CHAPTER 2
PROPOSED ACTIONS AND ALTERNATIVES

> Chapter 2 describes the processes and facilities that could be used to implement each of the alternatives proposed for this *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)*. Section 2.1 introduces the proposed actions addressed in this *TC & WM EIS* and outlines the contents of Chapter 2. Section 2.2 describes the existing and proposed tank farm operations and facilities and provides an overview of the various storage, retrieval, treatment, disposal, and closure technologies considered in the analyses of the tank closure proposed actions. Section 2.3 describes the existing Fast Flux Test Facility and auxiliary buildings; the status of ongoing deactivation activities, as well as proposed decommissioning activities and various technologies for disposition of the facilities; disposal of remote-handled special components; and bulk sodium processing. Section 2.4 describes the existing Hanford Solid Waste Operations Complex and proposed solid waste management activities. Section 2.5 describes the range of alternatives evaluated in detail in this *TC & WM EIS*, including the No Action Alternatives. Section 2.6 summarizes the other technologies and options that were initially considered for the proposed actions, but were not evaluated in detail in this *TC & WM EIS*. Section 2.7 compares the *TC & WM EIS* alternatives and describes associated technical and programmatic uncertainties. Sections 2.8 and 2.9 summarize the short- and long-term environmental impacts of the alternatives, respectively. Section 2.10 presents the key environmental findings and conclusions drawn from the analyses. Section 2.11 provides a general discussion of the costs associated with each alternative. The chapter concludes with a brief discussion of preferred alternatives in Section 2.12.

2.1 INTRODUCTION

> ***TC & WM EIS* Proposed Actions**
>
> (1) Retrieve, treat, and dispose of waste in single-shell tank (SST) and double-shell tank (DST) farms and close the SST system.
>
> (2) Decommission the Fast Flux Test Facility, manage the resulting waste, and manage the disposition of the Hanford Site's (Hanford's) inventory of bulk sodium.
>
> (3) Manage waste from tank closure and other Hanford activities, as well as limited volumes received from U.S. Department of Energy sites.

As discussed in Chapter 1, the U.S. Department of Energy (DOE) is proposing three sets of actions in this *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)*. The first set of proposed actions is to retrieve, treat, and dispose of waste being managed in the high-level radioactive waste (HLW) single-shell tank (SST) and double-shell tank (DST) farms at the Hanford Site (Hanford) and to close the SST system, which includes disposition of the SSTs, ancillary equipment, and soils. The SST (149 tanks) and DST (28 tanks) systems contain both hazardous and radioactive waste (mixed waste). The second set of proposed actions analyzed in this environmental impact statement (EIS) is to decommission Hanford's Fast Flux Test Facility (FFTF) and auxiliary facilities; manage the waste from the decommissioning process, including certain waste designated as remote-handled special components (RH-SCs); and handle disposition of Hanford's inventory of radioactively contaminated bulk sodium from FFTF and other facilities on site. The third set of proposed actions involves various options for managing the waste resulting from tank closure and other Hanford activities, as well as limited volumes received from other DOE sites.

DOE has developed various alternatives to address the three sets of proposed actions described above. As discussed in Chapter 1, Section 1.9, and throughout this chapter, there are 11 Tank Closure alternatives and subalternatives, 3 FFTF Decommissioning alternatives, and 3 Waste Management alternatives, as follows:

Tank Closure Alternatives

Tank Closure Alternative 1: No Action

Tank Closure Alternative 2: Implement the *Tank Waste Remediation System EIS* Record of Decision with Modifications

- Tank Closure Alternative 2A: Existing WTP Vitrification; No Closure
- Tank Closure Alternative 2B: Expanded WTP Vitrification; Landfill Closure

Tank Closure Alternative 3: Existing WTP Vitrification with Supplemental Treatment Technology; Landfill Closure

- Tank Closure Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure
- Tank Closure Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure
- Tank Closure Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

Tank Closure Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

Tank Closure Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

Tank Closure Alternative 6: All Waste as Vitrified HLW

- Tank Closure Alternative 6A: All Vitrification/No Separations; Clean Closure (Base and Option Cases)
- Tank Closure Alternative 6B: All Vitrification with Separations; Clean Closure (Base and Option Cases)
- Tank Closure Alternative 6C: All Vitrification with Separations; Landfill Closure

FFTF Decommissioning Alternatives

FFTF Decommissioning Alternative 1: No Action
FFTF Decommissioning Alternative 2: Entombment
FFTF Decommissioning Alternative 3: Removal

Waste Management Alternatives

Waste Management Alternative 1: No Action
Waste Management Alternative 2: Disposal in IDF, 200-East Area Only
Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas

The following sections provide an overview of current and proposed tank farm, FFTF decommissioning, and waste management activities and applicable technologies. Detailed descriptions of each Tank Closure, FFTF Decommissioning, and Waste Management alternative are presented in Section 2.5.

Dates for Alternatives

The dates referenced in this environmental impact statement (EIS) for the alternatives were selected to support relationships between, and durations for, activities, thus allowing comparisons of the alternatives. Due to ongoing technical developments and their inherent uncertainties, they do not necessarily represent the current dates. For example, this EIS used a Waste Treatment Plant (WTP) startup date of 2018; the 2010 Consent Decree milestone for WTP startup is 2022. Note that the durations, rather than the startup dates, of the activities evaluated in this EIS are of the most significance. As this EIS evaluates modeling from 1944 through 11,944, the dates provide a reference for past, current, and future activities.

2.2 HANFORD TANK FARM SYSTEM CLOSURE ACTIONS

The waste being managed in the HLW tank system is the byproduct of producing plutonium and other defense-related materials. From 1944 through 1990, chemical processing facilities at Hanford reprocessed irradiated or spent nuclear fuel (SNF) from defense reactors to separate and recover plutonium for weapons production. As new, improved reprocessing operations were developed over the last 50 years, processing efficiency improved, and the waste compositions sent to the tanks for storage changed both chemically and radiologically. The B and T Plants were the first separations facilities built at the site. The separations processes carried out at these plants recovered only plutonium; consequently, all remaining components of the dissolved fuel elements, including uranium, were sent to the waste tanks (DOE and Ecology 1996).

Waste Types Analyzed in This Environmental Impact Statement

Hazardous waste: A category of waste regulated under the Resource Conservation and Recovery Act (RCRA) (42 U.S.C. 6901 et seq.). To be considered hazardous, a waste must (1) be a solid waste under RCRA; (2) exhibit at least one of the four characteristics described in 40 CFR 261.20 through 261.24 (ignitability, corrosivity, reactivity, or toxicity); or (3) be specifically listed by the U.S. Environmental Protection Agency (EPA) in 40 CFR 261.31 through 261.33. Hazardous waste may also include solid waste designated as dangerous or extremely hazardous waste by the State of Washington (WAC 173-303-070 through 173-303-100).

High-level radioactive waste (HLW): Highly radioactive waste material resulting from reprocessing of spent nuclear fuel (SNF), including liquid waste produced directly from reprocessing; any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation (DOE Manual 435.1-1).

Low-activity waste (LAW): Waste that remains after as much radioactivity as technically and economically practical has been separated from HLW that, when solidified, may be disposed of as low-level radioactive waste (LLW) in a near-surface facility. In its final form, such solid LAW would not exceed 10 CFR 61.55 Class C radioisotope limits and would meet performance objectives comparable to those in 10 CFR 61, Subpart C. At the Hanford Site, this is mixed waste.

Low-level radioactive waste (LLW): Radioactive waste that is not HLW, SNF, transuranic (TRU) waste, byproduct material as defined in the Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.), or naturally occurring radioactive material.

Mixed waste: Waste that contains source, special nuclear, or byproduct material that is subject to the Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.), as well as a hazardous component subject to RCRA.

Transuranic (TRU) waste: Radioactive waste products containing more than 100 nanocuries (3,700 becquerels) of alpha-emitting TRU isotopes per gram of waste with half-lives greater than 20 years, except (1) HLW; (2) waste that does not need the degree of isolation required by the disposal regulations detailed in 40 CFR 191, as determined by the Secretary of Energy with the concurrence of the EPA Administrator; or (3) waste that the U.S. Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.

Processes were later developed to recover uranium, which was recycled back into the reactor fuel cycle. Many of the chemical processes associated with plutonium recovery from SNF involved dissolving the material in nitric acid. The resulting acidic waste streams were made alkaline by adding sodium hydroxide or calcium carbonate before being transferred to the tanks. These processing steps produced large volumes of sodium nitrate salts in the tanks (DOE and Ecology 1996).

The tank waste is categorized as liquid, sludge, or salt cake. Liquid tank waste is made up of water and organic compounds that contain dissolved salts. Depending on their type, the liquid organic compounds either are dissolved in the water or exist in separate phases of solution. Liquid is present in the tanks either as supernatant liquid (where the volume is relatively free of solid particles and present in larger pools) or as interstitial liquid (where the volume fills the interstitial spaces surrounding the sludge and salt cake particles). Sludge is a mixture of insoluble (i.e., will not dissolve in tank liquid) metal salt compounds that have precipitated and settled out of solution after the waste was made alkaline. Salt cake is primarily sodium and aluminum salts that have crystallized out of solution during evaporation (DOE and Ecology 1996; Naiknimbalkar 2006).

These three types of waste exist in the tanks in numerous combinations and proportions, resulting in complex waste combinations with varied physical and chemical properties. Sludge has been found with consistencies from mud to hardened clay. Layers of organic compounds have been found in some tanks floating on top of solid waste. Crusts have formed in some tanks where a layer of solid waste has formed on top of the liquid (DOE and Ecology 1996).

DOE's strategy for retrieving, treating, and disposing of the tank waste and closing the SST farms has evolved based on information developed since issuance of the *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement (TWRS EIS)* (DOE and Ecology 1996) Record of Decision (ROD) (62 FR 8693). The following items reflect this new information and the proposed changes to DOE's strategy.

- Changes in the design of, and preliminary performance projections for, the Waste Treatment Plant (WTP) (currently under construction) are being proposed to extend its operations beyond the original plan to operate the WTP for a 10-year period and to enhance its throughput compared with that of facilities that were proposed in the *TWRS EIS*.
- New information indicates that use of large-scale treatment facilities in approximately 2012 to immobilize waste not processed by the WTP, as identified in the *TWRS EIS* ROD, may be prohibitively expensive (68 FR 1052).
- DOE believes there may be certain HLW storage tanks that it could demonstrate should be classified as transuranic (TRU) waste based on the origin of the waste. This *TC & WM EIS* evaluates the environmental impacts of managing this waste as TRU waste because it assumes the historical processing data support this classification. For Tank Closure Alternatives 3 through 5, this EIS evaluates treating the waste stream associated with the TRU waste portion as both TRU waste and HLW because this waste has not gone through the TRU waste confirmation and certification processes.
- DOE wants to consider nonvitrification treatment technologies for low-activity waste (LAW), if this waste can be immobilized and disposed of on site while providing protection to the human environment, comparable to LAW immobilized by vitrification (see Appendix E, Section E.1.2).

DOE's present management of the Hanford tank farm system consists of four major components:

Ancillary Equipment

Ancillary equipment within the single-shell tank (SST) system, as established in the Resource Conservation and Recovery Act Part A permit, includes all subordinate tank systems, vaults, transfer pipelines, pump pits, valve pits, lift stations, catch tanks, unloading stations, and any other components that have been, are, or may be used to treat, store, or transfer hazardous and/or mixed waste within the boundary of the SST system. Appendix E, Section E.1.2.5.2, provides a detailed description of these components.

SST system. This component includes 149 SSTs, ancillary equipment, and soils (from surface soils to the soil interface with groundwater) within the HLW tank farms and/or waste management area boundaries used to support Hanford waste retrieval and storage activities.

DST system.[1] This component includes 28 existing DSTs, ancillary equipment, and soils. It also includes new retrieval and delivery systems that are currently under construction and (potentially) any new DSTs needed to complete the DOE River Protection Project (RPP) mission.[2]

1 For analysis purposes, the DST system includes the 242-A Evaporator, which has a separate operating permit from the DSTs.

2 A decision on closure of the DSTs is not part of the proposed actions because they are active components that are needed to complete waste treatment. Closure of the DSTs would need to be addressed at a later date subject to appropriate National Environmental Policy Act review. Some alternatives addressed by this EIS include closure of the SST system. Because DSTs may be located in an area of the SST system being closed under these alternatives, the impacts associated with closure of all of the DSTs (such as the impacts of filling the tanks and covering the tanks with a closure barrier) were evaluated.

Waste treatment. This component includes existing and potential new pretreatment, vitrification, and supplemental treatment facilities used to treat Hanford tank waste prior to disposal.

Waste disposal. This component includes existing and potential new facilities required for interim storage and disposal of treated Hanford tank waste.

2.2.1 Tank Farm Operations and Facilities

The 149 SSTs, 28 DSTs, and ancillary equipment considered under the set of proposed actions for tank closure are distributed among 18 tank farms located in the 200 Areas of Hanford. The 200 Areas are divided into east and west components (200-East Area and 200-West Area), and each tank farm contains 2 to 18 tanks (see Figure 2–1 for a photograph of the tanks under construction). Figure 2–2 illustrates the key components of the tank farm system and the range of tank waste remediation approaches considered in this *TC & WM EIS*. As shown in Figures 2–3 and 2–4, the 200-West Area includes 6 SST farms (S, SX, T, TX, TY, and U) and 1 DST farm (SY); the 200-East Area includes 6 SST farms (A, AX, B, BX, BY, and C) and 5 DST farms (AN, AP, AW, AY, and AZ).

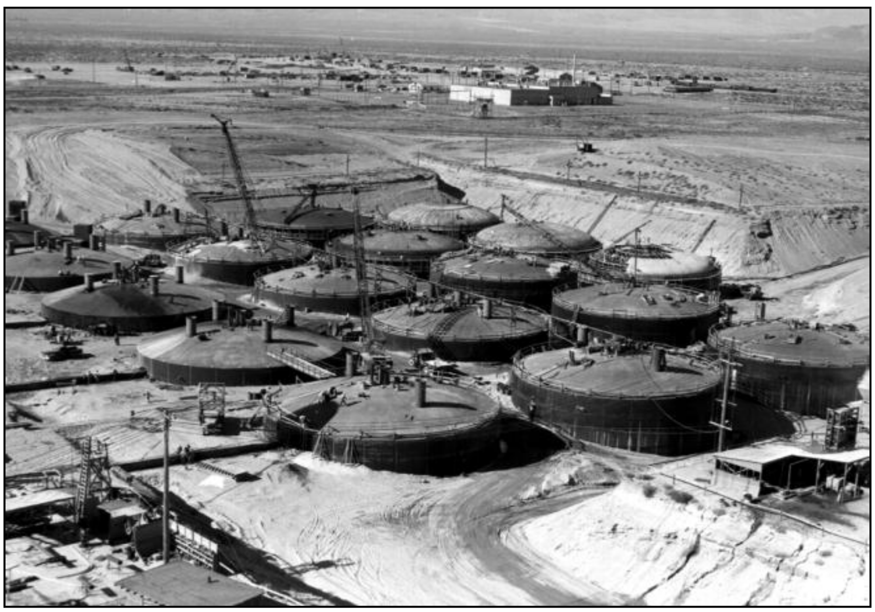
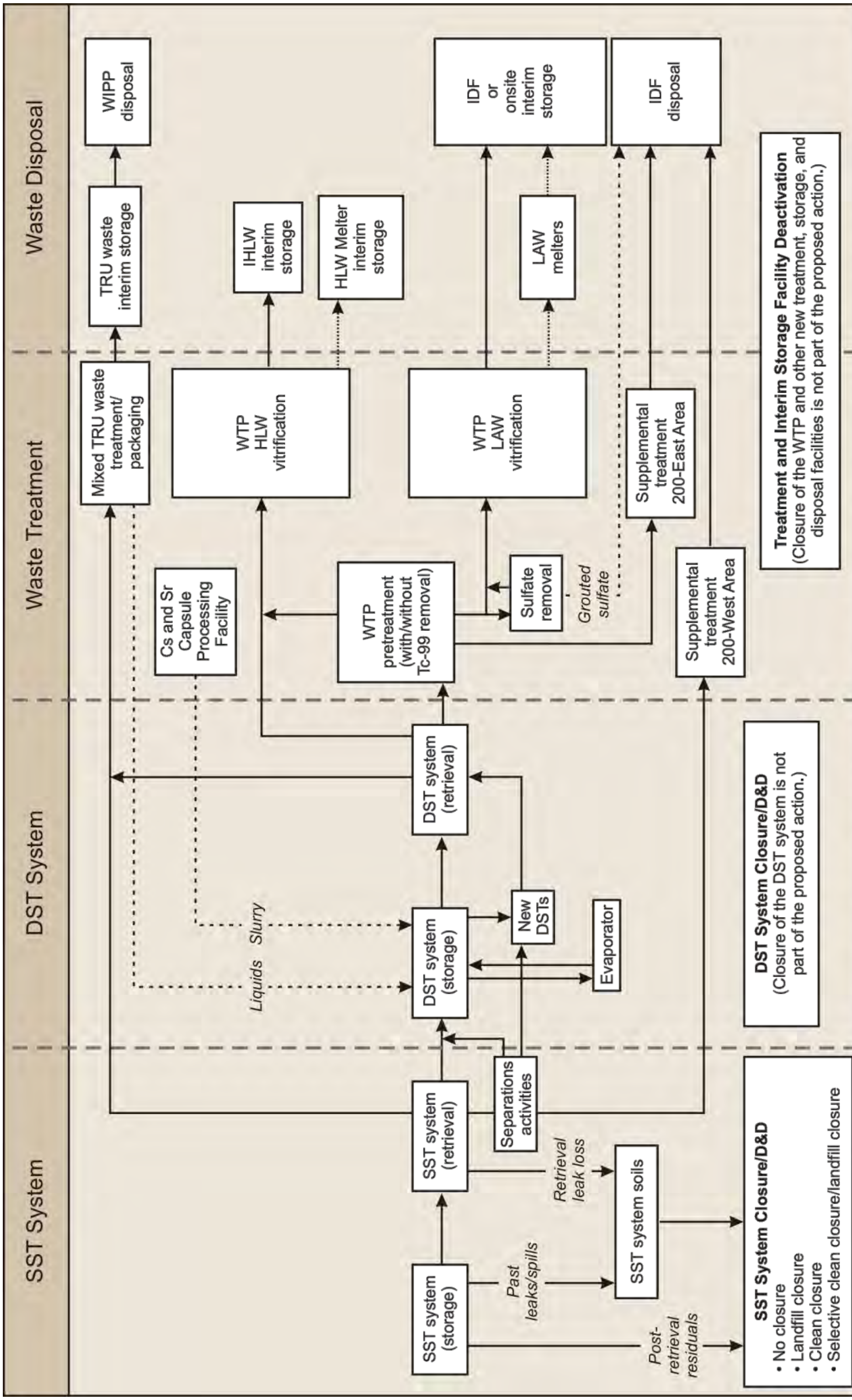


Figure 2–1. Single-Shell Tanks Under Construction at the Hanford Site, 1947–1948

Also included in the tank farm system are 66 miscellaneous underground storage tanks (MUSTs), most of which are inactive. These MUSTs are constructed of steel, concrete, or both, and range in capacity from approximately 3,000 to 190,000 liters (800 to 50,000 gallons). The inactive MUSTs, which are smaller than the SSTs and DSTs, were used for settling solids out of liquid waste before decanting the liquid to cribs and trenches (ditches), reducing the acidity of process waste, conducting uranium recovery operations, collecting waste transfer leakage, and performing waste handling activities and experiments. Active MUSTs are still used as receiver tanks during transfer activities or as catch tanks to collect potential spills and leaks (DOE 2003a; Hebdon 2001). The closure of 18 of these 66 MUSTs is not within the scope of this *TC & WM EIS*.



Key: Cs=cesium; D&D=decontamination and decommissioning; DST=double-shell tank; HLW=high-level radioactive waste; IDF=Integrated Disposal Facility; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; Sr=strontium; SST=single-shell tank; Tc-99=technetium-99; TRU=transuranic; WIPP=Waste Isolation Pilot Plant; WTP=Waste Treatment Plant.

Source: Modified from DOE 2003b.

Figure 2–2. Hanford Site High-Level Radioactive Waste Tank Farm System and Remediation Approaches

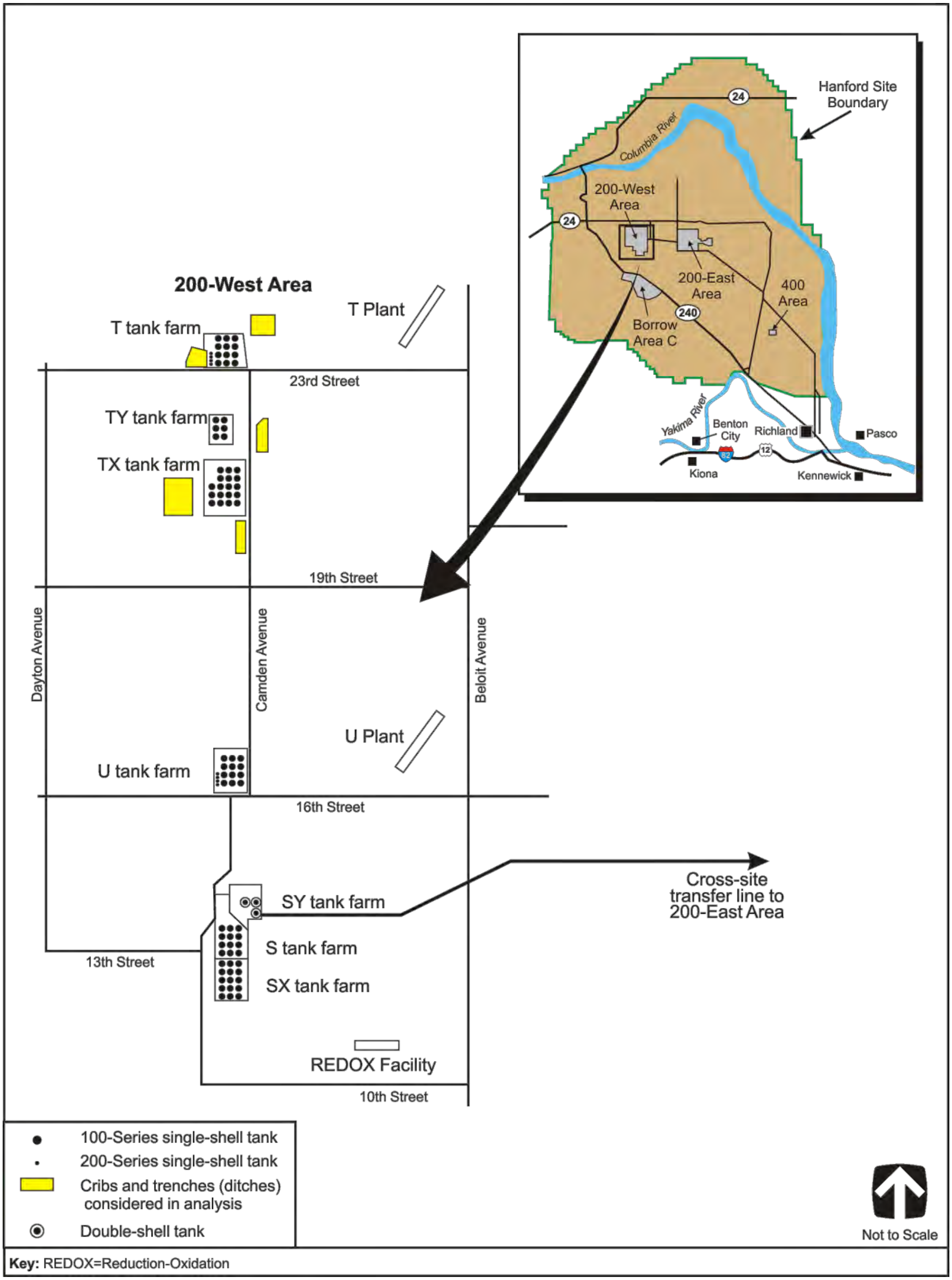
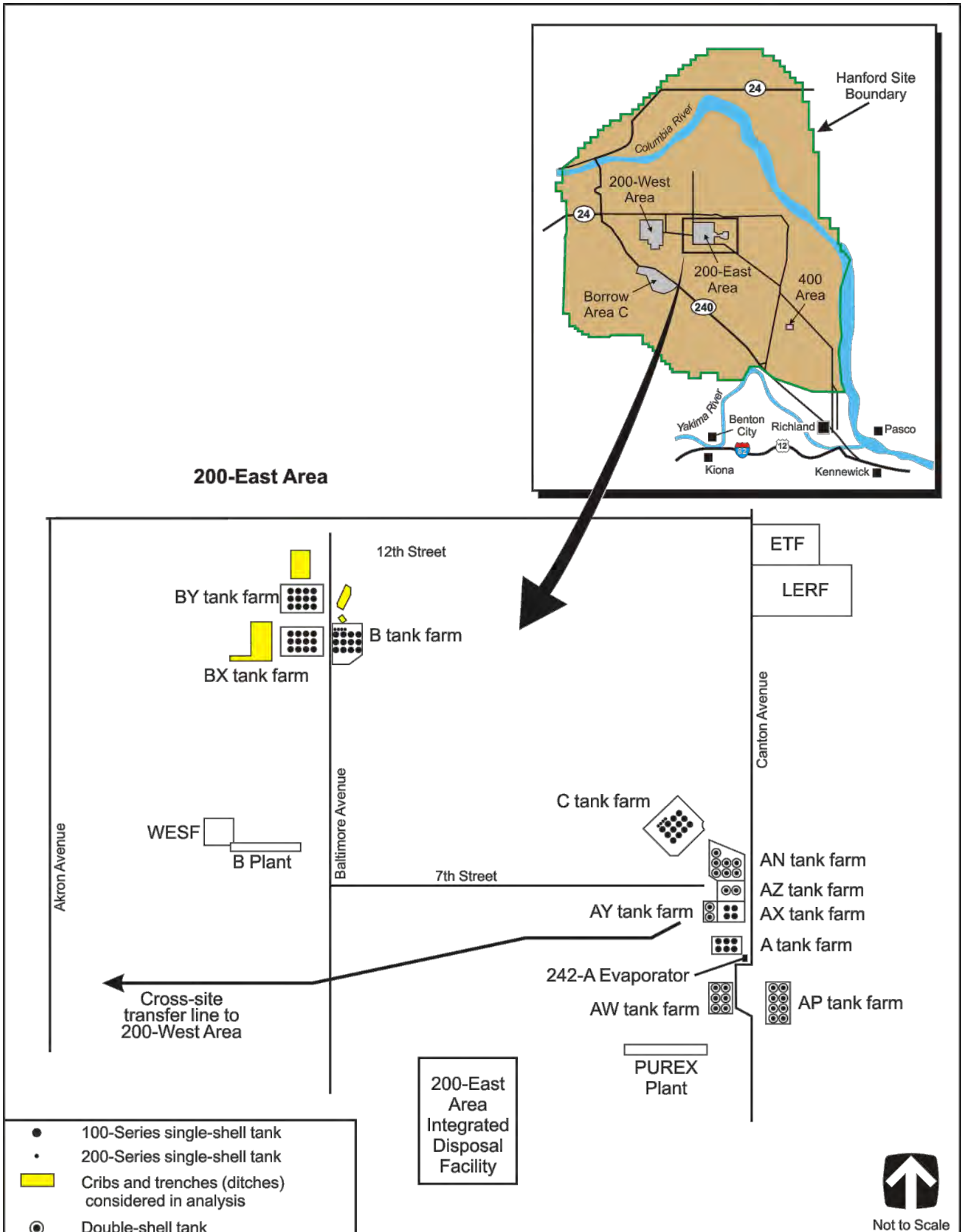


Figure 2–3. 200-West Area Tank Farm Location Map



Key: ETF=Effluent Treatment Facility; LERF=Liquid Effluent Retention Facility; PUREX=Plutonium-Uranium Extraction; WESF=Waste Encapsulation and Storage Facility.

Figure 2–4. 200-East Area Tank Farm Location Map

Waste was discharged directly to the ground from SSTs during the 1940s and 1950s as part of the early plutonium and uranium recovery operations. Two types of disposal sites, cribs and trenches (ditches), were used. Cribs are underground structures designed to distribute liquid waste, usually through a perforated pipe, to the soil directly or to a connected tile field. Trenches (ditches) are depressions dug in the ground that are open to the atmosphere and are designed for disposal of low- or intermediate-level radioactive waste. Some of these cribs and trenches (ditches), specifically the B Cribs, BX Trenches, BY Cribs, T Cribs, T and TX Trenches, and TY Cribs, are close to the SST farms. Because of this proximity, it is sometimes difficult to clearly identify contamination sources in the groundwater and vadose zone (Waite 1991). Therefore, these cribs and trenches (ditches) are included in the tank farm analyses as a connected action under all of the Tank Closure alternatives considered in this *TC & WM EIS*. The other cribs, trenches (ditches), MUSTs, and waste sites at Hanford that are outside the scope of the proposed actions are analyzed in Chapter 6 in terms of their potential cumulative impacts.

The following sections describe the existing SST and DST farm facilities, as well as current DOE activities associated with routine operations and maintenance, tank farm upgrades, and WTP construction.

2.2.1.1 Single-Shell Tanks

The first 149 waste storage tanks constructed were SSTs. An SST is a single-wall underground storage tank with carbon steel sides and bottom surrounded by a reinforced-concrete shell. The SSTs were built from 1943 to 1964 to hold the liquid radioactive waste created by the production and separation of plutonium. The numbers and nominal capacities of the SSTs are as follows (DOE 2003c):

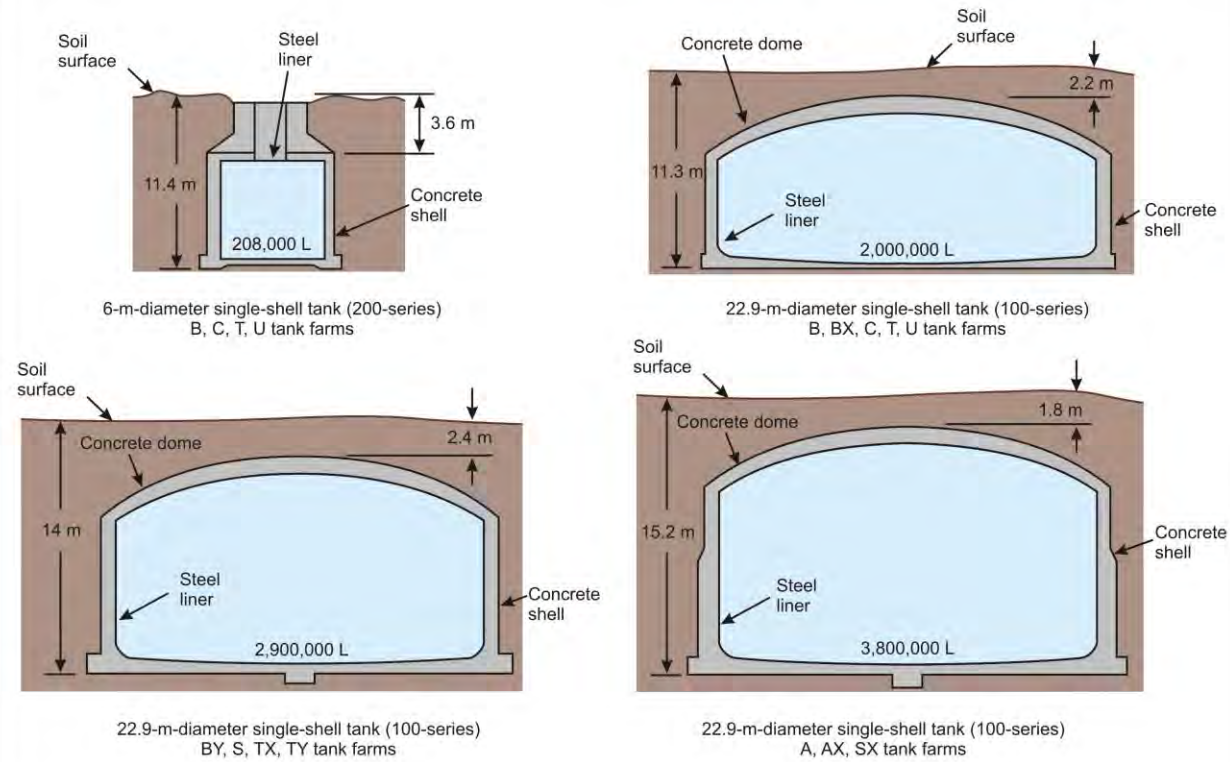
- 25 tanks of 3.8-million-liter[3] (1-million-gallon) capacity (100-series)
- 48 tanks of 2.9-million-liter (758,000-gallon) capacity (100-series)
- 60 tanks of 2.0-million-liter (530,000-gallon) capacity (100-series)
- 16 tanks of 208,000-liter (55,000-gallon) capacity (200-series)

A representative illustration of each of these SST types is presented in Figure 2–5.

