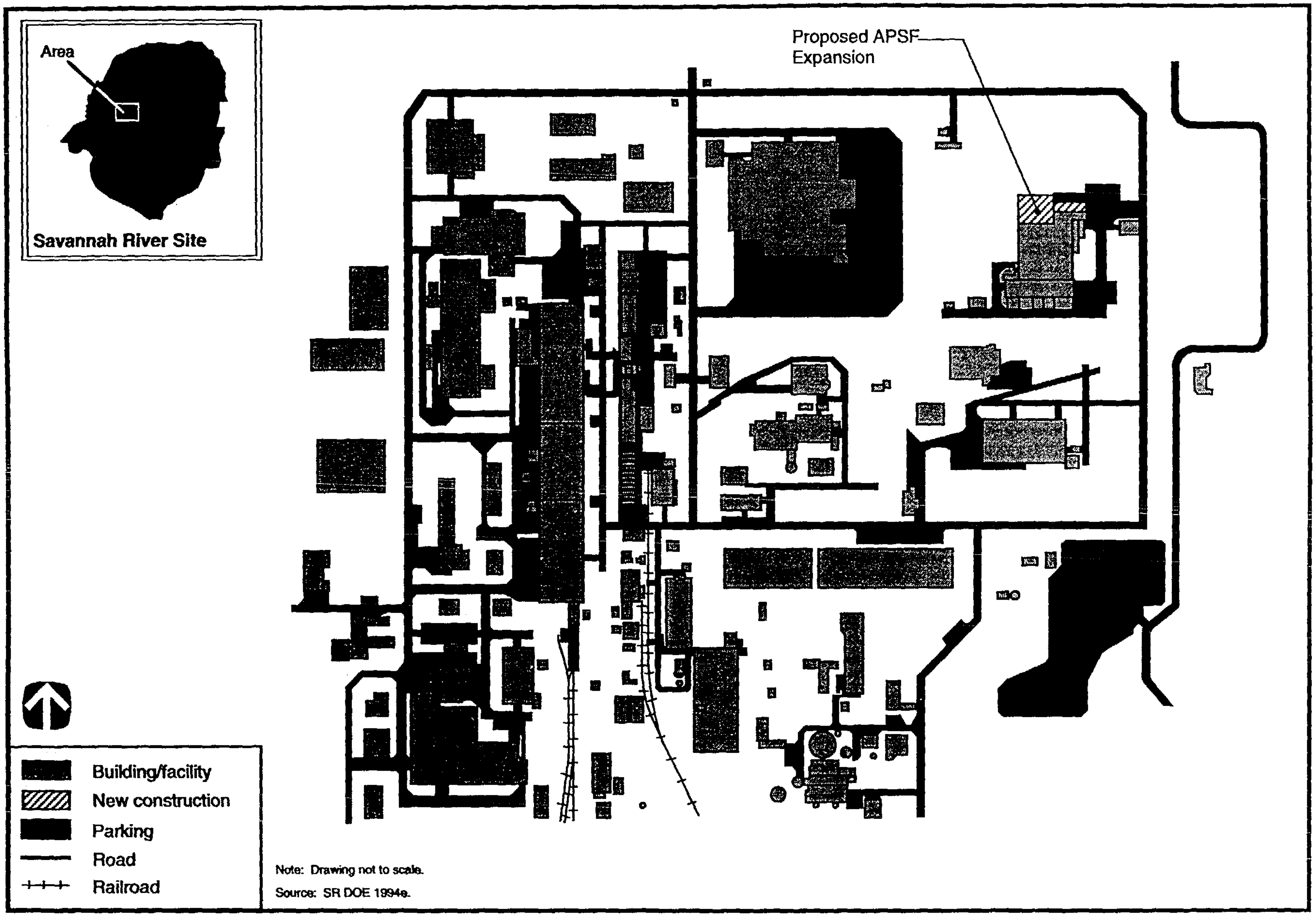
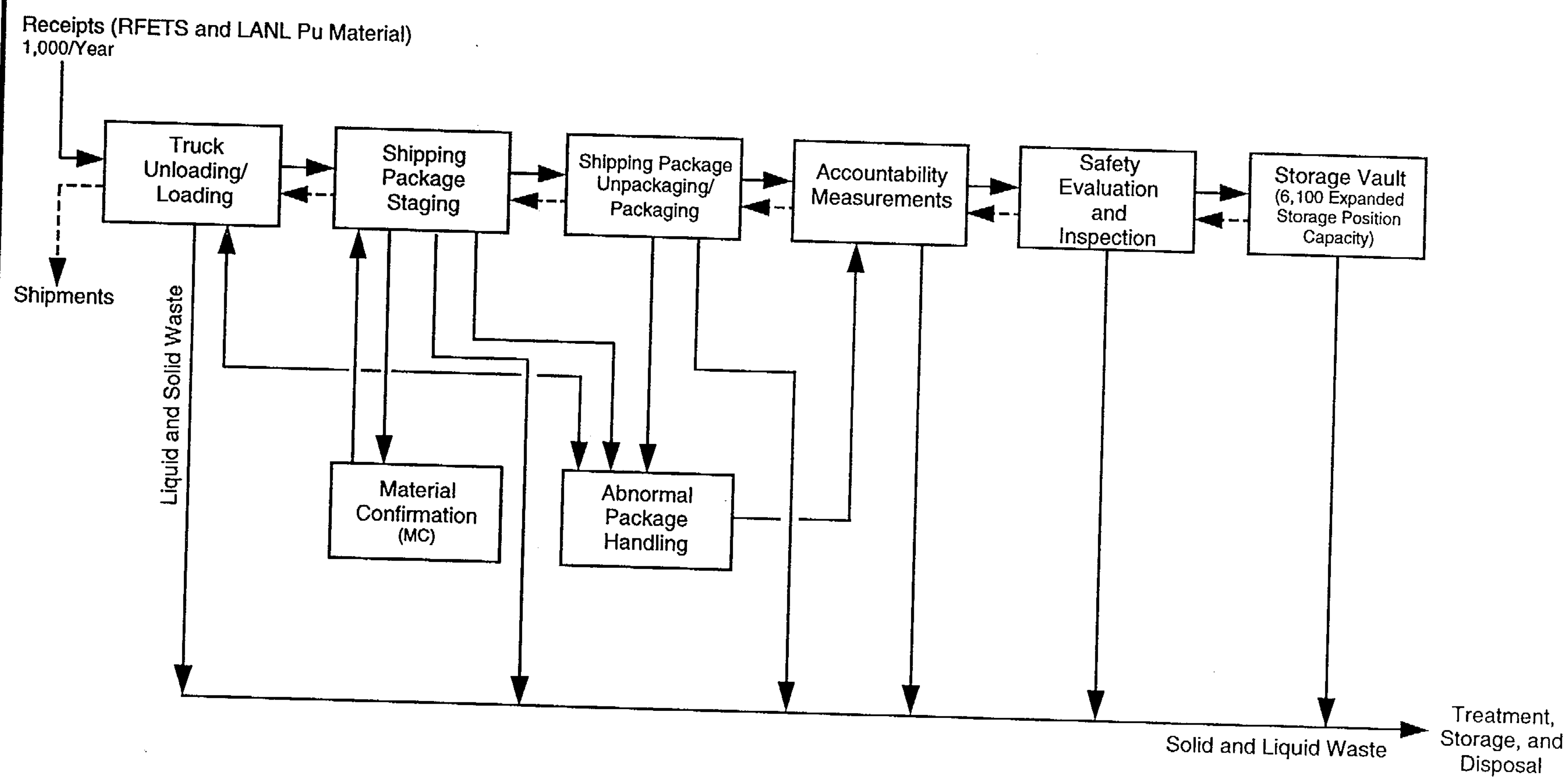


Figure 2.3.1–10. Proposed Plutonium Storage Upgrade at Savannah River Site F-Area (Plan View).



Source: SR DOE 1994e.

3131/S&D

Figure 2.3.1–11. Operational Flow Diagram for the Upgrade Alternative at Savannah River Site F-Area.

2.3.2 CONSOLIDATION OF PLUTONIUM ALTERNATIVE

2.3.2.1 Common Activities and Facility Requirements

If a new consolidated Pu storage facility were chosen to store the entire DOE inventory of Pu within the scope of this PEIS, surplus and nonsurplus Pu would be removed from existing storage facilities and relocated to the new facility at one of six candidate DOE sites.

The consolidated Pu storage facility would provide safe, secure, long-term storage of DOE surplus and nonsurplus Pu materials. These materials would be either in the form of pits (from disassembled nuclear weapons) or nonweapon forms such as metals or oxides. The stand-alone facility would perform a number of major functions to accomplish the storage mission, including the following:

- Material handling operations consisting of shipping/receiving, truck unloading/loading, cargo restraint transporter handling, unpackaging/packaging, material confirmation, staging of nuclear materials, material control and accountability (MC&A) verification, stabilization, and repackaging of Primary Containment Vessel (PCV) contents

- Material storage operations consisting of long-term storage of Pu materials in a safe, secure vault, material long-term safety evaluations, and international inspection of surplus material

- Analytical laboratory operations to support long-term storage of Pu materials

- Waste management operations, as required, to prepare wastes generated at the storage facility for shipment to disposal facilities

- Storage support functions necessary to meet DOE requirements for ES&H, waste management, maintenance, and safeguards and security

The consolidated Pu storage facility would also satisfy a variety of functional and administrative requirements:

- The consolidated Pu storage facility would have a design life of 50 years.

- Shipping sites would be responsible for initially meeting all long-term storage acceptance criteria, including processing, packaging, and certification before shipment. Materials received at the consolidated Pu storage facility would not require reprocessing, repackaging, or recertification before transfer to long-term storage vaults unless an abnormal condition is detected.

- The consolidated Pu storage facility would have the capability to offer surplus materials for international inspection. Inspection of nonsurplus materials would not be provided.

- The total capacity of the consolidated Pu storage facility would be 40,000 positions. [Text deleted.] Of the 40,000 positions, 35,000 would be allocated to surplus material, and 5,000 to nonsurplus materials.

- The maximum receipt rate would be 6,000 shipping packages per year, ranging from 6,000 pits to 5,000 pits plus 1,000 non-pits. The consolidated Pu storage facility would have the capability to simultaneously ship and receive PCVs and shipping packages.

- Storage capacity of the consolidated Pu storage facility would be expanded incrementally. The minimum capacity required upon initial operation would be 15,000 positions for surplus material and 5,000 positions for nonsurplus materials.

- The consolidated Pu storage facility would include the minimum capabilities necessary for onsite stabilization and repackaging of PCVs damaged in storage during the life of the facility. The consolidated storage facility would be able to package damaged pit PCVs to the Department of Transportation (DOT) requirements for shipment. It would also have the capability to repackage the contents of damaged PCVs into new PCVs. The consolidated Pu storage facility would not rely on existing Nuclear Weapons Complex Pu processing capabilities for the stabilization and packaging of metals and oxides from damaged PCVs. The stabilization and packaging of metals and oxides from damaged PCVs would generate TRU, low-level, mixed TRU, mixed low-level, hazardous, and nonhazardous wastes as outlined in Appendix E

- LLW would be immobilized and disposed of at an existing, onsite LLW facility or shipped offsite to a DOE-approved LLW disposal facility, depending on each site-specific practice and on decisions made pursuant to the Waste Management PEIS and any site-specific NEPA documents

- TRU waste and mixed TRU waste would be treated, packaged, and shipped offsite for disposal depending on decisions pursuant to the WIPP PEIS and the Waste Management PEIS

- Mixed LLW would be treated and disposed of offsite in accordance with site-specific treatment plans that were developed pursuant to the *Federal Facility Compliance Act* of 1992 in coordination with the EPA and State regulatory agencies and in accordance with decisions pursuant to the Waste Management PEIS

- Hazardous waste would be treated and disposed of through the use of *Resource Conservation and Recovery Act* (RCRA)-permitted facilities in accordance with site-specific practice. Temporary storage for up to 90 days would be provided as part of the facility design

- Sanitary solid and industrial solid wastes would be either disposed of at an existing, onsite, sanitary waste landfill or shipped to an offsite landfill, depending on each site-specific practice

To accomplish its mission, the consolidated Pu storage facility would require a main storage building and service support buildings and functional areas to support the storage function. The consolidated Pu storage facility would share security force, fire department, domestic water treatment, wastewater treatment, and utility distribution system services with other facilities onsite, as appropriate.

The storage facility conceptual design consists of a multilevel Pu storage building that would provide all required storage and support functions. This building would have three primary functions: material storage, material handling, and support. Three secondary functions would include repackaging, analytical laboratories, and waste management. Each of these six functions would be, in turn, supported by several service facilities, including fire protection, ES&H, safeguards and security, utilities, maintenance, and waste management. The MAA would house the nonsurplus material vault, the surplus material storage vault, and areas dedicated to providing safety evaluation, international inspection, automated guided vehicle (AGV) aisles, and personnel corridors. The material handling area would contain areas for shipping/receiving, staging, packaging/unpackaging, temporary storage, processing/recanning, AGV maintenance, and various support functions required for the primary storage operations and functions within the MAA. The material handling portion of the Pu storage building would also contain the Safe Secure Trailers (SST) loading/unloading, commodity shipping/receiving, waste shipping, and electrical and equipment maintenance shops. The support area would include the main MAA portal, control rooms, change rooms, showers, waste management, offices, kitchen, and cafeteria.

There would be three general zones within the consolidated Pu storage facility: the Property Protection Area (PPA), the Limited Area (LA), and the PA. The Pu Storage Building, which would contain the stored Pu, the Pu handling function, and support function, would be located in the PA, a higher security area. The general BOP support functions would be located in the PPA. This area contains administration offices; health, safety, and

environmental support laboratories and offices; fire protection; vehicle maintenance garage; water and sewage treatment facilities; warehousing; and other service facilities. An LA encloses the security center, with chainlink fencing and a guard station for both pedestrians and vehicles.

2.3.2.2 Site-Specific Requirements

Under this alternative, all surplus and nonsurplus Pu within the scope of this PEIS would be phased out of existing storage facilities and moved to a new long-term storage facility located at a DOE site. Hanford, NTS, INEL, Pantex, and SRS are candidate sites for the consolidated Pu storage facility. ORR is also a candidate site for the consolidated Pu storage facility. However, if Pu were consolidated at ORR, the presence of the HEU material already residing at Y–12 would create an HEU collocation condition. Since this alternative makes no provision to move the HEU material out of ORR, the Consolidation of Pu Alternative at ORR is described with the Collocation of Pu and HEU Alternative presented in Section 2.3.3.

Figure 2.3.2.2–1 shows the plan view of the conceptual design and layout for the new consolidated Pu facility. This layout is nearly identical for each candidate site. Slight variations are attributable to the BOP support buildings required at each site. The operational flow diagram is shown in Figure 2.3.2.2–2. A summary of the long-term storage options by candidate site is presented in Table 2.3.2.2–1.

Table 2.3.2.2–1. Long-Term Storage Options for the Consolidation of Plutonium Alternative

Candidate Site[a]	Storage Option
Hanford	Construct New Pu Storage Facility
NTS	Modify Existing Tunnel Drifts and Construct New Material Handling Building at the P-Tunnel, or
	Construct New Pu Storage Facility
INEL	Construct New Pu Storage Facility
Pantex	Construct New and Modify Existing Zone 12 South Facilities, or
	Construct New Pu Storage Facility
	[Text deleted.]
SRS	Construct New Pu Storage Facility

[a] Consolidation of Pu at ORR results in a HEU collocation condition. This is described with other HEU collocation subalternatives presented in Section 2.3.3.

Note: NA=not applicable.

At NTS, two options could be pursued. The first option is to modify and make use of the P-Tunnel. Figure 2.3.2.2–3 and Figure 2.3.2.2–4 show the plan views of the proposed locations and modifications at P-Tunnel and Area 12, respectively, for the storage vault and BOP support buildings that combine to form this consolidation alternative. Modified existing tunnel drifts could be used for storing surplus and nonsurplus Pu materials. The second option would be to construct a new consolidated Pu storage facility near the Device Assembly Facility (DAF) in Area 6.

At Pantex, two options could also be pursued. The first option uses modified existing facilities for nonsurplus materials in combination with a new vault to be built for surplus materials, all in Zone 12 South. Figure 2.3.2.2–5 shows the plan view of the proposed location in Zone 12 South for the new surplus Pu storage building, and Figure 2.3.2.2–6 shows the proposed modification in Zone 12 South for the existing building to be used for nonsurplus storage. Construction and modification of these buildings combine to form this Consolidation Alternative. The overall operational flow diagram for this option is shown in Figure 2.3.2.2–7. The second option would be to construct a new consolidated Pu Storage facility in Zone 12.