The total nominal holding capacity of the SSTs is approximately 356 million liters (94 million gallons) (DOE 2003b). The tanks currently contain approximately 122 million liters (32 million gallons) of radioactive and hazardous waste (DOE 2003d). These tanks contain salt cake and sludge; most of their free liquids were evaporated or transferred to the newer DSTs to reduce the potential consequences of leaks.

The tops of the tanks are buried approximately 2.4 meters (8 feet) below ground to provide radiation shielding. The larger tanks have multiple risers (shielded openings) that provide tank access from the surface. These risers provide access points for monitoring instrumentation, video observation, tank ventilation systems, and sampling. As analyzed in this *TC & WM EIS*, 67 of the SSTs are known or are suspected to have leaked liquid waste to the environment between the 1950s and the present, some of which has reached groundwater. However, it is likely that some of the tanks have not actually leaked. Estimates of the total leak loss range from less than 2.8 million to as much as 3.97 million liters (750,000 to 1,050,000 gallons) (Hanlon 2003).

[3] To convert liters to cubic meters, divide by 1,000; cubic meters to cubic feet, multiply by 35.315.



Note: To convert meters to feet, multiply by 3.281; liters to gallons, by 0.26417.
Key: L=liter; m=meter.
Source: Modified from DOE 2003a.

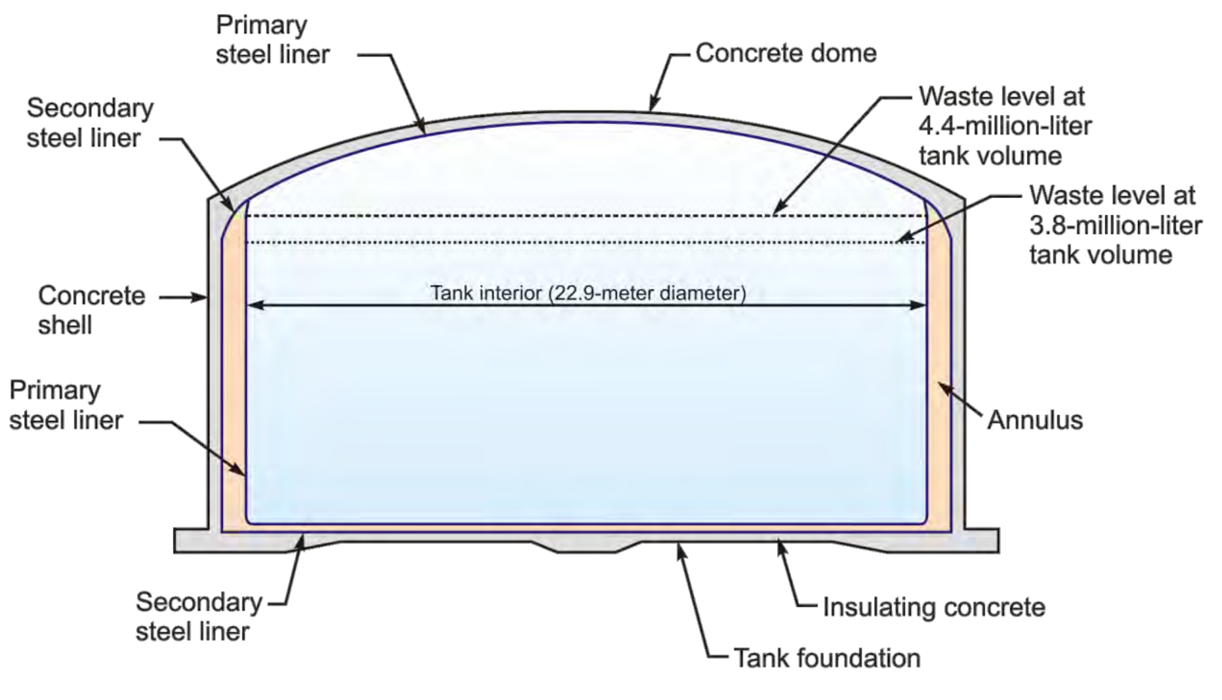
Figure 2–5. Cross-Sectional Views of Representative Hanford Site Single-Shell Tanks

2.2.1.2 Double-Shell Tanks

The last 28 waste tanks constructed at Hanford were DSTs built from 1968 to 1986. The DSTs contain a carbon steel tank inside a carbon steel–lined, reinforced-concrete tank. This design provides improved leak detection and waste containment. To date, no leaks have been detected in the annulus, the space between the inner and outer tanks that houses equipment to detect and recover waste in the event of a leak from the inner tank. Like the SSTs, the DSTs are buried below ground and have risers for tank monitoring and access. The numbers and nominal capacities of the DSTs are as follows (DOE 2003c):

- 4 tanks of approximately 3.8-million-liter (1-million-gallon) capacity
- 24 tanks of approximately 4.4-million-liter (1.16-million-gallon) capacity

The DSTs have a total nominal holding capacity of 121 million liters (32 million gallons) (DOE 2003b) and currently contain approximately 85 million liters (22.5 million gallons) of radioactive and hazardous waste, generally liquids and settled salts (DOE 2003d). Some tanks also contain a bottom layer of sludge. A representative DST is illustrated in Figure 2–6.



Note: To convert meters to feet, multiply by 3.281; liters to gallons, by 0.26417.
Source: Modified from DOE 2003b.

Figure 2–6. Cross-Sectional View of Representative Hanford Site Double-Shell Tank

2.2.1.3 DOE River Protection Project

Current RPP activities can be divided into three main areas: (1) routine operations and maintenance of the tank farm system, (2) tank farm upgrades and construction projects, and (3) WTP construction. The current program is based primarily on implementing Phase I of the Preferred Alternative identified in the *TWRS EIS*, as discussed in Chapter 1, Sections 1.2.2 and 1.2.3. The Tank Closure alternatives evaluated in this EIS (except the No Action Alternative) include the various activities needed to complete treatment of the tank waste and provide final disposition of the SST system. The following discussion presents an overview of current RPP activities. See Appendix E, Section E.1.1, for a more detailed description of RPP activities.

2.2.1.3.1 Routine Tank Farm Operations and Maintenance

Routine tank farm system operations entail waste retrieval and transfer operations, evaporation, SST system closure activities, DST integrity assessments, and life extension activities. Included among these activities are nondestructive examinations (NDEs) of the tank system, chemical adjustments to tank contents for corrosion control, and upgrades to the 242-A Evaporator and 222-S Laboratory as needed to support RPP activities. Interim stabilization of the SST waste was completed in 2009, and included stabilization pumping operations, transfer of waste to double-walled receiver tanks and DSTs, and transfer of waste from the 200-West Area tank farms to the 200-East Area tank farms (cross-site transfer activities).

Routine tank farm operations also include regular system monitoring to ensure compliance with safety basis, environmental, occupational safety and health, and other applicable regulatory requirements, as well as administrative and technical support. More discussion on potentially applicable requirements is provided in Chapter 8 of this EIS.

Routine maintenance activities consist primarily of preventive and corrective actions to ensure equipment remains operable and functional to support system operations. Such activities include maintenance of SST and DST system components and the waste feed delivery system that is currently being constructed to supply waste feed to the WTP.

2.2.1.3.2 Tank Farm Upgrades

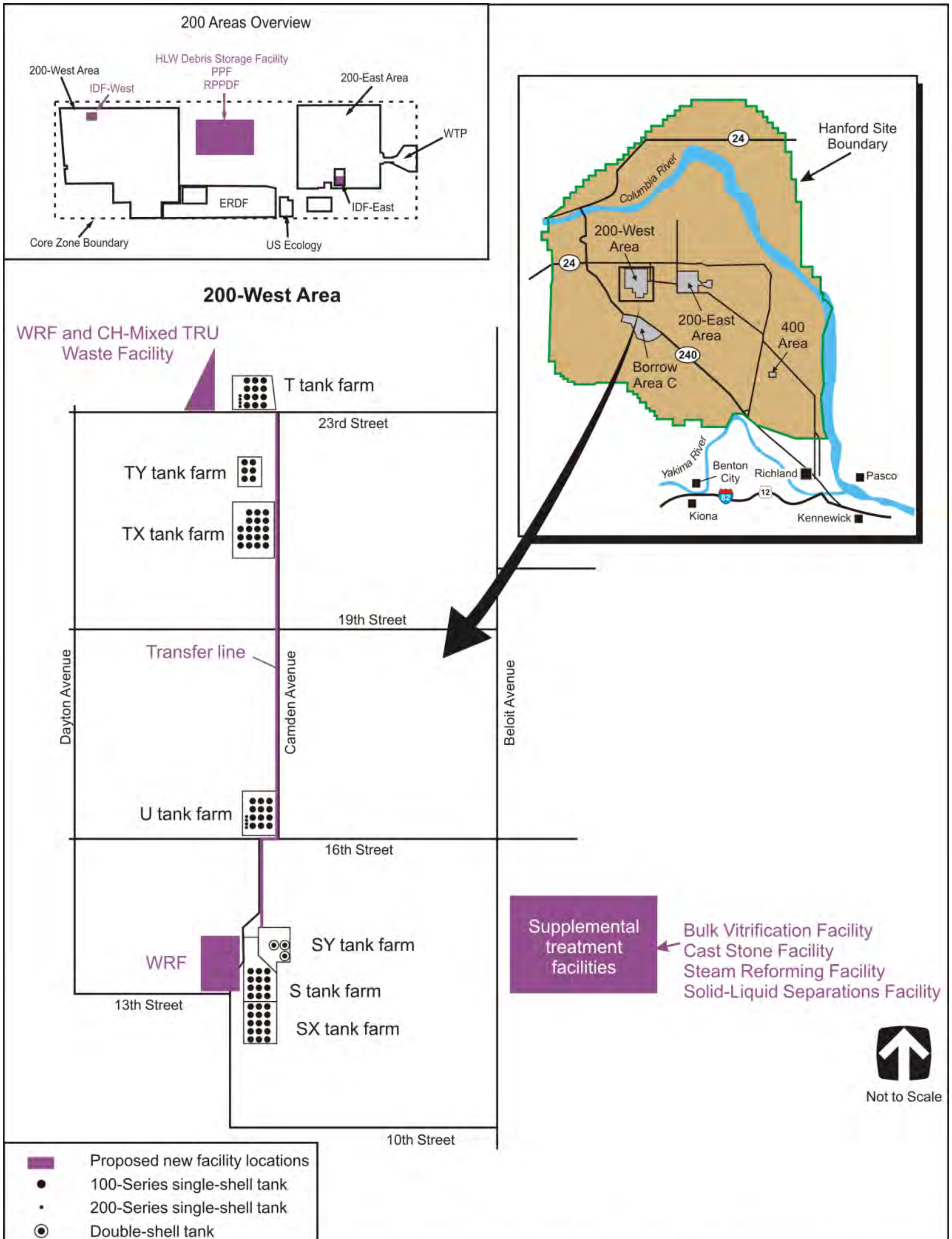
Tank farm upgrade and construction projects are presently under way to provide systems for retrieval and transfer of waste to the WTP and for storage or disposal of waste produced by the treatment process. Additional projects include tank upgrades and completion of upgrades to the Canister Storage Building (CSB) to provide interim storage of immobilized high-level radioactive waste (IHLW).

2.2.1.3.3 Waste Treatment Plant Construction

The WTP is currently under construction in the 200-East Area of Hanford; the project is more than 62 percent complete. As configured, the WTP will have four main components: plants for pretreatment of tank waste, LAW vitrification, and HLW vitrification, as well as a large Analytical Laboratory. The WTP is designed to receive tank waste via pipelines from the tank farm systems, treat the waste, and convert the treated waste into a glass form for storage, pending disposal. Current WTP activities include design, regulatory permitting and licensing, and construction.

2.2.2 Proposed Retrieval, Treatment, and Disposal of Tank Waste and Closure of the Single-Shell Tank System

This section presents an overview of the key storage, retrieval, treatment, disposal, and closure technologies and facilities that would be used at Hanford to implement the tank closure proposed actions. The candidate locations of new facilities in the 200-West and 200-East Areas that are considered under the proposed actions are illustrated in Figures 2–7 and 2–8, respectively. Final site selection for technologies other than the WTP has not been implemented and would proceed only following the ROD for this *TC & WM EIS*. More-detailed descriptions of these proposed technologies and facilities are presented in Appendix E, Section E.1. These are representative technologies, and their evaluation in this EIS does not preclude the use of other retrieval approaches or modification of existing retrieval systems.



Key: CH=contact-handled; ERDF=Environmental Restoration Disposal Facility; HLW=high-level radioactive waste; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; PPF=Preprocessing Facility; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WRF=Waste Receiver Facility; WTP=Waste Treatment Plant.

Figure 2–7. 200-West Area Proposed New Tank Closure Facility Locations

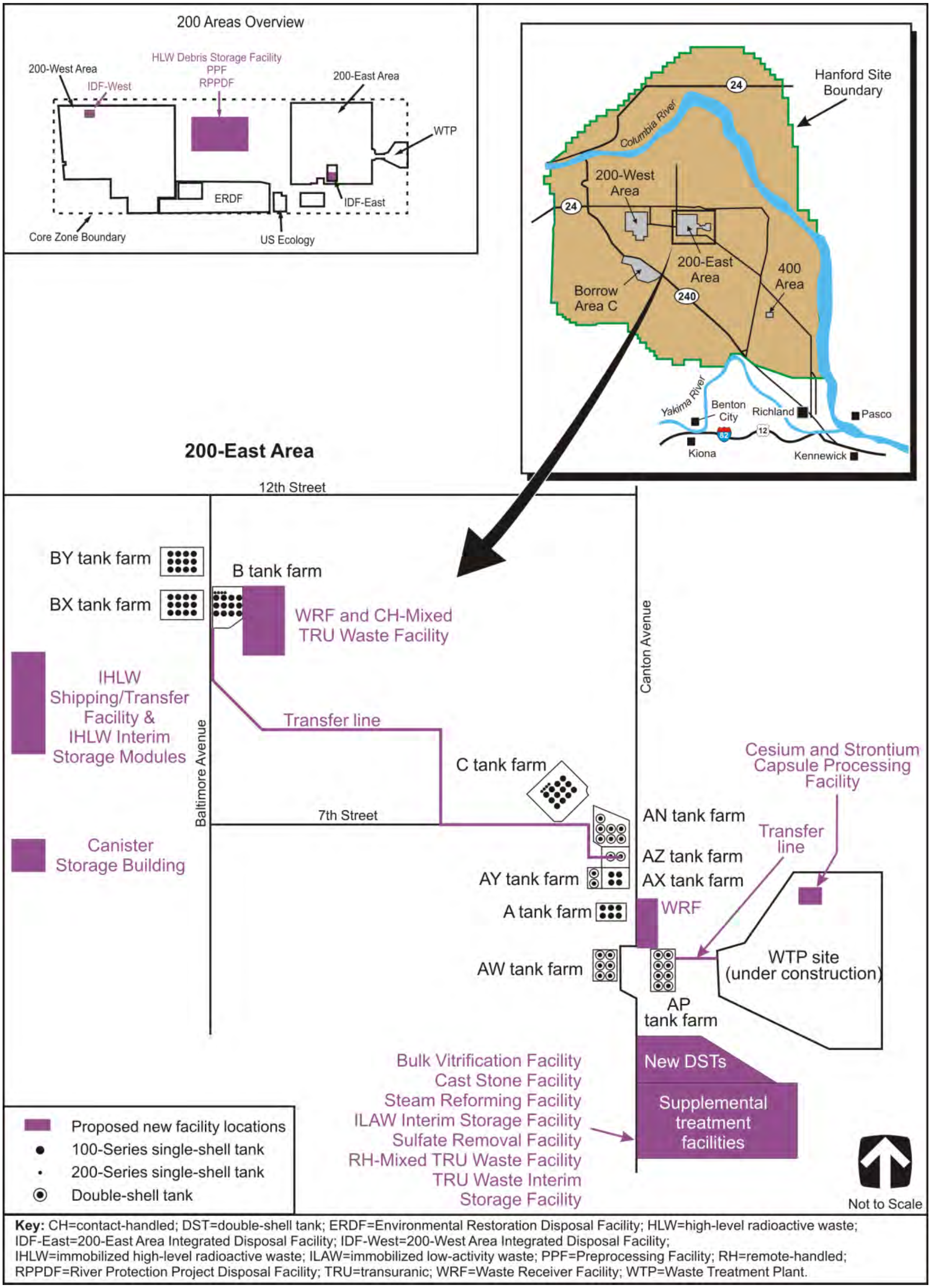


Figure 2–8. 200-East Area Proposed New Tank Closure Facility Locations

2.2.2.1 Waste Retrieval and Storage

This section describes the proposed technologies for retrieving and storing waste from the SST and DST systems that are analyzed in detail in this EIS. To support retrieval operations, these analyses also consider the existing, modified, and new systems (if required) that would be used to store and manage the waste pending retrieval.

2.2.2.1.1 Retrieval Systems

Various retrieval technologies were evaluated to determine their ability to achieve certain established waste retrieval benchmarks under the various Tank Closure alternatives. The four tank waste retrieval benchmarks considered in this *TC & WM EIS* are 0 percent (Alternative 1), 90 percent (Alternative 5), 99 percent (Alternatives 2A, 2B, 3A, 3B, 3C, and 6C), and 99.9 percent (Alternatives 4, 6A, and 6B). These waste retrieval benchmarks coincide with the following definitions for retrieval percentages, which were developed from Milestone M-45-00 and Appendix H, "Single Shell Tank Waste Retrieval Criteria Procedure," of the Hanford Federal Facility Agreement and Consent Order (also known as the Tri-Party Agreement [TPA]) (Ecology, EPA, and DOE 1989).

- A **0 percent retrieval** involves no removal of tank waste. The 0 percent retrieval was analyzed for the No Action Alternative.
- A **90 percent retrieval** involves removing tank waste to achieve a residual waste volume equal to 102 cubic meters (3,600 cubic feet) for the 100-series SSTs and 8.5 cubic meters (300 cubic feet) for the 200-series SSTs.
- A **99 percent retrieval** involves removing tank waste to achieve a residual waste volume equal to 10.2 cubic meters (360 cubic feet) for the 100-series SSTs and 0.85 cubic meters (30 cubic feet) for the 200-series SSTs.
- A **99.9 percent retrieval** involves removing tank waste to achieve a residual waste volume equal to 1 cubic meter (36 cubic feet) for the 100-series SSTs and 0.08 cubic meters (3 cubic feet) for the 200-series SSTs.

The four retrieval systems analyzed in this *TC & WM EIS* to attain these four benchmarks are modified sluicing, the mobile retrieval system (MRS), vacuum-based retrieval (VBR), and chemical wash tank cleaning. Other retrieval systems continue to be developed.

2.2.2.1.1.1 Modified Sluicing

Modified sluicing introduces liquid into the waste at low-to-moderate pressures and volumes. At lower pressures and flow rates, the retrieval action is primarily related to dissolution and retrieval of soluble materials. At higher pressures and flow rates, the retrieval action is related to both dissolution of soluble materials and the breaking apart of solid materials (such as the salt cake pictured in Figure 2–9) into a waste slurry. A transfer pump inside the tank pumps the waste to a receiver tank (either a DST or a waste receiver facility [WRF]) (DOE 2003b). See Appendix E, Section E.1.2.2.1, for a more detailed discussion of modified sluicing.

Figure 2–9. Crystallized Salt Cake Inside One of the Hanford Site's Waste Tanks

Modified sluicing differs from the past-practice sluicing previously used to remove waste from more than 50 tanks at Hanford. Past-practice sluicing introduced sluicing liquid from a single sluice nozzle in bulk fashion via a flooding action.

Modified sluicing, however, introduces sluice liquid from two to three sluicing nozzles in a controlled fashion and pumps out the resultant waste slurry at approximately the same rate that the sluice liquid is being pumped into the tank. This operating strategy maintains minimal liquid inventories within the tank at all times (DOE 2003b).

2.2.2.1.1.2 Mobile Retrieval System

The MRS uses an articulated-mast system and an in-tank vehicle to retrieve waste. The articulated-mast system is located in the central region of the tank because the required, relatively large access riser does not exist in other locations of the tank. The mast contains a waste vacuum system on an articulated arm that can be rotated to reach the central portion of the tank and can support a sluice nozzle. The in-tank vehicle can be moved around the entire tank to physically push the waste, carry a sluice nozzle, and carry a vacuum hose-and-nozzle assembly. The waste is physically removed from the tank by first mobilizing it, either physically using the in-tank vehicle or by pumping in sluice liquid, and then pumping it out of the tank using a vacuum hose-and-nozzle assembly. At the end of the retrieval campaign, the in-tank vehicle can be used to rinse the tank walls and in-tank equipment (DOE 2003b). See Appendix E, Section E.1.2.2.2, for a more detailed discussion of the MRS.

2.2.2.1.1.3 Vacuum-Based Retrieval

VBR uses little liquid; instead, it uses a vacuum system with air as the conveyance medium. The vacuum system is deployed on an articulated-mast system positioned in the central region of the tank. The vacuum system is similar to the MRS without the in-tank vehicle. The articulated-mast system has a 4.6-meter (15-foot) reach from the stationary mast and is capable of reaching the entire tank base of the 200-series SSTs (6-meter [20-foot] diameter), but only a portion of the tank base of the 100-series SSTs, which have a 22.9-meter (75-foot) internal diameter (DOE 2003b). See Appendix E, Section E.1.2.2.3, for a more detailed discussion of VBR.

2.2.2.1.1.4 Chemical Wash Tank Cleaning

Following bulk waste removal and residual waste retrieval using the systems discussed above, additional measures may be required to meet the target waste retrieval performance objectives established by the closure criteria. These additional measures may be needed because (1) the base program retrieval method may not directly meet the performance objective; (2) use of the base program method would require significant operational time; or (3) continued use of the base program method would impact other tank farm operations. For example, the MRS option may not be able to meet the performance objectives because the in-tank equipment may not allow direct access to some regions within the tank (DOE 2003b).

If this is the case for the retrieval approach(es) selected for a tank, then chemical cleaning may be employed. An example of chemical cleaning would be the use of oxalic acid to dissolve the waste. Acids or other chemicals can dissolve the waste into a solution that can be more readily removed from the tank. The same methods used to deliver water or waste supernatant into a tank can be used to introduce other chemicals, provided the construction materials have been selected accordingly. Likewise, the same equipment used to remove waste can be used to remove the chemical cleaning solutions if the construction materials are properly selected (DOE 2003b).

Specific chemicals to be used for Hanford tank waste retrieval could range from weak acids to strong caustics and are likely to be selected on a tank-by-tank basis to optimize, among other factors, effectiveness in retrieving the residual waste, compatibility with the tank waste and proposed treatment processes, and worker health and nuclear safety considerations (DOE 2003b). See Appendix E, Section E.1.2.2.4, for a more detailed discussion of the chemical wash system.

2.2.2.1.1.5 Retrieval Strategy

Any of the technologies described in Sections 2.2.2.1.1.1 through 2.2.2.1.1.4 could be used to retrieve waste from the SSTs and DSTs. All of the technologies are flexible in regard to the general configuration of the equipment, fluid velocities and flow rates, and methods of operation. As such, tank-specific considerations such as riser availability, waste condition, or in-tank interferences might favor one retrieval technology over another, leading to selection of that technology to retrieve waste from a particular tank. For analysis purposes, the following waste retrieval technologies were evaluated in this *TC & WM EIS* for the SST system:

- Modified sluicing would be implemented for 100-series SSTs that are not classified as known or suspected leakers. Use would be limited to those tanks that are not classified as known or suspected leakers because of concerns about the potential for leakage during retrieval, as well as regulatory prohibitions against introducing liquids into leaking tanks. A number of tanks classified as known or suspected leakers may be candidates for use of modified sluicing after further evaluation of historical leak data. Based on current design information, modified sluicing is expected to be capable of retrieving waste to both the 90 percent and 99 percent retrieval benchmarks, but is not expected to be capable of achieving 99.9 percent retrieval.

- The MRS would be used to retrieve waste from 100-series SSTs that are classified as known or suspected leakers. This technology would retrieve the waste using lower liquid volumes, thereby reducing the potential volume of a retrieval leak, should one occur. Based on current design information, the MRS is expected to be capable of retrieving waste to both the 90 percent and 99 percent waste retrieval benchmarks, but is not expected to be capable of achieving 99.9 percent retrieval.

- VBR would be used to retrieve waste from the 200-series tanks, MUSTs, and WRFs. This technology is flexible because it can be operated as a dry vacuum retrieval method, but liquid also can be introduced near the vacuum head if necessary, depending on the type of waste to be retrieved. This technology is suited for use in small tanks, and it would minimize the potential for leakage in some of the 200-series tanks that are classified as known or suspected leakers. Based on current design information, the VBR system is expected to be capable of retrieving waste to both the 90 percent and 99 percent waste retrieval benchmarks, but is not expected to be capable of achieving 99.9 percent retrieval.

- Tank chemical cleaning (coupled with the MRS and the VBR system) is capable of retrieving 99.9 percent of the waste in the tanks. This technology was selected based on the uncertainty associated with achieving 99.9 percent retrieval using modified sluicing, the MRS, or the VBR system.

Retrieval systems for DSTs have been designed and installed in select DSTs to support waste feed delivery for the WTP. These retrieval systems consist of a combination of mixer and retrieval pumps that are designed to slurry the contents of the tank and pump the waste out of the tank into the transfer system. It was assumed that the current operational DST retrieval systems are capable of retrieving 90 percent of the waste. For retrieval of DST waste to 99 or 99.9 percent, installation of additional equipment was assumed necessary. To be consistent with the retrieval methodology selection process articulated for SSTs, the modified sluicing system was assumed to be used in DSTs where 99 percent waste retrieval is required; the MRS with a chemical wash was assumed to be used in DSTs where 99.9 percent waste retrieval is required.

2.2.2.1.2 Leak Detection Monitoring

Detection, monitoring, and mitigation of liquid releases from SSTs during waste retrieval operations are problematic because of the physical limitations of the existing tank system. Currently available leak detection and monitoring technologies to support waste retrieval include dry-well monitoring, chemical process mass balance, static-liquid-level observation, and high-resolution resistivity. Performance limitations are associated with all four of these leak detection technologies, and current plans for near-term waste retrieval include the combined use of all. It is likely that SST leak detection strategies and technologies will continue to evolve. For the purpose of estimating the resources required to implement these leak detection technologies, the leak detection and monitoring system evaluated in this *TC & WM EIS* for use during SST waste retrieval consists of the following (DOE 2003b):

- Dry-well monitoring
- Chemical process mass balance
- Static-liquid-level observation
- High-resolution resistivity

Dry-well monitoring, chemical process mass balance, and static-liquid-level observation have been previously used as leak detection methods at Hanford. High-resolution resistivity has been tested at Hanford and is now the primary leak detection system being used during tank waste retrieval. To conservatively estimate the potential impacts associated with use of SST leak detection and monitoring technologies, this *TC & WM EIS* assumes that each of these technologies would be used for each tank, even though some SST system tanks may require use of only a subset of these technologies. This approach also supports the Tank Closure Alternative 4 and 6 analyses, which call for enhanced leak detection systems.

The DSTs have secondary containment, consisting of a primary steel liner and a secondary steel liner, separated by an annulus (see Figure 2–6). This annulus functions by detecting tank leaks, quantifying the liquid waste released in the event of a leak, and reducing the potential environmental impact should a leak occur. No leakage was assumed to occur from the DSTs during retrieval operations because the DSTs have provisions for leak containment and collection (DOE 2003b).

2.2.2.1.3 Internal Tank Interferences

Internal tank equipment/instrumentation could pose difficulties during tank retrievals. Figure 2–10 illustrates the general arrangement of this in-tank equipment in a typical SST. For modified sluicing, the equipment/instrumentation could create areas (shadows) behind the equipment that could not be reached with the sluice liquid. For the MRS, the equipment/instrumentation could create obstructions around which the in-tank vehicle would have to maneuver. Common in-tank equipment in SSTs that could potentially interfere with retrieval equipment includes the following (DOE 2003b):

- Temperature thermocouple assemblies
- Tank waste surface-level probes
- Liquid-observation wells
- Solids-level detectors
- Salt well screens

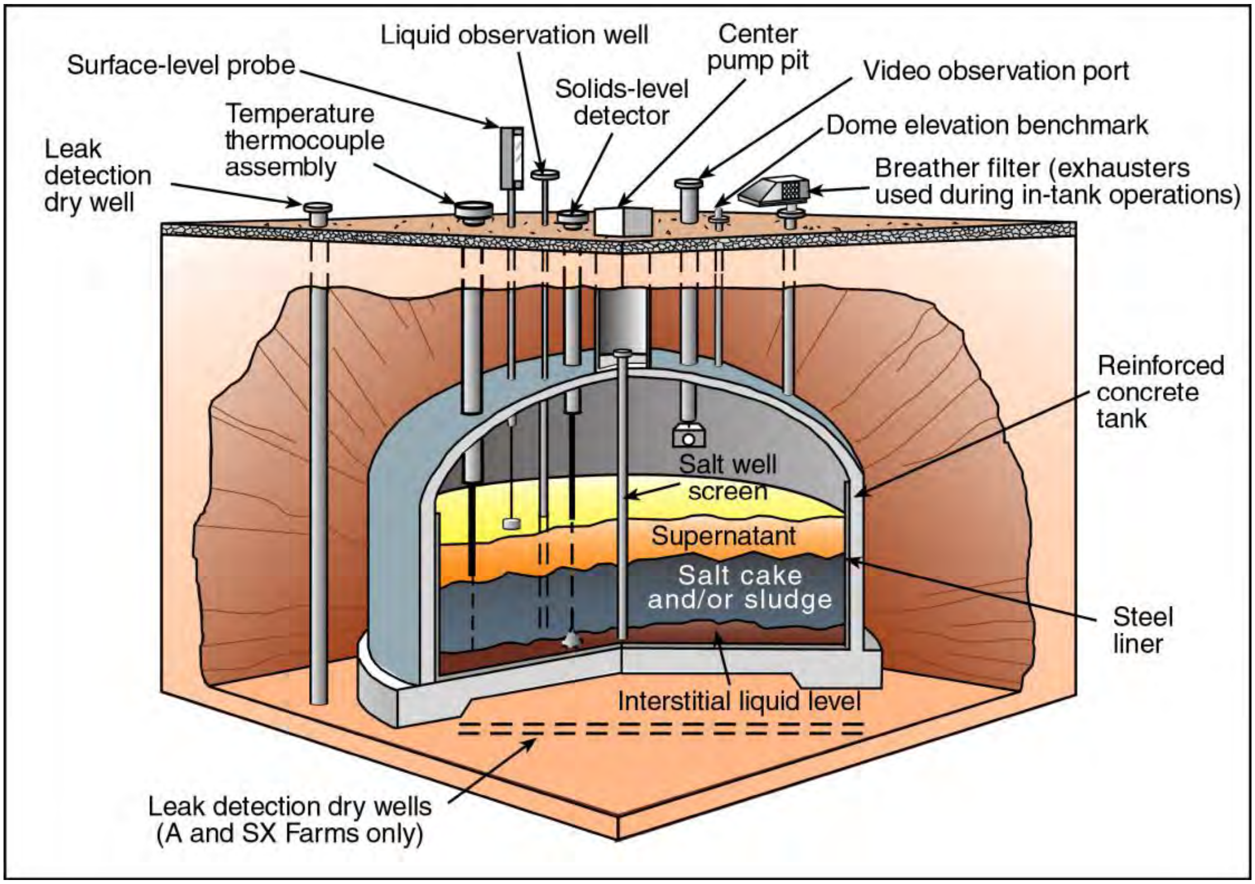


Figure 2–10. Representative Single-Shell Tank and In-Tank Equipment

Other in-tank interferences that may inhibit waste retrieval efforts include cement and bentonite, which were added to some tanks to absorb liquid, as well as other miscellaneous debris, including the following (DOE 2003b):

- Poly bottles (one tank in the SX tank farm)
- Plastic bottles (one tank in the SX tank farm)
- Ceramic balls, stainless steel capsules, and experimental fuel elements (one tank in the U tank farm)

Figure 2–11 illustrates the general arrangement of this in-tank equipment in a typical DST. Common in-tank equipment in DSTs that could potentially interfere with retrieval equipment includes the following (DOE 2003b):

- Surface-level probes
- Solids-level detectors
- Temperature thermocouple assemblies

In specific instances, other equipment (e.g., pumps, air-lift circulators) left in the SSTs and DSTs could potentially create additional interferences during retrieval and closure operations.

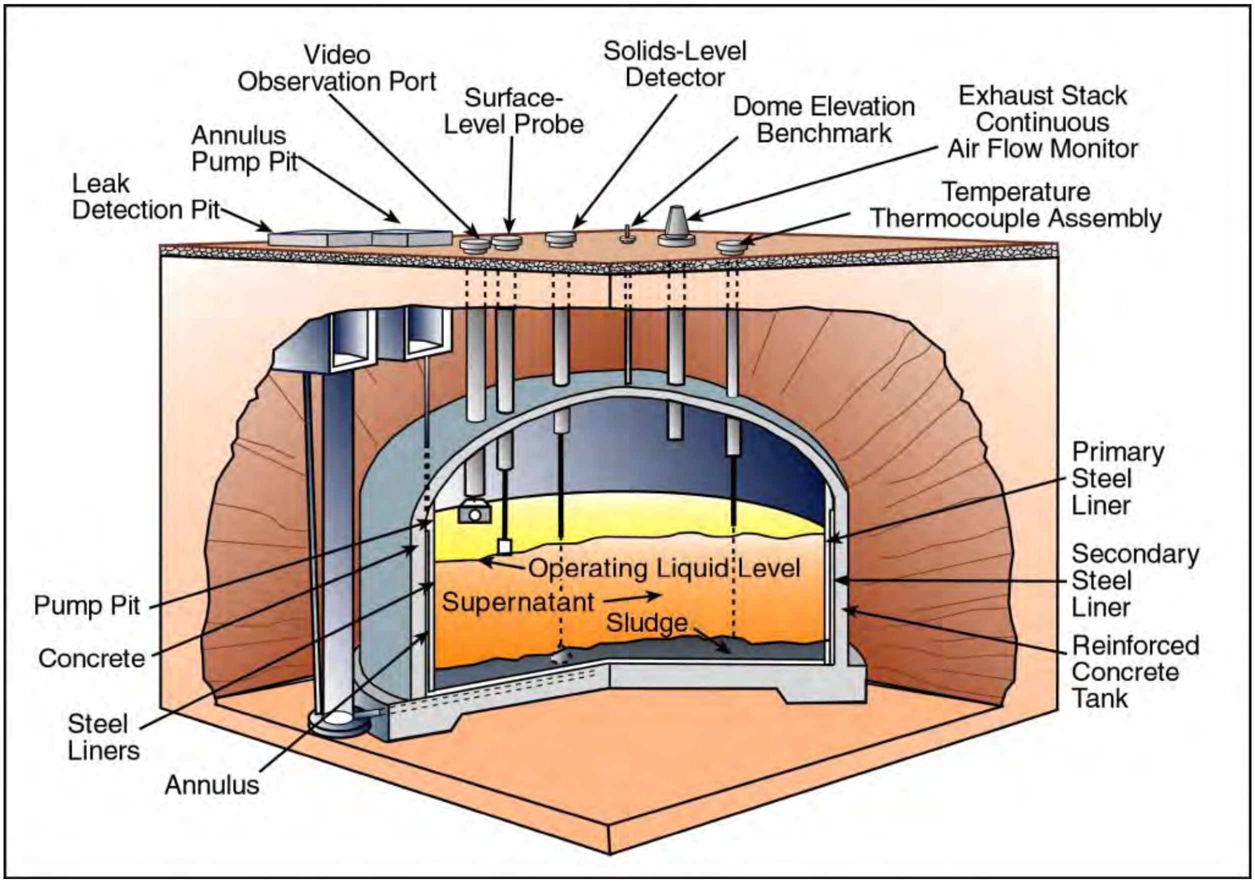


Figure 2–11. Representative Double-Shell Tank and In-Tank Equipment

2.2.2.1.4 Transfer Systems

The two approaches for transferring waste are as follows:

- Between tanks (e.g., from SSTs to DSTs and from DSTs to other DSTs)
- From tanks to treatment facilities (e.g., from SSTs, DSTs, or WRFs to treatment facilities)

This section addresses existing transfer approaches and their possible future augmentation, including piping, container transport, and WRFs. Waste transfer is discussed in more detail in Appendix E, Section E.1.2.2.7.

Existing transfer lines. None of the existing SST transfer piping would be used because (1) the pipelines are of single-wall construction and are noncompliant with current regulations, (2) some of the pipelines are plugged, (3) many of the pipelines leak, and (4) the pipelines are up to 60 years old.

An extensive existing system of underground piping connecting all of the DSTs is operated routinely. This piping would be used for final retrieval of DST waste. In particular, waste removed from DSTs in the 200-West Area would be transferred to selected DSTs in the 200-East Area through the existing underground cross-site transfer system that connects the DSTs in the 200-East Area to the SY tank farm in the 200-West Area (DOE 2003b).

Waste from various DSTs in the 200-East Area also would be transferred through existing underground pipelines to DSTs in the AP tank farm, then through a new underground pipeline to the WTP. The DST transfer system would continue to service the DSTs through the end of the mission. Processes involved in operating underground waste transfer lines would include pumping waste from the source tank to the receiver tank; recycling supernatant back to the source tank if required; flushing the lines after the waste has been transferred; and verifying the volume transferred by material balance. In addition, monitoring and periodic leak testing of transfer lines would be conducted (DOE 2003b).

Use of hose-in-hose transfer lines. Hanford utilizes a hose-in-hose transfer line (HIHTL) configuration on or near the surface. Interim stabilization project efforts have used this transfer line approach together with the single- and double-walled underground transfer lines (DOE 2003b).

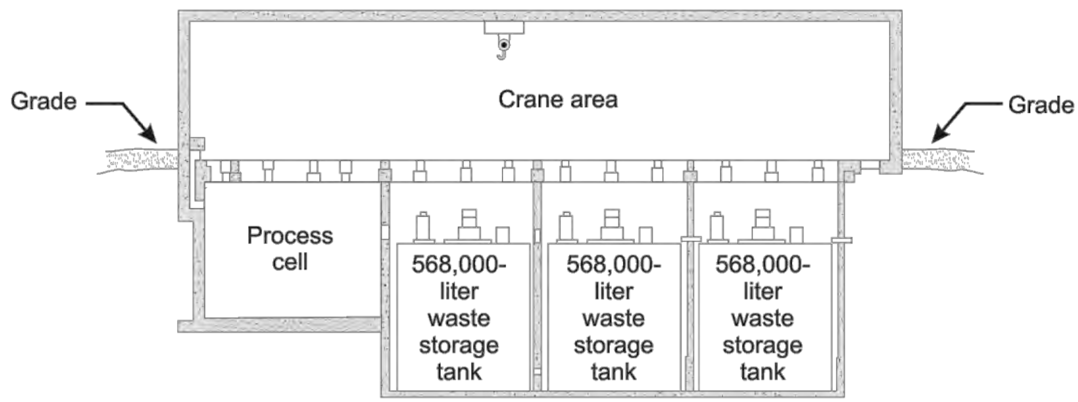
Future waste transfer systems. Existing transfer lines would be used to retrieve waste from DSTs and WRFs to the extent practicable. Because the DST transfer system would continue to service the DSTs through the end of the mission and the SST transfer system offers limited utility, future transfer system upgrades would be oriented primarily to service the SSTs through the use of HIHTL. The two primary methods available for transferring tank waste are pipeline and container transport (DOE 2003b). For analysis purposes, this *TC & WM EIS* assumes the tank waste would be transferred predominantly by pipeline with no loss from leaks. This does not preclude, however, transfers via other safe means when appropriate.

The modified sluicing system, MRS, and VBR system would make extensive use of HIHTL. The MRS and VBR system previously engineered for tank 241-C-104 include approximately 457 meters (1,500 feet) of HIHTL; the modified sluicing system for tank 241-S-112 includes approximately 229 meters (750 feet) of HIHTL (DOE 2003b). These HIHTL lengths were assumed to be suitable for analyzing all applications of the modified sluicing system, MRS, and VBR system, as well as sufficient to transfer waste beyond the tank farm boundary or to nearby supplemental treatment facilities, but insufficient to deliver waste to more-distant locations.

New underground transfer lines would be used to transfer waste beyond the distances of the HIHTL. The general configuration of the SST farms suggests that the maximum distances for underground transfer lines would be from the B tank farm complex to the 200-East Area DSTs and from the T tank farm complex to the 200-West Area DSTs. For analysis purposes, the 200-East Area destination was designated as the AY/AZ DST farm because of its location relative to the B tank farm complex. The 200-West Area destination was designated as the SY DST farm because it is the only DST farm in the 200-West Area.

2.2.2.1.5 Waste Receiver Facilities

Storage and waste treatment facilities may be required to facilitate waste transfers. One option is the construction and operation of WRFs that contain the tanks and process piping needed to provide temporary storage and simple waste-conditioning capabilities, including dissolution, dilution, and size reduction of particles suspended in the waste slurry. The general configuration of a WRF is depicted in Figure 2–12. WRFs accumulate waste during retrieval; condition waste by dissolution, dilution, or size reduction of particles; and provide batches of waste for subsequent transfer. The WRFs could also be used to recirculate sluicing liquids back to the SSTs. Not all SST retrievals were assumed to require the use of WRFs.



Note: To convert liters to gallons, multiply by 0.26417.
Source: DOE 2003b.

Figure 2–12. Cross-Sectional View of Representative Waste Receiver Facility

2.2.2.2 Waste Treatment

Waste treatment includes the methods, processes, and associated facilities used to change the physical or chemical character of the tank waste to render it less hazardous; make it safer to transport, store, or dispose of; or reduce its volume. This section describes the proposed technologies evaluated in this *TC & WM EIS* supporting WTP treatment and pretreatment, supplemental treatment of LAW, and supplemental treatment of tank mixed TRU waste.

These waste treatment technologies are described in more detail in Appendix E, Section E.1.2.3.

Waste Treatment Technologies Analyzed in This Environmental Impact Statement

Waste Treatment Plant (WTP) pretreatment and vitrification. The WTP Pretreatment Facility would remove selected radionuclides and high-level radioactive waste (HLW) solids from retrieved tank waste to produce an HLW stream and a low-activity waste (LAW) stream. The HLW stream would be routed to the WTP HLW Vitrification Facility, and the LAW stream would be routed to the WTP LAW Vitrification Facility. At each vitrification facility, the pretreated waste would be combined with glass-forming materials and melted to produce a molten glass waste form that would be poured into stainless steel containers for cooling into a solid for storage, pending disposal. Hazardous and radioactive constituents would be removed or immobilized through this vitrification process.

Bulk vitrification. This thermal supplemental treatment process would convert LAW into a solid glass form by drying the waste, mixing it with soil, and applying electrical current to it within a large steel waste disposal container.

Steam reforming. This thermal supplemental treatment process would dilute LAW with water to transform it into a pumpable liquid. Using steam, this liquid would be converted to granular minerals suitable for packaging as a free-form granulated material.

Cast stone. This nonthermal supplemental treatment process would mix LAW with grout-formers (e.g., Portland cement, fly ash, slag) and -conditioners to produce a liquid-grout stream that would then be cast into containers for solidification into a cement matrix.

Mixed transuranic (TRU) waste supplemental treatment. Some types of Hanford tank waste are candidates for designation as mixed TRU waste. Under some alternatives, this waste would be packaged for eventual disposal at the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, instead of being vitrified in the WTP HLW melter. Before packaging, the mixed TRU waste (both supernatants and sludges) would be dewatered. The resulting liquids would be sent for treatment in the WTP, while the solid waste would be packaged for eventual disposal at WIPP.

Separations processes. Some waste stored in the 200-West Area tank farms would not be pretreated in the WTP Pretreatment Facility. Instead, under some Tank Closure alternatives, the waste feed from 35 tanks that have been tentatively identified as containing low cesium-137 concentrations would be separated in a new Solid-Liquid Separations Facility in the 200-West Area to avoid the necessity of cross-site transport. Separations processes at this new facility may include selective dissolution and solid-liquid separations (gravity settling and/or decanting).

Sulfate removal. The presence of sulfate in the supernatant portion of the waste in many Hanford tanks poses potential technical and economic risks for the LAW vitrification process. If a separate, corrosive molten sulfur salt layer were to form and be allowed to accumulate, it could damage the LAW melter. Removal of sulfate from LAW after pretreatment, but before vitrification, could mitigate this problem and increase waste-loading, which would reduce the amount of immobilized low-activity waste (ILAW) glass produced in the WTP.

Technetium-99 removal. This WTP process would remove technetium-99 from the pretreated LAW stream via ion exchange. After removal, the technetium-99 would be blended with HLW solids for feed to HLW vitrification.

Cesium and strontium capsule treatment. Cesium and strontium would be extracted from storage capsules and prepared into a slurry waste stream. The slurry would then be treated in the WTP, resulting in an immobilized final waste form.

2.2.2.2.1 Waste Treatment Plant

The WTP is the cornerstone of tank waste treatment and is represented in each Tank Closure alternative in various configurations. The WTP is already under construction, having been analyzed in the 1996 *TWRS EIS* and three supplement analyses. However, under several of the alternatives evaluated in this *TC & WM EIS*, the WTP configuration and throughputs could change beyond those represented in the *TWRS EIS*. As such, construction, subsequent operations, and deactivation of the WTP from 2006 onward were analyzed under each *TC & WM EIS* alternative to establish a common reference point against which the impacts of other configurations and throughputs could be compared. Appendix E, Section E.1.2.3.1, provides an indepth discussion of the WTP.

Waste Treatment Plant

The Waste Treatment Plant (WTP) is currently being constructed at the Hanford Site. Site work associated with the project began in late 2001. The project is more than 62 percent complete. When completed, the WTP will be the largest radiochemical processing facility in the world. It will occupy 26 hectares (65 acres) and be composed of 38,000 tons of steel, 300 kilometers (1 million feet) of piping, 1,500 kilometers (5 million feet) of electrical cable, and 203,000 cubic meters (265,000 cubic yards) of concrete. The WTP will consist of four major facilities: the Pretreatment Facility, Low-Activity Waste Vitrification Facility, High-Level Radioactive Waste Vitrification Facility, and an Analytical Laboratory.

The WTP as it is currently being constructed includes four primary facilities: a Pretreatment Facility; an HLW Vitrification Facility housing two 3-metric-ton melters with a combined theoretical maximum capacity (TMC) of 6 metric tons of glass IHLW per day; a LAW Vitrification Facility housing two 15-metric-ton melters with a combined TMC of 30 metric tons of glass immobilized low-activity waste (ILAW) per day; and an Analytical Laboratory.[4]

The general configuration of the WTP is depicted in Figures 2–13 and 2–14. The WTP would receive HLW feed solutions and slurries transferred by pipeline for pretreatment and immobilization by vitrification. The pretreatment process would remove selected radionuclides (cesium, strontium, and transuranics), separate the HLW solids, and leach those solids to remove nonradioactive components that drive up total IHLW glass volume. The pretreated aqueous feed (referred to as the "LAW feed") would be routed to the LAW Vitrification Facility. The separated radionuclides and pretreated solids would be routed to the HLW Vitrification Facility.

---

[4] The LAW Vitrification Facility was originally designed to produce 30 metric tons of glass ILAW per day with three melters. Improvements in melter technology have demonstrated that a 30-metric-ton-of-glass-per-day vitrification capacity can be achieved with two melters. Construction of the LAW Vitrification Facility is proceeding; as presently designed, this facility will have two melters with a TMC of 30 metric tons of glass ILAW per day. Two approaches to providing the additional LAW vitrification capacity needed to accelerate treatment of the tank waste are addressed in this *TC & WM EIS*. The first approach is installation of additional melter capacity (e.g., a third LAW melter) in the LAW Vitrification Facility currently under construction as part of the WTP, bringing the total design capacity from a TMC of 30 metric tons of glass per day to a TMC of 45 metric tons of glass per day (Tank Closure Alternative 5). Installation of additional melter capacity in the LAW Vitrification Facility, though technically possible, would require design modifications for additional infrastructure tie-ins. The second approach includes installation of this additional melter capacity in the LAW Vitrification Facility now being constructed, as well as construction of a second LAW Vitrification Facility, to achieve a total TMC of 90 metric tons of glass per day (Tank Closure Alternatives 2B, 6B, and 6C).

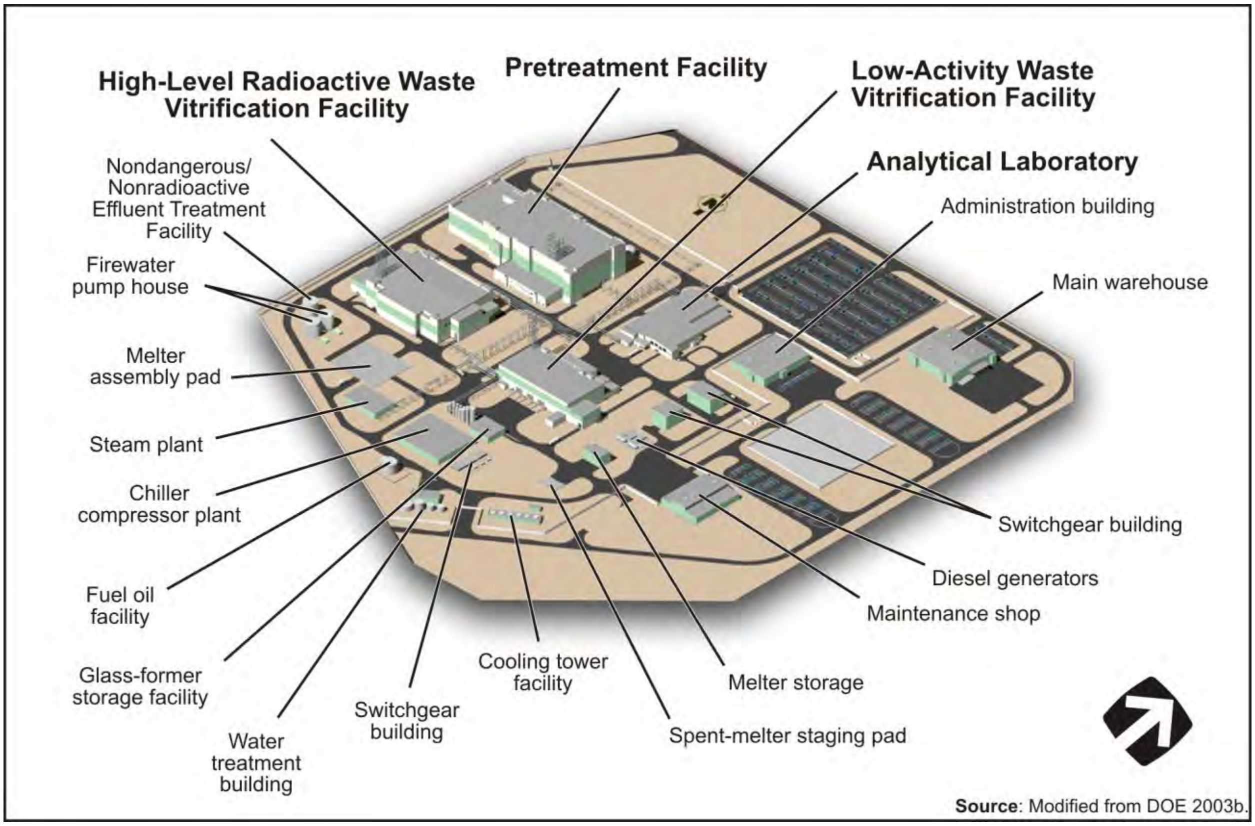


Figure 2–13. Waste Treatment Plant Facilities

Figure 2–14. Aerial View of Waste Treatment Plant Construction Site, February 2008

The vitrification process would combine the pretreated tank waste with glass-forming materials and melt the mixture at high temperatures (approximately 1,150 degrees Celsius [2,100 degrees Fahrenheit]) into a liquid that would be poured into stainless steel containers. After the glass cools and hardens, each container would be sealed and decontaminated in preparation for storage and permanent disposal. The dangerous waste and radioactive constituents would be either destroyed or immobilized in this durable glass matrix through the vitrification process. The offgas from the processes would be treated to a level compliant with regulations protecting human health and the environment. IHLW glass would be placed in canisters 0.6 meters (2 feet) in diameter by 4.6 meters (15 feet) long, each with a capacity of approximately 3.2 metric tons. ILAW glass would be placed in containers 1.2 meters in diameter by 2.3 meters long (4 feet in diameter by 7.5 feet long), each with a capacity of 6 metric tons.

Secondary Waste

Secondary waste is waste generated as a result of other activities, e.g., waste retrieval or waste treatment, that is not further treated by the Waste Treatment Plant or supplemental treatment facilities, and includes liquid and solid wastes. Liquid waste sources could include process condensates, scrubber wastes, spent reagents from resins, offgas and vessel vent wastes, vessel washes, floor drain and sump wastes, and decontamination solutions. Solid waste sources could include worn filter membranes, spent ion exchange resins, failed or worn equipment, debris, analytical laboratory waste, high-efficiency particulate air filters, spent carbon adsorbent, and other process-related wastes. Secondary waste can be characterized as low-level radioactive waste, mixed low-level radioactive waste, transuranic waste, or hazardous waste.

The various WTP processes (e.g., pretreatment, vitrification, and offgas treatment) would generate secondary waste. This secondary waste would be transferred to accumulation or storage facilities at the WTP and then either transferred to onsite storage facilities or transported to offsite facilities (e.g., TRU waste could be transported to the Waste Isolation Pilot Plant [WIPP] near Carlsbad, New Mexico), as appropriate. Nonradioactive dangerous waste could be generated by operations, laboratory, and maintenance activities. This waste would be managed at the WTP until it could be released for transfer to a permitted disposal facility. The secondary waste associated with each of the WTP processes is detailed in Appendix E.

2.2.2.2.2 Thermal Supplemental Treatment: Bulk Vitrification

Thermal supplemental treatment would be used to treat a portion of the tank waste under Tank Closure Alternatives 3A, 4, and 5. Bulk vitrification is one of the two representative thermal supplemental treatment processes analyzed in this *TC & WM EIS* (the other is steam reforming) that may be used to immobilize LAW in a non-WTP vitreous waste form. Analysis of either of these representative processes (bulk vitrification and steam reforming) does not preclude potential consideration of other suitable thermal supplemental treatment technologies. However, if it were determined that the impacts of these other technologies were outside the envelope of impacts analyzed in this *TC & WM EIS*, further National Environmental Policy Act (NEPA) analyses would be required.

Waste feeds to the bulk vitrification process from the 200-East Area tank farms would consist of LAW resulting from pretreatment of waste in the WTP Pretreatment Facility. Waste feeds to the bulk vitrification process from the 200-West Area tank farms would consist of LAW separated in a new Solid-Liquid Separations Facility (see the discussion in Section 2.2.2.2.6). The bulk vitrification process would convert the LAW into a solid glass by drying the waste, mixing it with soils from onsite sources, and applying an electrical current within a large steel container. A temporary offgas hood would be placed over the LAW-filled steel container, and graphite electrodes would be inserted into the waste. The mixture of waste and soils and/or sand would then be melted into liquid glass by passing electrical current to the electrodes. Air emissions would be collected by the offgas hood and directed to an offgas treatment system.

Bulk Vitrification Facilities may be placed in both the 200-East and 200-West Areas. Construction and operation of a 200-East Area facility was analyzed under Tank Closure Alternative 3A. In addition, construction and operation of a 200-West Area facility was analyzed under Tank Closure Alternatives 3A, 4, and 5.

Regardless of location, each Bulk Vitrification Facility is currently configured to have parallel processing lines that can process more than one vitrification container at a time. Two rectangular, steel roll-off boxes would typically be processed in parallel. The 2.4-meter-wide by 3.0-meter-high by 7.3-meter-long (8-foot-wide by 10-foot-high by 24-foot-long) boxes could be staged to accommodate approximately 42.6 metric tons of glass waste. The boxes would be allowed to cool for approximately 3 days before being transferred to a disposal site (DOE 2003e; SAIC 2010).

The vitrified waste form contained inside the boxes would consist of a mixture of waste glass and crystalline materials and likely have an appearance similar to obsidian (a dark, volcanic glass). Generally, glass is one of the better-performing waste forms for containment of radioactive and hazardous waste because its high concentrations of silicon dioxide and aluminum oxide provide both durability and leach resistance. The waste vitrification process would result in an approximate net volume reduction of one-third to one-half due to the loss of volatile components and a reduction of void space from melting. Based on the assumptions used in this analysis, the estimated waste loading of the vitrified waste product would be 20 weight-percent sodium oxide (DOE 2003e). See Appendix E, Section E.1.2.3.6, for a more detailed discussion of thermal supplemental treatment.

2.2.2.2.3 Thermal Supplemental Treatment: Steam Reforming

Steam reforming, the second of the two representative thermal supplemental treatment processes analyzed in this *TC & WM EIS* for immobilizing LAW, is proposed for treating a portion of the tank waste under Tank Closure Alternative 3C. Steam reforming is used extensively in nonradioactive processing in the petroleum industry and has recently been used to treat radioactive waste. The steam reforming process would begin with the receipt of pretreated waste or retrieved LAW and the dilution of this LAW stream with water. Dilution of the tank LAW is required to transform the waste feed into a pumpable liquid that can be introduced into a fluidized-bed vessel. Within this vessel, the water would be volatilized (heated into steam); the LAW material would be converted to granular minerals; and organic compounds, nitrate, and nitrite would decompose. The offgas from the steam reforming process would be treated to remove radionuclides and other pollutants before discharge. The mineralized product resulting from the steam reforming process is assumed to be suitable for packaging as a free-form granulated material. This steam reforming waste would be placed in 2.25-cubic-meter-volume (3.0-cubic-yard-volume) steel packages for disposal or storage. Based on the assumptions used in the *TC & WM EIS* analysis, the estimated waste loading of the steam reforming waste would be 19.8 weight-percent sodium oxide (SAIC 2010). Steam reforming facilities may be placed in both the 200-East and 200-West Areas. The 200-East Area Steam Reforming Facility would be located near the WTP and would accept a portion of the LAW generated from the WTP Pretreatment Facility (other portions would be treated in either the WTP LAW Vitrification Facility or the WTP HLW Vitrification Facility). The 200-West Area Steam Reforming Facility would accept LAW generated by the Solid-Liquid Separations Facility from separating the waste contained in the 35 SSTs with low cesium-137 concentrations via settling and decanting processes that would reduce the solids content of the waste.

2.2.2.2.4 Nonthermal Supplemental Treatment: Cast Stone

Cast stone, the representative nonthermal supplemental treatment process that is analyzed in this *TC & WM EIS*, would be used to treat a portion of the tank waste under Tank Closure Alternatives 3B, 4, and 5. The cast stone process would be used to immobilize LAW in a cementitious waste form. Analysis of this representative process does not preclude potential consideration of other suitable nonthermal supplemental treatment technologies to treat this waste. However, if it were determined that the impacts of these other technologies were outside the envelope of impacts analyzed in this *TC & WM EIS*, further NEPA analysis would be required.

The cast stone supplemental treatment process involves mixing LAW with a Portland-cement-type grout, pumping it into disposal containers, and allowing it to solidify. Waste feeds to the cast stone process would consist of LAW separated in the new Solid-Liquid Separations Facility or LAW that has been pretreated in the WTP Pretreatment Facility. Storage vessels may be needed for Portland cement, fly ash, slag, and stabilizing chemicals if the dry blend mixture cannot be procured. Waste feeds would be directly transferred from retrieval operations or staged in a receiver tank. Waste and grout additives would be mixed and poured into 1.2- by 1.2- by 2.4-meter (4- by 4- by 8-foot) container boxes, each holding approximately 5.4 metric tons of cast stone waste. The cast stone waste containers would be managed using standard industrial handling equipment (DOE 2003e).

The addition of grout-forming materials would increase the cast stone waste volume by approximately 1.4 times the feed volume. Based on the assumptions used in this analysis, the estimated waste loading of the cast stone waste would be 7.8 weight-percent sodium oxide (DOE 2003e). It is possible that actual cast stone waste formulations would be tailored to adjust for batch-to-batch variations as waste is retrieved from different tanks. Use of grout on a wide variety of radioactive wastes has been documented for over 30 years. The cast stone process does not require development of any unique process equipment. See Appendix E, Section E.1.2.3.7, for a more detailed discussion of nonthermal supplemental treatment.

Cast stone facilities may be placed in one or both of the 200-East and 200-West Areas. Construction and operation of a 200-East Area Cast Stone Facility are analyzed under Tank Closure Alternatives 3B, 4, and 5. Construction and operation of a 200-West Area Cast Stone Facility are analyzed under Tank Closure Alternative 3B.

2.2.2.2.5 Tank-Derived Mixed Transuranic Waste Supplemental Treatment

Presently, 20 Hanford underground storage tanks (17 SSTs and 3 DSTs) contain waste types that are candidates for classification as mixed TRU waste. Under Tank Closure Alternatives 3A, 3B, 3C, 4, and 5, approximately 11.8 million liters (3.1 million gallons) of waste that could be designated as mixed TRU waste would be retrieved from the tanks, treated, and packaged for eventual disposal at WIPP instead of being turned into a vitrified waste form in the WTP. As additional waste process records are reviewed, additional tanks may be identified as containing waste that can be designated as mixed TRU waste (DOE 2003e).

> **Contact-handled transuranic waste** has a radiation level less than or equal to 200 millirem* per hour at the surface of a waste container and can be safely handled by direct contact.
>
> **Remote-handled transuranic waste** is packaged transuranic waste whose external surface dose rate exceeds 200 millirem per hour. This waste requires special shielding and handling to protect workers and the public.
>
> * A millirem (one-thousandth of a rem) is a unit of measure of absorbed ionizing radiation used to assess the biological effects of a given dose of any type of radiation.

For analysis purposes in this *TC & WM EIS*, it was assumed that mixed TRU waste would be segregated into two categories: contact-handled (CH) and remote-handled (RH). Reviews of the process history and tank inventory data indicate that the waste in 11 of the SSTs may be processed using CH methods, but the waste in the remaining 6 SSTs and 3 DSTs would likely need to be processed using RH methods. These specific tanks and their associated waste volumes are detailed in Appendix E, Table E–11.

Mixed TRU waste (liquids and sludges) would first be retrieved from underground storage tanks and transferred to either the CH-Mixed TRU Waste Facilities or RH-Mixed TRU Waste Facility for dewatering and packaging. The liquids extracted during the dewatering process would be transferred to the DST system for treatment in the WTP. The resulting waste package configuration (drums or waste boxes) would need to meet WIPP disposal requirements, as well as requirements for transportation and interim storage on site in a new TRU Waste Interim Storage Facility. For analysis purposes, this *TC & WM EIS* conservatively assumes that the mixed TRU solid tank waste would be packaged for disposal in 208-liter (55-gallon) drums, each filled with approximately 151 liters (40 gallons) of sludge and 57 liters (15 gallons) of absorbent material (DOE 2003e). After being filled, the containers would be closed with a bolted lid. The RH-mixed TRU waste and CH-mixed TRU waste process systems would be similar. The difference would be that all RH-mixed TRU waste packaging operations would be conducted remotely in the RH-Mixed TRU Waste Facility, which would be permanently located in the 200-East Area, while all CH-mixed TRU waste packaging operations would be conducted in mobile CH-Mixed TRU Waste Facilities that can relocate to each of the tank farms in both the 200-East and 200-West Areas.

Activities planned for the mixed TRU waste packaging systems would be similar in nature and facility scale to waste management activities practiced at other DOE facilities (e.g., the Rocky Flats Site in Colorado). See Appendix E, Section E.1.2.3.11, for a more detailed discussion of mixed TRU waste processing.

2.2.2.2.6 Separations Processes

Each of the *TC & WM EIS* alternatives that consider use of supplemental treatment technologies in the 200-East Area of Hanford would use the capability provided by the WTP to pretreat the waste in 114 of the 149 SSTs and all 28 DSTs. In contrast, waste feeds for supplemental treatment technologies used in the 200-West Area would not undergo WTP pretreatment, but instead would be processed in the new Solid-Liquid Separations Facility in the 200-West Area. These waste feeds would include waste from the remaining 35 SSTs, which have tentatively been identified as containing low-cesium-137-concentration salt cake. The waste contained in many of these 35 tanks was previously treated in processing facilities that removed radionuclides such as cesium, strontium, and TRU radionuclides (see Appendix E, Section E.1.2.3.5.2, for a more detailed discussion of these tanks). The extent of the separations processes conducted in the new Solid-Liquid Separations Facility would depend on the waste feed being processed and the immobilization operation being used.