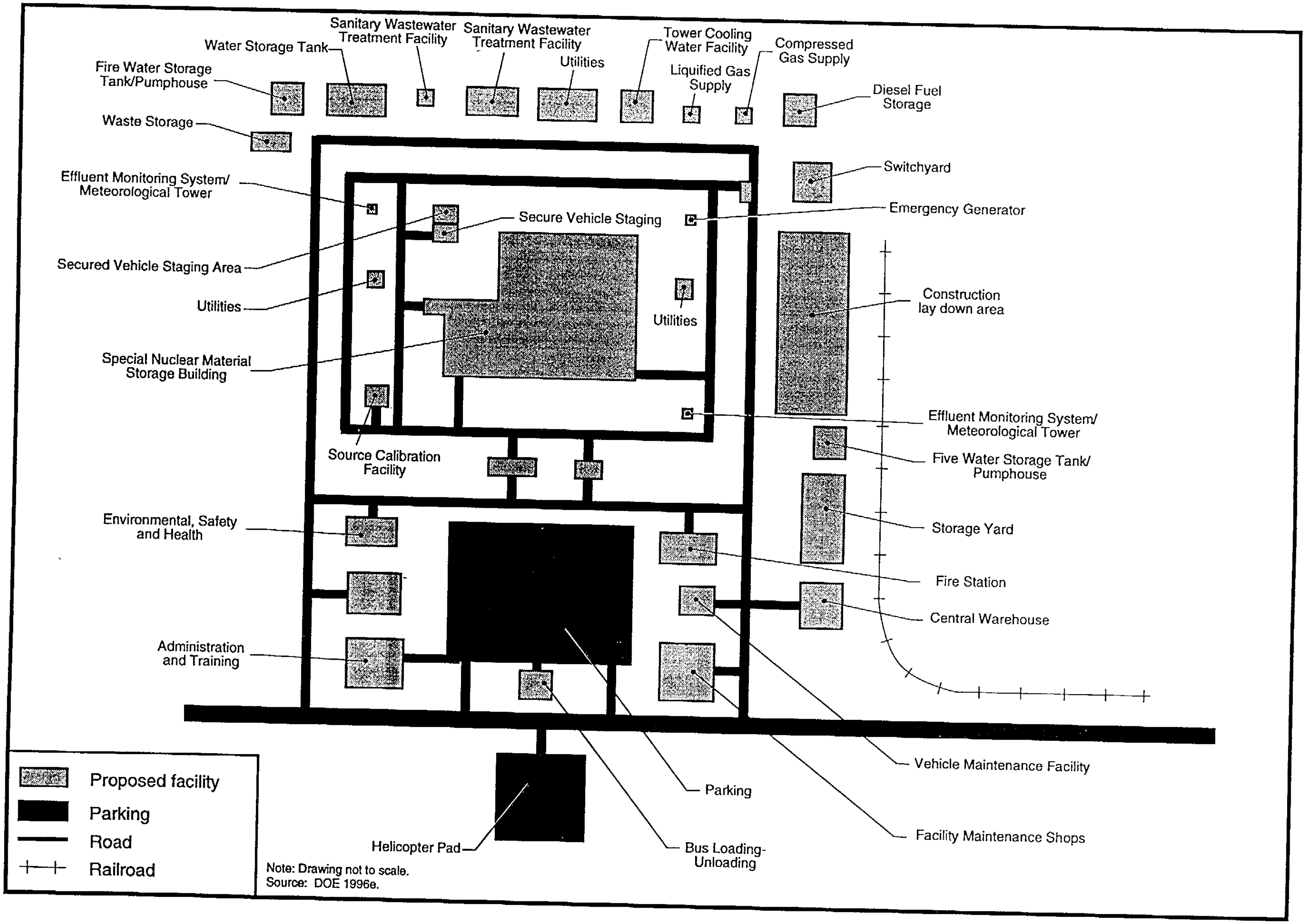


Figure 2.3.2.2–1. ***Conceptual Consolidated Plutonium Storage Facility (Plan View).***

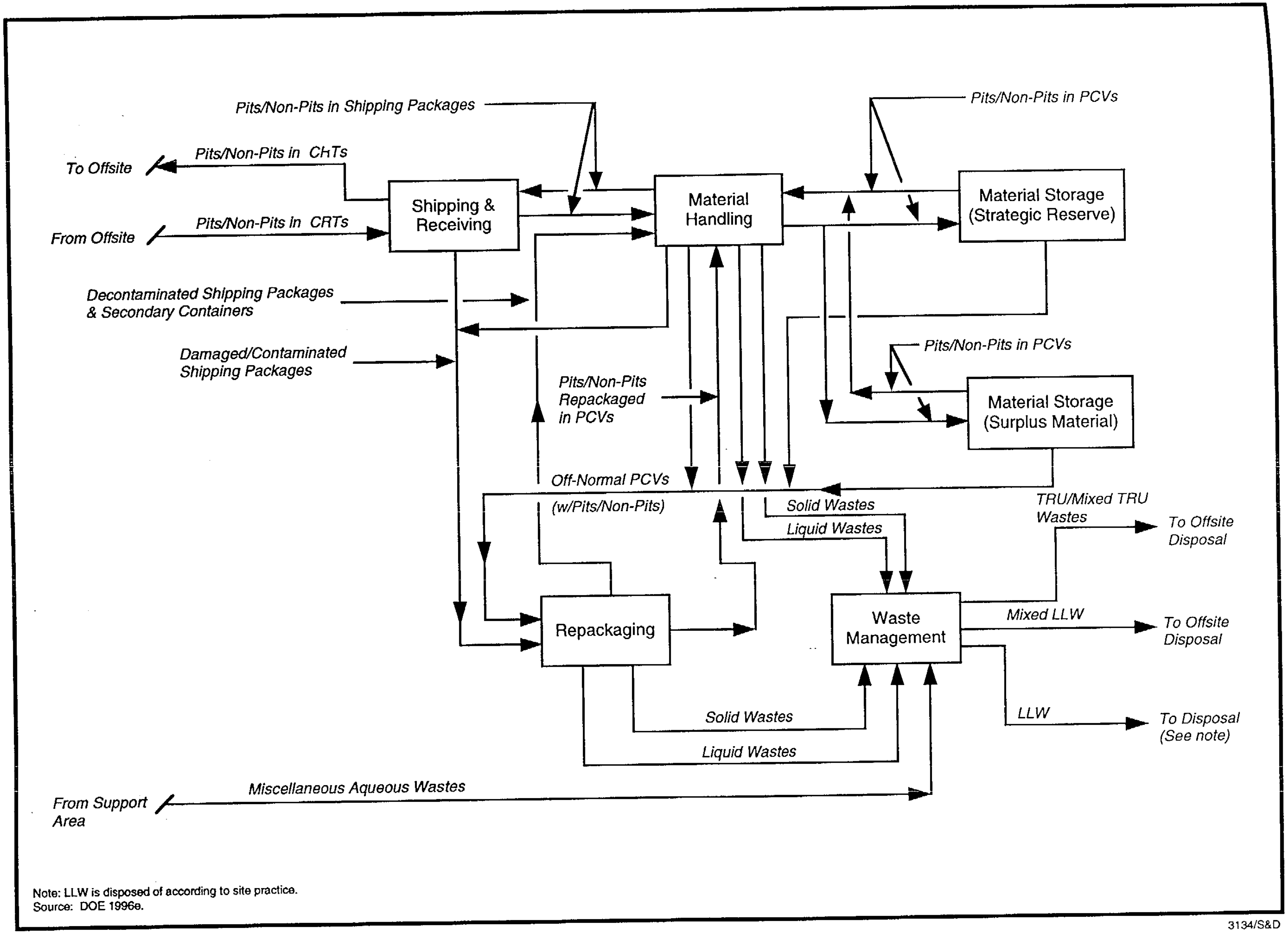


Figure 2.3.2.2–2. Operational Flow Diagram for the Consolidation Alternative.

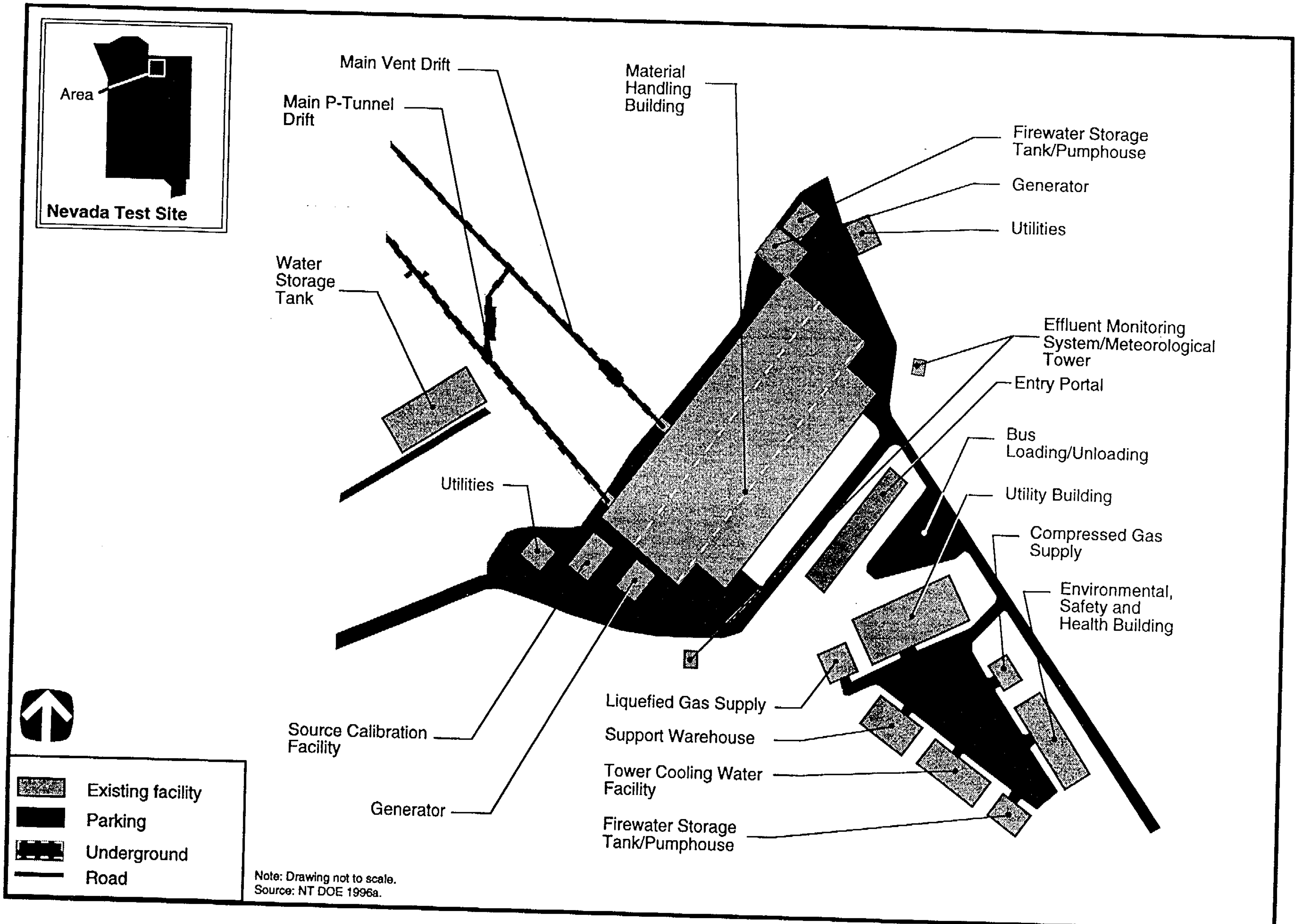


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Figure 2.3.2.2–3. P-Tunnel Modifications for the Consolidated Plutonium Storage Facility at Nevada Test Site (Plan View).

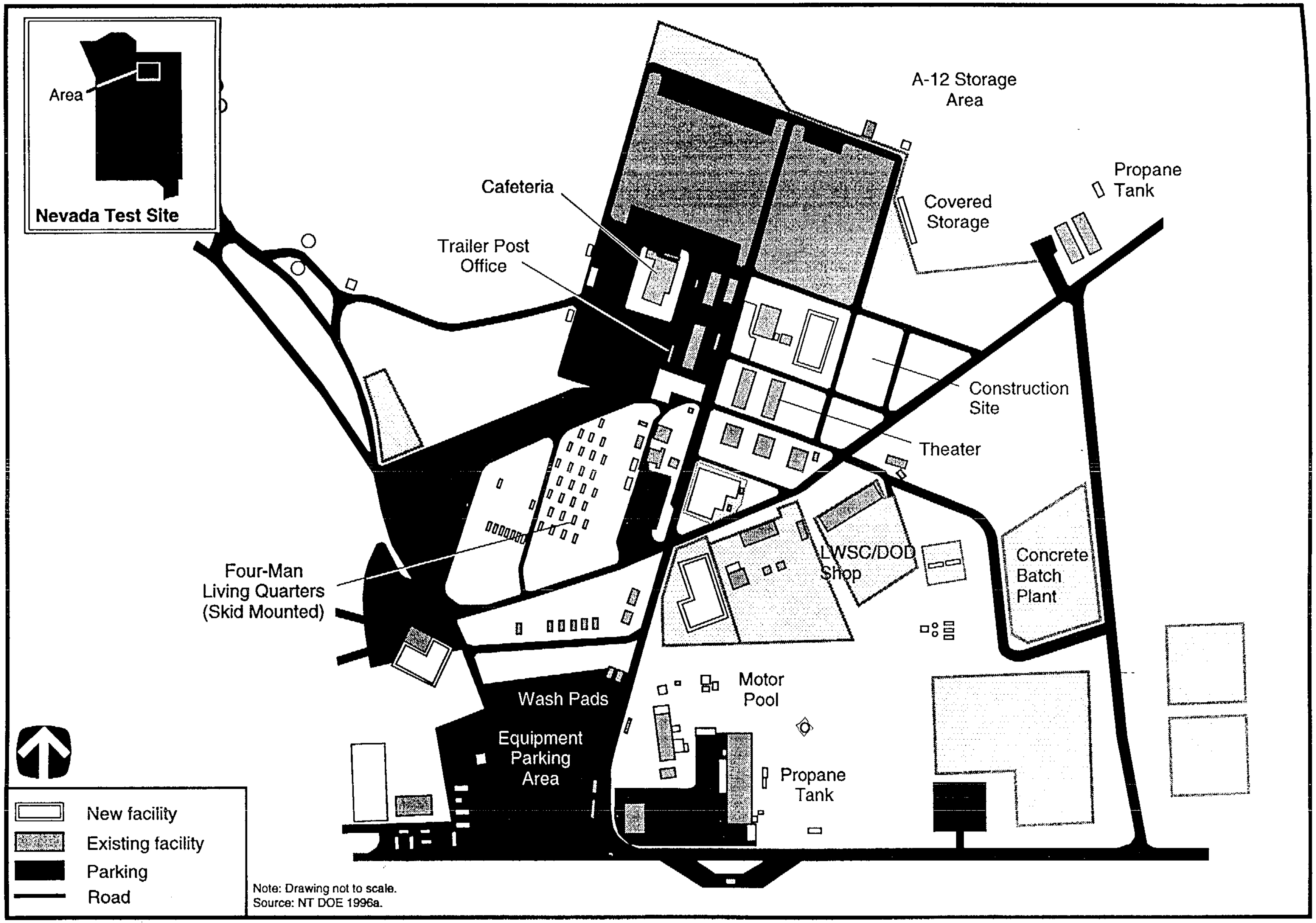

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Figure 2.3.2.2–4. Proposed Area 12 Modifications for the Consolidated Plutonium Storage Facility at Nevada Test Site (Plan View).