The new Solid-Liquid Separations Facility would employ settling and decanting processes that are expected to return 50 percent of the entrained solids to the WTP for further processing. Strontium-90 and TRU radionuclides would be precipitated using a chemical addition during this settling process, resulting in a portion of the strontium-90 and TRU radionuclides being forwarded to the WTP and the balance being forwarded to the selected supplemental treatment (bulk vitrification, steam reforming, or cast stone) facility in the 200-West Area. Some precipitation, settling, and decanting could be conducted in the existing underground storage tanks. However, for analysis purposes, this *TC & WM EIS* assumes that all separations activities would occur in the new Solid-Liquid Separations Facility (DOE 2003e).

2.2.2.2.7 Sulfate Removal

The sulfate removal pretreatment process is a representative technology that could be used to increase the waste loading in the ILAW glass. The sulfate removal approach involves sulfate precipitation using strontium nitrate addition, filtration, and solidification with grout-forming additives to create an immobilized waste form (grouted waste). As considered under Tank Closure Alternative 5 of this *TC & WM EIS*, sulfate removal would potentially increase waste loading, which would reduce the amount of ILAW glass produced in the WTP. The sulfate removal process is not proposed for use on waste provided as feed for supplemental technologies (bulk vitrification, cast stone, or steam reforming) because it would provide no added benefit for these technologies. Low-sulfate waste streams also may not need sulfate removal (DOE 2003e).

The sulfate removal process would require construction of two new facilities in the 200-East Area adjacent to the WTP—a Sulfate Removal Facility and an associated grout facility. The sulfate removal process would occur following pretreatment of waste at the WTP, but prior to treatment in the LAW Vitrification Facility. This process is expected to remove 90 to 95 percent of the sulfate present in the incoming pretreated LAW. From the perspective of waste form performance, sulfate removal is expected to increase waste loadings in the ILAW glass from approximately 14 percent to approximately 20 percent (sodium oxide basis) (DOE 2003e). Such an increase in waste loading would decrease the volume of ILAW glass produced over the life of the project by approximately 35 percent. See Appendix E, Section E.1.2.3.9, for a more detailed discussion of the sulfate removal process.

The sulfate would be removed from the WTP LAW Vitrification Facility feed stream in the form of strontium sulfate precipitate. This precipitate would be immobilized in a grout waste form that is expected to exhibit improved performance characteristics relative to previous Hanford grouts for two reasons:

- Select radionuclides (e.g., TRU radionuclides, cesium) would be removed from the WTP LAW Vitrification Facility feed stream in the WTP Pretreatment Facility before the LAW is processed in the Sulfate Removal Facility.
- Other radionuclides and constituents of potential concern (COPCs) exhibit little affinity for the strontium sulfate precipitate. Accordingly, these radionuclides and COPCs would not be incorporated into the grout waste form; instead, they would be forwarded as components of the LAW Vitrification Facility feed stream for incorporation into ILAW glass (DOE 2003e).

In addition, high concentrations of sulfate in the LAW feed solutions would present problems for the current WTP LAW vitrification process. Preliminary testing of the LAW melter system indicated that a separate molten sulfur layer could form in the LAW melter at the maximum sulfate-to-sodium ratio in the LAW solutions. This molten sulfur layer would be highly corrosive to the LAW melter components. Formation of the sulfur layer can be avoided by reducing the amount of sulfate in the LAW melter feed stream.

2.2.2.2.8 Technetium-99 Removal

Technetium-99, a long-lived, mobile radionuclide present in the tank waste, is of particular interest in regard to long-term waste form performance. Tank Closure Alternatives 2B and 3B include removal of technetium-99 from the LAW stream during WTP pretreatment. For analysis purposes, it was assumed that technetium-99 removal would be conducted in the WTP Pretreatment Facility via ion exchange with a removal efficiency of approximately 99 percent.[5] Therefore, under Tank Closure Alternatives 2B and 3B, approximately 99 percent of the technetium-99 would be removed from the LAW stream, transferred to the HLW stream, and vitrified as IHLW glass. Under all other Tank Closure alternatives, this technetium-99 would remain in the LAW stream and be incorporated into an ILAW product. For a more detailed discussion of the technetium removal process, see Appendix E, Section E.1.2.3.10.

[5] The WTP Pretreatment Facility evaluated in the *TWRS EIS* was originally designed to remove technetium-99. However, based on subsequent analysis of the ILAW glass, DOE and the Washington State Department of Ecology agreed to delete technetium removal from the WTP permit (Hedges 2008). Therefore, the detailed design of the Pretreatment Facility eliminated the technetium-99 removal capability from the LAW stream. However, under Tank Closure Alternatives 2B and 3B, this *TC & WM EIS* assumes that technetium-99 could be removed in the WTP Pretreatment Facility. Should DOE decide to implement technetium-99 removal, design modifications would be needed to add the technetium-99 removal capacity later, which could alter the assumed location of the unit.

2.2.2.2.9 Cesium and Strontium Capsule Treatment

There are currently 1,335 cesium capsules and 601 strontium capsules stored in the Waste Encapsulation and Storage Facility (WESF) pool cells in the 200-East Area. Most of the capsules are composed of an inner and outer capsule. The cesium capsules are 6.7 centimeters (2.6 inches) in diameter and 51.1 centimeters (20.1 inches) long, and the strontium capsules are 6.7 centimeters (2.6 inches) in diameter and 52.8 centimeters (20.8 inches) long (Jeppson 1973). Cesium and strontium waste would be extracted from the storage capsules prior to treatment in the WTP HLW melters. A new Cesium and Strontium Capsule Processing Facility would be constructed to extract and prepare the cesium and strontium waste into a slurry waste stream acceptable for treatment in the WTP. Under all Tank Closure alternatives except the No Action Alternative, immobilization of cesium and strontium capsule waste would take place during a separate campaign following treatment of all HLW from the tanks. It is estimated that an additional 340 canisters would be produced during this treatment campaign (CEES 2006a). For a more detailed discussion of cesium and strontium capsule treatment and storage, see Appendix E, Section E.1.2.3.4.

2.2.2.2.10 Interfacing Facilities

The following facilities would interface with storage, retrieval, and treatment of tank waste:

Liquid Waste Processing Facilities. The Liquid Waste Processing Facilities include the Effluent Treatment Facility (ETF), Liquid Effluent Retention Facility (LERF), and Treated Effluent Disposal Facility (TEDF). The ETF and LERF process liquid effluents designated as radioactive and dangerous wastes. Operation of the ETF is planned to continue until fiscal year 2025. Replacement ETFs would need to be constructed and operated to support the Tank Closure alternatives. The LERF would need a life extension upgrade in 2015. After the life extension upgrade, the LERF was assumed to operate through the end of WTP operations. The 200 Area TEDF is permitted for disposal of nonradioactive, nondangerous liquid effluents and was similarly assumed to operate through the end of WTP operations. Detailed descriptions of the ETF, LERF, and TEDF are presented in Appendix E, Section E.1.2.3.3.

242-A Evaporator. The continued operation of the 242-A Evaporator is required to support treatment of tank waste. The current and future mission of the evaporator is to support environmental restoration and remediation of Hanford by optimizing the 200 Area DST waste volumes in support of the tank farm management and WTP operations. To accomplish this mission, the 242-A Evaporator would require multiple replacements for some Tank Closure alternatives analyzed in this EIS. The 242-A Evaporator's estimated useful life is 25 years. The evaporator also depends on the continued operation of the ETF, LERF, and TEDF to accept and treat both contact (process condensate) and noncontact (steam condensate and cooling water) effluent waste streams. A detailed description of the 242-A Evaporator is presented in Appendix E, Section E.1.2.3.2.

222-S Analytical Laboratory. The 222-S Analytical Laboratory is a dedicated facility that provides analytical chemistry services in support of characterization. The laboratory is expected to operate as long as required to support tank waste characterization, tank waste retrieval, and waste feed delivery to the WTP. Upgrades to, or replacements of, the 222-S Analytical Laboratory were not analyzed in this EIS because its use is expected to be limited following the start of operations of the WTP Analytical Laboratory.

2.2.2.3 Waste Disposal

Many waste disposal aspects of the proposed actions have been addressed in previous EISs. DOE evaluated the programmatic aspects of waste management across the DOE complex in the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE 1997a). The *Waste Isolation Pilot Plant Disposal*

Phase Final Supplemental Environmental Impact Statement (WIPP SEIS-II) (DOE 1997b) addressed transportation and disposal of given waste quantities at WIPP. These documents adopted assumptions and methodologies for assessing waste transportation and disposal and reported the anticipated environmental impacts. This *TC & WM EIS* was developed to be as consistent as possible with these adopted assumptions and methodologies to avoid contradictions in the anticipated impacts reported for overlapping activities.

This section addresses the disposal considerations associated with each of the waste types after completion of the proposed retrieval and, where applicable, treatment activities (see Appendix E, Section E.1.2.4, for a more detailed discussion of waste disposal). This *TC & WM EIS* addresses the following key waste types and the activities proposed to support their transport, interim storage, and disposal.

IHLW. HLW, as defined in DOE Manual 435.1-1, *Radioactive Waste Management Manual*, would be immobilized (vitrified) in the WTP, resulting in IHLW glass. This tank IHLW glass would be mixed waste containing both radionuclides subject to the Atomic Energy Act of 1954 and hazardous components subject to the Resource Conservation and Recovery Act (RCRA).

IHLW glass canisters produced under the alternatives would be stored in the existing CSB and additional storage modules. (The analyses in this EIS are not affected by recent DOE plans to study alternatives for the disposition of the Nation's SNF and HLW because the EIS analysis shows that vitrified HLW can be stored safely at Hanford for up to 145 years until disposition decisions are made and implemented.)

Tank-derived mixed TRU waste. DOE proposes to designate waste in certain SSTs and DSTs as tank-derived mixed TRU waste in accordance with the TRU waste definition cited in DOE Manual 435.1-1 and the Waste Isolation Pilot Plant Land Withdrawal Act (P.L. 102-579). Prior to treatment in either the CH- or RH-Mixed TRU Waste Facilities, this tank-derived mixed TRU waste would be further subdivided into CH- and RH-mixed TRU waste streams to aid in defining packaging, transportation, and interim storage pathways.

Mixed TRU waste generated under the Tank Closure action alternatives would be stored in a new TRU Waste Interim Storage Facility pending shipment to WIPP. The mixed TRU waste would be placed in Type B containers certified by the U.S. Nuclear Regulatory Commission (NRC) (e.g., TRUPACT-II [transuranic package transporter model 2] containers) and shipped to WIPP by truck.

ILAW. This waste would be composed of LAW that has been immobilized by the WTP processes (ILAW glass) or by supplemental treatment (e.g., bulk vitrification glass, cast stone waste, steam reforming waste) in other facilities. Under Tank Closure Alternatives 2A through 5, this ILAW would be managed as mixed low-level radioactive waste (MLLW) and disposed of on site. Under Tank Closure Alternatives 6B and 6C, the ILAW would be managed as HLW and stored on site pending disposition.

ILAW that is subject to disposal after treatment by one of the supplemental treatment processes would be disposed of on site in an Integrated Disposal Facility (IDF). The facility would include an RCRA-compliant liner and leachate collection system; upon closure, it would be capped with a modified RCRA Subtitle C barrier.

Sulfate grout waste. This waste would result from the sulfate removal pretreatment process. The precipitate would be grouted, containerized, and managed as MLLW. Similar to ILAW, sulfate grout waste would be sent directly to an IDF.

WTP melters. Melters taken out of service at the WTP would be disposed of based on their waste types. WTP melters used for LAW vitrification and determined to be MLLW would be disposed of on site in an

IDF. WTP melters used for HLW vitrification would be placed in interim storage on the new onsite melter storage pads.

In addition to the waste forms discussed above, secondary waste would be produced as a result of construction and operation of the facilities associated with the alternatives analyzed in this EIS. Secondary waste includes items such as protective clothing, construction materials, tools, liquids, and excess materials whose characterization as low-level radioactive waste (LLW), MLLW, mixed TRU waste, or hazardous waste depends on the characteristics of the waste. Secondary LLW and MLLW would be disposed of on site in an IDF. Secondary TRU waste would be stored in existing facilities at the Central Waste Complex (CWC) pending disposal at WIPP.

2.2.2.4 Tank System Closure and Facility Decontamination and Decommissioning

The final major component of the tank closure proposed actions evaluated in this *TC & WM EIS* is closure of the SST system.[6] Three approaches to closure were considered.

- Landfill closure
- Clean closure
- Selective clean closure/landfill closure

Tank Closure Alternatives 2B through 6C include a closure component. The specific closure approach proposed for each alternative varies in accordance with the specific objectives of that alternative or subalternative. The following sections describe the closure activities that would be included under each closure approach. Tank system closure is described in detail in Appendix E, Section E.1.2.5.

> **Closure Options Analyzed in This Environmental Impact Statement**
>
> **Landfill Closure** – Following tank waste retrieval, the single-shell tank (SST) system would be closed in accordance with state, Federal, and/or U.S. Department of Energy requirements for closure of a landfill. Landfill closure typically includes site stabilization and emplacement of a surface barrier, followed by a postclosure care period.
>
> **Clean Closure** – Following tank waste retrieval, the tanks, ancillary equipment, and contaminated soils would be removed as necessary to protect human health and the environment and to allow unrestricted use of the tank farm area.
>
> **Selective Clean Closure/Landfill Closure** – This hybrid closure approach would implement clean closure of a representative tank farm in each of the 200-East and 200-West Areas (i.e., the BX and SX tank farms), while implementing landfill closure for the balance of the SST system.

2.2.2.4.1 Landfill Closure

Landfill closure of the SST system would generally include the following:

- Grout-filling of tanks
- Grouting of ancillary equipment and WRFs
- Removal of some ancillary equipment and near-surface contaminated soils
- Placement of a surface barrier
- Postclosure care

Grout-filling of tanks. Grout is formed from sand, cement, and fly ash to create a free-flowing material that would be used to fill the tanks after tank waste is removed. The grout would harden in the tanks to provide structural stability for completion of landfill

[6] WTP closure is not part of the proposed actions because it is an active facility needed to complete waste treatment. The existing 28 DSTs, which are also active components, are included in the closure scenario for each alternative presented in this *TC & WM EIS* that includes landfill closure. When the closure barrier is placed over the SSTs, it will need to cover nearby DSTs as well, due to the engineering design and the proximity of the DSTs to the SSTs. Therefore, the decision was made to include the existing DSTs in the closure configuration. In contrast, new DSTs proposed for construction, along with other infrastructure needed to support certain alternatives, would not be closed because these new DSTs would be located away from the original 177 tanks (149 SSTs and 28 DSTs) built at Hanford and outside the areal extent of the SST closure barriers. Although a closure configuration for the DSTs is evaluated in this EIS, a decision on closure of the DSTs is not part of the proposed actions. Closure of both the DSTs and the WTP would need to be addressed at a later date subject to appropriate NEPA review.

closure of the tank farms. The tanks would be filled with grout in a series of "lifts" in two separate phases. Lifts are separate applications of grout applied over time to allow added grout to set. The first phase of the process would involve initial grout placement to stabilize the residual waste heel expected to remain following retrieval. Materials called sequestering agents would be added to immobilize specific COPCs (i.e., technetium and uranium) in residual waste. The second phase would involve filling the remaining tank void space to the tank dome to minimize water infiltration, prevent long-term degradation of the tank farm surface barrier due to subsidence, and discourage intruder access (DOE 2003a). The use of two mobile plants (one each in the 200-East and 200-West Areas) was assumed for this grouting activity.

Grouting of ancillary equipment and WRFs. Tank farm ancillary equipment includes MUSTs; the waste transfer system (diversion boxes, valve pits, and transfer piping); tank pits; tank risers; in-tank equipment; and miscellaneous facilities used to treat, transfer, or store tank waste. Above-grade ancillary equipment would be removed to grade. Below-grade ancillary equipment would be filled with grout produced at either of the two mobile grout plants located in the 200-East and 200-West Areas and trucked to the local site for placement into the ancillary equipment (DOE 2003a). All SST system ancillary equipment and WRFs inside the projected closure barriers would be grouted under Tank Closure Alternatives 2B, 3A, 3B, 3C, 5, and 6C. SST system ancillary equipment and WRFs outside the area covered by the surface barriers, except under Alternatives 1, 2A, and 5, would be removed or remediated. Under these three alternatives, the ancillary equipment would be left as is, with no remediation actions. Alternative 4 would involve grout-fill stabilization of ancillary equipment associated with landfill closure of all tank farms except the BX and SX tank farms.

Removal of ancillary equipment and near-surface contaminated soils. Ancillary equipment and near-surface contaminated soil removal is an additional remediation component considered under Tank Closure Alternatives 4, 6A, and 6B. Under Tank Closure Alternative 4, associated equipment in the BX tank farm in the 200-East Area and the SX tank farm in the 200-West Area would be removed and replaced with clean soils from onsite sources. This activity would require construction and operation of two containment structures, one over each farm. The removed materials would be disposed of on site in the proposed River Protection Project Disposal Facility (RPPDF), located between the 200-East and 200-West Areas. The proposed RPPDF would be similar to an IDF. This additional level of remediation is proposed for the BX and SX tank farms to assess this activity's potential effectiveness at reducing long-term impacts on groundwater. The BX and SX tank farms were chosen for this option because (1) their tank waste inventories are well characterized and the nature and extent of past leaks and spills are documented; (2) their current in-tank inventories include substantial amounts of long-lived, highly mobile constituents and short-term health risks; and (3) they are in separate geographic locations, i.e., the BX tank farm is located in the 200-East Area and the SX tank farm is located in the 200-West Area.

Tank Closure Alternatives 6A and 6B would provide clean closure of all SST farms, including removal of ancillary equipment. Alternatives 6A and 6B, Option Cases, would also include removal of soils contaminated by liquid releases from the six sets of contiguous cribs and trenches (ditches). Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C would partially remove soils from the tank farms along with ancillary equipment.

Placement of a surface barrier. An above-grade, multilayered engineered surface barrier would be placed over the tank farms and the six sets of contiguous cribs and trenches (ditches) under all of the alternatives involving landfill closure. This barrier would be designed to provide long-term containment and hydrologic protection of the waste site. Two types of surface barriers were considered in this *TC & WM EIS*: the modified RCRA Subtitle C barrier (under Alternatives 2B, 3A, 3B, 3C, 4, and 6C) and the Hanford barrier (under Alternative 5). The modified RCRA Subtitle C barrier would consist of 8 layers, with a combined thickness of approximately 2.7 meters (9 feet). It would be designed to provide protection for 500 years, with no need for maintenance following a 100-year postclosure care period. The more robust Hanford barrier would consist of 10 layers, with a combined thickness of approximately 4.6 meters (15 feet). For analysis purposes, it was assumed that the Hanford barrier would be designed to provide protection for 1,000 years without maintenance. The Hanford barrier would provide additional protection against wind and water erosion, as well as plant, animal, and human intrusion (DOE 2003a). Both types of surface barriers would be constructed as a set of five "lobes." (A lobe is a section of a barrier that covers a tank farm or an area of contiguous tank farms.) Two large lobes would be constructed in the 200-East Area, and three smaller lobes would be constructed in the 200-West Area (DOE 2003a). For more information on these barriers, see Appendix E, Section E.1.2.5.4.1.

Postclosure care. Under Alternatives 2B, 3A, 3B, 3C, 4, and 6C, which would use a modified RCRA Subtitle C barrier, monitoring during the postclosure care period would be consistent with RCRA landfill closure requirements (WAC 173-303) for 100 years after completion of the surface barrier. Under DOE's regulations implementing its Atomic Energy Act responsibilities (DOE Order 458.1), postclosure care may exceed 100 years; however, for analysis purposes, it was assumed not to exceed 100 years. Monitoring activities would focus on air, groundwater, and the vadose zone. Air monitoring would be conducted under the existing air monitoring program and would concentrate on sampling for, detecting, and analyzing volatile compounds that may be moving up through the surface barrier. Groundwater monitoring would require installation and monitoring of new wells up- and downgradient of each barrier lobe. Monitoring of the vadose zone would require installation and monitoring of new boreholes along the perimeter of the barrier. Surface-barrier monitoring would include surveillance of structural integrity, animal burrowing, soil erosion and deposition, and vegetation status. For more information on postclosure care, see Appendix E, Section E.1.2.5.4.2.

2.2.2.4.2 Clean Closure

Alternatives 4, 6A, and 6B consider clean closure of all or parts of the SST system. Clean closure of the SST system would include the following:

- Removal of ancillary equipment, WRFs, and SSTs
- Deep soil removal
- Additional waste preprocessing/packaging

Removal of ancillary equipment, WRFs, and SSTs. Under the clean closure approach, ancillary equipment, WRFs, SSTs, and contaminated soils within the areal extent of a tank farm would be removed to a depth of 3 meters (10 feet) below the tank bases (approximately 20 meters [65 feet] below the ground surface). For analysis purposes, the removal of 3 meters (10 feet) of additional soils beneath the tank bases was assumed to be sufficient to remove contamination from retrieval leakage.

Tank farm removal activities would consist of removing cover soils, demolishing the tank domes, removing soils to the level of the tank bases, removing the tank sides, and, finally, removing the remaining base sections of the tanks (DOE 2003a). Ancillary equipment removal would consist of removing the equipment, reducing its size, and packaging it. This work would be conducted remotely whenever necessary.

Deep soil removal. Deep soil removal activities would include localized excavations to remove contaminated soils from past leaks to the depth necessary to protect human health and the environment and to allow unrestricted use of the tank farms. The clean closure approach would require installation of deep pilings for soil support and worker safety, as well as construction and operation of an overarching confinement structure or bubble over each tank farm prior to tank and deep soil removal. The exhaust from this structure would be filtered and would have at least two zones of negative pressure, each with personnel and equipment airlocks. The structure would be used to keep fugitive dusts containing hazardous or radioactive particles from escaping to the environment (DOE 2003f).

Under Tank Closure Alternatives 6A and 6B, Option Cases, additional highly contaminated soils would be decontaminated at the Preprocessing Facility (PPF), and lightly contaminated soils would be disposed of in the proposed RPPDF. This additional contaminated soils volume would come from the six sets of contiguous cribs and trenches (ditches) in the B and T Areas.[7]

Additional waste preprocessing/packaging. Lightly contaminated ancillary equipment, rubble, and removed soil would be disposed of on site in the proposed RPPDF. Under Tank Closure Alternative 4, a portion of the tank debris, equipment, soils, and rubble recovered from ancillary equipment, tank, and deep soil removal activities is expected to be highly contaminated with tank waste. Because these materials would likely exceed the waste acceptance criteria for onsite disposal, they would be treated at a standalone, 4-hectare (10-acre) PPF using a strong acid wash (DOE 2003e). The washed tank debris, equipment, and soils would be packaged and disposed of on site in the proposed RPPDF. The contaminated liquid waste stream from the acid wash would be neutralized and sent to the DSTs for treatment in the WTP. The contaminated soils from deep soil excavation would be treated in the PPF using a weak acid soil wash. The washed soils would be disposed of on site in the proposed RPPDF, and the contaminated liquid waste stream from the soil acid wash would be neutralized and sent to the DSTs prior to treatment in the WTP.

Under Tank Closure Alternatives 6A and 6B, highly contaminated tank debris, equipment, soils, and rubble from tank removal activities would be considered HLW. These materials would be packaged in approximately 147,000 shielded storage boxes. To accommodate the shielded storage boxes, 35 covered, concrete pads would be constructed near the PPF (SAIC 2010). It was assumed that the boxed HLW would be stored on site until disposition decisions are made and implemented and that the radiological and nonradiological inventories in this waste would be contained during onsite storage. Therefore, this waste would not represent a contaminant source to groundwater. Highly contaminated soils removed from deep soil excavation would be treated in the PPF using a weak acid wash. The washed soils would be disposed of on site in the proposed RPPDF, and the contaminated liquid waste stream from the soil acid wash would be further treated in the PPF using a glass melter. The melter would produce an immobilized waste form that would be equivalent to ILAW glass in waste form performance. Under Alternatives 6A and 6B, Base Cases, the volume of PPF glass produced would fill approximately 700 canisters, while under Alternatives 6A and 6B, Option Cases, the volume of PPF glass would fill approximately 18,320 canisters. This PPF glass would be disposed of on site in an IDF. Figure 2–15 depicts the movement of these highly contaminated materials through their preprocessing and disposal steps under Alternatives 4, 6A, and 6B. Appendix E, Section E.1.2.5.3.2, provides more detail on clean closure.

---

7 The following 33 cribs and trenches (ditches) are analyzed in this *TC & WM EIS*: 2 cribs in the B tank farm, 8 trenches in the BX tank farm, 7 cribs in the BY tank farm, 2 cribs and 6 trenches in the T tank farm, 5 trenches in the TX tank farm, and 3 cribs in the TY tank farm. Additional information addressing these cribs and trenches (ditches) is presented in Appendix D, Section D.1.5. Note: The T and TX trenches are considered one set.

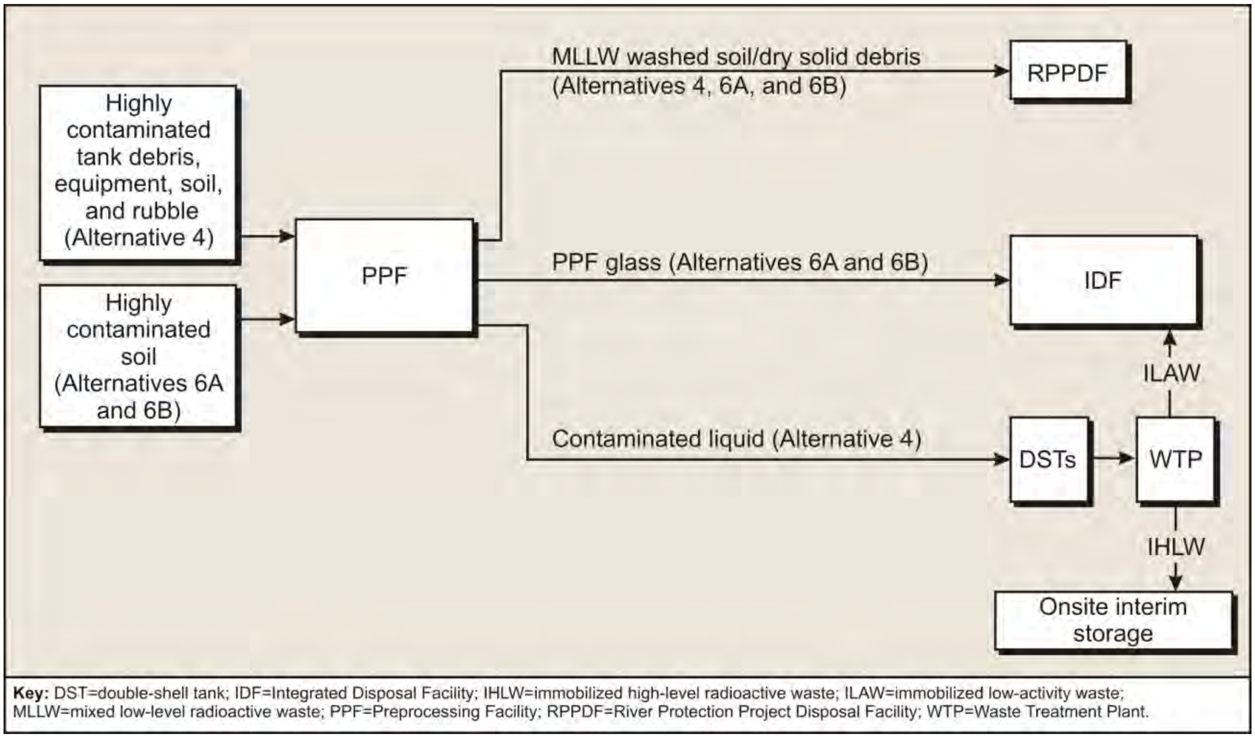


Figure 2–15. Preprocessing Waste Streams Associated with Tank Farm Clean Closure

2.2.2.4.3 Selective Clean Closure/Landfill Closure

This *TC & WM EIS* evaluates a hybrid closure approach under Tank Closure Alternative 4 that would implement clean closure of the BX and SX tank farms and landfill closure of the balance of the SST system. DOE proposes clean closure of the BX and SX tank farms to assess the potential effectiveness of this additional level of remediation to reduce long-term impacts on groundwater—i.e., to establish what might be gained from clean closure of a subset of SST farms (as under Alternative 4) compared with clean closure of the entire SST system (as under Alternatives 6A and 6B).

The BX and SX tank farms were chosen for selective clean closure to represent an intermediate case in the range of closure options. Analysis of Alternative 4 was designed to evaluate the impacts and potential benefits of a case where soil remediation and tank removal could be selectively performed. The purpose of this intermediate case was to examine the activities, impacts, and potential incremental benefit associated with clean closure of a single, moderately contaminated farm in each of the 200-East and 200-West Areas.

This information could be useful to a decisionmaker who wanted to clean-close a different farm or as a metric for scaling the potential impacts and benefits of remediating other single or multiple farms. However, selection of the BX and SX tank farms was not meant to preclude remediation of any different or additional tank farms or to suggest that these farms represent the only case for selective or clean closure. The final agency action could involve remediation of additional or different tank farms other than the BX and SX tank farms.

Selective clean closure, as presented under Alternative 4, was broadly designed to examine an intermediate concept of remediation and closure among alternatives, including waste retrieval without soil remediation or closure (Alternative 2A); landfill closure without soil removal (Alternative 5); landfill closure with surface soil remediation (Alternatives 2B, 3A, 3B, 3C, and 6C); and complete clean closure with tank removal (Alternatives 6A and 6B).

DOE anticipated that, if incremental benefits could be discerned at points of groundwater analysis within the sensitivity of the modeling, then decisionmakers would have a better range of options to consider, including selection of any, all, or none of the farms for remediation and/or clean closure. In addition, DOE expects that its analysis will conservatively estimate the potential impacts of selective or clean closure of some or all of the tank farms in question.

2.2.2.4.4 Borrow Area C Operations

Borrow Area C comprises approximately 930 hectares (2,300 acres) and is located south of the Hanford 200-West Area along State Route 240. It is a proposed supply site for the sand, soil, and gravel needed to support environmental remediation activities throughout Hanford. Specific alternatives discussed in this *TC & WM EIS* require the use of borrow materials from Borrow Area C. Resource material from Borrow Area C would be used primarily for construction of new facilities, backfilling and regrading where facilities and/or contaminated soils were removed from the ground, and creation of modified RCRA Subtitle C or Hanford barriers.

Conventional excavation, loading, and transportation equipment would be used at Borrow Area C. Conveyor systems may be employed to move excavated material to stockpile areas or load trucks. Conveyor systems may be outfitted with crushing, sorting, and screening systems to segregate rock and fines according to Hanford's needs. Basalt, when encountered, would be blasted with controlled, subsurface detonations.

Borrow Area C was evaluated for use as a borrow area because it is relatively close to most of the proposed activities that would require borrow materials and because it could provide the variety of gravel, sand, and soil types necessary to support such activities. A detailed description of Borrow Area C is presented in Appendix E, Section E.1.2.5.5.

2.2.2.4.5 Facility Decontamination and Decommissioning

This *TC & WM EIS* specifically evaluates the decontamination and decommissioning (D&D) activities that would be required prior to final closure of the SST system for only the following 10 existing Hanford facilities.[8]

242-S Evaporator. Located north of the S tank farm, this facility was used to concentrate tank waste. Operation of the 242-S Evaporator began in 1973 and continued until 1980. The facility was shut down in 1980 and placed in a standby mode in 1981.

Deactivation is placing a facility in a stable and known condition, including removal of hazardous and radioactive materials, to ensure adequate protection of workers, public health and safety, and the environment, thereby limiting the long-term cost of surveillance and maintenance. Actions include removing fuel, draining and/or de-energizing nonessential systems, removing stored radioactive and hazardous materials, and related actions. Deactivation does not include all of the decontamination activities necessary for the dismantlement and demolition phase of decommissioning (e.g., removal of contamination remaining in the fixed structures and equipment after deactivation).

Decommissioning is the process of closing and securing a nuclear facility or nuclear materials storage facility to provide adequate protection from radiological exposure and to isolate radioactive contamination from the human environment. It takes place after deactivation and includes surveillance, maintenance, decontamination, and/or dismantlement. These actions are taken at the end of a facility's life to retire it from service with adequate regard for the health and safety of workers and the public and protection of the environment. The ultimate goal of decommissioning is unrestricted release or restricted use of the site.

Decontamination is the removal or reduction of residual chemical, biological, or radiological contaminants and hazardous materials by mechanical, chemical, or other techniques to achieve a stated objective or end condition.

8 This *TC & WM EIS* evaluates deactivation of the WTP and other proposed waste treatment and interim storage facilities at the end of their operational lives. However, closure and D&D of these new facilities are not within the scope of the tank closure proposed actions.

242-T Evaporator. This facility is adjacent to the TX tank farm. Operation of the 242-T Evaporator began in 1952 and continued intermittently until 1980. In April 1981, a shutdown/standby plan was written, and a final waste transfer out of the facility was made in 1982.

204-AR Receiver Station. The 204-AR Receiver Station is located west of the AX tank farm. The facility was designed to receive liquid waste from rail tank cars or tank trailers and to pump the waste to a designated 200-East Area tank farm. The facility was constructed in 1981 and is still operational.

241-A-431 Vent Building. This facility was constructed in 1953 to provide offgas de-entrainment of the six tanks in the A tank farm and to receive drainage from the 296-A-11 stack. It began operation in 1955 and was shut down in 1969.

241-AX-IX Ion Exchange Facility. Designed and built in the late 1960s and located east of the A tank farm, this facility operated routinely from 1973 to 1976 to treat condensate from the waste facility exhauster between the A and AX tank farms.

241-BY-ITS1 In-Tank Solidification Facility. Located in the BY tank farm, this facility was constructed in the late 1950s and operated until the mid-1970s to concentrate waste in the BY tanks.

241-C-801 Cesium Loadout Facility. This cesium processing transfer facility, located in the C tank farm, operated from 1962 until 1976.

241-SX-401 and 241-SX-402 Condenser Shielding Buildings. Built in 1954, these condenser shielding buildings are located within the SX tank farm. Building 241-SX-401 was used as designed to cool some of the tanks in the SX tank farm until 1975, when use of the facility ended.

241-AX-WT-SP-137 Seal Pot. This facility is located underground in the AX tank farm. D&D of the 241-AX-WT-SP-137 Seal Pot would involve filling it with grout and abandoning it in place.

D&D of these facilities would occur under all Tank Closure alternatives except the No Action Alternative. Activities would generally include decontamination of building surfaces and equipment; removal of major vessels from inside each facility; demolition of each facility to ground level (except for the 241-AX-WT-SP-137 Seal Pot); and transfer of waste, rubble, and debris into containers or shielded burial boxes for shipment to appropriate disposal locations (DOE 2003a).

2.3 FAST FLUX TEST FACILITY DECOMMISSIONING ACTIONS

FFTF is a DOE-owned, formerly operating, 400-megawatt (thermal) liquid-metal (sodium)-cooled research and test reactor located in the 400 Area of Hanford. The original purpose of the facility was to develop and test advanced fuels and materials for the Liquid Fast-Breeder Reactor Program; other missions were subsequently pursued. Construction of FFTF was completed in 1978, and initial criticality was achieved on February 9, 1980, with full power initiated on December 21, 1980. Following an additional year of acceptance testing, FFTF operated from 1982 to 1992, providing the nuclear industry with advances in fuel performance, medical isotope production, materials performance, and passive and active safety system testing. In December 1993, DOE decided not to continue operating FFTF due to a lack of economically viable missions at that time and issued a shutdown order. Figure 2–16 shows the location of the FFTF complex within the 400 Area. A detailed description of the FFTF complex is provided in Appendix E, Section E.2.

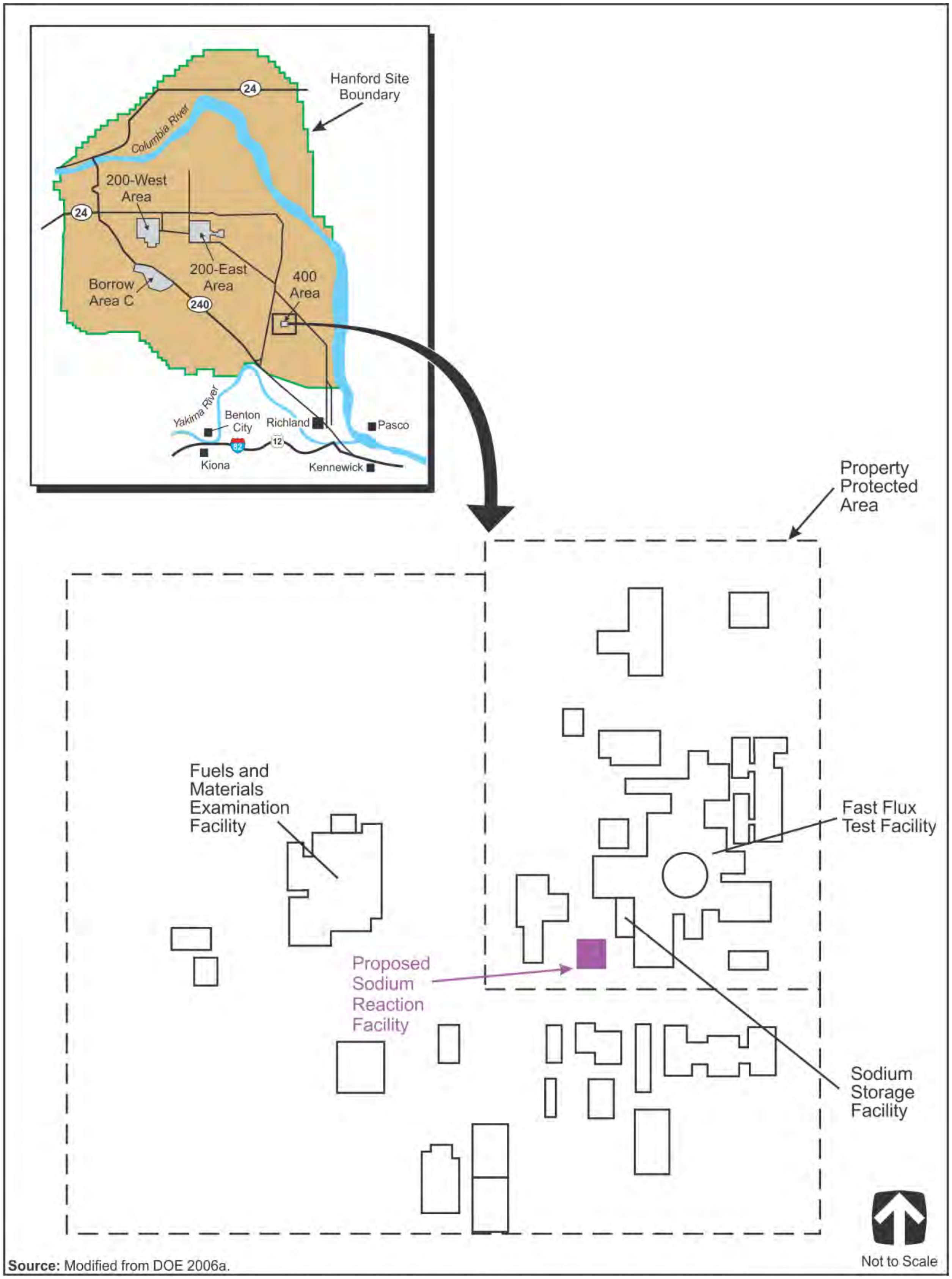


Figure 2–16. 400 Area Fast Flux Test Facility Complex Location Map

2.3.1 Decommissioning of Fast Flux Test Facility and Auxiliary Buildings

Forty-five structures or buildings within the FFTF Property Protected Area (PPA) would be decommissioned under the FFTF decommissioning set of proposed actions. These buildings fall under three general groups: the Reactor Containment Building (RCB), reactor support buildings (19 structures), and auxiliary buildings (25 structures).

Of the 45 facilities, 15 have basements or other below-grade structures, and 12 are potentially contaminated with radioactive materials. Because of the nature of the operations and maintenance work conducted in the area, most of the facilities are believed to contain hazardous materials as well.

2.3.1.1 Reactor Containment Building

The RCB is the major facility associated with the FFTF complex (see Figure 2–17) that would be decommissioned under the FFTF decommissioning proposed actions. The RCB consists of a cylindrical carbon steel reactor-containment vessel 56.7 meters high by 41.1 meters in diameter (186 feet high by 135 feet in diameter), as well as several principal structures and various equipment that are located inside the building. Reinforced-concrete cells occupy the lower portion of the containment vessel from grade level to approximately 24 meters (78 feet) below grade. Some areas near the sodium piping and vessels are steel-lined. Below-grade structures containing the greatest radionuclide inventories include the reactor vessel, the Interim Examination and Maintenance Cell, the Test Assembly and Conditioning Station, and the Interim Decay Storage Vessel (Fluor Hanford 2005a). Radionuclide and hazardous chemical inventories associated with FFTF decommissioning actions are presented in Appendix D, Section D.2.

Figure 2–17. Fast Flux Test Facility Complex

2.3.1.2 Reactor Support and Auxiliary Buildings

Various reactor support and auxiliary buildings surround the RCB. These buildings are structurally independent of the RCB, and their structural designs reflect specific requirements for resisting natural forces such as earthquakes, winds, and tornadoes. The reactor support and auxiliary buildings are listed in Table 2–1, which also summarizes the proposed decommissioning activities for each building under both the Entombment and Removal Alternatives.

Table 2–1. Fast Flux Test Facility and Support Facilities

Building Number	Building Name	Action Alternative: FFTF Decommissioning Alternative 2: Entombment	Action Alternative: FFTF Decommissioning Alternative 3: Removal
405	FFTF Reactor Containment Building	F	E
491E	HTS Service Building, East	F	C
491W	HTS Service Building, West	F	C
4621E	Auxiliary Equipment Building, East	D	C
4621W	Auxiliary Equipment Building, West	D	C
4703	FFTF Control Building	D	C
4717	Reactor Service Building	D	C
491S	HTS Service Building, South	D	C
408A	Main Heat Dump, East	B	A
408B	Main Heat Dump, South	B	A
408C	Main Heat Dump, West	B	A
409A	Closed Loop Heat Dump, East 1	B	A
409B	Closed Loop Heat Dump, East 2	B	A
403	Fuel Storage Facility	C	C
402	Sodium Storage Facility	A	A
432A	ISA Covered Equipment Storage	A	A
436	Training Facility	A	A
437	Maintenance and Storage Facility	A	A
440	90-Day Covered Storage Pad	A	A
451A	Substation	A	A
453A	Transformer Station, East DHX A1, 2.4 kV	A	A
453B	Transformer Station, South DHX A2, 2.4 kV	A	A
453C	Transformer Station, West DHX A3, 2.4 kV	A	A
4701	Former FFTF Guard Station	A	A
4710	FFTF Office Building	A	A
4713A	Riggers and Drivers Operations Facility	A	A
4713B	FFTF Maintenance Shop	A	A
4713C	Contaminated Storage Warehouse	A	A
4713D	Interim Maintenance and Storage Facility	A	A
4716	FFTF Rigging Loft	A	A
4718	400 Area Interim Storage Area Pad	A	A

Table 2–1. Fast Flux Test Facility and Support Facilities *(continued)*

Building Number	Building Name	Action Alternative: FFTF Decommissioning Alternative 2: Entombment	FFTF Decommissioning Alternative 3: Removal
4721	FFTF Emergency Generator Building	A	A
4734A	FFTF Argon/Nitrogen Pad	A	A
480A	Water Supply Well House (P-14)	A	A
480B	Water Supply Well House (P-15)	A	A
480D	Water Supply Well House (P-16)	A	A
481	Water Pump House	A	A
481A	Water Pump House	A	A
482A	Water Storage Tank (T-58)	A	A
482B	Water Storage Tank (T-87)	A	A
482C	Water Storage Tank (T-330)	A	A
483	Cooling Towers Chemical Addition Building	A	A
484	FFTF In-Containment Chiller Water Equipment Building	A	A
4842B	Switchgear Building for Pump Houses	A	A
SRF[a]	Sodium Reaction Facility (proposed)	A	A

[a] If the U.S. Department of Energy decides to process the bulk sodium at an existing Idaho National Laboratory (INL) facility, the Sodium Reaction Facility would not be constructed. Decommissioning of the INL facility is not addressed in this *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*.

Note: Gray shading indicates buildings with reinforced-concrete basements.

A = Demolish and remove building and soils, down to 0.91 meters (3 feet) below grade; if present, collapse subsurface floors and interior walls into the below-grade space (basement exterior walls below 0.91 meters [3 feet]; basement floor and foundations would remain). Backfill to grade with soil, then compact and contour surface and revegetate. Remove all radioactive and/or hazardous material, as well as wood and large steel components. Foundation rubble (e.g., concrete and rebar) could remain.

B = Same as A, except the building footprint would be partially covered by the engineered barrier system.

C = Demolish and remove building down to grade. Remove above- and below-grade components and systems, then collapse floors and walls into the below-grade space at least down to 0.91 meters (3 feet) below grade (basement exterior walls below 0.91 meters [3 feet]; basement floor and foundations would remain). Backfill to grade with soil, then compact and contour surface and revegetate. Remove all radioactive and/or hazardous material, as well as wood and large steel components. Foundation rubble (e.g., concrete and rebar) can remain.

D = Same as C, except the building footprint would be partially covered by the engineered barrier system.

E = Same as C, except small amounts of radioactive activation products in structural concrete and steel would remain.

F = Remove above-grade structures and systems. Contaminated equipment and systems below grade can remain. Consolidate waste and demolition debris below grade, then backfill with grout and cover entirely as part of the engineered barrier system. Radioactive and hazardous waste would remain entombed.

Key: DHX=Dump Heat Exchanger; FFTF=Fast Flux Test Facility; HTS=Heat Transport System; ISA=Interim Storage Area; kV=kilovolts.

2.3.2 Deactivation Activities

As discussed in Chapter 1, Section 1.2.5, and detailed in Appendix E, FFTF decommissioning will follow a series of facility deactivation actions specified by previous FFTF NEPA decisions; therefore, these actions were not included as part of the *TC & WM EIS* analyses. The major deactivation activities that have been completed at FFTF since June 2007 include shipment of fuel off site and deactivating auxiliary plant systems. Approximately 916,000 liters (242,000 gallons) of a total 958,000 liters (253,000 gallons) of radioactively contaminated bulk sodium has been drained from the FFTF reactor vessel, three primary and three secondary heat transport system loops, the Fuel Storage Facility, and the Interim Decay Storage Vessel and associated auxiliary systems and transferred to the Sodium Storage Facility (SSF) located adjacent to FFTF. Associated trace heat systems have been de-energized (Chapin 2007).

2.3.3 Proposed Fast Flux Test Facility and Auxiliary Building Disposition Activities

This section presents an overview of the key technologies and facilities that would be used to implement the proposed FFTF decommissioning activities, i.e., disposition of facilities, RH-SCs, and bulk sodium. More-detailed descriptions of these proposed technologies and facilities are presented in Appendix E, Section E.2.

2.3.3.1 Facility Disposition

Table 2–1 in Section 2.3.1.2 summarizes the proposed decommissioning activities for FFTF and its support facilities under the Entombment and Removal Alternatives (FFTF Decommissioning Alternatives 2 and 3, respectively). Under both alternatives, all sodium residuals would be removed from the RCB systems or treated in place. The sodium would be drained from plant systems to the extent practicable, followed by in situ moist-gas passivation and/or flushing with water to stabilize the residuals. Sodium residuals in small-diameter piping would be treated in the 400 Area after the components are removed from the reactor plant.

Demolition debris, radioactive waste, and other regulated hazardous waste would be handled in the same manner under both action alternatives; only the volume of waste would change. Debris not placed in the RCB or other voids or used as backfill would be transported to an IDF for disposal. Radioactive liquid waste volume resulting from treatment of the sodium residuals would be reduced at FFTF, either through ion exchange and reuse or evaporation. The remaining liquids would be transported to the 200 Area ETF for processing and disposal. It was assumed for analysis purposes that a 90 percent reduction in volume could be achieved prior to shipment to the ETF. Volumes of other regulated waste, such as polychlorinated biphenyls and asbestos, are expected to be small, and their disposition would be in accordance with existing Hanford facility waste acceptance criteria.

The FFTF disposition proposed actions evaluate various end-state approaches in accordance with the specific objectives of that alternative. Under the No Action Alternative, the facilities and infrastructure within the PPA, including the RCB, would undergo long-term surveillance with appropriate monitoring and controls to ensure that environmental and safety concerns are minimized for the foreseeable future. Under FFTF Decommissioning Alternative 2: Entombment, facilities would be dismantled to grade, and an engineered barrier compliant with regulations, such as a modified RCRA Subtitle C barrier, would be constructed over the RCB and Buildings 491E and 491W, all of which contain radioactive and/or hazardous wastes. In addition, the barrier would extend over part or all of the immediately adjacent facility footprints.

The modified RCRA Subtitle C barrier would be circular, with a radius of about 39.2 meters (128.5 feet), excluding the side slope used for drainage. It would be composed of eight layers of durable material with a combined minimum thickness of about 1.7 meters (5.7 feet). It would be designed to provide long-term containment and hydrologic protection for a performance period of 500 years. Like some of the Tank Closure alternatives, postclosure care would include monitoring of air, groundwater, and the vadose zone.

Under FFTF Decommissioning Alternative 3: Removal, no barrier would be built. The RCB and other buildings would be dismantled, and the reactor vessel, including piping, equipment, and the attached uranium shield, would be removed. Below-grade portions of structures would be backfilled with soil and compacted to eliminate void spaces, contoured to prevent natural settling resulting in depressions, and revegetated. Institutional controls or postclosure care may be established and continue for 100 years after revegetation of the area is complete.

2.3.3.2 Disposition of Remote-Handled Special Components

A number of components would require special handling and disposition because of high radiation levels and/or the inability to drain the component effectively. These components include a sodium cold trap, a cesium trap, and two sodium vapor traps. These components collected significant amounts of radioactive fission products during operation of the reactor. The resulting high radiation levels require these components to be handled remotely, which complicates removal and disposition. Removal of these RH-SCs from FFTF will be completed as part of the deactivation work and is evaluated in the *Environmental Assessment, Sodium Residuals Reaction/Removal and Other Deactivation Work Activities, Fast Flux Test Facility (FFTF) Project, Hanford Site, Richland, Washington* (DOE 2006a). The removed components will be stored within the FFTF complex under all FFTF Decommissioning alternatives. Under FFTF Decommissioning Alternatives 2 and 3, the components would be sent to the selected treatment facility once it has been built and is ready to receive them.

2.3.3.2.1 Fast Flux Test Facility Remote-Handled Special Components

The following is a brief description of the four FFTF traps that are considered to be RH-SCs.

2.3.3.2.1.1 Sodium Cold Trap

When FFTF operated, the primary coolant system cold trap was cooled by a sodium-potassium cooling jacket around the outside of the sodium-containing crystallizer tank. The sodium and sodium-potassium system piping were interconnected and the sodium-potassium flushed into the sodium system, thus eliminating the sodium-potassium storage/disposal concern. However, sodium in both the tank and the cooling jacket is not fully drainable, and high dose rates make it impossible to enter the cold trap cell to do manual work. Therefore, DOE is proposing to flush the sodium-potassium from the cold trap cooling jacket with sodium. The sodium-potassium system would then be drained to the maximum extent possible and the sodium in the crystallizer tank, as well as the sodium residuals left in the cooling jacket, would be allowed to freeze. The cold trap would be removed using remote operations and special shielding.

2.3.3.2.1.2 Cesium Trap

The cesium trap is a reticulated vitreous carbon filter designed to remove radioactive cesium caused by fuel cladding failures from the primary sodium. It is located outside of containment in a shielded cell in the Heat Transport System Service Building South. The trap is not drainable; as with the cold trap, it would be removed using remote operations and special shielding.

2.3.3.2.1.3 Sodium Vapor Traps

The sodium vapor traps minimized sodium vapor transport into the primary cover-gas system piping. These components are located in isolated cells within the RCB. One vapor trap has large quantities of cesium-137, and considerable quantities have migrated beyond the trap into the downstream gas piping systems. Both of these traps would be remotely removed and shielded.

2.3.3.2.2 Processing Facility Options and Description

Sodium residuals would be left in the traps during their removal and transport to an interim storage facility. Currently, no facility exists within the DOE complex for handling or treating the traps or other Hanford RH-SCs. There are two options for treatment of these traps:

Hanford Option. DOE proposes constructing a new Remote Treatment Project (RTP) near the T Plant complex at Hanford. This new facility would be similar to Idaho National Laboratory's (INL's) RTP, with the addition of a new high-bay cask-unloading area. RH-SCs would be removed from FFTF, stored on site at Hanford until the new RTP is permitted and built, then treated in the new RTP and disposed of in an IDF.

Idaho Option. The Idaho Option analyzed in this *TC & WM EIS* assumes shipment of RH-SCs to an RTP at INL's Idaho Nuclear Technology and Engineering Center (INTEC) for processing. Under the Idaho Option, RH-SCs from Hanford would be shipped to INL for treatment in this RTP at INTEC, then disposed of either at the Nevada National Security Site (NNSS), formerly the Nevada Test Site, or in a Hanford IDF. Treatment activities would be conducted in modified hot cells in either the New Waste Calcining Facility or the Fluorinel Dissolution Process and Fuel Storage Facility, both at INTEC. Construction activities associated with modification of these existing INTEC facilities for the INL RTP have been addressed in the *Final Environmental Assessment for the Remote-Handled Waste Disposition Project* (DOE 2009a). As such, this *TC & WM EIS* analyzes only the environmental impacts associated with the operation and deactivation of the INL RTP.

The two primary design features of both the Hanford and INL RTPs are as follows:

- A waste processing cell used to prevent the release of radioactive and hazardous contaminants to the environment
- Waste processing equipment designed to handle and process the RH-waste received in liners, drums, and large waste boxes

The Hanford RTP would be a concrete and steel structure with planned dimensions of 22 by 29 meters (72 by 94 feet). The facility would consist of four floors: the service floor (basement), operating floor (grade level), utility floor, and high-bay floor. The total floor area would be approximately 2,600 square meters (28,000 square feet).

2.3.3.2.3 Process Flow Description

Handling of RH-SC waste packages in an RTP would begin when the waste shipments were received in trailer trucks carrying shielded casks or waste containers. After unloading the waste, it would be transferred into the waste processing cell, which would contain a variety of processing equipment for storing, sorting, sizing, processing, and repackaging the waste. Because the RH-SCs would enter the processing cell in some form of packaging (liners, drums, or boxes), the first step would be to open the packages and extract the RH-SCs. Specialized handling equipment would be used to open specific types of waste containers. CH-debris created during disassembly would be placed in large cans (drums), which would then be placed into standard waste boxes for transport and disposal at an appropriate CH-waste disposal facility, depending on the characteristics of the waste. RH-debris would be transferred to the RH-waste processing area, sorted at a waste sorter station, and reduced in size for packaging, removal, and disposal.

The following initial RH-SC waste package processing equipment and steps are proposed:

- A liner disassembly station would handle, unload, and disassemble liners and waste cans.
- Nondestructive assays (NDAs) would be used to quantify identifiable, separate items encountered in the repackaging process (item assays), as well as items that have been packaged for shipment (package assays). Both types of assays employ qualitative gamma-ray spectroscopy to identify isotopes and quantitative gamma-ray spectroscopy (such as segmented gamma scanning, tomographic gamma scanning, and whole-item corrected assays) to quantify isotopes whose gamma rays are detectable. Both types of assays also use passive and active neutron measurement methods to quantify fissile materials.
- A waste can size-reducing device would be used to compact CH-waste can tubes or cut the tubes into smaller pieces suitable for denser packing in waste containers such as 208-liter (55-gallon) drums.
- A sodium removal (melt-drain-evaporate) system would remove the sodium contained in some of the RH-waste. The RH-waste would be placed in an evaporation vessel and heated to melt and drain the sodium. The vessel would then be heated further under vacuum to remove sodium from the crevices. Test demonstrations have shown a removal rate greater than 99 percent.
- A waste sorting station would disassemble waste cans and remove, resize, and sort waste into various waste containers.
- An induction melter would consolidate irradiated and contaminated metal components that require deep geologic disposition, including zircaloy and stainless steel. The melter would improve volumetric packaging in the waste containers without the particulate contamination created by other mechanical size-reduction techniques.
- After completion of melt processing, the crucible containing the waste ingot would be removed from the melter and transferred to the melter equipment-handling station, which would prepare and load the crucibles, dump and sample the ingots, and package the ingots into waste cans.

2.3.3.3 Sodium Processing

The FFTF reactor coolant systems and storage vessels contained approximately 958,000 liters (253,300 gallons) of radioactively contaminated sodium (Chapin 2007). This sodium is stored in solid form under an inert cover gas (argon or nitrogen) in four steel tanks located inside the 400 Area SSF. Management and disposition of this sodium, along with 128,700 and 26,500 liters (34,000 and 7,000 gallons) of radioactive sodium from the Hallam Reactor and the Sodium Reactor Experiment (SRE), respectively, are analyzed in this EIS. The Hallam Reactor sodium is stored in solid form under an inert cover gas in five stainless steel tanks inside the 200-West Area's 2727-W Facility, a Butler-type steel building. The SRE sodium is stored in solid form in 158 drums (208 liters [55 gallons] each) sealed within 322-liter (85-gallon) overpacks inside eight storage modules located in the 200 Area CWC (Burke 2007). All of this bulk sodium would undergo a sodium reaction process to produce a caustic sodium hydroxide solution at either a proposed Hanford Sodium Reaction Facility (SRF) or the Sodium Processing Facility (SPF) at INL's Materials and Fuels Complex (MFC). This caustic solution would then be available for reuse in processing tank waste at the WTP or for supporting Hanford tank corrosion controls. The following section provides a general process description that would apply to either facility option, as well as a brief description of each facility.

2.3.3.3.1 Sodium Reaction Process

Elemental sodium is a silver, soft, ductile alkali metal at room temperature with a density slightly less than that of water. It reacts vigorously with water and steam and oxidizes rapidly when exposed to air. The basic chemical reaction is an exothermic reaction with water that produces a caustic sodium hydroxide solution that yields hydrogen gas.

Liquid sodium would be transferred from a storage tank into the processing facility where the reaction would be controlled by adjusting the injection rate of the liquid reactants. The process would take place in a nickel pressure vessel. The entire system would use nitrogen as an inert cover and pressurizing gas. Offgases emitted during the process would contain hydrogen, nitrogen, water vapor, and caustic vapor. The gases would be exhausted from the vessel, dried, scrubbed, filtered through a high-efficiency particulate air filter, and monitored before venting as a nonflammable nitrogen-hydrogen mixture. The final caustic solution would be pumped from the reaction vessel to a fill station where transportation tanks or drums would be used to contain it for storage.

The following descriptions detail the bulk sodium processing steps proposed by DOE:

- Bulk sodium would be transported to either INL's SPF or Hanford's SRF, where a sodium barrel melt-and-drain system would remove the sodium from its packaging and transfer it into a sodium storage tank.
- A sodium transfer system would transfer the bulk sodium to two carbon steel sodium day tanks (so named because they will be sized to contain sufficient sodium for one day of processing). A pressurized nitrogen blanket would be used to push the bulk sodium from the storage tank to fill one of the day tanks, while the other day tank is used for processing.
- The sodium reaction system would chemically convert the bulk sodium to a caustic sodium hydroxide solution using a reaction vessel consisting of a 76.2-centimeter-diameter by 4.6-meter-high (30-inch-diameter by 15-foot-high) corrosion-resistant vertical cylinder.
- A caustic transfer system would be used to pump (1) caustic sodium hydroxide solution from the bottom of the reaction vessel and cycle it back to the vessel, (2) some of the solution into a caustic cooling tank to reduce the temperature of the solution below the level necessary for caustic corrosion, and (3) some of the solution to the product system.
- In the product system, the caustic sodium hydroxide solution would pass through a product fill line to be cooled prior to entering a product container. When filled, the container would be sampled, sealed, inspected, and moved to a storage bay.

2.3.3.3.2 Sodium Reaction Facility—Hanford Reuse Option

The sodium reaction process used by the SPF at INL's MFC forms the basis for the Hanford Reuse Option using the SRF. The SRF would be located directly adjacent to the existing SSF, as shown in Figure 2–18. This proposed location would reduce construction and operations costs through utilities sharing and operation integration. The SSF is located west of the FFTF Dump Heat Exchanger South and would be used to store the bulk sodium until it could be transferred to the SRF for processing. Like the SPF, the SRF would process the bulk sodium analyzed in this EIS to produce approximately 7,600 liters (2,000 gallons) of 50 weight-percent caustic sodium hydroxide solution each day (ANL-W and Fluor Hanford 2002).

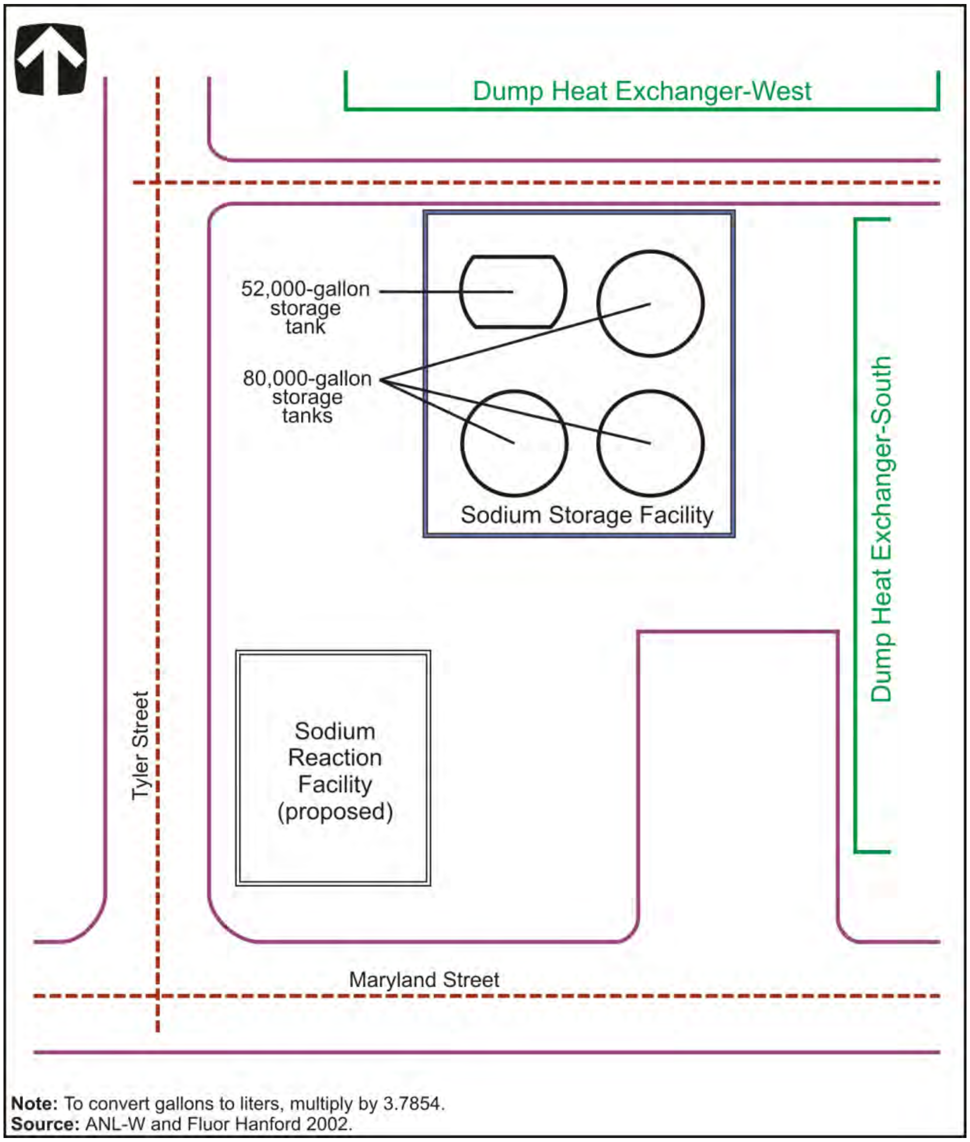


Figure 2–18. Location of the Hanford Site Sodium Reaction Facility and Sodium Storage Facility

2.3.3.3.3 Sodium Processing Facility—Idaho Reuse Option

The SPF is located within the MFC at INL and consists of several buildings, including the original SPF building (with a large addition), a caustic storage tank room, an operations support trailer, the Experimental Breeder Reactor II (EBR-II) sodium boiler building, and the sodium transfer system located in the yard area between the sodium boiler building and the SPF (see Figure 2–19).

Source: ANL-W and Fluor Hanford 2002.