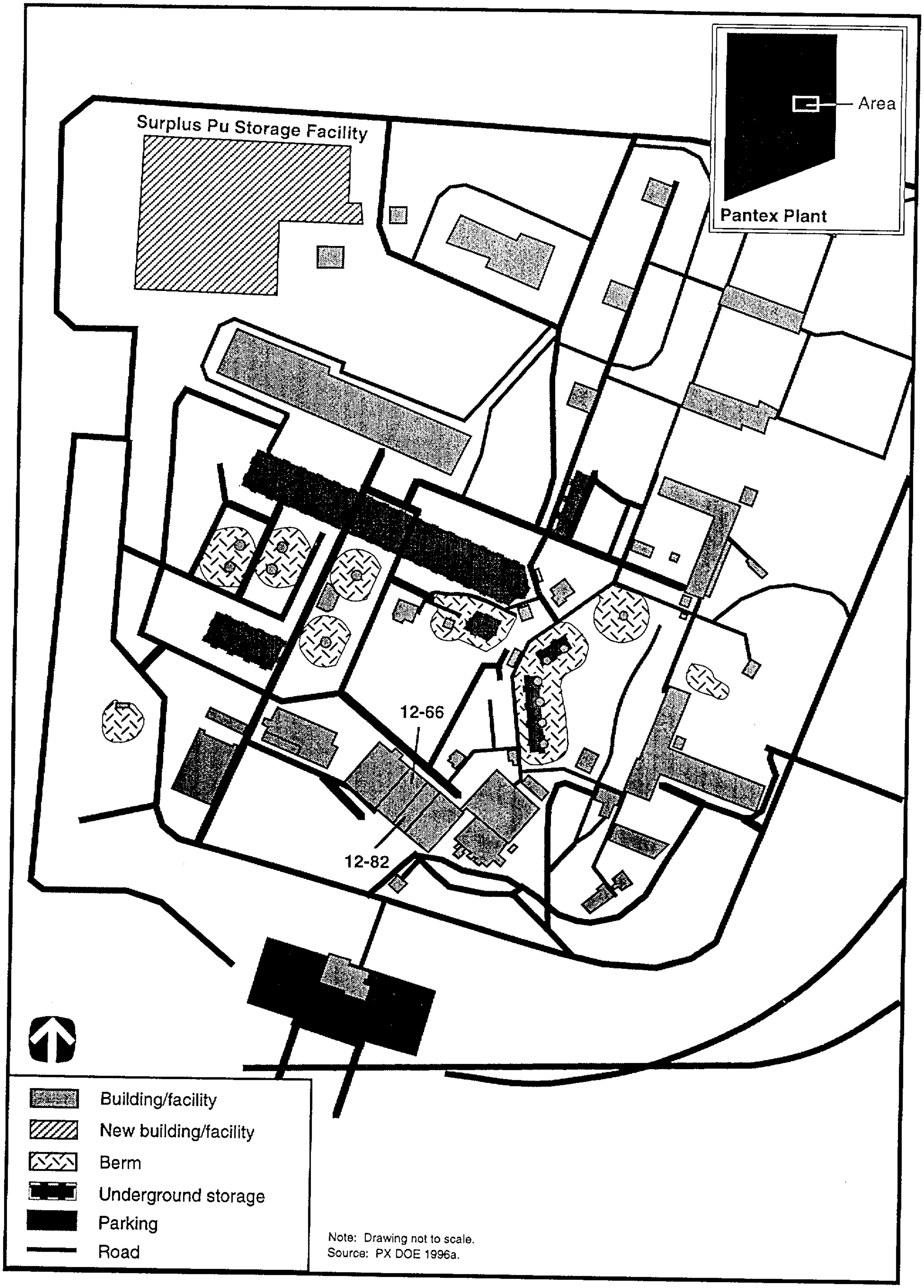


Figure 2.3.2.2–5. Proposed Zone 12 South New Facility for the Consolidated Plutonium Storage Facility at Pantex Plant (Plan View).

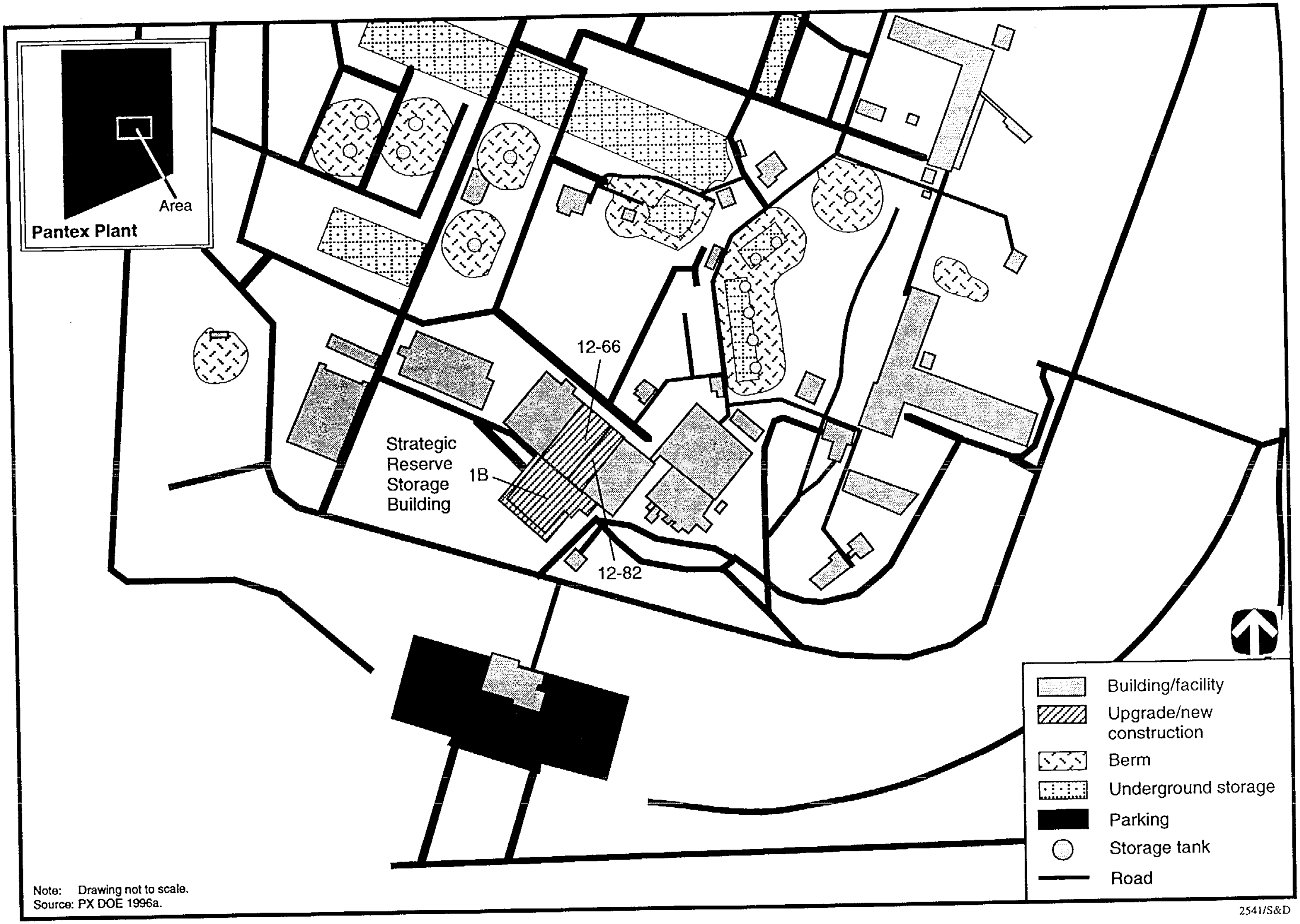
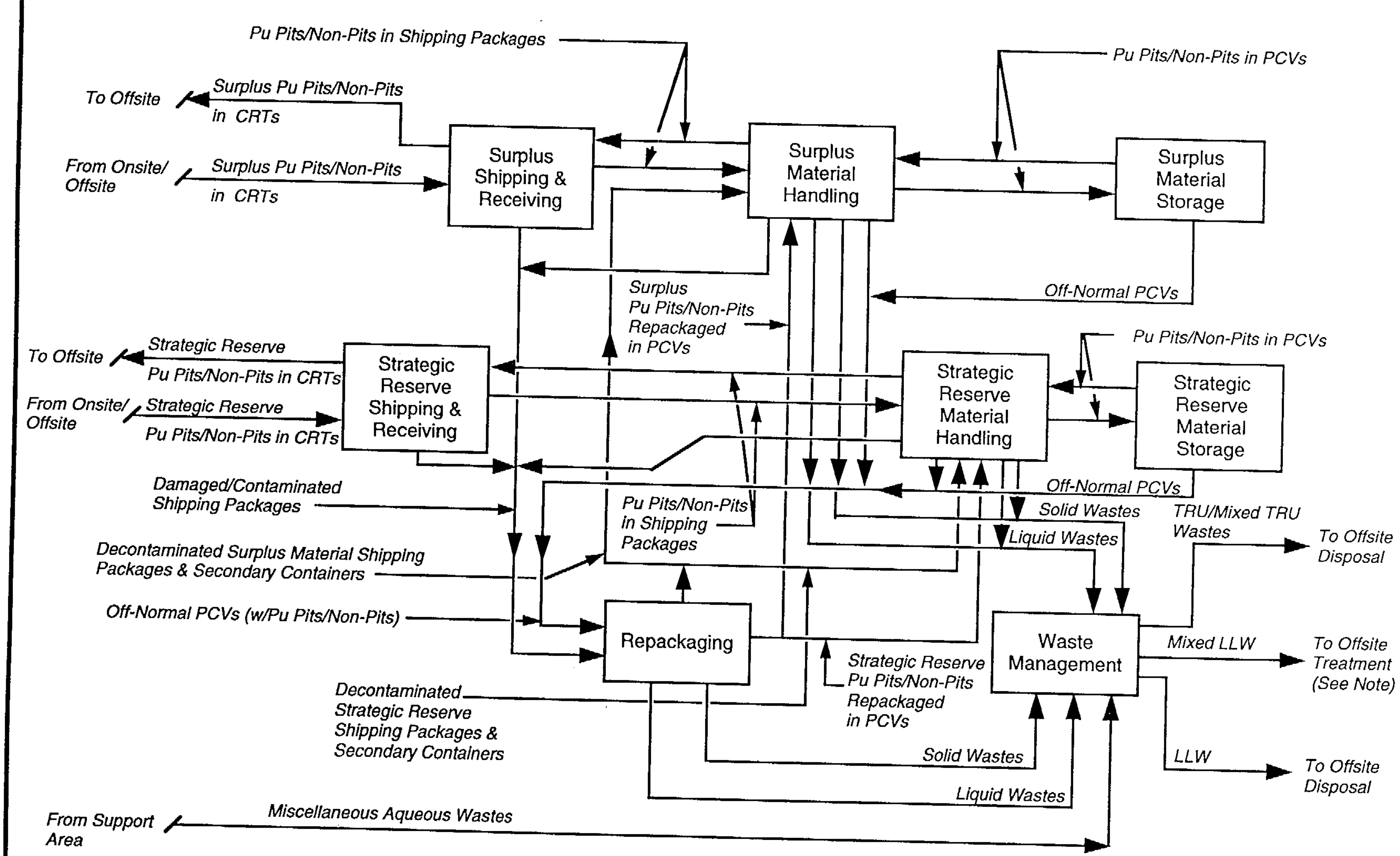


Figure 2.3.2.2–6. Proposed Zone 12 South Modifications for the Consolidated Plutonium Storage Facility at Pantex Plant (Plan View).



Note: Shipment of Mixed LLW offsite for treatment is a site specific treatment plan option.
Source: PX DOE 1996a.

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Figure 2.3.2.2–7. Operational Flow Diagram for the Consolidation Alternative Modifying Existing Buildings and Constructing a New Facility in Zone 12 South at Pantex Plant.

In addition to the environmental analysis for the long-term storage of all weapons-usable fissile materials within the scope of this PEIS at a consolidated Pu storage facility, an analysis of consolidated Pu storage without those nonsurplus materials covered under the Stockpile Stewardship and Management Final PEIS (strategic reserves and weapons R&D materials) is also presented as a subalternative to this alternative. Location options for all sites for the consolidation of Pu are also shown in Figures 2.3–1 through 2.3–6.

Construction and operations data for the consolidated Pu storage facility at Hanford, NTS, INEL, Pantex, ORR, and SRS are listed in Appendices B, C, D, E, and F.

2.3.3 COLLOCATION OF PLUTONIUM AND HIGHLY ENRICHED URANIUM ALTERNATIVE

2.3.3.1 Common Activities and Facility Requirements

If new consolidated Pu and new collocated HEU storage facilities are chosen to store the entire DOE inventory of Pu and nonsurplus HEU within the scope of this PEIS, all Pu and nonsurplus HEU would be removed from existing storage facilities and relocated to the new consolidated Pu and collocated HEU storage facilities at one of the six candidate sites. Surplus HEU would continue to be stored at Y–12. It is assumed that most surplus HEU from other sites in the DOE complex would already have been relocated to Y–12. Missions and functions resulting from construction and operation of a new collocated HEU storage facility are presented below.

The stand-alone facility would perform a number of major functions to accomplish the HEU storage mission in addition to those presented earlier for Pu storage in Section 2.3.2.1. These include the following:

- Material handling functions consisting of shipping/receiving, unpackaging/packaging, material confirmation, and preparation of nonsurplus HEU materials for long-term storage
- Material storage functions consisting of long-term storage of HEU materials in a safe, secure vault; material inventory evaluations; and MC&A verifications
- Storage support functions required to meet DOE requirements for ES&H, waste management, maintenance, safeguards and security, and BOP services

In order to fulfill its prescribed mission, the collocated HEU storage facility would also satisfy a variety of functional and administrative requirements:

- The collocated HEU storage facility would store HEU materials. HEU metal castings or loose HEU oxide powder would be contained in cans. Assembled components containing HEU would be contained in drums. There would be no uranium liquids or gases and no irradiated materials stored at the facility.
- The collocated HEU storage facility would have a design life of 50 years.
- The total capacity of the collocated HEU storage facility would be 6,000 positions for HEU cans and 8,500 positions for HEU drums. The number of cans and drums that would be placed in a single storage position would vary depending on the contents of individual cans and drums.
- The maximum receipt rate would be 2,900 shipping packages per year, ranging from 2,900 HEU cans to 2,900 HEU drums, or any mixture thereof. The facility would have the capability to prepare and ship packages.
- The collocated HEU storage facility would include capabilities necessary for repackaging and waste management.

To accommodate its mission, the collocated HEU storage facility would include a main storage building and all of the service support buildings and functional areas that support the storage function. These facilities are in addition to the consolidated Pu storage facility. The collocated HEU storage facility would share security force, fire department, domestic water treatment, sewage treatment, and utility distribution system services with other onsite facilities, as appropriate.

There would be three zones within the combined Pu and HEU storage facility: the PPA, the LA, and the PA. The consolidated Pu storage facility, the collocated HEU storage facility, and the material handling and storage support functions would be located in the PA, a higher security area. The general BOP support functions of the collocated HEU storage facility are shared and located in the PPA.

2.3.3.2 Site-Specific Requirements

Under this alternative, all nonsurplus HEU within the scope of this PEIS would be located on the same DOE site as the consolidated Pu storage facility described in Section 2.3.2. Hanford, NTS, INEL, Pantex, ORR, and SRS are candidate sites for the Collocation of Pu and HEU Alternative. Figure 2.3.3.2–1 shows the plan view of the conceptual design and layout for the new collocated Pu and HEU facilities. This layout is nearly identical for each candidate site. Slight variations are attributable to the BOP support buildings required at each site. The operational flow diagram is shown in Figure 2.3.3.2–2. A summary of these long-term storage options by candidate site is presented in Table 2.3.3.2–1.

Table 2.3.3.2–1. Long-Term Storage Options for the Collocation of Plutonium and Highly Enriched Uranium Alternative

Candidate Site	Storage Option
Hanford	Construct New Pu and HEU Storage Facilities
NTS	Modify Existing Tunnel Drifts and Construct New Material Handling Building at the P-Tunnel, or
	Construct New Pu and HEU Storage Facilities
INEL	Construct New Pu and HEU Storage Facilities
Pantex	Construct New Pu and HEU Storage Facilities
ORR	Construct New Pu Storage Facility; Maintain Existing (No Action) HEU Storage Facilities at Y–12 Plant, or
	Construct New Pu Storage Facility and Modify Existing (Upgrade) HEU Storage Facilities at Y–12 Plant, or
	Construct New Pu and HEU Storage Facilities
SRS	Construct New Pu and HEU Storage Facilities

At NTS, two options could be pursued. The first option would be to construct a new consolidated Pu storage facility and construct a new collocated HEU storage facility near the DAF in Area 6. The second option would be to make use of the P-Tunnel. Figures 2.3.3.2–3 and 2.3.3.2–4 show the plan view of the proposed locations and modifications at P-Tunnel and Area 12, respectively, for the storage vaults and BOP support buildings that combine to form this collocation of Pu and HEU option. Modified existing tunnel drifts could be used for storing surplus and nonsurplus Pu materials along with nonsurplus HEU materials. The operational flow diagram is shown in Figure 2.3.3.2–5.