Figure 2–19. Sodium Processing Facility at Idaho National Laboratory

The SPF is a 20.4- by 17.4-meter (67- by 57-foot) galvanized, structural-steel building containing the barrel melt-and-drain room, barrel holding room, and equipment and control room, as well as a carbon steel–lined concrete pad on which the process equipment is located. The barrel melt-and-drain room has reinforced-concrete block walls and a reinforced-concrete roof. A 7.6- by 22.6-meter (25- by 74-foot) addition to the SPF building was constructed to house the product area, and two storage bays with a combined outside dimension of 7.3 by 9.8 meters (24 by 32 feet) are also attached. A small metal-sided building constructed over a lined-concrete secondary-containment basin and located west of the original SPF building houses the caustic storage tank. An operation support trailer provides office space, a lunchroom, a locker room, and showers for the operating crews. The EBR-II sodium boiler building contains the secondary sodium drain tank, a recirculation system, and pumps to transfer sodium to the SPF.

The EBR-II/SPF complex was originally constructed in the mid-1980s to convert sodium from the Enrico Fermi Nuclear Generating Station (Fermi), a commercial power plant near Detroit, Michigan, into a 50 weight-percent caustic sodium hydroxide solution designated for use in the PUREX [plutonium-uranium extraction] process at Hanford. This designated use was abandoned after the SPF was constructed, but before SPF operations began. Once the EBR-II reactor was ordered to be shut down, defueled, and prepared for deactivation, the SPF was used to prepare the Fermi and EBR-II sodium for disposal. Production operations with radioactive sodium began in 1998 and were completed in 2001. The facility was then placed in a standby condition. To date, approximately 662,000 liters (175,000 gallons) of radioactive sodium have been processed in the SPF. The SPF would process the bulk sodium analyzed in this EIS to produce approximately 7,600 liters (2,000 gallons) of 50 weight-percent caustic sodium hydroxide solution each day (ANL-W and Fluor Hanford 2002).

2.4 SOLID WASTE MANAGEMENT ACTIONS

Each facility within the Hanford Solid Waste Operations Complex (SWOC) performs duties to achieve waste management goals. These duties are generally complementary, and each facility contributes to the overall process. However, some processes and activities are performed at more than one facility, either because it is necessary or because it maximizes flexibility and project efficiency. The primary processes for each facility include receipt, staging, storage, repackaging, treatment, and shipment of waste, all of which must comply with the waste acceptance criteria.

2.4.1 Existing Solid Waste Operations Complex

The existing SWOC consists of five components, which are depicted in Figures 2–20 and 2–21 and briefly described below. The SWOC units are currently operating under interim status standards as RCRA treatment, storage, and disposal (TSD) units. A detailed description of these facilities is presented in Appendix E, Section E.3.1.

2.4.1.1 Low-Level Radioactive Waste Burial Grounds

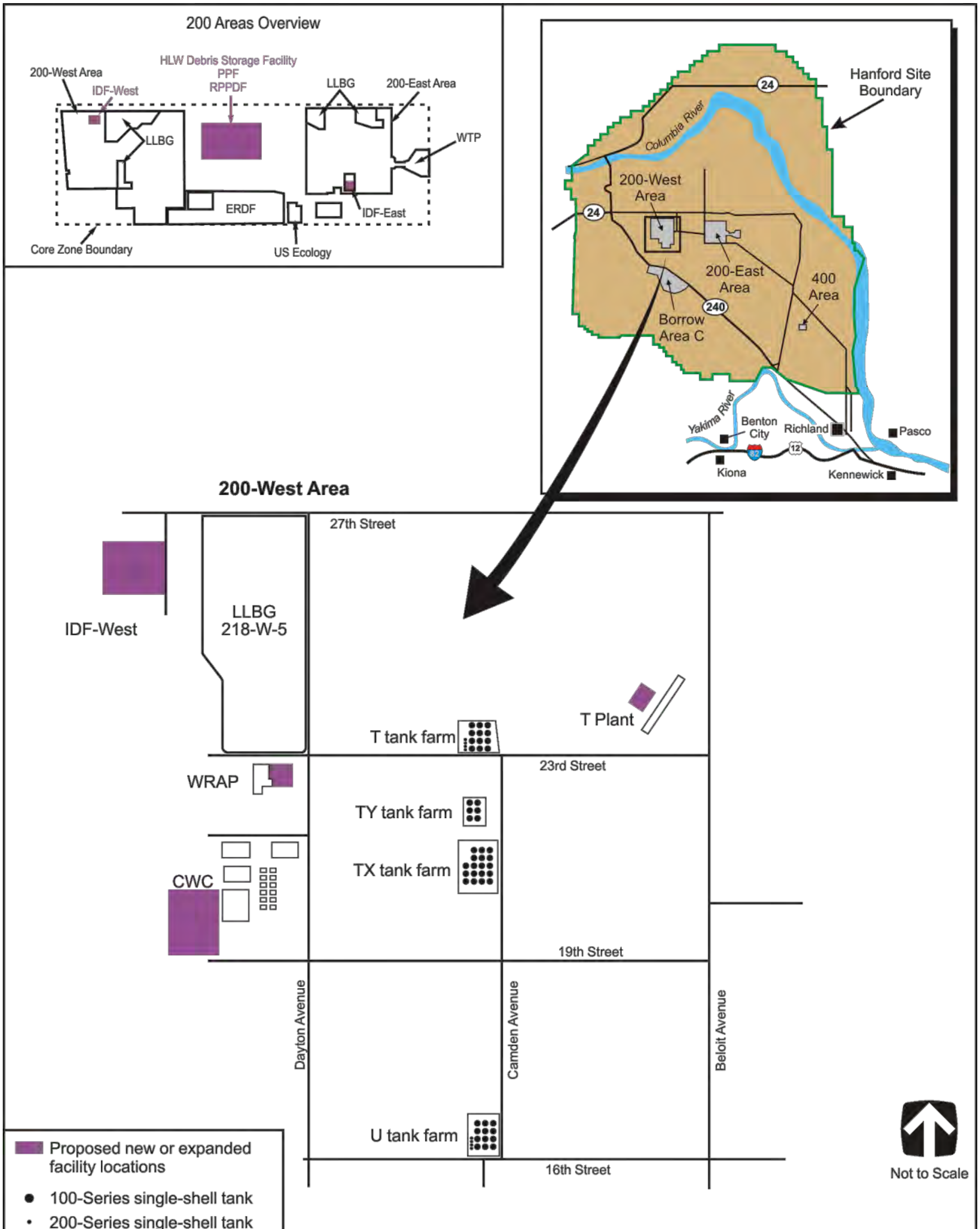
The low-level radioactive waste burial grounds (LLBGs) consist of eight separate waste disposal areas consolidated into a single radioactive waste unit. Two burial grounds are located in the 200-East Area, and six are located in the 200-West Area. The combined area of the burial grounds is about 220 hectares (544 acres) (DOE 1997c). The LLBGs contain lined and unlined trenches of varying size and depth that are used for disposal of LLW and MLLW and for retrievable storage of TRU waste.

Currently, LLW and MLLW are sent to RCRA-compliant trenches in LLBG 218-W-5 (trenches 31 and 34, the only lined trenches in the LLBGs) or the Environmental Restoration Disposal Facility. Figure 2–22 shows one of the lined disposal trenches in LLBG 218-W-5. Naval reactor compartments are sent to LLBG 218-E-12B (trench 94). Additional activities at the trenches include immobilization and macroencapsulation of difficult-to-handle packages and radioactive lead solids. In general, most types of waste packages are received, stored, or disposed of in the same manner. Active trenches are backfilled as needed to minimize exposure and dose rates to operators. Backfilling a trench also minimizes the amount of waste exposed to conditions that could cause package degradation and waste-handling accidents.

Ongoing TRU waste retrieval activities include uncovering and moving the waste containers that were retrievably stored in LLBGs 218-W-4C, 218-W-4B, and 218-W-3A. Preliminary site investigations are conducted in the burial grounds as needed to obtain in situ information regarding the current physical condition of buried TRU waste containers and to determine the status of the environmental conditions immediately surrounding the stored waste. Once stored waste locations are confirmed and conditions are assessed, a few selected waste containers may be retrieved and characterized to provide additional information for preliminary site investigations and prepare for the full-scale retrieval operations that will follow (Weidert 2003).

2.4.1.2 Central Waste Complex

The CWC provides storage and staging for waste containers awaiting waste processing operations at other waste management facilities. Primary activities include receiving and storing waste. The CWC's main buildings are shown in Figure 2–23, including Building 2403-WD, which has a radioactive waste storage capacity of 17,500 drums. Other structures include the Low-Flashpoint Mixed Waste Storage Modules, Alkali Mixed Waste Modules, South Alkali Metal Storage Modules, Mixed Waste Storage Modules, Waste Receiving and Staging Area, Mixed Waste Storage Pad, 2420-W Cask Storage Pad, and Outdoor Storage Area. The storage buildings and pads have physical features that provide segregated storage areas to maintain appropriate separation between groups of incompatible wastes. The total CWC drum capacity is 82,480 drums (Weidert 2003).



Key: CWC=Central Waste Complex; ERDF=Environmental Restoration Disposal Facility; HLW=high-level radioactive waste; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; LLBG=low-level radioactive waste burial ground; PPF=Preprocessing Facility; RPPDF=River Protection Project Disposal Facility; WRAP=Waste Receiving and Processing Facility; WTP=Waste Treatment Plant.

Figure 2–20. 200-West Area Waste Management Facility Locations

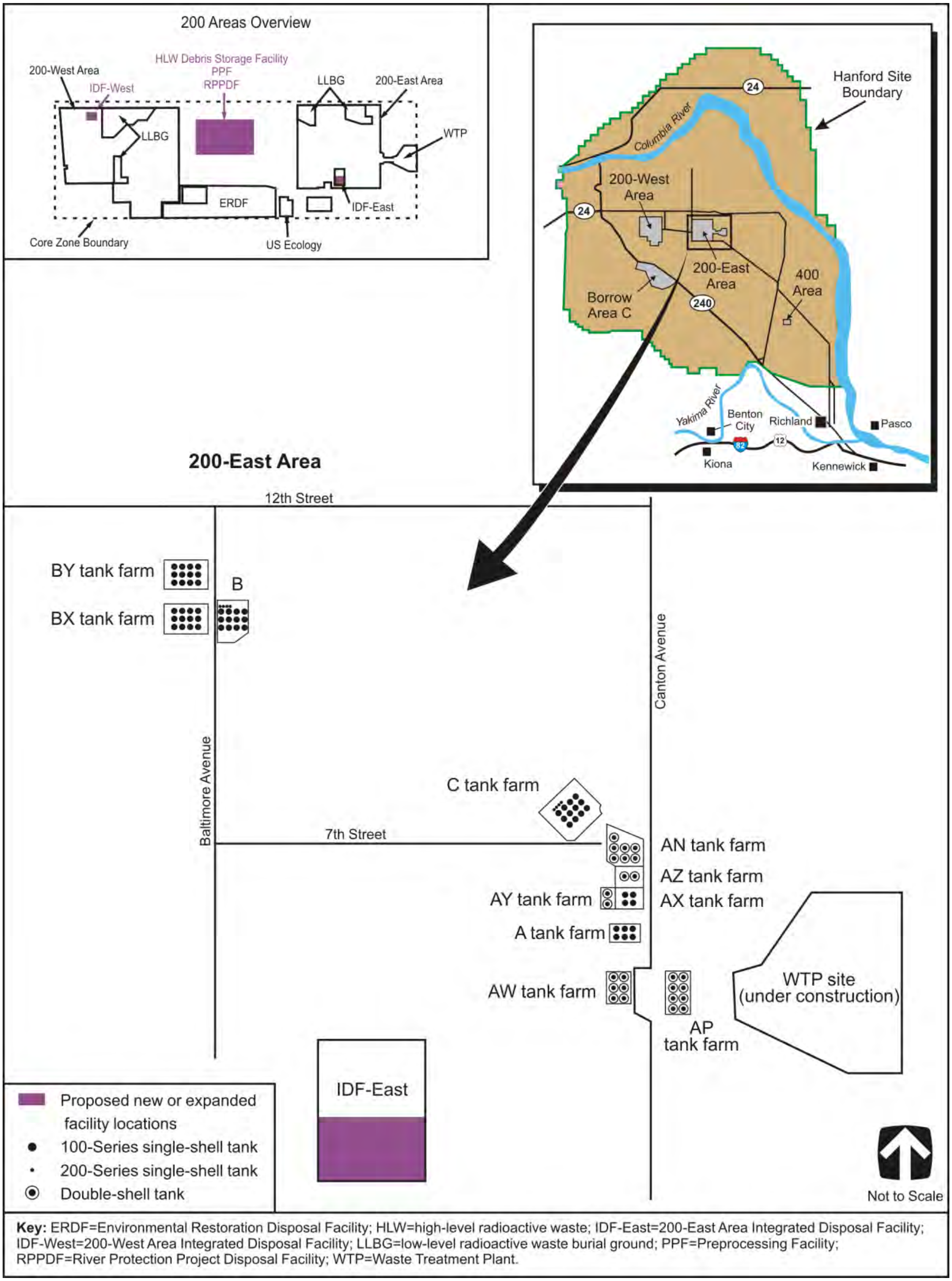


Figure 2–21. 200-East Area Waste Management Facility Locations

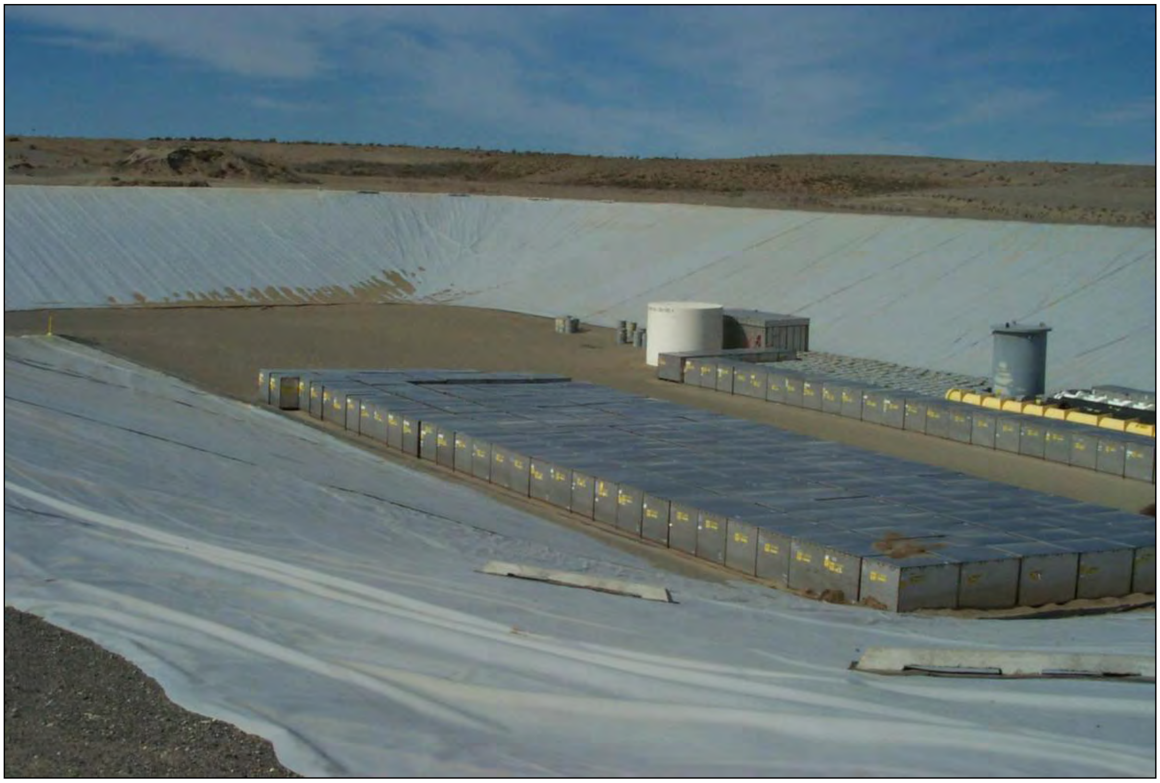


Figure 2–22. Lined Disposal Trench in Low-Level Radioactive Waste Burial Ground 218-W-5

Figure 2–23. Aerial View of the Central Waste Complex

2.4.1.3 T Plant

The T Plant operates under interim status as an RCRA TSD unit with no current RCRA permit capacity limit. Waste storage, decontamination, treatment, repackaging, and verification are the T Plant's primary activities. The T Plant complex, shown in Figure 2–24, includes the 221-T Canyon, which has RH-waste processing capabilities, and the 2706-T/TA/TB Facility. The 221-T Canyon is a heavily shielded, reinforced-concrete structure with an overall area of 5,370 square meters (57,800 square feet) (CEES 2006b). The 2706-T/TA/TB Facility, shown in the foreground of Figure 2–24, is a smaller, pre-engineered metal building with a concrete slab foundation. The overall area of the building is approximately 900 square meters (9,700 square feet).

Figure 2–24. Aerial View of the T Plant Complex

Solid waste processing at the T Plant consists of adding absorbent or grout material to the waste matrix, neutralization, and amalgamation of mercury or other metals. Additional services include sampling of drum headspace to support the TRU waste program and management of analytical samples returned from commercial laboratories.

2.4.1.4 Waste Receiving and Processing Facility

The primary activities at the Waste Receiving and Processing Facility (WRAP) are to confirm, sample, repackage, certify, store, and treat waste for shipment to a TSD unit. The facility, shown in Figure 2–25, measures 305 meters by 125 meters (1,000 feet by 410 feet), and consists of three buildings: 2336W, the main processing facility; 2740W, an administrative support building; and 2620W, a maintenance support building. WRAP receives containers of CH-waste from Hanford generators, including the CWC, waste retrieval operations, LLBGs, and T Plant, as well as from offsite generators. Radioactive waste is processed in three operational areas within the main processing facility: the shipping and receiving area, the NDE/NDA area, and the process area. Inspections include high-energy x-ray imaging of sealed waste containers (NDE), radioactive emission measurement quantification of sealed waste containers (NDA), and visual examination of open waste containers in gloveboxes. Additional activities at WRAP include waste treatment, intrusive sampling, packaging, repackaging, loading, headspace gas sampling, drum venting, and decontamination.

Figure 2–25. Waste Receiving and Processing Facility

2.4.1.5 Integrated Disposal Facility

The primary mission of an IDF is to dispose of LLW and MLLW. In April 2006, an RCRA-permitted IDF in the 200-East Area (IDF-East) was partially completed at Hanford (shown in Figure 2–26). IDF-East measures 457 meters wide by 233 meters long by 12.8 meters deep (1,500 feet wide by 765 feet long by 42 feet deep), currently consists of two cells, and is expandable. As currently planned, one cell would be used to dispose of MLLW, including vitrified LAW from the WTP and 50 large containers of waste from the planned Demonstration Bulk Vitrification System Project. The second cell would be used to dispose of LLW from Hanford cleanup activities. Each cell has a 2.1-meter-thick (7-foot-thick) liner system consisting of a 0.9-meter (3-foot) clay liner topped by two separate, high-density polyethylene liners, a geosynthetic clay liner, and 0.3 meters (1 foot) of drain gravel. These layers are covered with a 0.9-meter (3-foot) earthen layer to protect the liners from heavy equipment during waste placement operations (CH2M HILL 2006).

2.4.1.6 Solid Waste Operations Complex Process Flow

The overall SWOC process flow follows each waste type through generation, storage, treatment, and disposal. LLW and MLLW can be generated either on or off site. Once generated, the waste can be staged or stored at the CWC, LLBGs, or T Plant until it is treated, analyzed, or directly disposed of at the LLBGs or off site at a compliant facility. If the waste requires treatment, it would likely be conducted within the SWOC or at an offsite facility. After treatment, the waste would be staged or stored at an SWOC facility until disposal is completed.

Figure 2–26. 200-East Area Integrated Disposal Facility

TRU waste and mixed TRU waste can also be generated on or off site. TRU waste can be either staged or stored within the SWOC until it is treated, or it can be sent directly from generation to treatment. Once the waste is treated, it can be disposed of at WIPP if it meets the WIPP Waste Acceptance Criteria, or it can be stored within the SWOC until disposal is complete (Weidert 2003).

2.4.2 Proposed Solid Waste Management Activities

This section presents an overview of the waste technologies and facilities that would be used to implement the proposed actions to dispose of both Hanford and DOE offsite LLW and MLLW. More-detailed descriptions of these proposed technologies and facilities are presented in Appendix E, Section E.3.

2.4.2.1 Use of Existing Low-Level Radioactive Waste Burial Grounds

Under the Waste Management No Action Alternative, the two lined LLBG 218-W-5 trenches 31 and 34 would continue to receive LLW and MLLW from onsite non–Comprehensive Environmental Response, Compensation, and Liability Act (non-CERCLA) generators through 2035. Under Waste Management Alternatives 2 and 3, trenches 31 and 34 would continue to receive LLW and MLLW from onsite non-CERCLA generators through 2050. Currently, the remaining space in the two trenches totals approximately 17,215 cubic meters (22,520 cubic yards). At the projected emplacement rate, the trenches would be filled to capacity by no later than 2050. No construction activities would be necessary because the trenches are already in operation. For analysis purposes, this EIS assumed the trenches would continue to operate even after IDF-East begins operations; however, all waste generated after the opening of IDF-East was assumed to be disposed of in an IDF, not trenches 31 and 34.

2.4.2.2 Expanded Central Waste Complex, T Plant, and Waste Receiving and Packaging Facility

Due to the uncertainty of the waste forecasts for Hanford, it was assumed for analysis purposes that additional solid waste storage capacity would be required at the CWC as soon as possible following issuance of the ROD for this *TC & WM EIS*. Another 2403-WD Facility would be constructed at the CWC under Waste Management Alternatives 2 and 3. The drum storage capacity of 17,500 drums at the current 2403-WD Facility would therefore be duplicated, as would the footprint of 52 meters by 99 meters (170 feet by 325 feet) (Weidert 2003).

It was also assumed for analysis purposes that approximately 8,000 cubic meters (10,500 cubic yards) of high-dose (i.e., RH) or oversized waste packages may not meet the *Hanford Site Solid Waste Acceptance Criteria* for disposal (Fluor Hanford 2005b). Either a new facility or modifications to an existing facility may be required to process these waste volumes. To meet this need, under Waste Management Alternatives 2 and 3, DOE proposes constructing another 2706-T/TA/TB Facility-type building near the T Plant complex to allow processing of RH-waste in the 221-T Canyon, and shifting all other processing to the new 2706-T/TA/TB Facility-type buildings located near the T Plant.

The existing WRAP main processing facility has no vacant area for expansion of LLW, MLLW, and CH-mixed TRU waste processing, nor does it have an RH-mixed TRU waste processing capability. Thus, it was assumed for analysis purposes that new WRAP CH-Mixed TRU/TRU waste facilities would be constructed at the CWC, which would increase the throughput of LLW, MLLW, and CH-mixed TRU waste by approximately 40 percent, and that a new WRAP RH-Mixed TRU/TRU waste facility with approximately the same size and dimensions as the existing WRAP would be constructed adjacent to the existing facility.

Closure and postclosure care of the proposed CWC, T Plant, and WRAP expansions are not within the scope of the Waste Management alternatives, but are analyzed as part of the cumulative impacts addressed in Chapter 6.

2.4.2.3 Integrated Disposal Facility

Three different IDF configurations were analyzed in this *TC & WM EIS*. Under the Waste Management No Action Alternative, no additional construction would occur to expand IDF-East. The site would be deactivated, including removing the liner and backfilling the site to restore it to its natural grade. Under Waste Management Alternative 2, IDF-East would be either expanded from a planned capacity of 900,000 cubic meters (1.18 million cubic yards) to 1.2 million cubic meters (1.6 million cubic yards) or reduced to 425,000 cubic meters (556,000 cubic yards), depending on the disposal group analyzed (disposal groups are specific combinations of IDF and proposed RPPDF waste capacities and operational timeframes that were grouped together for waste management analysis purposes in this EIS). Under Waste Management Alternative 3, two IDFs would be utilized: the existing IDF-East in the 200-East Area and a proposed second IDF in the 200-West Area (IDF-West). IDF-East would receive only waste generated under the Tank Closure alternatives. IDF-West would receive the balance of the waste, including FFTF decommissioning waste, onsite non-CERCLA waste, and waste received from offsite DOE sources. As with Waste Management Alternative 2, IDF-East's capacity would vary, depending on the waste disposal group, from 340,000 cubic meters (445,000 cubic yards) to 1.1 million cubic meters (1.43 million cubic yards). IDF-West would have a capacity of 90,000 cubic meters (118,000 cubic yards) under all disposal groups analyzed.

2.4.2.4 River Protection Project Disposal Facility

Another new, onsite disposal facility, the RPPDF, would be constructed under the Waste Management action alternatives. Rubble, soils, and ancillary equipment that are not highly contaminated, but result from closure activities at various SST farms, would be disposed of in the proposed RPPDF. For analysis purposes, it was assumed that the design, construction, and operations activities necessary for the proposed RPPDF would be the same as those needed for IDF-West. However, the proposed RPPDF's capacity would differ from the IDF capacities previously discussed. Under the Waste Management No Action Alternative, there would be no need for the RPPDF because no closure activities would take place. Under Waste Management Alternatives 2 and 3, a single RPPDF would be constructed in the 200 Areas near IDF-East. Three disposal groups have been identified to support closure activities under the Tank Closure alternatives. Depending on the disposal group analyzed, the proposed RPPDF could occupy from 29.5 to 228 hectares (73 to 564 acres) and have a capacity of 1.08 to 8.37 million cubic meters (1.41 to 10.9 million cubic yards).

2.4.2.5 Closure of Integrated Disposal Facility and River Protection Project Disposal Facility

Closure of IDF-East and the proposed RPPDF were analyzed in this *TC & WM EIS* under Waste Management Alternatives 2 and 3. Closure activities for the CWC, WRAP, T Plant, and lined LLBGs are addressed in Chapter 6, "Cumulative Impacts." IDF-East and the proposed RPPDF would be closed under a modified RCRA Subtitle C barrier over the landfill, similar to the barrier proposed under the Tank Closure alternatives. Postclosure care would consist of air, groundwater, and vadose zone monitoring.

2.5 DESCRIPTION OF THE ALTERNATIVES

This *TC & WM EIS* evaluates the impacts associated with 11 Tank Closure alternatives, 3 FFTF Decommissioning alternatives, and 3 Waste Management alternatives. For Tank Closure alternatives, impacts resulting from storage, retrieval, treatment, disposal, and closure activities at Hanford's HLW tank farms were evaluated, as well as the impacts of a No Action Alternative. The Tank Closure alternatives are as follows:

Tank Closure Alternative 1: No Action

Tank Closure Alternative 2: Implement the *Tank Waste Remediation System EIS* Record of Decision with Modifications

- Tank Closure Alternative 2A: Existing WTP Vitrification; No Closure
- Tank Closure Alternative 2B: Expanded WTP Vitrification; Landfill Closure

Tank Closure Alternative 3: Existing WTP Vitrification with Supplemental Treatment Technology; Landfill Closure

- Tank Closure Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure
- Tank Closure Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure
- Tank Closure Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

Tank Closure Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

Tank Closure Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

Tank Closure Alternative 6: All Waste as Vitrified HLW

- Tank Closure Alternative 6A: All Vitrification/No Separations; Clean Closure (Base and Option Cases)
- Tank Closure Alternative 6B: All Vitrification with Separations; Clean Closure (Base and Option Cases)
- Tank Closure Alternative 6C: All Vitrification with Separations; Landfill Closure

These alternatives represent the range of reasonable approaches to removing waste from the tanks to the extent that is technically and economically feasible; treating the waste by vitrifying it in the WTP and/or by using one or more supplemental treatment processes; packaging the waste for either offsite shipment and disposal or onsite disposal; and closing the SST system to permanently reduce the potential risk to human health and the environment.

This *TC & WM EIS* also evaluates the impacts associated with three alternatives for decommissioning FFTF and associated support buildings; managing the resulting waste using existing capabilities; managing designated RH-SCs for which waste management capabilities do not currently exist; closing FFTF and its associated support buildings; and managing the disposition of the inventory of bulk sodium resulting from deactivation of FFTF, as well as bulk sodium from the Hallam Reactor and the SRE, which is now in storage at Hanford. The FFTF Decommissioning alternatives are as follows:

FFTF Decommissioning Alternative 1: No Action
FFTF Decommissioning Alternative 2: Entombment
FFTF Decommissioning Alternative 3: Removal

These alternatives represent the range of reasonable approaches to dismantling and removing the FFTF-related structures, equipment, and materials within the 400 Area PPA; treating and disposing of these components and equipment as necessary either in place or at other facilities; treating RH-SCs either at a new facility located at Hanford or INTEC at INL; converting Hanford bulk sodium to a caustic sodium hydroxide solution at Hanford or INL for use in the WTP; and closing the area (1) permanently to reduce the potential risk to human health and the environment or (2) to prepare the area for future industrial use.

This *TC & WM EIS* also provides analyses of the impacts associated with the following Waste Management alternatives for managing the storage, processing, and disposal of solid waste at Hanford, as well as the subsequent closure of associated disposal facilities. The Waste Management alternatives are as follows:

Waste Management Alternative 1: No Action
Waste Management Alternative 2: Disposal in IDF, 200-East Area Only
Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas

These Waste Management alternatives represent the range of reasonable approaches to continued storage of LLW, MLLW, and TRU waste at Hanford; onsite waste processing using two expansions of WRAP; onsite disposal of onsite non-CERCLA LLW and MLLW in trenches; disposal of tank, onsite non-CERCLA, FFTF decommissioning, waste management, and offsite LLW and MLLW in new onsite facilities; and closure of disposal facilities to reduce water infiltration and the potential for intrusion.

Several hundred impact scenarios could result from the potential combinations of the 11 Tank Closure, 3 FFTF Decommissioning, and 3 Waste Management alternatives when factored with their associated Base and Option Cases and waste disposal groups. For analysis purposes, certain combinations of alternatives were chosen to represent key points along the range of actions and associated overall impacts that could result from full implementation of the three sets of proposed actions. Selection of these three alternative combinations for detailed analysis in this EIS was done only to establish overall impact level reference cases for stakeholders and decisionmakers to consider, and does not preclude the selection and implementation of different combinations of the various alternatives in support of final agency decisions. These combinations and the associated potential short-term and long-term impacts are detailed in Chapter 4, Section 4.4, and Chapter 5, Section 5.4, respectively.

2.5.1 Development of the Alternatives

The alternatives presented in this *TC & WM EIS* were developed under NEPA to address the essential components of DOE's three sets of proposed actions (tank closure, FFTF decommissioning, and waste management) and to provide an understanding of the differences between the potential environmental impacts of the range of reasonable alternatives.

A No Action Alternative, required under the Council on Environmental Quality's NEPA-implementing regulations to provide a point of comparison against which the proposed actions and alternatives can be compared (40 CFR 1502.14(d)), is also evaluated. Council on Environmental Quality and DOE NEPA guidance directs that the number of reasonable alternatives in an EIS should represent the full spectrum of alternatives for meeting the agency's purpose and need, but an EIS need not discuss every unique alternative when an unmanageably large number is involved (DOE 2004a).

Each alternative relies on a combination of technologies, processes, and facilities that could accomplish the desired outcome for that alternative. In many cases, those technologies were selected to provide bounding environmental consequences and do not necessarily represent the exact technologies or processes that could be implemented to achieve the desired outcome. This *TC & WM EIS* does not attempt to analyze all possible permutations of the alternatives using available technologies and processes, but instead groups activities logically into reasonable alternatives for analysis. The technologies, processes, and facilities analyzed in detail in this EIS have sufficient performance data to make conservative assumptions regarding construction, operations, and decommissioning impacts. However, comprehensive and specific engineering designs may still have to be developed once a series of technologies is selected for implementation.

2.5.1.1 Tank Closure Alternatives

The Tank Closure alternatives evaluated in this *TC & WM EIS* were constructed to address each of the primary tank closure components (storage, retrieval, treatment, disposal, and closure) and to consider a range of options for each component.

Storage. Tank farm storage operations would be required under each Tank Closure alternative and would include safe storage of the tank waste, necessary waste monitoring activities, routine maintenance activities, and waste transfers as required for tank space management and waste feed operations. Tank farm storage operations are considered a dependent function that varies based on changes in the duration of waste retrieval and treatment operations. If the tank waste is not retrieved and treated (the No Action Alternative), ongoing activities similar to those currently conducted (e.g., tank monitoring and security maintenance) would continue for a 100-year administrative control period.

Retrieval. Options range from retrieving none of the tank waste (the No Action Alternative) to retrieving the tank waste to the maximum extent that is both technically practical and required to support clean closure of the SST system. Based on the reasonable range of potential waste retrieval scenarios (from 90 percent, reflecting less than optimal waste retrieval system performance, to 99.9 percent, representing a retrieval end state following multiple uses of retrieval systems), various technology configurations could be used for this purpose.