If ORR were selected as the collocated Pu and HEU storage site, any one of three options could be pursued. These include constructing the consolidated Pu storage facility and continuing storage of HEU in existing (No Action) storage facilities at Y–12 (under the No Action Alternative, DOE would not undertake any new construction projects except those that are considered part of ongoing site operations to ensure continued safe, secure storage; however, any new facility construction deemed necessary to maintain safe, secure storage would be addressed in appropriate, individual, site-specific EISs and site development plans); constructing the

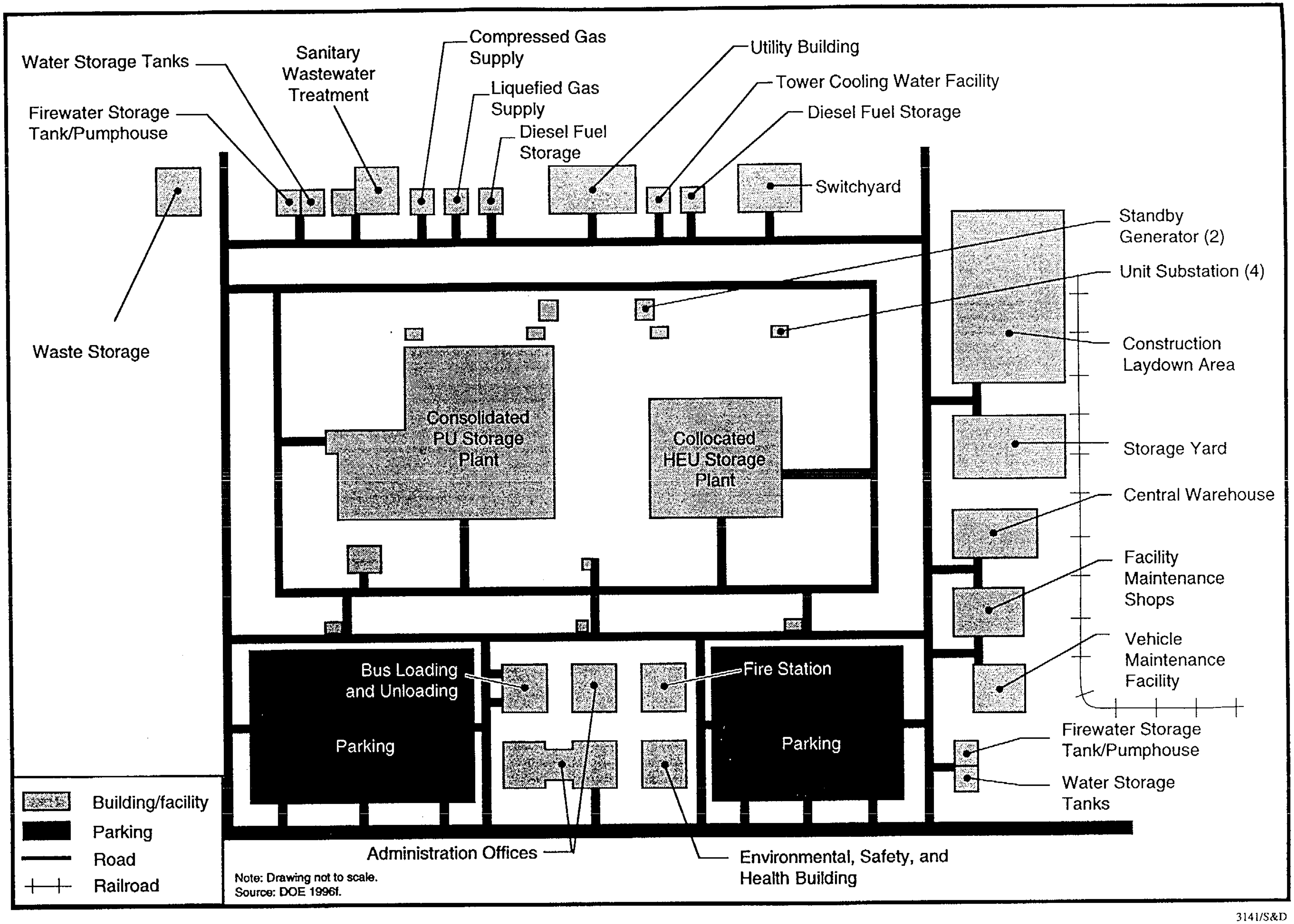

Figure 2.3.3.2–1. Conceptual Collocated Plutonium and Highly Enriched Uranium Storage Facility (Plan View).

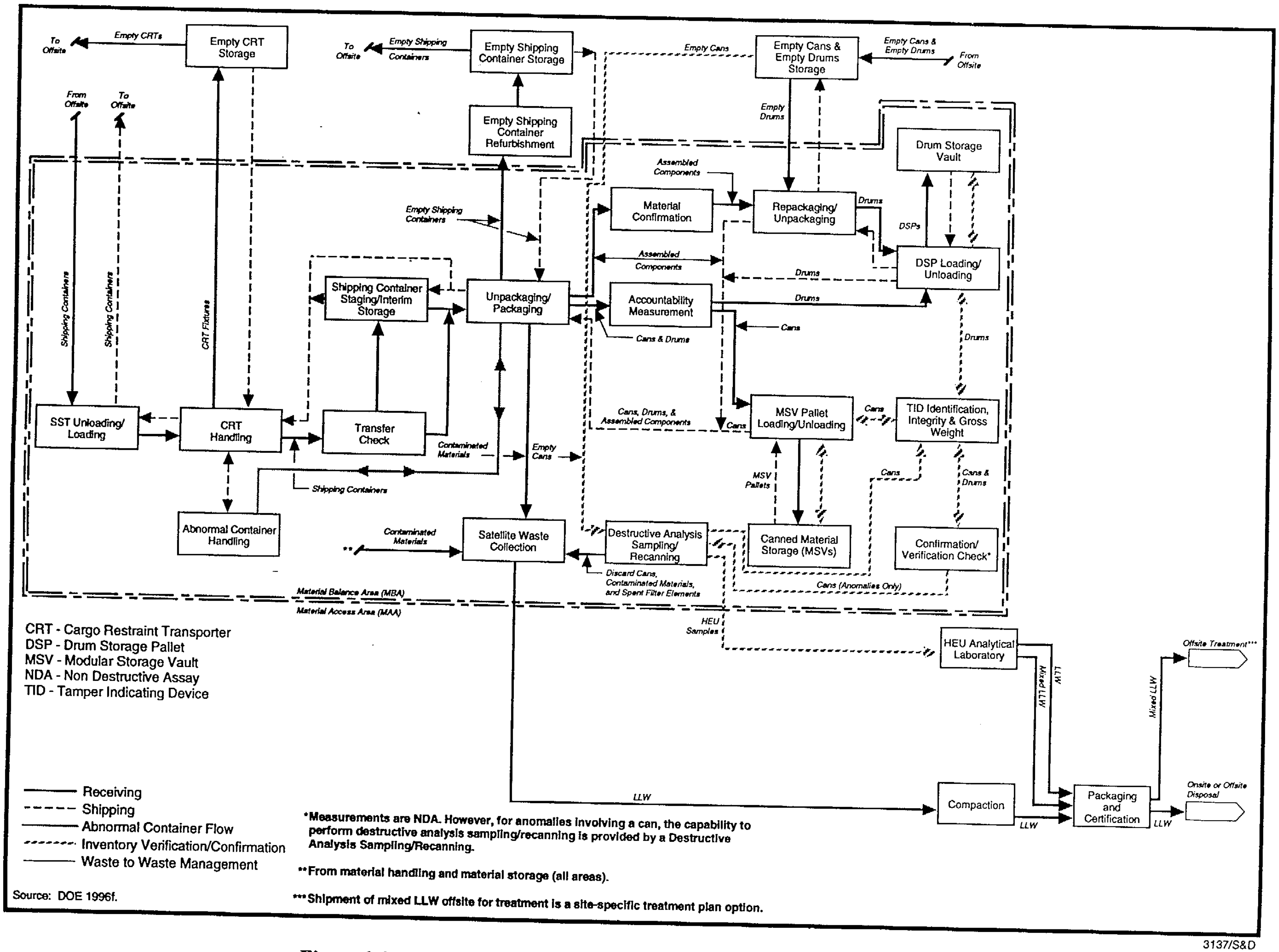

Figure 2.3.3.2–2. Operational Flow Diagram for the Collocation Alternative.

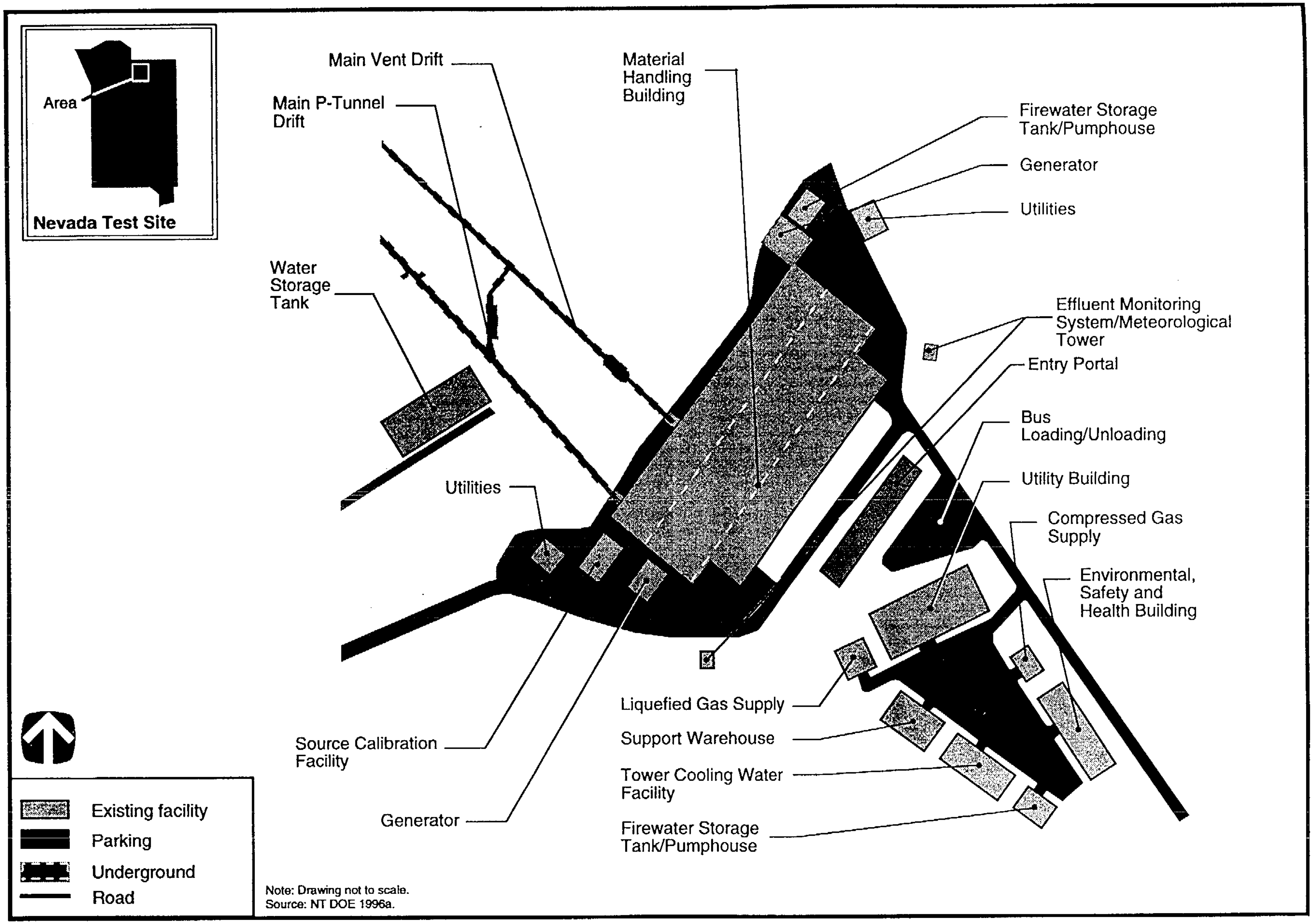

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Figure 2.3.3.2–3. P-Tunnel Modifications for the Collocated Plutonium and Highly Enriched Uranium Storage Facility at Nevada Test Site (Plan View).