Treatment. Options range from treating none of the tank waste (the No Action Alternative) to treating all of the tank waste to the extent required to meet disposal requirements. A variety of technologies could be used for tank waste treatment, ranging from a single technology resulting in a single waste form for disposal to multiple technologies resulting in multiple waste forms for disposal. Due to prior NEPA analysis (DOE and Ecology 1996) and commitments made by DOE under agreements with the Washington State Department of Ecology (Ecology) and the U.S. Environmental Protection Agency (EPA), e.g., the TPA (Ecology, EPA, and DOE 1989), all action alternatives assume, at a minimum, continued use of the WTP in its current configuration (including pretreatment and HLW and LAW vitrification), as well as immobilization at a TMC of 6 metric tons of glass IHLW per day (using two HLW melters) and 30 metric tons of glass ILAW per day (using two LAW melters). Some alternatives consider expansion of the current WTP configuration. The one alternative that does not include continuing WTP construction and operations is the No Action Alternative.[9]

End-State Management of the Tank Farm Systems

Administrative controls: The provisions related to organization and management, procedures, record-keeping, assessment, and reporting necessary to ensure safe operation of a facility. For analysis purposes, it was assumed that administrative controls would be conducted at the single-shell tank (SST) system for those alternatives that do not include closure. Administrative controls would include monitoring the tanks for signs of deterioration that would threaten the structural integrity of the tanks. The period for administrative controls is the 100 years following the termination of Waste Treatment Plant construction under the No Action Alternative and the 100 years following retrieval of the waste from the SST system under Alternative 2A (applicable to Tank Closure Alternatives 1 and 2A).

Active institutional controls: The period when a site is under active governmental controls. Institutional controls may include administrative or legal controls, physical barriers or markers, and methods to preserve information and to inform current and future generations of hazards and risks. This would include controls necessary to ensure continued safe storage of waste following treatment. For analysis purposes, it was assumed that active institutional controls would be maintained for 100 years following final placement of waste in storage facilities (applicable to all Tank Closure alternatives except the No Action Alternative).

Postclosure care: The period following closure of a hazardous waste disposal system (e.g., a landfill) during which monitoring and maintenance activities must be conducted to preserve the integrity of the disposal system and continue preventing or controlling releases from the disposal unit. Under the hazardous waste regulations (WAC 173-303), postclosure care is typically 30 years. However, the regulator may extend this period as necessary to protect human health and the environment. For analysis purposes, it was assumed that the postclosure care period following landfill closure of the SST system would be extended to 100 years (applicable to Tank Closure Alternatives 2B, 3A, 3B, 3C, 4, 5, and 6C).

10,000-year period of analysis: The period of analysis used in this environmental impact statement for the long-term impacts analysis for groundwater, human health, and ecological risks.

Disposal. Potential options include both on- and offsite disposal. Disposal is a dependent function that varies across the Tank Closure alternatives based on changes in the treatment of the tank waste. Onsite disposal would be influenced by the volume of waste produced and its ability to meet waste acceptance criteria for disposal in a near-surface onsite facility or in offsite disposal facilities such as WIPP. Onsite waste disposal also would be influenced by waste form performance issues, including the cumulative effects of waste disposal actions in proximity to other disposal and closure actions conducted in the Hanford 200 Areas (including closure of the SST system).

Closure. Options range from continuing tank farm operations (without closing the SST system) to closing the SST system under a landfill or clean closure configuration (or some combination of these two

[9] In August 2007, DOE issued a study, the *Hanford River Protection Project Low Activity Waste Treatment: A Business Case Evaluation* (Wade et al. 2007), that considered the possibility of starting WTP LAW and/or supplemental LAW treatment earlier than scheduled under the *TC & WM EIS* alternatives. Appendix E, Section E.1.2.3.5.1, details the purpose and conclusions of this study.

end-states). In addition, each of these options may include one or more end-state management activities (administrative controls, active institutional controls, postclosure care) that would take place at the completion of each action.

Because of the complexity of the RPP mission and its components (which are directly related to the proposed actions), the array of tank closure technologies that could be used is very large. In some cases, technologies were excluded from detailed analysis (see Section 2.6) because they were not practical (e.g., offsite disposal of ILAW). In other cases, technologies were excluded because they were characteristically similar to other technologies (e.g., the different types of melters used to vitrify HLW).

Appendix E, Section E.1, includes a detailed discussion of the tank closure technologies analyzed in this EIS, and Section E.1.3 describes those technologies considered but not analyzed in detail because they were not technically or economically practical. The technology groupings were distilled into a limited number of viable technologies capable of supporting the range of reasonable Tank Closure alternatives in accordance with NEPA requirements (DOE 2004a).

As the tank closure technologies were grouped under the alternatives, reasonably conservative assumptions related to each technology and the associated alternatives were developed to ensure clear distinctions were made among the alternatives and to preserve sufficient flexibility for midcourse corrections as the selected alternative is implemented over an array of programmatic functions and a long timeframe. All of the Tank Closure alternatives except the No Action Alternative would implement a wide variety of complex technologies. Some of these technologies have never been used in conditions similar to those of the tank farms or to treat waste similar to the Hanford tank waste. The assumptions associated with the Tank Closure alternatives and technologies are presented in Appendix E, Section E.1.

2.5.1.2 FFTF Decommissioning Alternatives

The FFTF Decommissioning alternatives evaluated in this *TC & WM EIS* were constructed to address disposition of facilities, RH-SCs, and bulk sodium. In constructing the FFTF Decommissioning alternatives, DOE considered a range of options for each component.

Facility disposition. Options include maintaining the deactivated FFTF and its associated facilities and components in a long-term surveillance and maintenance condition (No Action Alternative); dismantling and removing the RCB and immediately adjacent support facilities to grade, stabilizing associated below-grade contaminated components and equipment in place, and covering this area with an engineered barrier compliant with regulations (Entombment Alternative); or dismantling and removing the RCB and immediately adjacent support facilities to grade, removing below-grade radioactively contaminated components and equipment (including the reactor vessel), and backfilling this area with either soil or grout (Removal Alternative). Under both action alternatives, all other ancillary buildings would be demolished and the area previously occupied by these facilities would be backfilled, compacted, contoured, and revegetated.

Disposition of remote-handled special components. Due to the inability to completely drain sodium from certain reactor system components with high radiation levels (primarily from cesium-137), these components would require remote handling, decontamination, and disposal. Options for disposition of these RH-SCs range from leaving the untreated materials on site (No Action Alternative), consistent with other Hanford NEPA activities, to treating the RH-SCs (removing the sodium residuals) and disposing of them either on or off site (Entombment and Removal Alternatives). No currently existing DOE facility without modifications can treat these RH-SCs. An RTP at INL's INTEC would have the capabilities to perform the required decontamination and sodium removal operations. Under this offsite treatment option, the RH-SCs would be transported from Hanford to INL for treatment. However, no U.S. Department of Transportation (DOT)–approved transport casks capable of holding such large components are currently available. A second option was developed under which an RTP capable of treating the RH-SCs would be constructed at Hanford, thus eliminating the need for intersite transport. Options for disposal of treated RH-SCs include disposal on site at Hanford in an IDF or disposal off site at DOE's NNSS. Both of these options were analyzed under the Entombment and Removal Alternatives.

Disposition of bulk sodium. Options for treatment and disposal of Hanford bulk sodium range from leaving the untreated materials on site in storage (No Action Alternative) to treating the bulk sodium for use in the WTP (Entombment and Removal Alternatives). DOE has determined that the FFTF sodium coolant, as well as other radioactively contaminated bulk sodium stored at Hanford, could be converted to a concentrated caustic sodium hydroxide solution that could be reused to process tank waste at the WTP, or for Hanford tank corrosion control. Options for converting the sodium range from conducting conversion activities on site at Hanford in the proposed SRF (Hanford Reuse Option) to shipping the sodium to INL for conversion in the existing SPF at the MFC (Idaho Reuse Option). Both of these options were analyzed under the Entombment and Removal Alternatives.

2.5.1.3 Waste Management Alternatives

The Waste Management alternatives evaluated in this *TC & WM EIS* were constructed to address the essential components of the proposed actions: onsite storage and disposal of Hanford and other DOE sites' LLW and MLLW and closure of the waste disposal facilities. In constructing the Waste Management alternatives, DOE considered a range of options for each component.

Storage. Options range from continued storage of LLW, MLLW, and TRU waste at existing facilities, with no acceptance of offsite-waste shipments (Waste Management Alternative 1: No Action) to expansion of Hanford facilities' storage capacity to accommodate limited shipments of LLW and MLLW from offsite DOE sources (Waste Management Alternatives 2 and 3). Hanford-generated LLW, MLLW, and TRU waste would continue to be processed on site in existing facilities (No Action) or in the expanded facilities (Waste Management Alternatives 2 and 3). Offsite LLW and MLLW would be treated off site prior to shipment to Hanford under Waste Management Alternatives 2 and 3.

Disposal. Options include on- or offsite disposal. Disposal of waste on site would be influenced by the volume of waste produced and whether the waste could meet the criteria for disposal in a near-surface onsite facility or at an offsite facility (e.g., WIPP). The use of existing disposal facilities (e.g., the lined LLBG trenches), expansion of existing disposal facilities (IDF-East), and construction of new facilities (such as IDF-West and the proposed RPPDF) were analyzed under the Waste Management alternatives. All three Waste Management alternatives include continued disposal of LLW and MLLW in lined trenches, with the timeframe for completing disposal activities varying from 2035 to 2050. Both of the action alternatives include the construction of the proposed RPPDF (for disposal of equipment and soils that are not highly contaminated and result from closure activities) and use of the existing or expanded IDF-East (for disposal of tank, onsite non-CERCLA, FFTF decommissioning, and waste management–produced wastes, as well as LLW and MLLW from offsite sources). The difference between the two action alternatives is that only IDF-East would be used to support Waste Management Alternative 2, but two IDFs would be used to support Waste Management Alternative 3 (IDF-East [for tank waste only] and IDF-West). Under Waste Management Alternative 1: No Action, any further construction of IDF-East would be discontinued.

Three disposal groups were analyzed under both action alternatives. The size, capacity, and number of facilities associated with each disposal group were developed based on the amounts and types of waste generated under each of the three sets of *TC & WM EIS* alternatives (Tank Closure, FFTF Decommissioning, and Waste Management). Facility timeframes would vary among the disposal groups, with the last year of operations ranging from 2050 to 2165.

Closure. Options range from operating the proposed RPPDF and IDF(s) indefinitely using administrative controls to closing these disposal facilities followed by postclosure care. Closure type does not vary among the alternatives; both Waste Management Alternatives 2 and 3 include closing the proposed RPPDF and IDF(s) under engineered modified RCRA Subtitle C barriers.

2.5.2 Tank Closure Alternatives

The Tank Closure alternatives are described in detail in this section. A summary of these alternatives by mission component is provided in Table 2–2.

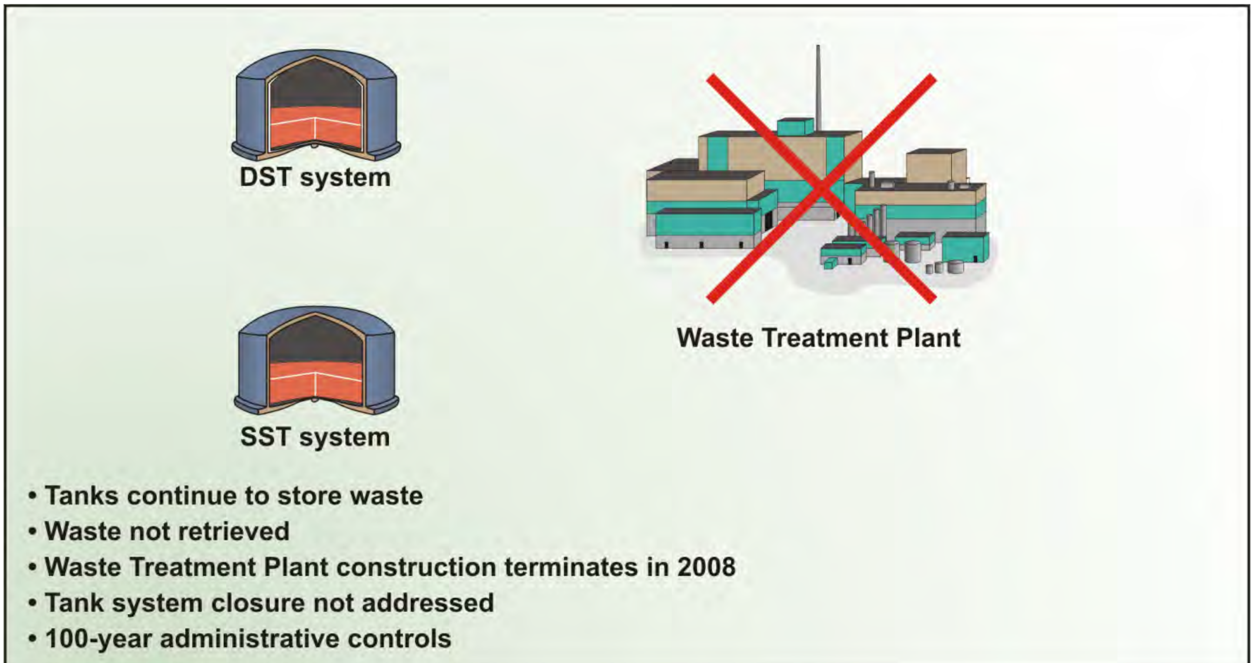
Table 2–2. Tank Closure Alternatives – Summary by Mission Component

Mission Component	Range of Action	Alternative										
		1	**2A**	**2B**	**3A**	**3B**	**3C**	**4**	**5**	**6A**	**6B**	**6C**
Storage	None beyond 2004 (except administrative controls)	X										
	Existing system with minimum changes			X	X	X	X	X			X	X
	Existing system with extensive changes		X						X	X		
Retrieval	None	X										
	90 percent								X			
	99 percent		X	X	X	X	X					X
	99.9 percent							X		X	X	
Treatment	None	X										
	Existing WTP capacity		X									
	Expanded WTP LAW capacity only			X								
	Existing WTP capacity; supplement with mixed TRU waste and thermal treatment				X		X					
	Existing WTP capacity; supplement with mixed TRU waste and nonthermal treatment					X						
	Existing WTP capacity; supplement with mixed TRU waste, thermal, and nonthermal treatment							X				
	Replacement of WTP		X							X		
	Expanded WTP LAW capacity; supplement with mixed TRU waste, thermal, and nonthermal treatment								X			
	Expanded WTP HLW capacity; no LAW capacity									X		
	Expanded WTP LAW capacity (all HLW)										X	X
	Cesium and strontium capsule contents treated in WTP		X	X	X	X	X	X	X	X	X	X
Disposal	None	X										
	IHLW glass off site; ILAW glass on site		X	X								
	IHLW and TRU waste off site; ILAW (WTP and supplemental) on site				X	X	X	X	X			
	IHLW glass and ILAW glass managed as HLW and stored on site									X	X	X
Closure	None	X	X									
	Landfill closure (no soil removal)								X			
	Landfill closure (with soil removal)			X	X	X	X					X
	Selective clean closure/landfill closure							X				
	Clean closure/landfill closure of adjacent cribs and trenches (ditches)									X	X	

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low-activity waste; TRU=transuranic; WTP=Waste Treatment Plant.

2.5.2.1 Tank Closure Alternative 1: No Action

The Tank Closure No Action Alternative is based on the No Action Alternative presented in the 1996 *TWRS EIS*, updated to reflect actions taken and new information developed since the *TWRS EIS* was issued, including additional consideration of the past leak inventory associated with the Hanford 200-East and 200-West Area tank farms. As shown in Figure 2–27, no retrieval, treatment, disposal, or closure operations would take place under the Tank Closure No Action Alternative.



Key: DST=double-shell tank; SST=single-shell tank.

Figure 2–27. Tank Closure Alternative 1 Overview

Under the Tank Closure No Action Alternative, DOE would cease further construction of the WTP and any ongoing construction of upgrades to the tank farm systems in 2008, and the WTP site would be isolated pending some future use. No other waste would be retrieved from the tanks, and no IHLW glass or ILAW glass would be produced. DOE would maintain security and management of the site for a 100-year administrative control period (ending in 2107). During this administrative control period, DOE would continue to store and conduct routine monitoring of the waste in the SSTs, DSTs, and MUSTs. The cesium and strontium capsules would remain in storage in the WESF. The proposed schedule for implementing Alternative 1 is presented in Figure 2–28.

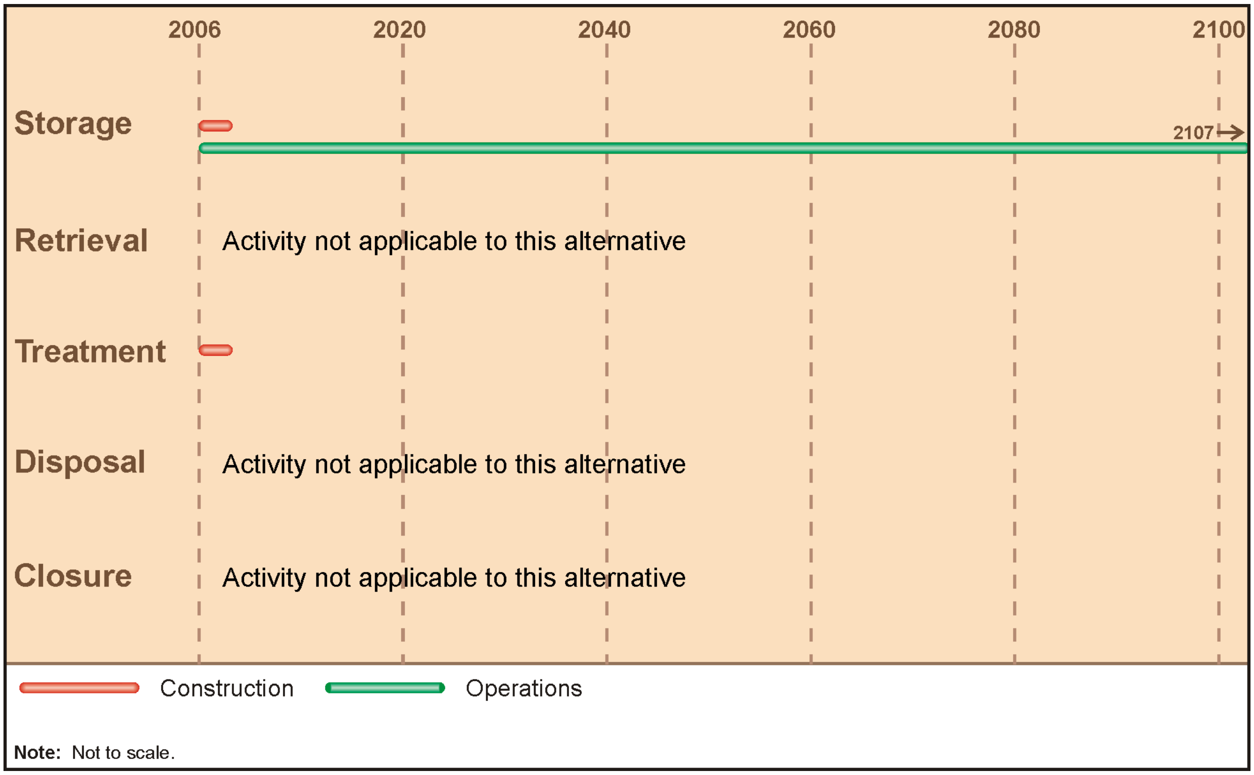


Figure 2–28. Tank Closure Alternative 1 Proposed Schedule

The waste in the SST and DST systems would remain in the tank farms indefinitely. SSTs showing signs of deterioration that would threaten the structural integrity of the tanks would be filled with grout or gravel as a corrective action or emergency response. Waste contained in DSTs showing similar signs of deterioration would be removed from the tanks and consolidated in existing DSTs to the extent possible. The deteriorated DSTs would then be filled with grout or gravel as a corrective action or emergency response. Figure 2–29 illustrates the primary components of the No Action Alternative.

2.5.2.2 Tank Closure Alternative 2: Implement the *Tank Waste Remediation System EIS* Record of Decision with Modifications

Tank Closure Alternative 2 considers all vitrification treatment with 99 percent retrieval of waste from the Hanford 200-East and 200-West Area tank farms in accordance with the *TWRS EIS* ROD and three supplement analyses completed through 2001. Two subalternatives were separately evaluated. Under Alternative 2A, waste would be treated using the existing WTP configuration and the SST system would not be closed. In contrast, under Alternative 2B, WTP capacity for producing ILAW glass would be expanded; technetium-99 would be removed from the WTP LAW stream during pretreatment; and the SST system would be closed (landfill closure). In addition, cesium and strontium capsules would be treated under both subalternatives.

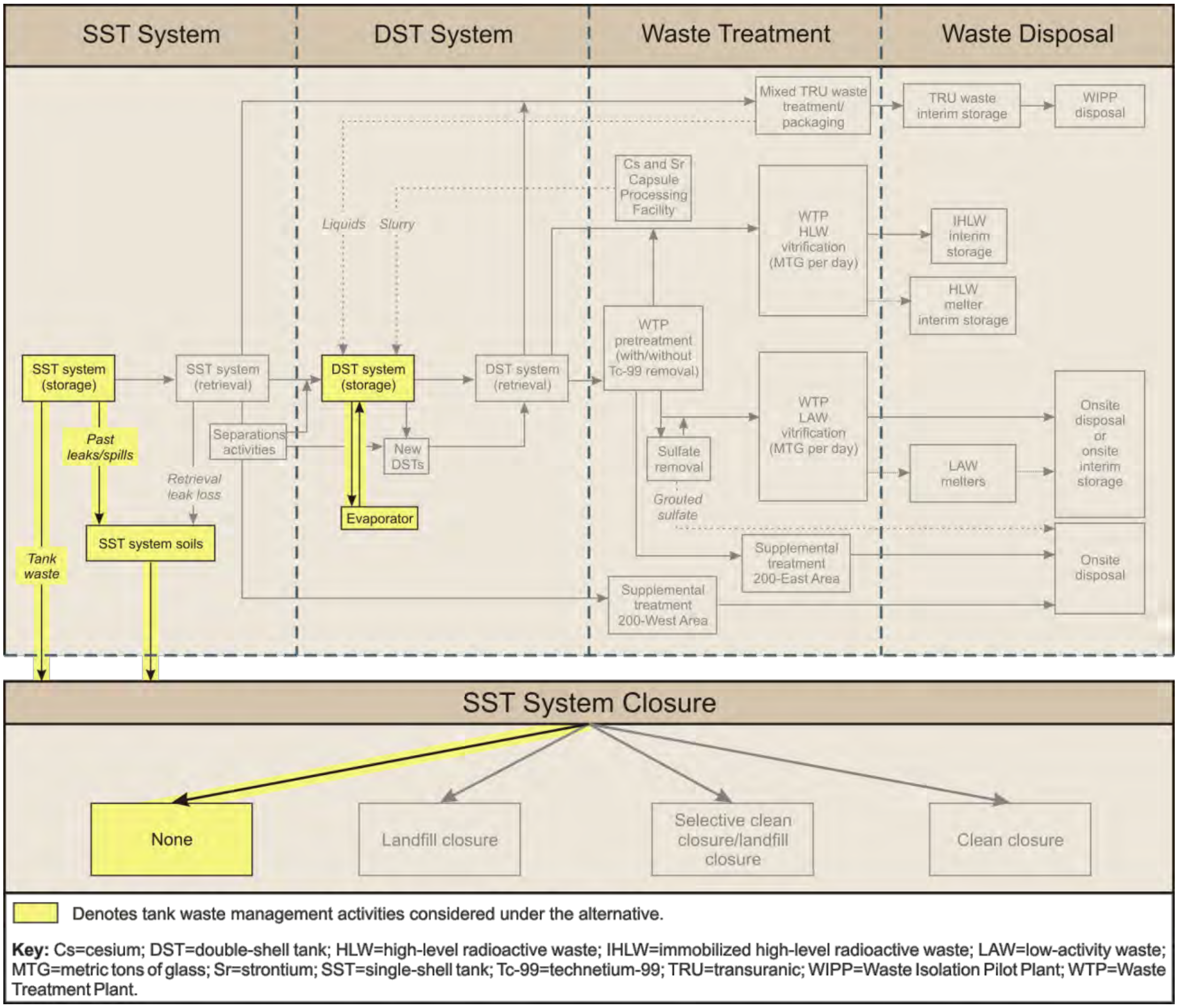
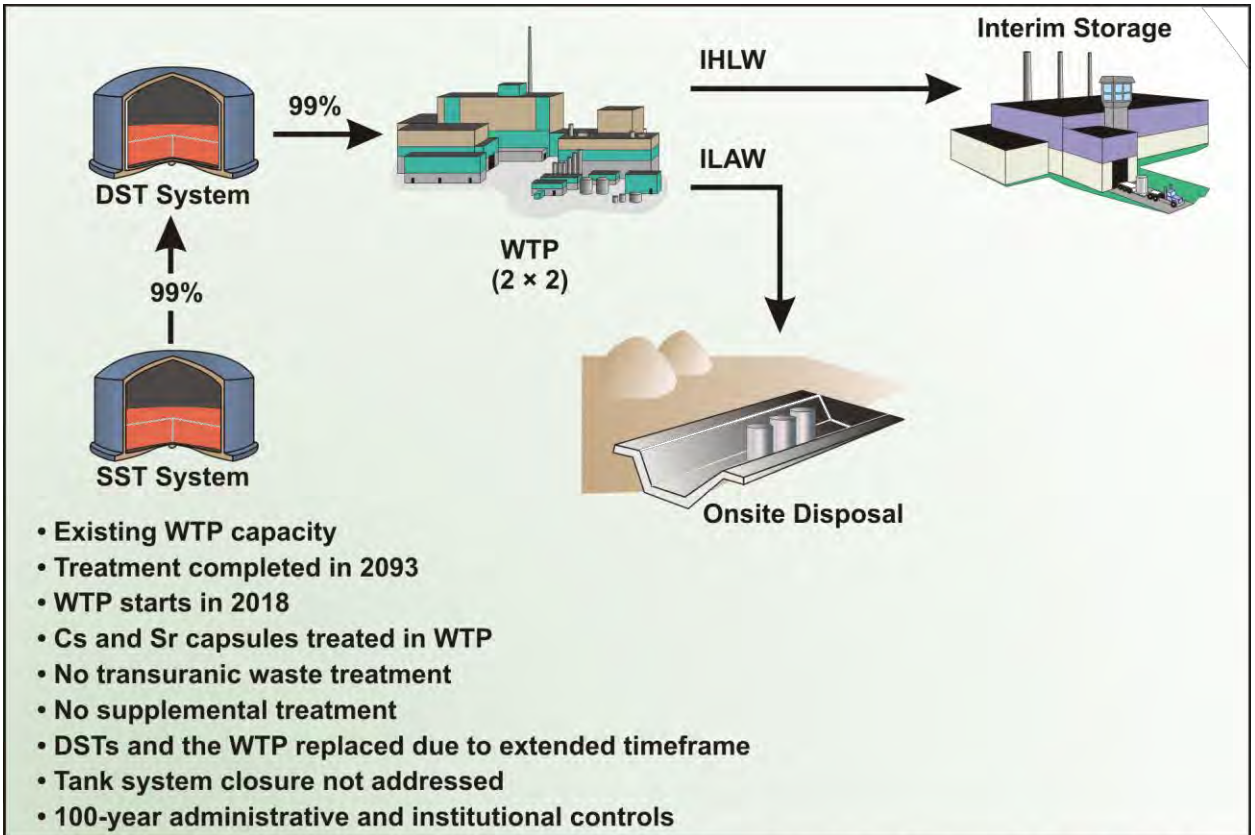


Figure 2–29. Tank Closure Alternative 1 Primary Components

2.5.2.2.1 Tank Closure Alternative 2A: Existing WTP Vitrification; No Closure

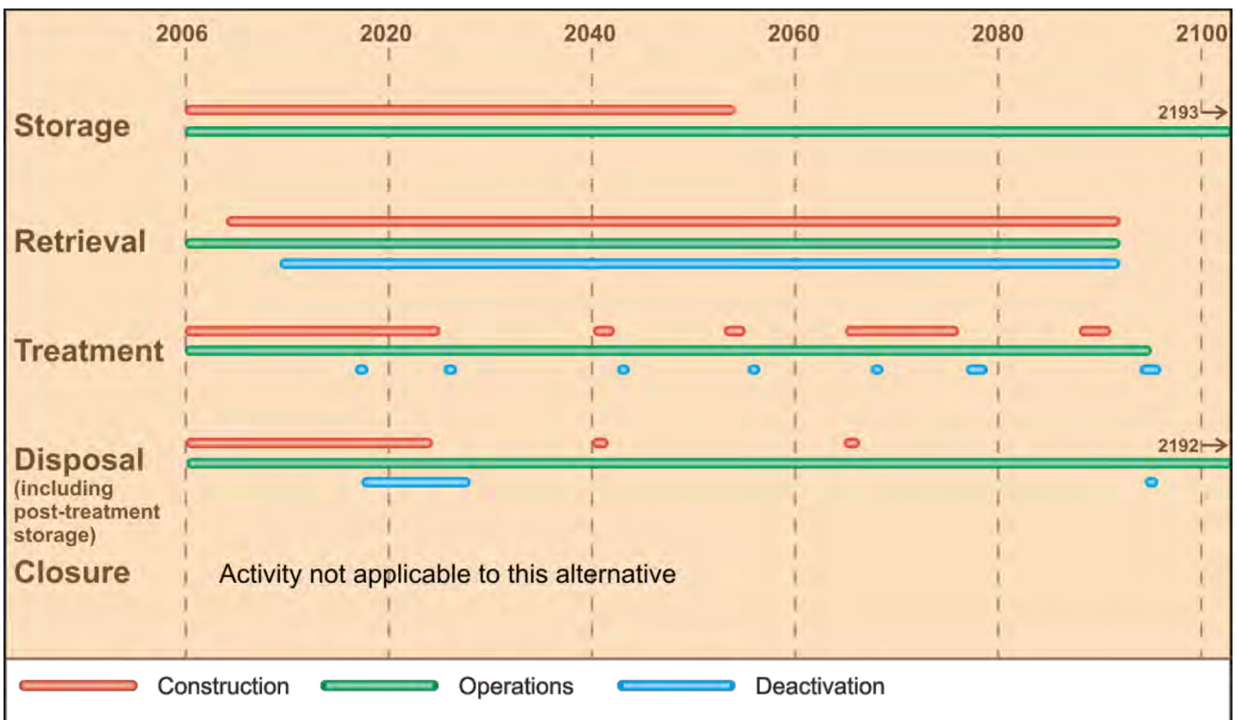
As shown in Figure 2–30, under this subalternative, DOE would retrieve and treat 99 percent of the waste volume from the Hanford 200-East and 200-West Area tank farms using only the currently planned WTP vitrification capacity. The waste retrieved from the tanks would be segregated into one of two waste streams during WTP pretreatment: (1) an HLW stream that would be vitrified to form IHLW glass or (2) a LAW stream that would be vitrified to form ILAW glass. Under Tank Closure Alternative 2A, technetium-99 removal would not occur as part of WTP pretreatment, and no supplemental technologies would be employed to treat the LAW.

Following completion of construction and a 2018 start, WTP vitrification operations under Tank Closure Alternative 2A would extend through 2093. No separate mixed TRU waste treatment capability would be provided under this alternative. Similarly, no tank or facility closure would be conducted under this alternative, although administrative controls would be maintained for 100 years (through 2193) following completion of vitrification operations. The proposed schedule for implementing Tank Closure Alternative 2A is presented in Figure 2–31.



Key: Cs=cesium; DST=double-shell tank; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; Sr=strontium; SST=single-shell tank; WTP=Waste Treatment Plant.

Figure 2–30. Tank Closure Alternative 2A Overview



Note: Not to scale.

Figure 2–31. Tank Closure Alternative 2A Proposed Schedule

The following storage, retrieval, treatment, disposal, and closure actions, as depicted in Figure 2–32, would occur under Tank Closure Alternative 2A.