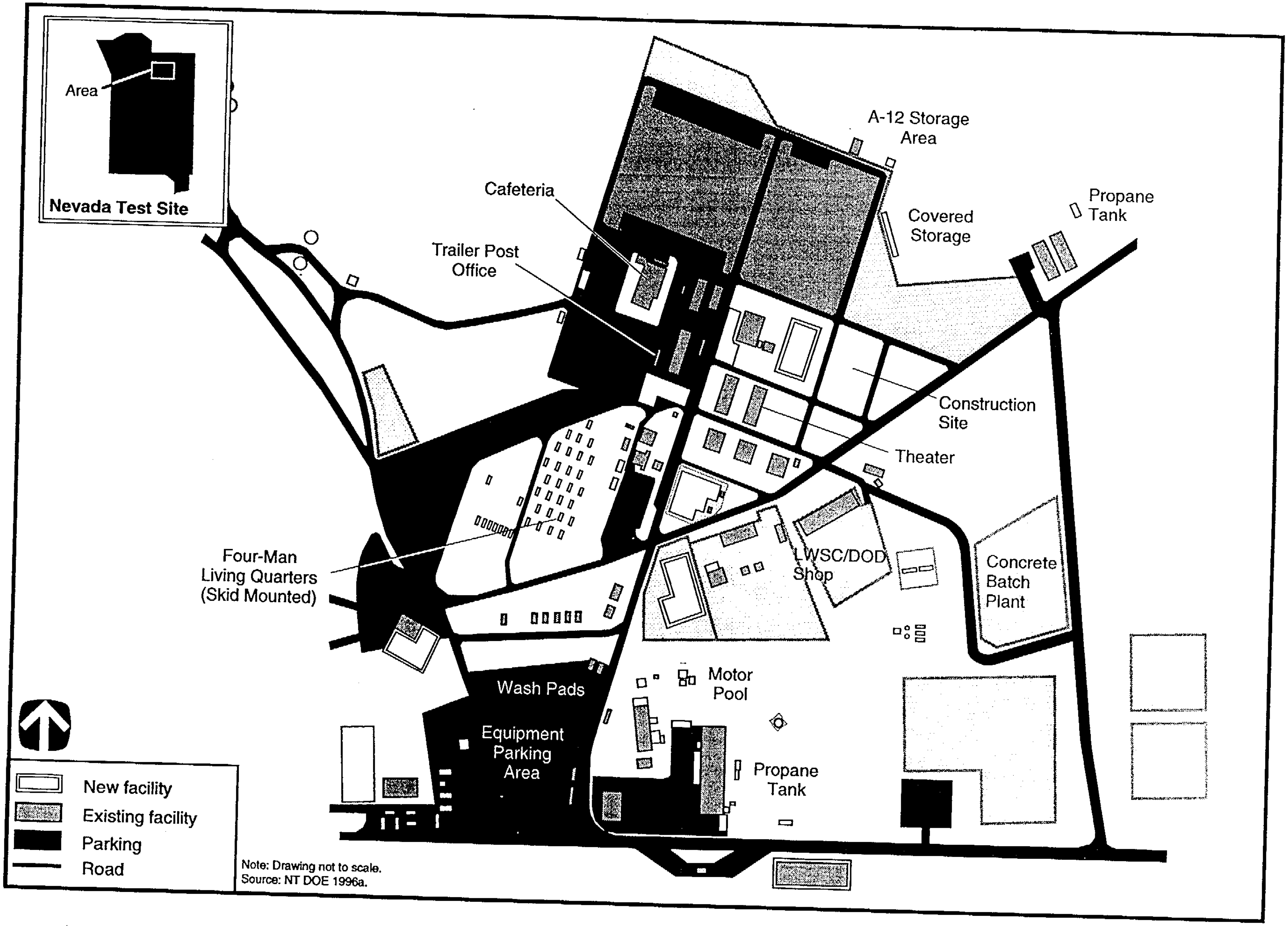

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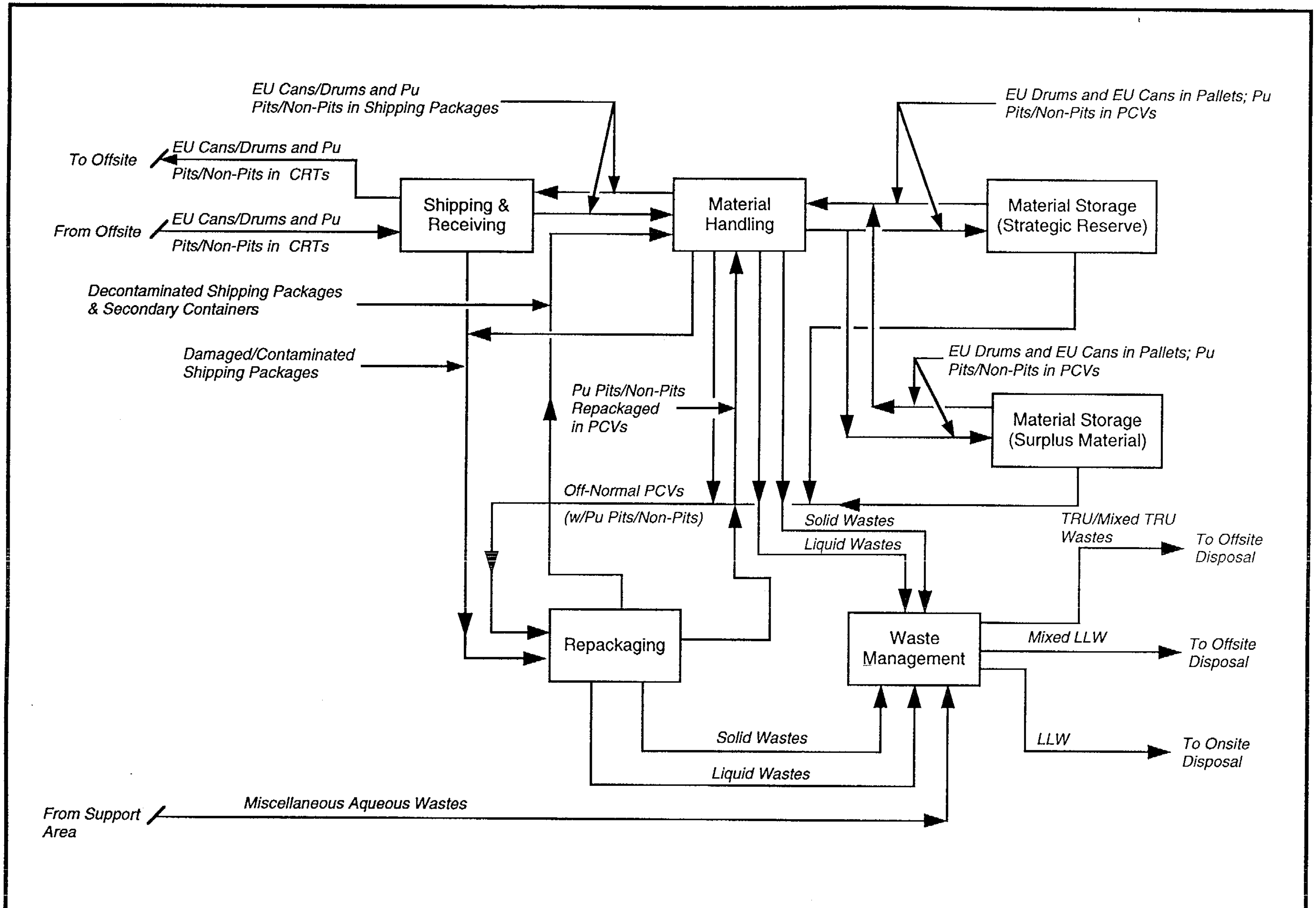
Figure 2.3.3.2–4. Proposed Area 12 Modifications for the Collocated Plutonium and Highly Enriched Uranium Storage Facility at Nevada Test Site (Plan View).



Source: NT DOE 1996a.

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Figure 2.3.3.2–5. Operational Flow Diagram for the Collocation Alternative Modifying P-Tunnel at Nevada Test Site.

consolidated Pu storage facility and upgrading HEU storage facilities at Y–12; and constructing the consolidated Pu storage facility and constructing a new collocated HEU storage facility at a location on ORR other than Y–12. Under all three of these ORR options, it is assumed that HEU from other sites in the DOE complex would already be relocated to Y–12.

If ORR were not selected as the collocated HEU storage site, all nonsurplus HEU within the scope of this PEIS would be phased out of Y–12 and moved to a new facility collocated with the consolidated Pu storage facility located at another DOE site. Surplus HEU would continue to be stored at Y–12 as described above.

At all other sites a new consolidated Pu storage facility and new collocated HEU storage facility would be constructed to satisfy requirements under this alternative. Locations of facilities under the Collocation of Pu and HEU Alternative are shown in Figures 2.3–1 through 2.3–6. In addition to the environmental analysis performed for the long-term storage of all weapons-usable fissile materials under the scope of this PEIS at a consolidated Pu storage facility and collocated HEU storage facility, an analysis of consolidated Pu storage without those nonsurplus materials covered under the Stockpile Stewardship and Management Final PEIS (strategic reserve and weapons R&D materials) is also presented.

Construction and operations data for the Collocation of Pu and HEU Alternative are listed in Appendices B, C, D, E, and F.

2.3.4 STORAGE PHASEOUT

For alternatives described in Sections 2.3.1, 2.3.2, and 2.3.3, storage of existing Pu and HEU materials at various sites may be partly or entirely phased out. For Pu, under the phaseout process, material within the scope of this PEIS would be removed from one or more of the current storage sites and dispositioned (surplus materials only), partially consolidated at more than one storage site (all materials), or fully consolidated at a single storage site (all materials). Phaseout could occur at more than one of these sites because surplus and/or nonsurplus Pu materials currently exist at Hanford, INEL (ANL-W), Pantex, SRS, RFETS, and LANL. For HEU, nonsurplus HEU, which consists of strategic reserves (nuclear weapon secondary components and working material), and naval nuclear fuel, would be removed from its current storage site (assumed to be Y–12 for all HEU by the time actions under this PEIS are begun) and transported to the storage site chosen for collocation of Pu and HEU.

Although Pu and HEU may be transferred from a shipping site to a receiving site, the shipping site may still store material outside the scope of this PEIS (for example, residues with less than 50 percent Pu, and irradiated fuel). In addition to the environmental analysis performed for storing all weapons-usable fissile materials within the scope of this PEIS under the various long-term storage alternatives, an analysis of Pu storage without those materials covered under the Stockpile Stewardship and Management Final PEIS (strategic reserve and weapons R&D materials) is also presented.

2.4 PLUTONIUM DISPOSITION ALTERNATIVES AND RELATED ACTIVITIES

As described in Section 2.1.4, nine alternatives, which can be grouped into three categories, were identified as reasonable for disposition of Pu. The three categories and the alternatives within them are as follows:

Deep Borehole Category

- *Direct Disposition Alternative*—direct emplacement to deep boreholes without immobilizing Pu forms
- *Immobilized Disposition Alternative*—immobilization of Pu forms without adding radionuclides and then emplacement into deep boreholes

Immobilization Category

- *Vitrification Alternative*—immobilization of Pu in a glass matrix with processing in a vitrification facility and then dispose in a HLW repository[16]
- *Ceramic Immobilization Alternative*—immobilization of Pu in a ceramic matrix with processing in a ceramic immobilization facility and then dispose in a HLW repository[16]
- *Electrometallurgical Treatment Alternative*—immobilization of Pu in a GBZ form in an electrometallurgical treatment facility and then dispose in a HLW repository[16]

Reactor Category

- *Existing LWR Alternative*—convert Pu into MOX fuel, use MOX fuel in existing LWRs, and then dispose of spent fuel in an HLW repository[16]
- *Partially Completed LWR Alternative*—convert Pu into MOX fuel, use MOX fuel in partially completed LWRs, which are completed under this program, and then dispose of spent fuel in a HLW repository[16]
- *Evolutionary LWR Alternative*—convert Pu into MOX fuel, use MOX fuel in evolutionary LWRs, and then dispose of spent fuel in a HLW repository[16]
- *CANDU Reactor Alternative*—convert Pu into MOX fuel, use MOX fuel in Canadian CANDU reactors, and then dispose of spent fuel in the Canadian spent fuel program

Preferred Alternative for Pu Disposition: A combination of reactor and immobilization alternatives. The Preferred Alternative calls for (1) immobilizing at least those Pu materials not readily suitable for MOX fuel using vitrification or ceramic immobilization and (2) converting pure Pu metal, including pits, and oxides into MOX fuel for use in existing reactors. Use of Canadian CANDU reactors would be retained in the event that a multilateral agreement is made among Russia, Canada, and the United States to implement this.

The number of years a specific facility is expected to operate is based on facility sizing and throughput capacities. Preconstruction activities would require about 5 years for all the alternatives.[17] Preconstruction activities for the deep borehole category may take longer and may require additional legislation and associated

[16] See Appendix H (appropriate regulatory section) for a discussion of how the NWPA, as amended, might apply for disposal in a HLW repository.

[17] Preconstruction activities include tests, demonstrations, licenses, and tiered NEPA activities.

regulations. About another 5 years would be required for construction, startup, preoperational testing, and operational readiness review for all the alternatives. Construction of completely new reactors or deep boreholes could take longer. The time required for operations of all alternatives will vary depending on the amount of Pu material remaining after stabilization activities and the size, number, and throughput capacities of disposition facilities. If one of the domestic Reactor Alternatives were chosen, the MOX-based spent nuclear fuel is assumed to remain in the spent fuel pool for up to 10 years before relocation to a HLW repository. If either of the Deep Borehole Alternatives were chosen, the time to emplace the surplus Pu would depend on the number of deep boreholes being drilled. For each alternative, if decontamination and decommissioning (D&D) is proposed in the future, such activities are estimated to require up to 5 years for all but MOX fuel fabrication and reactors, which could take up to 10 years. D&D would not be proposed for the borehole sites, but for long-term institutional control (for future deterrence), the Deep Borehole Alternatives would likely take longer. D&D, if proposed, would be preceded by appropriate NEPA analysis.

As the various disposition technologies evolve and are refined through further study, development, and design, processes and facility arrangements would be optimized. This optimization would include specific operational relationships of facilities common to the selected alternatives, such as pit disassembly/conversion and Pu conversion facilities. Because this refinement process is ongoing, information and data presented in the technical documents for some of the alternatives are updated from that which was initially presented in the data reports supporting this PEIS. However, this PEIS considers the updated information as well. [Text deleted.]

Each of the nine disposition alternatives can be implemented in a number of ways because each alternative merely defines the generic technology approach used to achieve the Spent Fuel Standard. For example, using different numbers of existing reactors to accomplish the mission or utilizing different Pu concentrations within a borosilicate glass formulation represent variations for the existing reactor and vitrification alternatives, respectively. Determining which of the many possible variants to analyze within the PEIS is a matter of engineering judgment. A list of possible variants to the nine disposition alternatives is shown in Table 2.4–1.

[Text deleted.]

Representative facility locations for analyzing Pu disposition alternatives at Hanford, NTS, INEL, Pantex, ORR, and SRS are shown in Figures 2.4–1 through 2.4–6. These locations include those for the pit disassembly/conversion, Pu conversion, vitrification, ceramic immobilization, MOX fuel fabrication, and evolutionary LWR facilities. Locations for the deep borehole complex, commercial MOX fuel fabrication facility, and existing LWRs, are generic. At ORR, the representative site for the evolutionary LWR is on undeveloped land (see Figure 2.4–5). This site is not within the ORR boundary, but is owned by the Tennessee Valley Authority (TVA). A previous agreement between DOE and TVA has reserved the site for a nuclear application, and it is anticipated that the land area would be transferred from TVA to DOE. The Bellefonte Nuclear Plant, approximately halfway between Huntsville, Alabama, and Chattanooga, Tennessee, is the representative analysis site for the partially completed reactor alternative. INEL is the representative site for the Electrometallurgical Treatment Alternative. For the CANDU Reactor Alternative, the Bruce-A Nuclear Generating Station is the representative site for the analysis. The following sections describe the requirements for each disposition technology listed above.

[Text deleted.] Three Immobilization Alternatives and three reactor alternatives produce a waste form that could be suitable for disposal in a domestic HLW repository. Such a repository, if approved under the provisions of the NWPA and its amendments, would serve as the disposal site for commercial and DOE-owned spent nuclear fuel and HLW. DOE is currently characterizing the Yucca Mountain site for the repository. If the Secretary of Energy recommended the Yucca Mountain site for the repository, the recommendation would be accompanied by an EIS (the repository EIS), the NOI for which was published on August 7, 1995 (60 FR 40164). DOE completed scoping in Fiscal Year 1996 and will continue working the EIS given sufficient appropriations. The Yucca Mountain site has not yet been recommended by the President and approved by Congress; therefore, this Storage and Disposition PEIS does not analyze impacts to a repository. No waste forms are currently licensed for disposal

Table 2.4–1. Descriptions of Variants to Analyzed Disposition Alternatives

Alternatives	Possible Variants
• Deep borehole direct disposition	• Arrangement of Pu in different types of emplacement canisters.
• Deep borehole immobilized disposition	• Bucket emplacement of pellet-grout mix. • Pumped emplacement of pellet-grout mix. • Pu concentration loading, size and shape of ceramic pellets.
• New vitrification facilities	• Collocated pit disassembly, Pu conversion, and immobilization facilities. • Use of either Cs-137 from capsules or HLW as a radiation barrier. • Wet or dry feed preparation technologies. • An adjunct melter adjacent to the DWPF at SRS, in which borosilicate glass frit with Pu (without highly radioactive radionuclides) is added to borosilicate glass containing HLW from the DWPF. • A can-in-canister approach at SRS in which cans of Pu glass (without highly radioactive radionuclides) are placed in DWPF canisters which are then filled with borosilicate glass containing HLW in the DWPF (See Appendix O). • A can-in-canister approach similar to above but using new facilities.
• New ceramic immobilization facilities	• Collocated pit disassembly, Pu conversion, and immobilization facilities. • Use of either Cs-137 from capsules or HLW as a radiation barrier. • Wet or dry feed preparation technologies. • A can-in-canister approach at SRS in which the Pu is immobilized without highly radioactive radionuclides in a ceramic matrix and placed in which are then placed in the DWPF canisters that are then filled with borosilicate glass containing HLW (see Appendix O). • A can-in-canister approach similar to above but using new facilities.
• Electrometallurgical treatment (glass-bonded zeolite form)	• Immobilize Pu into metal ingot form. • Locate at DOE sites other than ANL-W at INEL.
• Existing LWR with new MOX facilities	• Pressurized or Boiling Water Reactors. • A different number of reactors. • European MOX fuel fabrication. • Modification/completion of existing facilities for MOX fuel fabrication. • Collocated pit disassembly/conversion, Pu conversion, and MOX fuel facilities. • Reactors with different core management schemes (Pu loadings, refueling intervals).
• Partially completed LWR with new MOX facilities	• Same as for existing LWR (except that MOX fuel would not be fabricated in Europe).
• Evolutionary LWR with new MOX facilities	• Same as for partially completed LWR.
• CANDU reactor with new MOX facilities	• A different number of reactors. • Modification/completion of existing facilities for MOX fabrication. • Collocated pit disassembly/conversion, Pu conversion, and MOX facilities. • Reactors with different core management schemes (Pu loadings, refueling intervals).

in a HLW repository. For the Immobilization Alternatives, legislative clarification or NRC determination by rule may be required before the immobilized Pu can be placed in an NWPA repository. Data to estimate waste forms under consideration in this PEIS for disposal in a repository are compared to data currently being evaluated for disposal in a NWPA-licensed repository. The results of this analysis are in Appendix H.

The fourth Reactor Alternative would use surplus U.S. Pu in MOX fuel for Canadian reactors, with the spent nuclear fuel managed by Canada. The MOX-based spent nuclear fuel from the alternative would be comparable to spent fuel from ongoing power producing operations in that country. This PEIS presents an analysis of domestic activities within the continental United States. A brief impact assessment of activities in Canada is included in Appendix I.

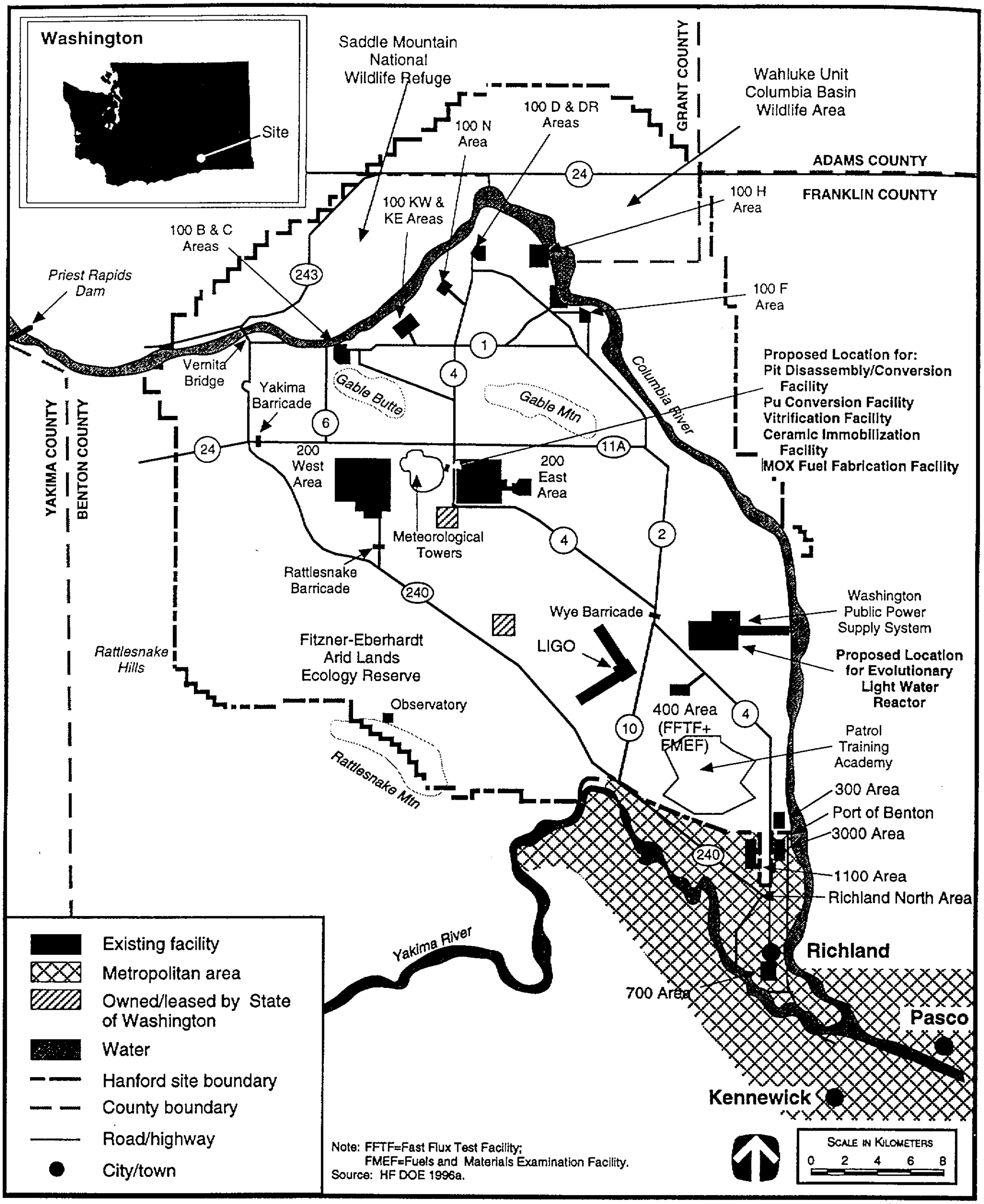

Figure 2.4–1. Representative Facility Locations for the Disposition of Plutonium at Hanford Site.

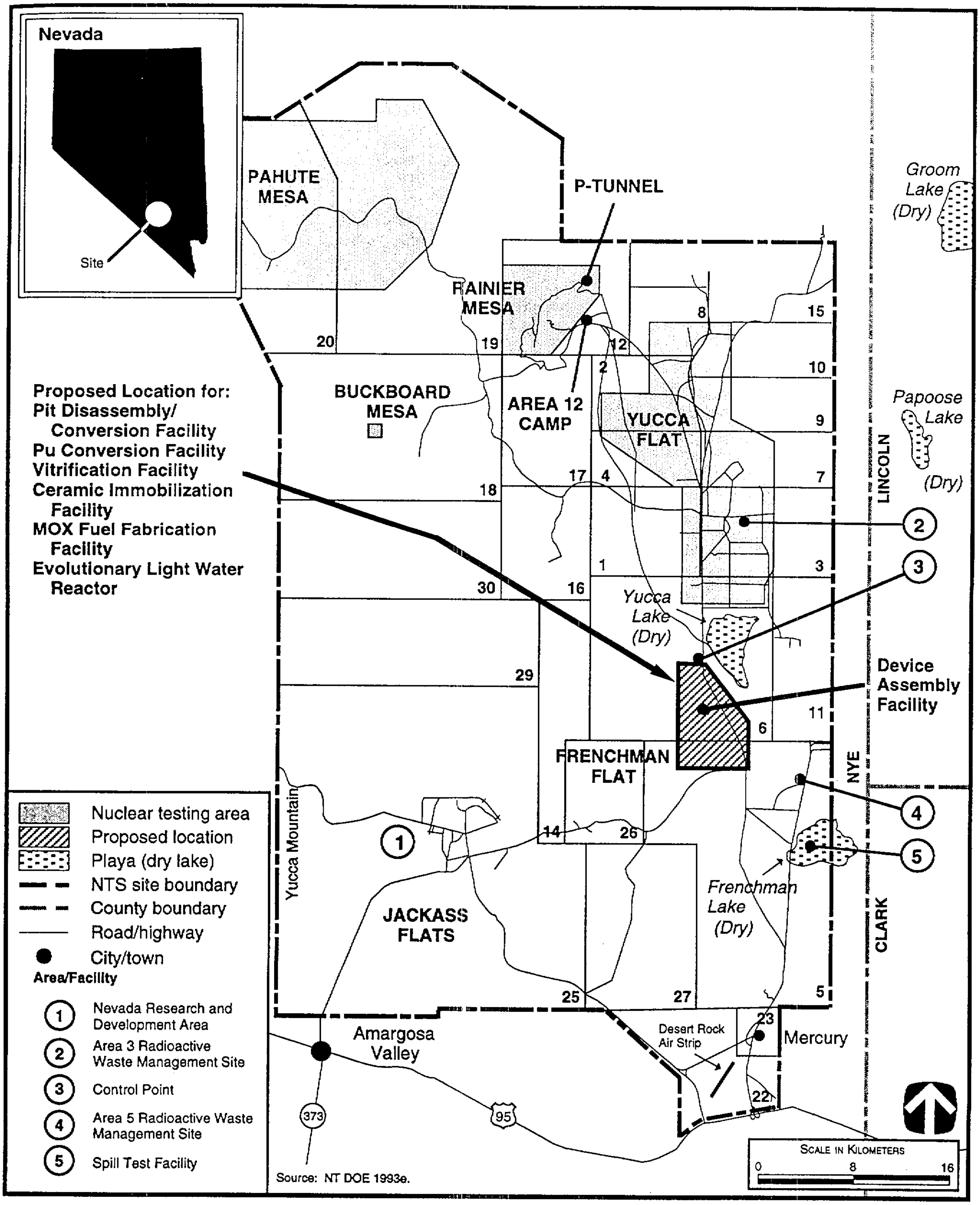

Figure 2.4–2. Representative Facility Locations for the Disposition of Plutonium at Nevada Test Site.

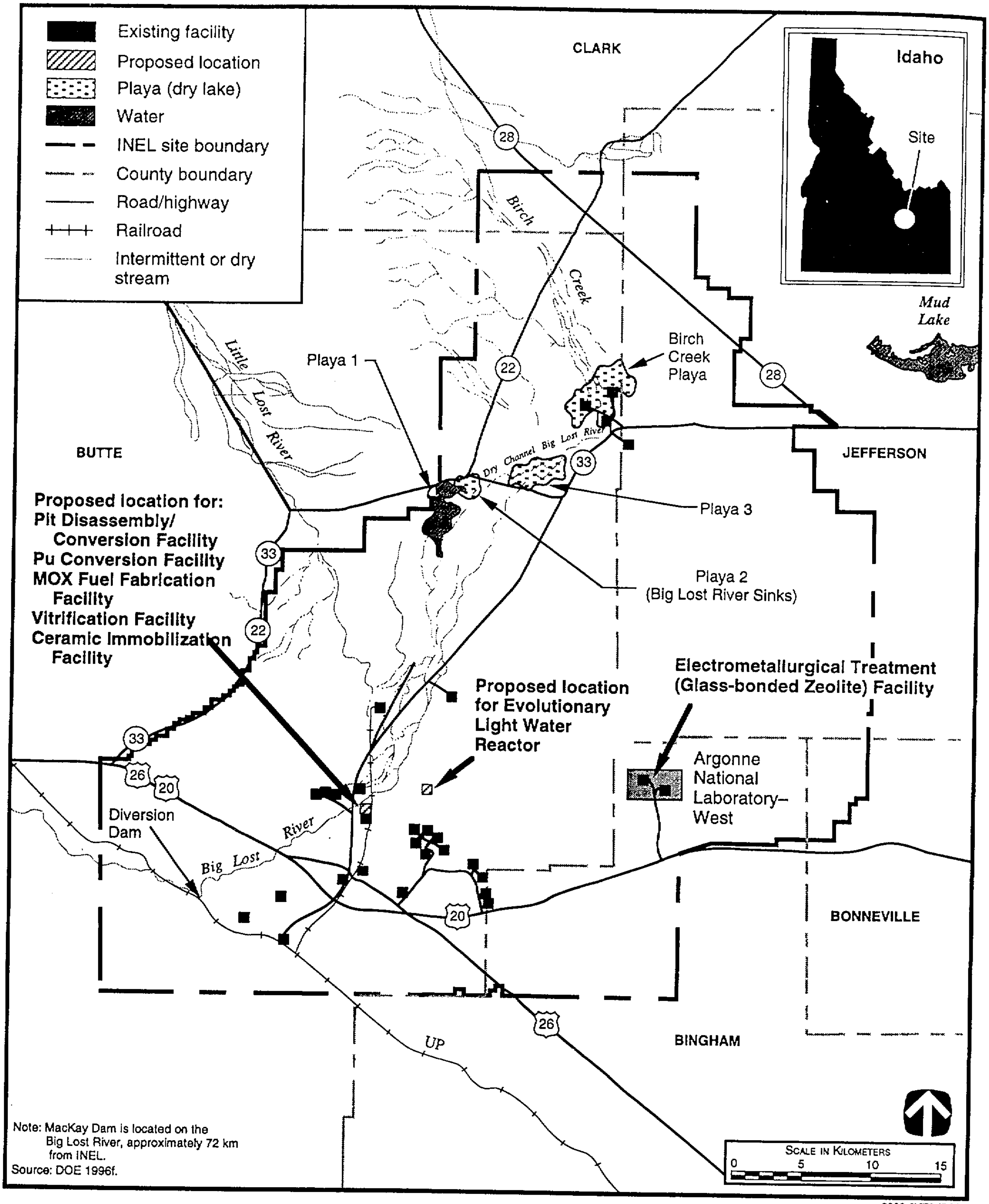

Figure 2.4–3. Representative Facility Locations for the Disposition of Plutonium at Idaho National Engineering Laboratory.

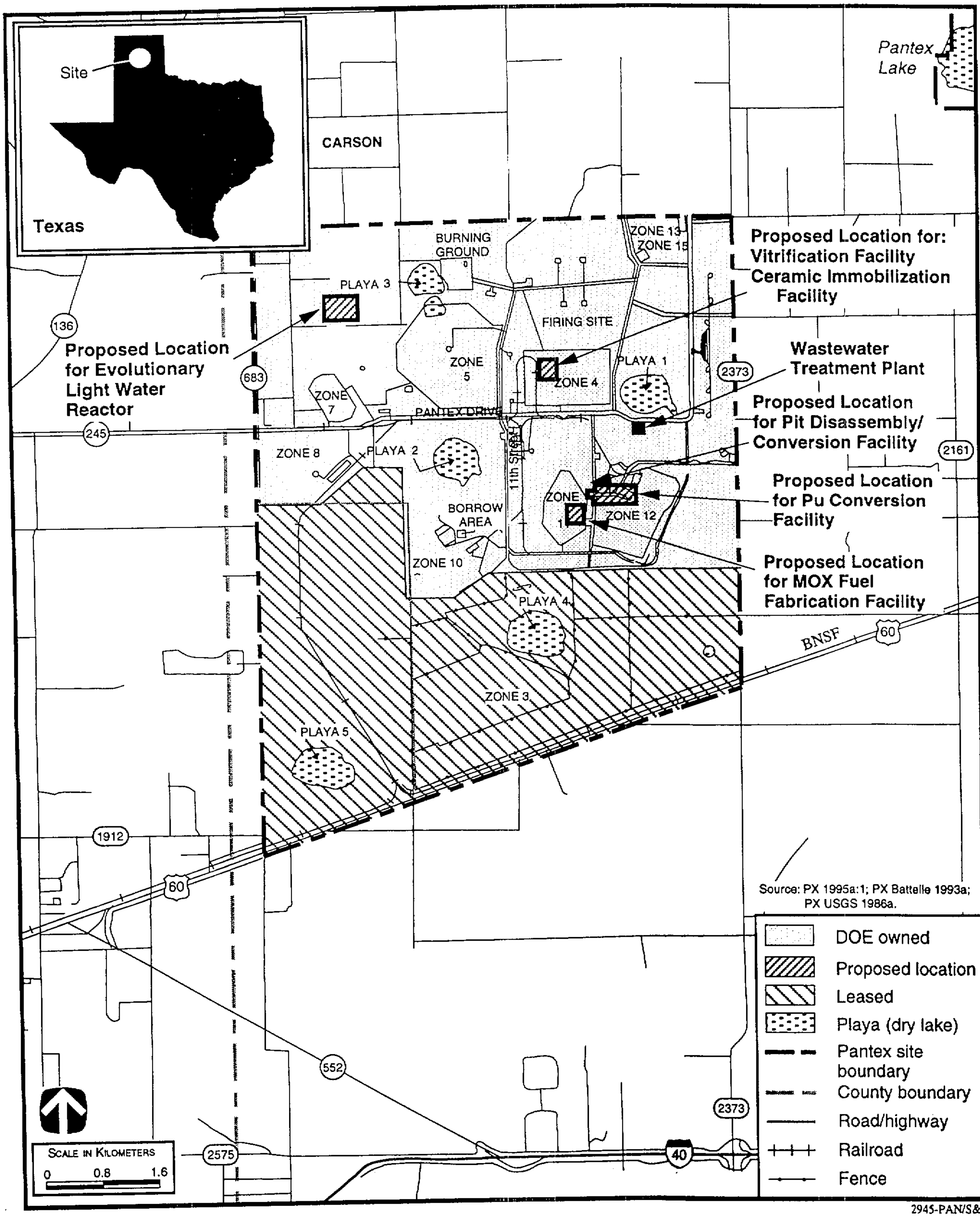

Figure 2.4–4. Representative Facility Locations for the Disposition of Plutonium at Pantex Plant.

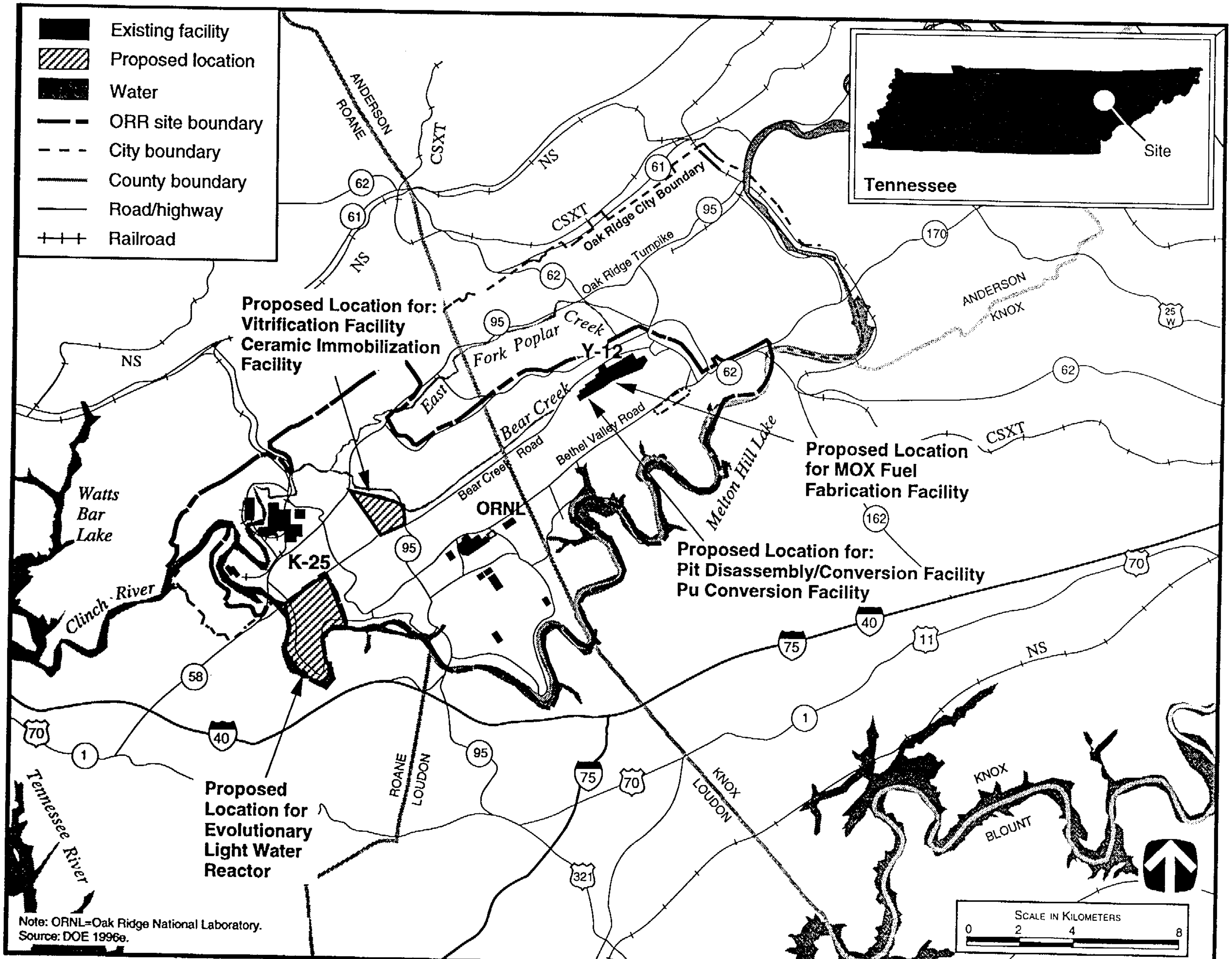

Figure 2.4–5. Representative Facility Locations for the Disposition of Plutonium at Oak Ridge Reservation.

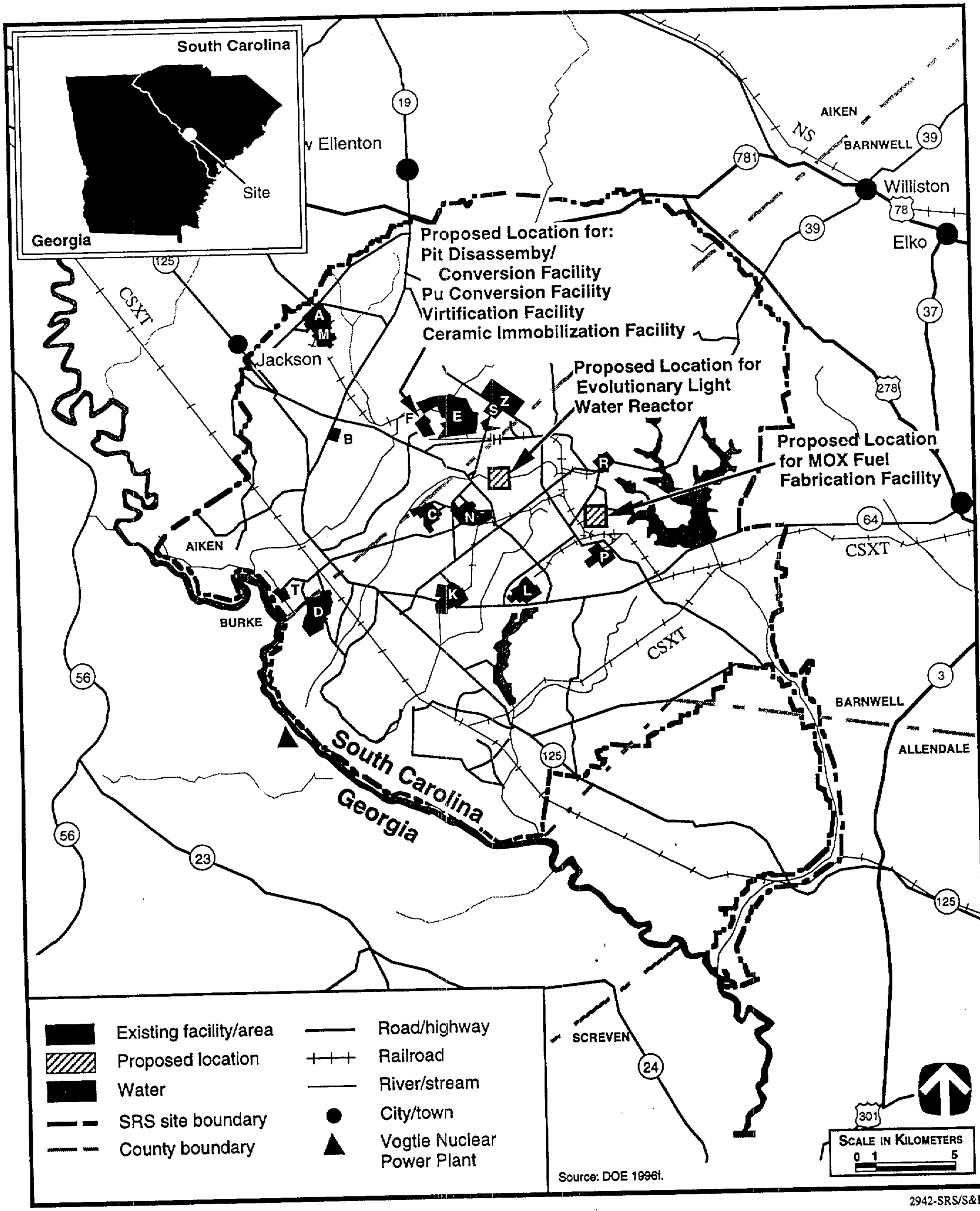

Figure 2.4–6. Representative Facility Locations for the Disposition of Plutonium at Savannah River Site.

DOE would analyze the impacts of continued storage of immobilized Pu waste forms or MOX-based spent nuclear fuel in a tiered NEPA document under any of the following conditions: (1) if the DOE HLW Program changes its approach for disposal of commercial spent nuclear fuel, (2) if the timeframe for acceptance of waste by the program is significantly delayed beyond current projections, or (3) if the Pu immobilized waste forms or MOX-based spent nuclear fuel resulting from Pu disposition alternatives are not acceptable to a licensed repository.

Six DOE sites and other generic and specific sites were used for assessing the environmental impacts of various disposition technologies and strategies. The locations of the new facilities considered for the various disposition technologies are representative and for analysis purposes only. Until tiered NEPA documentation has been completed, no specific location within any specific site (or sites) will be selected for any disposition alternative action.

This Storage and Disposition PEIS assumes all surplus Pu could be processed through each of the various disposition technology alternatives. However, some surplus Pu material may not be suitable for processing under every disposition technology. As a result, the strategy for disposition of surplus Pu could involve a combination of disposition alternatives. In addition, if any of the LWR alternatives are selected, there is also a multipurpose reactor variant (see Section 1.4 and Appendix N) that could produce tritium, use Pu as fuel, and in some designs generate revenue through the sale of electricity.

No Plutonium Disposition Action

As discussed in Section 1.6, a "No Pu Disposition" action means disposition would not occur, and surplus Pu-bearing weapon components (pits) and other forms, such as metal and oxide, would remain in long-term storage in accordance with decisions on the long-term storage of Pu.

Activities Common to Multiple Plutonium Disposition Alternatives

As previously described, the disposition alternatives for surplus Pu involve a variety of technologies. However, two activities are common to all the disposition alternatives, including the Preferred Alternative:

- Pit disassembly/conversion
- Pu conversion

Since these common activities involve the conversion of surplus Pu from current forms to one suitable for disposition, they are essential components of each disposition alternative. Pit disassembly and Pu conversion facilities could be collocated. Multiple facilities located at the same site are analyzed in Section 4.7.3, and more specific analysis will be performed in tiered NEPA documents, as appropriate.

Upon completion of the pit disassembly/conversion and/or Pu conversion processes, the Pu materials would be ready for further actions under one or more of the disposition technology alternatives.

2.4.1 PIT DISASSEMBLY/CONVERSION FACILITY

The pit disassembly/conversion facility would be common to all disposition alternatives, including the Preferred Alternative. The facility would disassemble, reshape, and convert the pits into an unclassified metal or oxide form usable by the next facility in the disposition process. In addition, some non-pit material (such as pure Pu metal) may be processed at the pit disassembly/conversion facility. The material contained in the pit disassembly/conversion facility, would require the highest levels of protection.

In accordance with the Preferred Alternative for surplus Pu disposition, the pit disassembly/conversion facility could be located at either Hanford, INEL, Pantex, or SRS. Further tiered NEPA review will be conducted to examine alternative locations, including new and existing facilities, at these four sites should the Preferred Alternative be selected at the ROD.

Facility Description. The surplus Pu would be removed from the pits by separating them in half with a cutting wheel and subjecting each half to a dry chemical process that converts the metal to a hydride powder, then either back to metal or to an oxide powder. Figure 2.4.1–1 depicts the material flow through the facility.

The total disturbed land area for the operating facility would be approximately 12 hectares (ha) (30 acres), plus a 1.6-kilometer (km) (1-mile [mi]) buffer zone around the operating facility. Provisions would be included to accommodate future international treaty requirements for inspection. Figure 2.4.1–2 shows a conceptual site layout perspective.

[Text deleted.] Appendix B provides a more detailed breakdown of the key buildings required at the pit disassembly/conversion facility. These buildings and their missions include the following:

Plutonium Processing Building. Pits would be disassembled, and the Pu and other components would be separated in this building. All wastes would be processed here for disposal. In addition, the building would contain maintenance facilities, laboratories, utility systems, heating ventilation and air conditioning (HVAC) equipment, and other support functions.

Administration Building. Management offices, meeting and conference rooms, a visitor control office, and the cafeteria would be contained here.

Plutonium Operations Support Building. Change rooms, decontamination facilities, offices, maintenance shops, operator training rooms, process demonstration laboratories, and general storage areas would be located in this building.

Warehouse. This building would provide miscellaneous storage and general delivery areas.

Utilities Building. Steam and water treatment facilities, the plant air system, and the chilled water system would be located in this building.

Generator Building. Emergency generators would be located in this building.

Guard and Vehicle Monitoring Station. This building would serve as the pedestrian and vehicle entrance to the facility. A hardened guard booth and a vehicle entrance lane next to the pedestrian entrance would be provided.

Facility Operations. Wherever possible, operations would be conducted by automated and robotic systems to reduce personnel exposure. The facility would be designed for a throughput of 3.25 t (3.58 tons) of Pu per year, using two shifts per day, 5 days per week. Surge capability would be provided by increasing plant personnel and adding weekend work shifts.

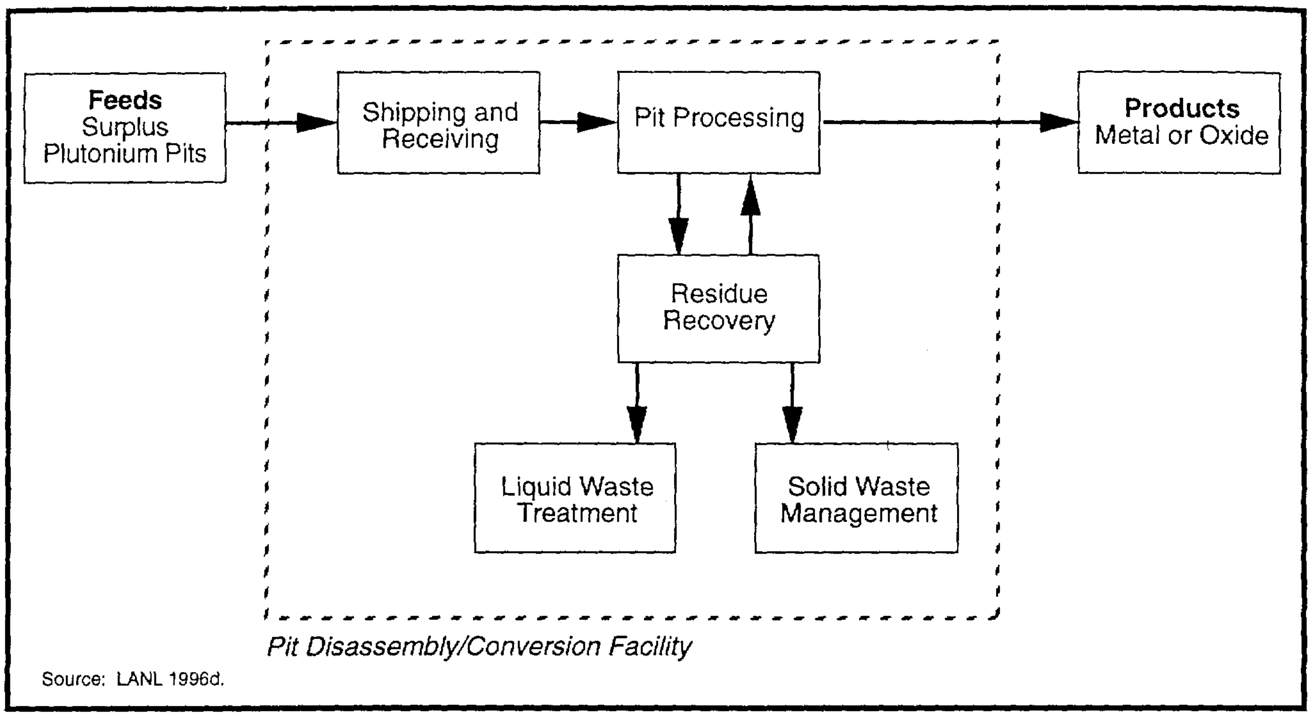

Figure 2.4.1–1. Pit Disassembly/Conversion Facility Material Process Flow.

The pit disassembly/conversion facility would contain all required systems to remove Pu from weapons components and to package the material into an unclassified form suitable for shipment to the next facility in the disposition process. Operational flow within the facility would be through several main processing areas. Shipping and receiving would handle the incoming pit inspection, decontamination, storage, and initial processing and the outgoing shipping functions for the Pu metal or oxide produced by the facility. Pit disassembly and conversion operations[18] would process the pit mechanically and chemically within gloveboxes into either Pu metal or oxide (depending upon the selected disposition process) and would package it for removal. Another output of the process would be waste, both liquid and solid, consisting of low-level, TRU, hazardous, and mixed waste. An analytical laboratory would be required to perform Pu assays on product and waste streams as well as to certify waste streams. A lag storage vault would be used to store product metal or oxide, uranium forms, and other components before packaging for shipment to the next disposition facility. Utilities and manpower resources needed during operation are presented in Appendix C. Chemicals required during operations can be found in the classified appendix. The water balance is depicted in Appendix D.

Construction. Construction of the facility would take approximately 6 years and have a peak annual employment of 125 construction workers. Construction of the pit disassembly/conversion facility would require an additional 2 ha (5 acres) of land for construction laydown, warehousing, and construction parking. Resources consumed during construction are shown in Appendix C.

Waste Management. The solid and liquid nonhazardous wastes generated during construction would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap metal before construction was completed. The remaining nonhazardous wastes generated during construction would be disposed of by the contractor as part of the construction project. Uncontaminated

[18] The Department is developing ARIES to remove Pu from weapons pits and convert it into either an oxide or metal. This prototype program is intended to demonstrate a completely integrated process to disassemble and convert pits into an unclassified metal or oxide form that would be usable in the next disposition process facility.

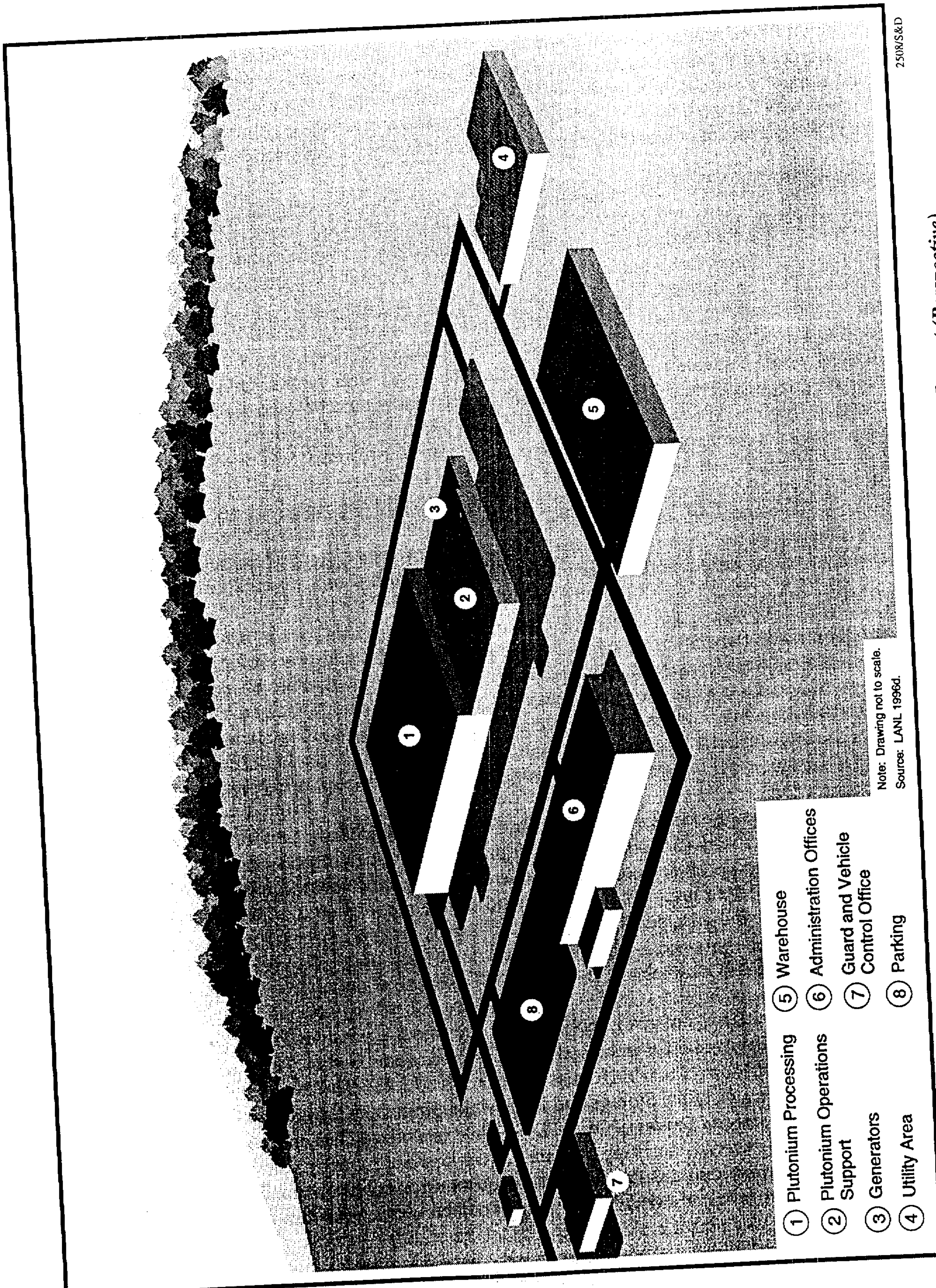

Figure 2.4.1–2. Conceptual Pit Disassembly/Conversion Facility Site Layout (Perspective).

wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes such as adhesives, oils, and solvent rags would be packaged in DOT-approved containers and shipped to offsite commercial RCRA-permitted treatment, storage, and disposal facilities. No soil contaminated with hazardous or radioactive constituents is expected to be generated during construction. However, if any was generated, it would be managed in accordance with site practice and all Federal and State standards.

Operation of the pit disassembly and conversion facility would generate TRU, low-level, hazardous, mixed, and nonhazardous wastes. The conceptual design includes waste management facilities that would treat and package all waste generated into forms that would enable staging and/or disposal in accordance with RCRA and other applicable statutes. TRU and mixed TRU waste would be treated and packaged to meet the WIPP WAC. These wastes would be stored awaiting shipment to a Federal repository (assumed to be WIPP, depending on decisions resulting from the supplemental EIS for the proposed continued phased development of WIPP for disposal of TRU waste). LLW would be treated and packaged to meet the waste acceptance criteria of an onsite or offsite DOE LLW disposal facility. The DOE LLW disposal facility that would be used would be consistent with decisions resulting from the Waste Management PEIS and tiered NEPA documents. Mixed LLW would be treated and disposed in accordance with the respective site treatment plan that was developed to comply with the *Federal Facility Compliance Act*. Hazardous wastes would be packaged in DOT-approved containers and shipped to RCRA-permitted treatment and disposal facilities. Liquid nonhazardous wastes such as sanitary, utility, and process wastewater would be treated and discharged in accordance with the site practice. Treated wastewater would be reclaimed to use as makeup water when economically and/or environmentally desirable. Solid nonhazardous waste would be disposed of in permitted landfills and recycled, as appropriate. [Text deleted.]

Transportation. Intrasite transportation of all the receiving, storage, and processing activities would be contained within the facility. Transfers within the processing building would be through tunnels or secure transfer hallways. Material would be moved between process areas by carts, forklifts, or a conveyer system. Upon receipt, material would go either directly into the process lines or into lag storage, depending on the amount of material received and the status of the processing areas. After processing is complete, the material would be placed in lag storage before being sent to the next facility in the disposition process.

For offsite transfers, the organization initiating action for the material would have the ultimate responsibility for its safe transfer from the time the material is offered for transportation until it is received at the final destination. Shippers, transporters, and receivers are responsible for compliance with applicable transportation requirements. Destination of the products would depend on the disposition alternatives that are chosen. Transportation data can be found in Appendix G.

2.4.2 PLUTONIUM CONVERSION

For all the surplus Pu disposition alternatives, including the Preferred Alternative, Pu not processed at the pit disassembly/conversion facility would be processed at the Pu conversion facility. This facility would convert non-pit, surplus Pu into metal or oxide suitable for use at the next disposition facility in the process. Most, if not all, of the Pu material in the scope of the Storage and Disposition program is assumed to be in the *Criteria for Safe Storage of Plutonium Metal and Oxides* (DOE-STD-3013-94) stabilized form prior to disposition activities. However, a small amount of material consisting of metals, oxides, and alloys may need additional processing. Such materials would be converted in this facility for subsequent disposition. The facility would also provide lag storage for some materials to be converted. Figure 2.4.2–1 depicts the material flow through the facility.

In accordance with the Preferred Alternative for surplus Pu disposition, the Pu conversion facility could be located at either Hanford or SRS. Further tiered NEPA review will be conducted to examine alternative

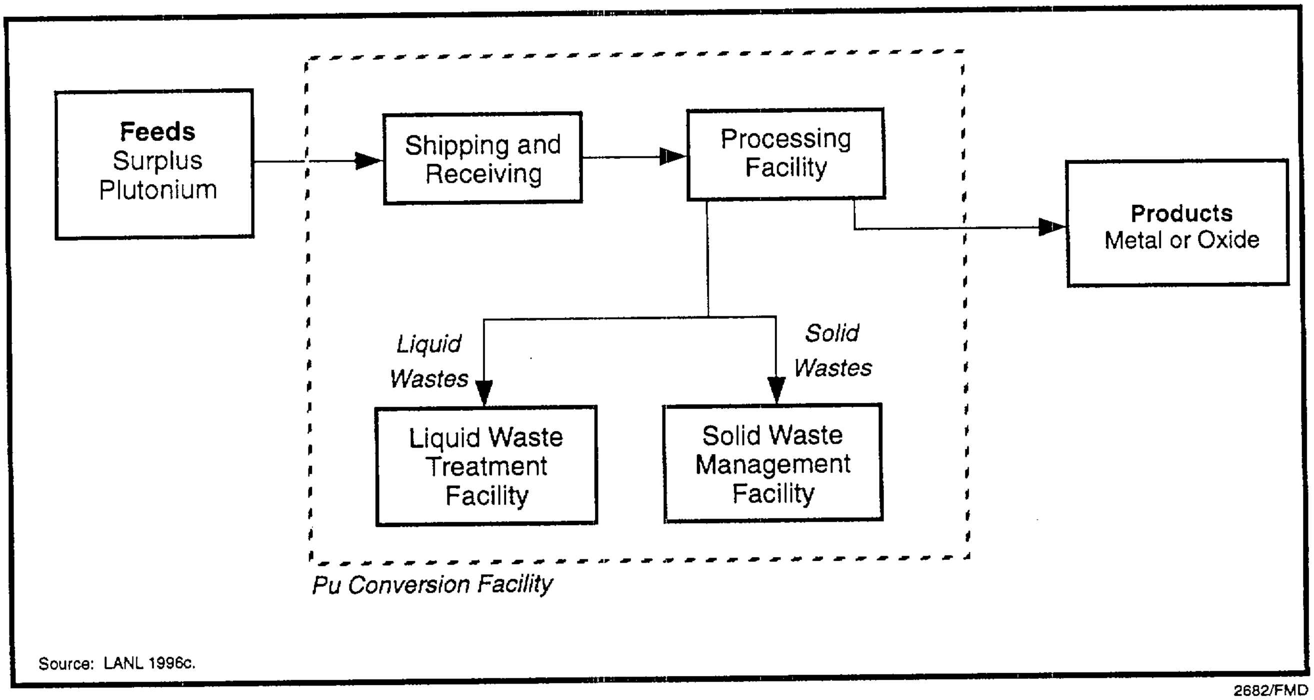

Figure 2.4.2–1. Plutonium Conversion Facility Material Flow Diagram.

locations, including new and existing facilities, at these two sites should the Preferred Alternative be selected at the ROD.

Facility Description. The material contained in the Pu conversion facility would require the highest levels of protection, including a 1.6-km (1-mi) buffer zone around the operating facility. Personnel security programs would require badging and access control of all personnel. For a new facility, the total disturbed land area would be approximately 28 ha (70 acres). Figure 2.4.2–2 depicts the conceptual site layout. Appendix B provides a more detailed description of key Pu conversion facility buildings. The mission of these buildings is as follows:

Central Warehouse, Shipping and Receiving Building. Packaging, safety confirmation of containers from the lag storage vault, and truck loading functions would be provided here. Services include unloading feed from transports, removing items from the shipping containers, confirming the contents, and handling abnormally sized packages.

Staging/Storage Facility. The interface between receiving and processing, and repackaging and storage functions would be provided in this building. These functions characterize, verify, and prepare the feeds and products for lag storage and control the flow and quality of material into and out of the glovebox operations.

Processing Building. Handling and processing Pu into a form acceptable for the next facility in the disposition process would occur here. This building would also provide utility support functions, MC&A, safety systems, waste management, repackaging, and assay and analysis.

Facility Operations. The Pu conversion facility conceptual design assumes that scrap and surplus Pu materials are pretreated to meet DOE interim storage and DOT shipping regulations. [Text deleted.] The facility design is flexible and provides for additional or reduced processing with minor process changes, such as increasing metal dissolution capacity for conversion to oxide, adding americium extraction, oxidation furnaces, or nitrate processing to meet additional alternative feed pretreatment requirements as feed forms and quantities are better

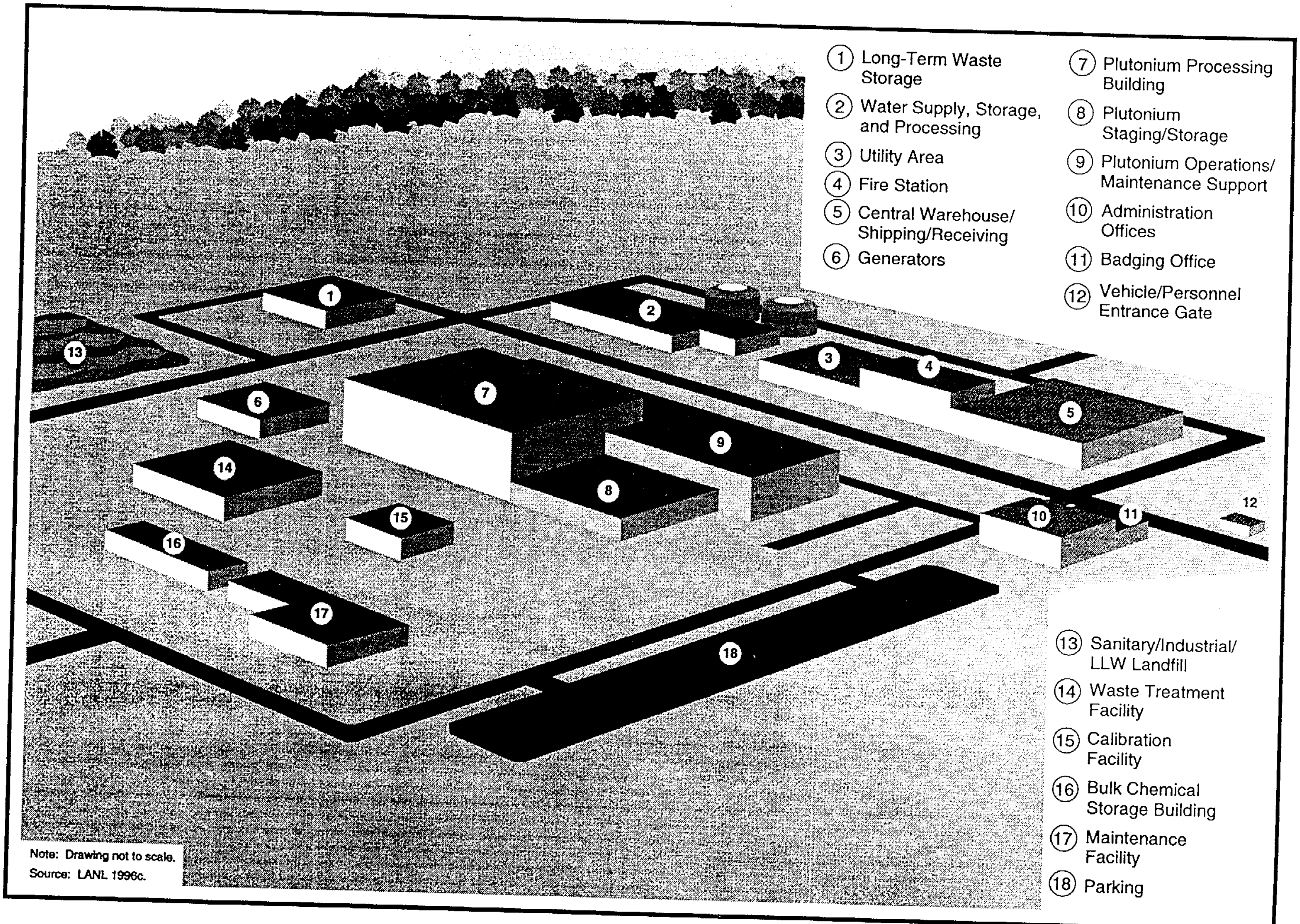

Figure 2.4.2–2. Conceptual Plutonium Conversion Facility Site Layout (Perspective).

defined. The Pu conversion facility would process Pu to a form that meets nuclear fuels feed or immobilization feed criteria. The facility design would be based on an annual throughput rate of 0.4 t (0.44 tons) of Pu, using one 10-hour shift, 200 days per year. Surge capability would be provided by increasing personnel and adding work shifts. Utilities and manpower resources needed during operations are presented in Appendix C. The water balance is depicted in Appendix D. Chemicals required during operations can be found in the Classified Appendix.

Construction. The construction of the Pu conversion facility would take approximately 6 years and have a peak annual employment of 358 construction workers. For a new facility, additional land area required temporarily for construction is projected to be approximately 8 ha (20 acres). This provides for construction material laydown, warehousing, and parking. Other resources consumed during construction are shown in Appendix C.

Waste Management. The solid and liquid nonhazardous wastes generated during construction would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap metal before construction was completed. The remaining nonhazardous wastes generated during construction would be disposed of by the contractor as part of the construction project. Uncontaminated wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes such as adhesives, oils, and solvent rags would be packaged in DOT-approved containers and shipped to offsite commercial RCRA-permitted treatment, storage, and disposal facilities. No soil contaminated with hazardous or radioactive constituents is expected to be generated during construction. However, if any were generated, it would be managed in accordance with site practice and all Federal and State standards.

Operation of the Pu conversion facility would generate TRU, low-level, hazardous, mixed, and nonhazardous wastes. The conceptual design includes waste management facilities that would treat and package all waste generated into forms that would enable staging and/or disposal in accordance with the RCRA and other applicable statutes. TRU and mixed TRU waste would be treated and packaged to meet the WIPP WAC. These wastes would be stored awaiting shipment to a Federal repository (assumed to be WIPP, depending on decisions resulting from the supplemental EIS for the proposed continued phased development of WIPP for disposal of TRU waste). LLW would be treated and packaged to meet the WAC of an onsite or offsite DOE LLW disposal facility. The DOE LLW disposal facility that would be used would be consistent with decisions resulting from the Waste Management PEIS and tiered NEPA documents. Mixed LLW would be treated and disposed in accordance with the respective site treatment plan which was developed to comply with the *Federal Facility Compliance Act*. Hazardous wastes would be packaged in DOT-approved containers and shipped to RCRA-permitted treatment and disposal facilities. Liquid nonhazardous wastes such as sanitary, utility, and process wastewater would be treated and discharged in accordance with the site practice. Treated wastewater would be reclaimed to use as makeup water when economically and/or environmentally desirable. Solid nonhazardous waste would be disposed of in permitted landfills and recycled, as appropriate.

Transportation. Intrasite transportation of radiological and hazardous materials would be between the Pu processing and manufacturing building and the Pu storage building. The storage container packages would be transported between vault storage and staging buildings via a hardened transfer corridor. Primary containers that have failed in storage or require intensive testing would be transported to Pu processing and manufacturing.

For offsite transfers, the organization initiating action for the material would have the ultimate responsibility for its safe transfer from the time the material is offered for transportation until it is received at the final destination. Shippers, transporters, and receivers would be responsible for compliance with applicable transportation requirements. Destination of the products would depend on the disposition alternatives that are chosen. Transportation data can be found in Appendix G.