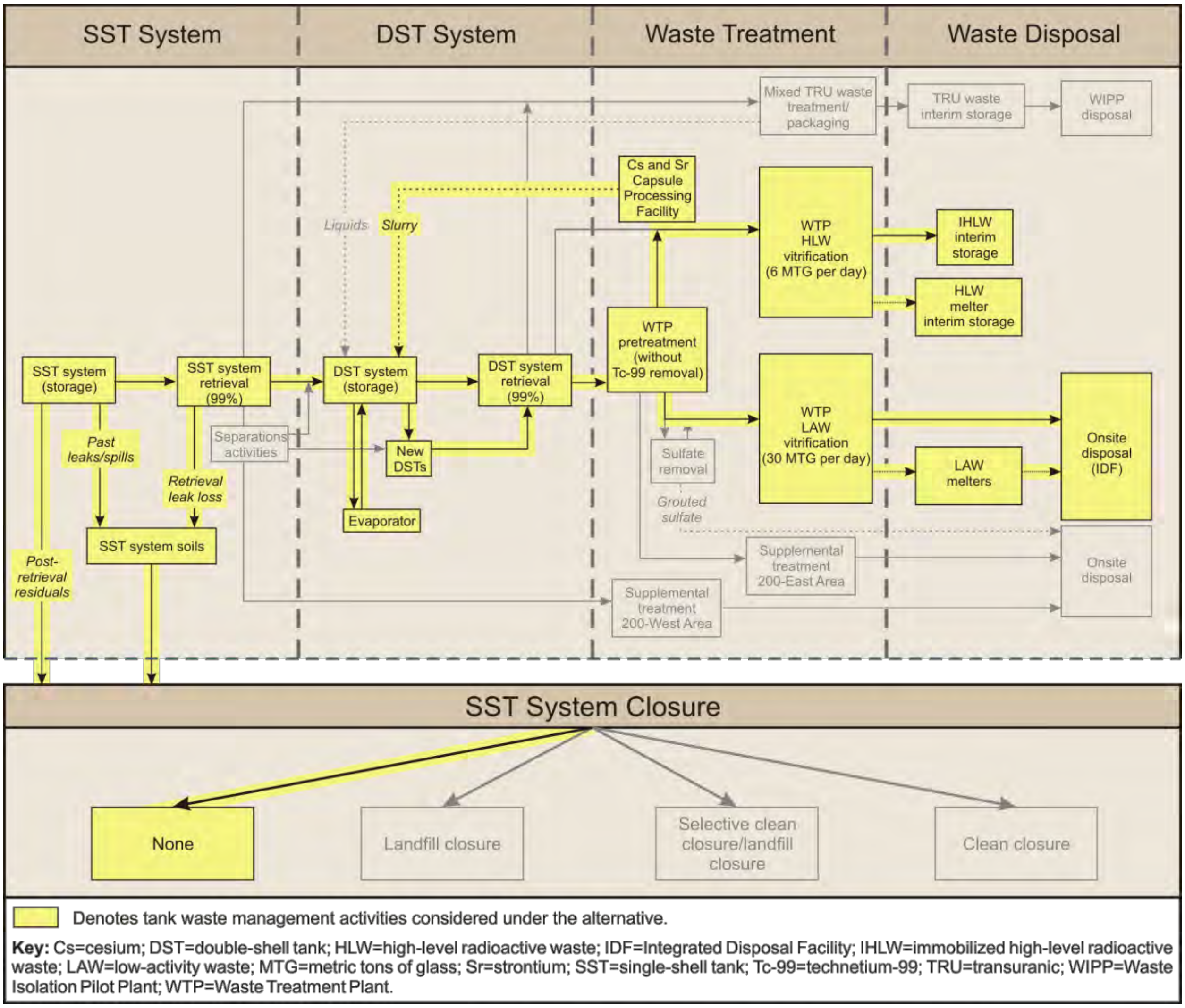


Figure 2–32. Tank Closure Alternative 2A Primary Components

Storage. DOE would continue current waste management operations using existing tank storage facilities. Because retrieval operations would be spread over an 80-year period, no WRFs would be required. However, all of the DSTs will exceed their 40-year design life by 2028, and all would be replaced in a phased manner through 2054.

Retrieval. Waste would be retrieved to the TPA Milestone M-45-00 minimum goal (Ecology, EPA, and DOE 1989), i.e., using currently available liquid-based waste retrieval and leak detection systems, residual waste would not exceed 10.2 cubic meters (360 cubic feet) for the 100-series tanks or 0.85 cubic meters (30 cubic feet) for the 200-series tanks, corresponding to 99 percent retrieval. Waste from 129 tanks (28 existing DSTs, 28 replacement DSTs, and 73 nonleaking 100-series SSTs) would be retrieved using the modified sluicing technology; waste from approximately 60 SSTs (100-series SSTs that are known or suspected leakers) would be retrieved using the MRS technology; and waste from 77 tanks (61 MUSTs and 16 SSTs [200-series], 7 of which are known or suspected leakers) would be retrieved using the VBR technology.

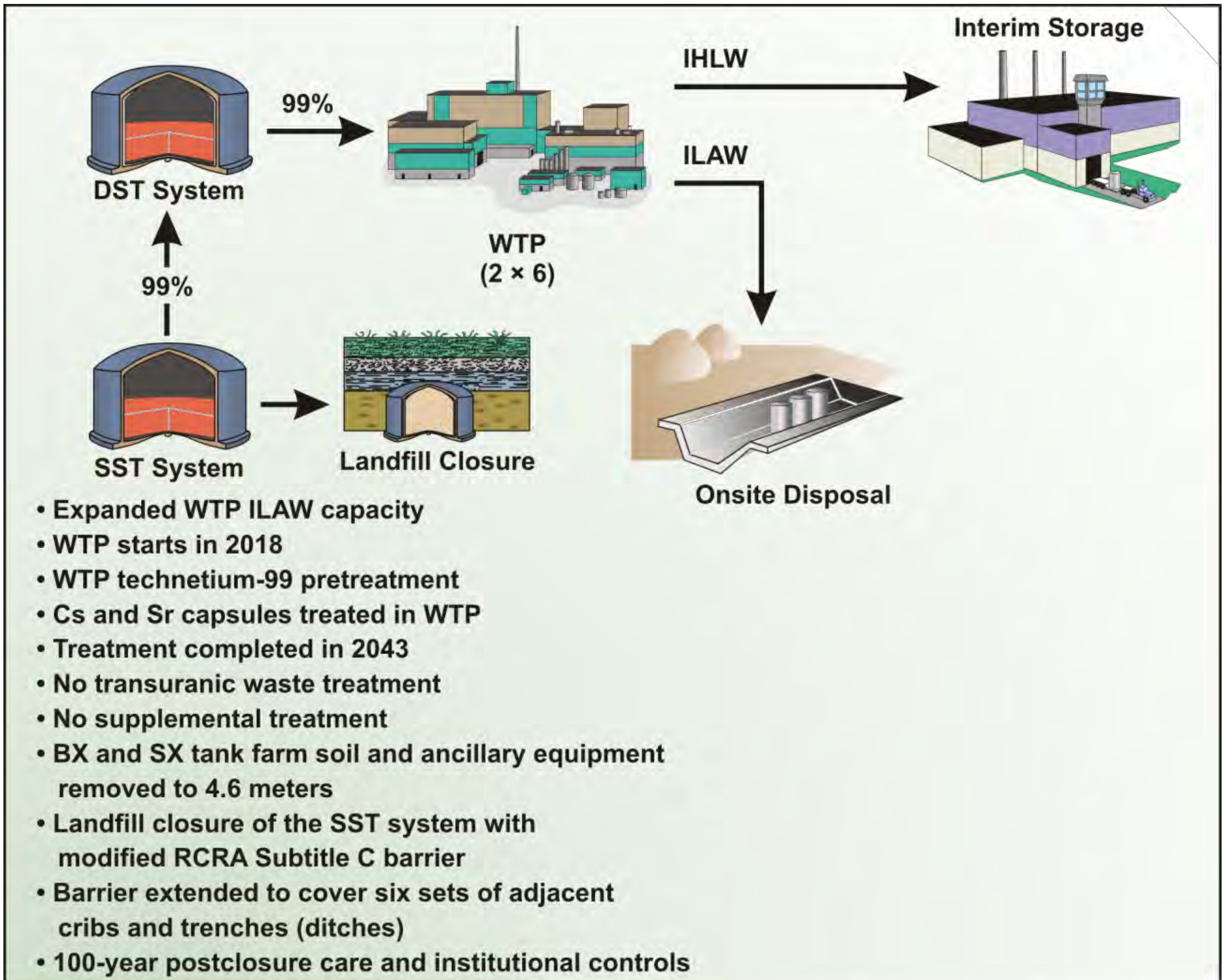
Treatment. The existing WTP configuration (two HLW melters and two LAW melters) would be used, representing a vitrification TMC of 6 metric tons of glass IHLW per day and 30 metric tons of glass ILAW per day. All waste streams routed to the WTP would be pretreated, although technetium-99 removal would not occur as part of WTP pretreatment. The cesium and strontium capsules would be retrieved from the WESF and de-encapsulated in a new Cesium and Strontium Capsule Processing Facility located adjacent to the WTP; their contents would be treated in the WTP. Under Alternative 2A, the WTP would produce a total of 38,400 metric tons of glass IHLW (approximately 12,000 canisters, as well as 340 canisters from treatment of cesium and strontium capsules) and 553,510 metric tons of glass ILAW (approximately 92,250 containers). Due to the extended timeframe associated with this alternative, WTP pretreatment and vitrification facilities and the underground transfer lines that support staging of waste feed to the WTP would need to be replaced after they exceed their assumed maximum design lives (60 and 40 years, respectively). The ETF would be replaced twice, and the 242-A Evaporator would be replaced once.

Disposal. IHLW glass would be stored in the completed CSB, as well as in up to four new IHLW Interim Storage Modules until disposition decisions are made and implemented. ILAW glass would be disposed of on site in an IDF.

Closure. No tank farm system closure would occur under Tank Closure Alternative 2A. The tank farms and associated facilities would be maintained for 100 years (through 2193) following completion of waste treatment operations. DOE would maintain security and management of all tank system TSD facilities during this 100-year administrative and institutional control period, including surveillance, leak detection, and routine monitoring of residual waste in the SSTs, DSTs, and MUSTs. Tanks and associated facilities showing signs of deterioration threatening the integrity of the tanks would be filled with grout or gravel as a corrective action or emergency response. Any such actions would be designed to avoid precluding potential implementation of future closure actions. After 2193, administrative and institutional controls would end.

2.5.2.2.2 Tank Closure Alternative 2B: Expanded WTP Vitrification; Landfill Closure

As shown in Figure 2–33, under this subalternative, DOE would retrieve and treat 99 percent of the waste volume from the Hanford 200-East and 200-West Area tank farms using expanded WTP vitrification capabilities. As under the previous subalternative, no supplemental technologies would be employed under Tank Closure Alternative 2B to treat LAW, and the tank waste would be segregated into one of two waste streams during WTP pretreatment: (1) an HLW stream that would be vitrified to form IHLW glass or (2) a LAW stream that would be vitrified to form ILAW glass. However, under Tank Closure Alternative 2B, technetium-99 would be removed from the LAW stream during WTP pretreatment and incorporated into the HLW stream for immobilization and offsite disposal.



Note: To convert meters to feet, multiply by 3.281.

Key: Cs=cesium; DST=double-shell-tank; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; RCRA=Resource Conservation and Recovery Act; Sr=strontium; SST=single-shell tank; WTP=Waste Treatment Plant.

Figure 2–33. Tank Closure Alternative 2B Overview

Following WTP construction and a 2018 start, WTP vitrification operations under Tank Closure Alternative 2B would extend through 2043. No separate mixed TRU waste treatment capability would be provided under this alternative. Landfill closure of the SST system was evaluated under Tank Closure Alternative 2B, including completion of a modified RCRA Subtitle C barrier over the tank system by 2045, followed by a postclosure care period of 100 years through 2145. The proposed schedule for implementing Tank Closure Alternative 2B is presented in Figure 2–34.

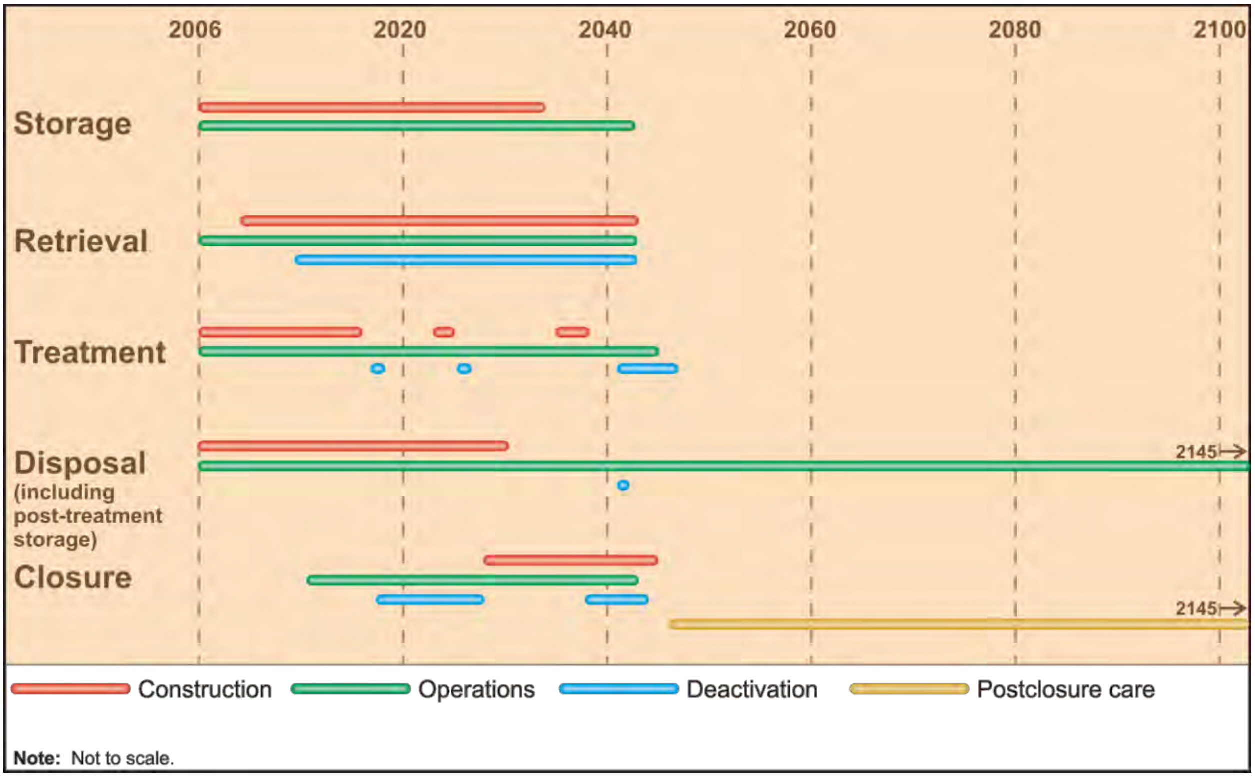


Figure 2–34. Tank Closure Alternative 2B Proposed Schedule

The following storage, retrieval, treatment, disposal, and closure actions, as depicted in Figure 2–35, would occur under Tank Closure Alternative 2B.

Storage. DOE would continue current waste management operations using existing tank storage facilities. No new DSTs would be required, but four WRFs would be constructed. Each WRF would contain three 568,000-liter (150,000-gallon) tanks.

Retrieval. Waste would be retrieved to the TPA Milestone M-45-00 minimum goal (Ecology, EPA, and DOE 1989), i.e., residual waste would not exceed 10.2 cubic meters (360 cubic feet) for 100-series tanks or 0.85 cubic meters (30 cubic feet) for 200-series tanks, which would correspond to 99 percent retrieval using currently available liquid-based waste retrieval and leak detection systems (DOE 2003b). Under Tank Closure Alternative 2B, waste from 101 tanks (28 DSTs and 73 nonleaking 100-series SSTs) would be retrieved using the modified sluicing technology; waste from approximately 60 SSTs (100-series SSTs that are known or suspected leakers) would be retrieved using the MRS technology; and waste from 89 tanks (61 MUSTs, 16 SSTs [200-series], and 12 WRF tanks) would be retrieved using the VBR technology.

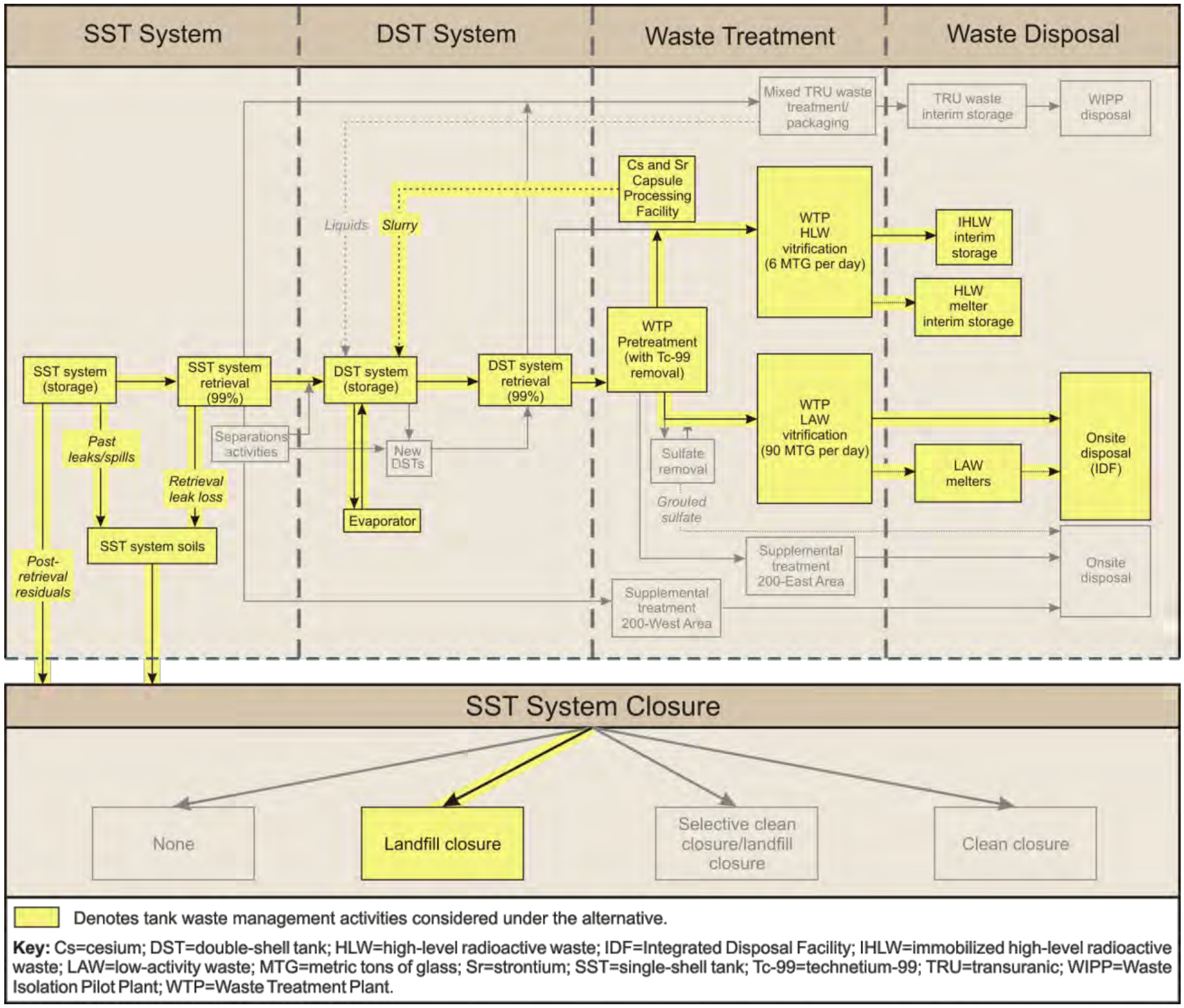


Figure 2–35. Tank Closure Alternative 2B Primary Components

Treatment. LAW vitrification capacity would be expanded by the addition of four more LAW melters to the existing WTP configuration of two HLW melters and two LAW melters. This new WTP configuration would provide a vitrification TMC of 6 metric tons of glass IHLW per day and an expanded vitrification TMC of 90 metric tons of glass ILAW per day. All of the waste streams routed to the WTP would be pretreated, including the stream in which technetium-99 removal from the LAW stream would occur. The cesium and strontium capsules would be retrieved from the WESF and de-encapsulated in a new Cesium and Strontium Capsule Processing Facility located adjacent to the WTP; their contents would be treated in the WTP. Under Alternative 2B, the WTP would produce a total of 38,400 metric tons of glass IHLW (approximately 12,000 canisters, as well as 340 canisters from treatment of cesium and strontium capsules) and 553,510 metric tons of glass ILAW (approximately 92,250 containers). Both the ETF and the 242-A Evaporator would be replaced once under this subalternative.

Disposal. IHLW glass would be stored in the completed CSB and in up to four new IHLW Interim Storage Modules until disposition decisions are made and implemented. This EIS assumes ILAW glass would be disposed of on site in an IDF.

Closure. As operations are completed, the SST waste system at Hanford would be closed as an RCRA hazardous waste landfill unit under *Washington Administrative Code* (WAC) 173-303 and DOE Order 435.1, as applicable, or decommissioned under DOE Order 430.1B.[10] The tanks and ancillary equipment would be filled with grout to immobilize residual waste, prevent long-term degradation of the tanks, and discourage intruder access. Contaminated soil would be removed down to 4.6 meters (15 feet) at the BX and SX tank farms and replaced with clean soil from onsite sources. The 4.6-meter (15-foot) depth would allow removal of some of the ancillary equipment prior to closure. Contaminated soil and ancillary equipment would be disposed of on site in the proposed RPPDF, a new disposal facility similar to an IDF. The closed tank system and six sets of adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier, followed by postclosure care for 100 years. SST system ancillary equipment outside the boundary of the modified RCRA Subtitle C barrier would be remediated or removed to meet landfill closure requirements.

2.5.2.3 Tank Closure Alternative 3: Existing WTP Vitrification with Supplemental Treatment Technology; Landfill Closure

Under Tank Closure Alternative 3, removal of 99 percent of the waste volume from the Hanford 200-East and 200-West Area tank farms would occur. Three subalternatives were separately evaluated. Under Tank Closure Alternative 3A, the waste would be treated using the existing WTP configuration supplemented with thermal treatment capacity (bulk vitrification) and separate treatment of the tank mixed TRU waste. Under Tank Closure Alternative 3B, the waste would be treated using the existing WTP configuration supplemented with nonthermal treatment capacity (cast stone) and separate treatment of the tank mixed TRU waste. Technetium-99 would be removed from the LAW stream during pretreatment and incorporated into the HLW stream for immobilization and offsite disposal. Under Tank Closure Alternative 3C, the waste would be treated using the existing WTP configuration supplemented with thermal treatment capacity (steam reforming) and separate treatment of the tank mixed TRU waste. Cesium and strontium capsules would be treated under all three subalternatives.

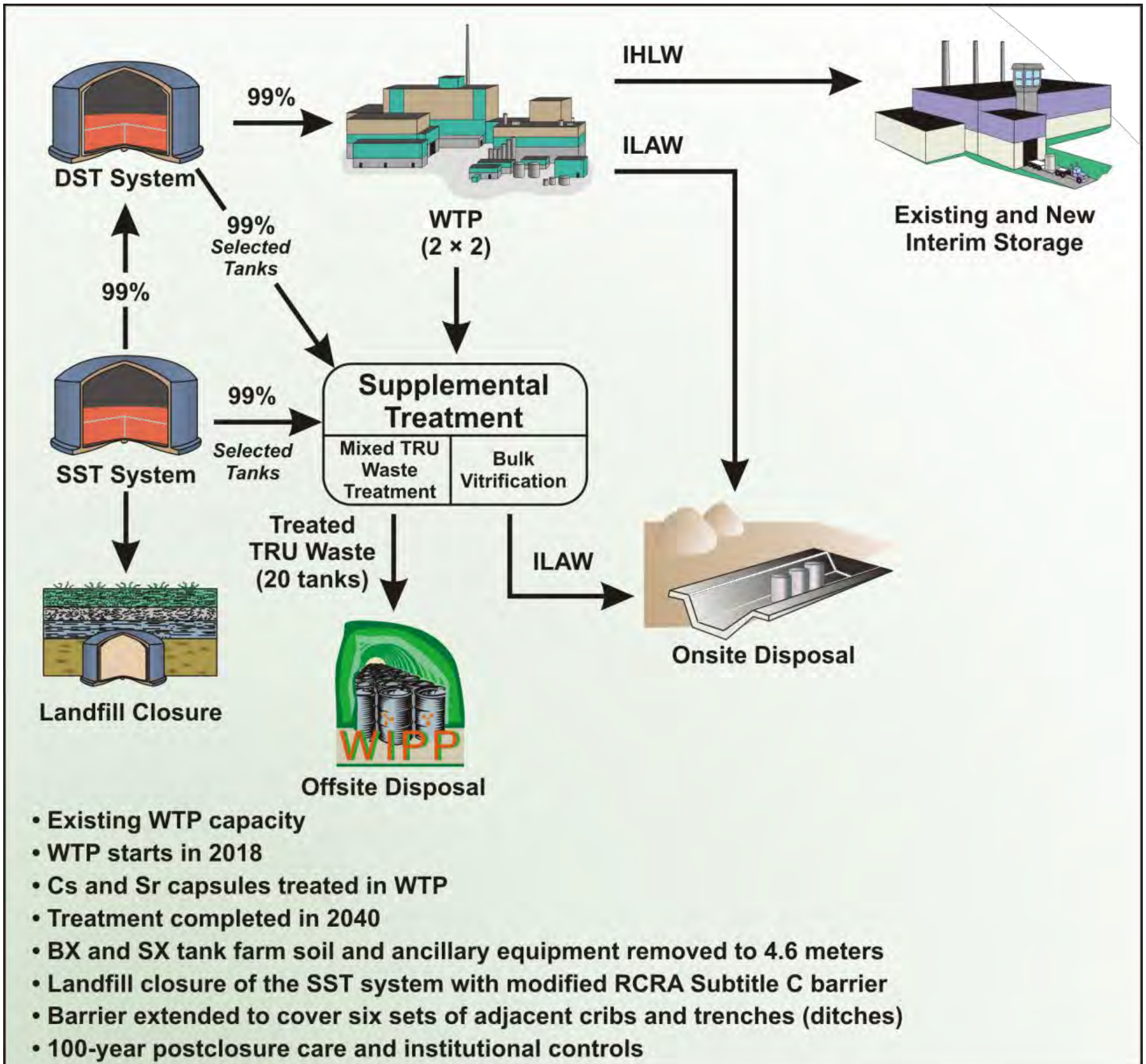
2.5.2.3.1 Tank Closure Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure

As shown in Figure 2–36, this subalternative evaluates retrieval and treatment of 99 percent of the waste volume from the Hanford 200-East and 200-West Area tank farms using a combination of WTP vitrification and supplemental technologies. A portion of the overall tank waste volume would be segregated into one of two waste streams during WTP pretreatment: (1) an HLW stream that would be vitrified to form IHLW glass or (2) a LAW stream that would be vitrified to form ILAW glass. Under Tank Closure Alternative 3A, technetium-99 removal would not occur as part of WTP pretreatment. The portion of the tank waste not vitrified in the WTP would be treated using the following supplemental technologies:

- Mixed TRU waste supplemental treatment
- Thermal supplemental treatment (bulk vitrification)

Mixed TRU waste supplemental treatment would be used to separately treat a select number of tanks believed to currently contain only mixed TRU waste by 2019. Bulk vitrification is the thermal supplemental treatment technology analyzed under this subalternative. The balance of the tank waste (i.e., the portion that would not be vitrified in the WTP or treated as mixed TRU waste) would be directed to the 200-East and 200-West Area Bulk Vitrification Facilities through 2039.

[10] DOE must submit a closure plan to Ecology for approval prior to undertaking any closure activities. The approved closure plan will become a condition of the Hanford RCRA permit. The Ecology permitting process includes opportunity for further public review and comment.



Note: To convert meters to feet, multiply by 3.281.

Key: Cs=cesium; DST=double-shell-tank; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; RCRA=Resource Conservation and Recovery Act; Sr=strontium; SST=single-shell tank; TRU=transuranic; WIPP=Waste Isolation Pilot Plant; WTP=Waste Treatment Plant.

Figure 2–36. Tank Closure Alternative 3A Overview

Following construction and a 2018 start, WTP operations under Tank Closure Alternative 3A would extend through 2040. Landfill closure of the SST system was evaluated under Tank Closure Alternative 3A, including completion of a modified RCRA Subtitle C barrier over the tank system by 2041, followed by postclosure care for 100 years (through 2141). The proposed schedule for implementing Tank Closure Alternative 3A is presented in Figure 2–37.

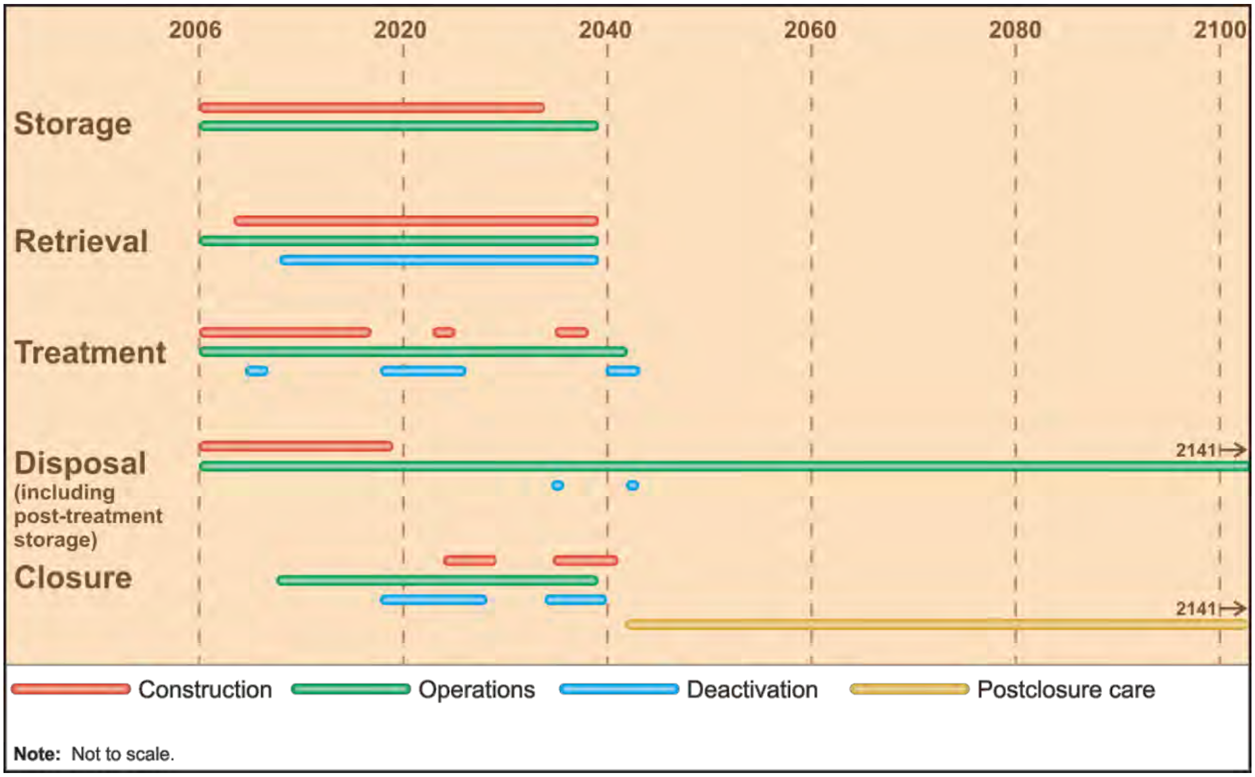


Figure 2–37. Tank Closure Alternative 3A Proposed Schedule

The following storage, retrieval, treatment, disposal, and closure actions, as depicted in Figure 2–38, would occur under Tank Closure Alternative 3A.

Storage. DOE would continue current waste management operations using existing tank storage facilities. No new DSTs would be required, but four new WRFs would be constructed. Each WRF would contain three 568,000-liter (150,000-gallon) tanks. Treated mixed TRU waste would be stored in a separate new TRU Waste Interim Storage Facility.

Retrieval. Waste would be retrieved to the TPA Milestone M-45-00 minimum goal (Ecology, EPA, and DOE 1989), i.e., residual waste would not exceed 10.2 cubic meters (360 cubic feet) for 100-series tanks or 0.85 cubic meters (30 cubic feet) for 200-series tanks, which would correspond to 99 percent retrieval using currently available liquid-based waste retrieval and leak detection systems. Under Tank Closure Alternative 3A, waste from approximately 101 tanks (28 DSTs and 73 nonleaking 100-series SSTs) would be retrieved using the modified sluicing technology; waste from approximately 60 tanks (100-series SSTs that are known or suspected leakers) would be retrieved using the MRS technology; and waste from 89 tanks (61 MUSTs, 16 SSTs [200-series], and 12 WRF tanks) would be retrieved using the VBR technology.

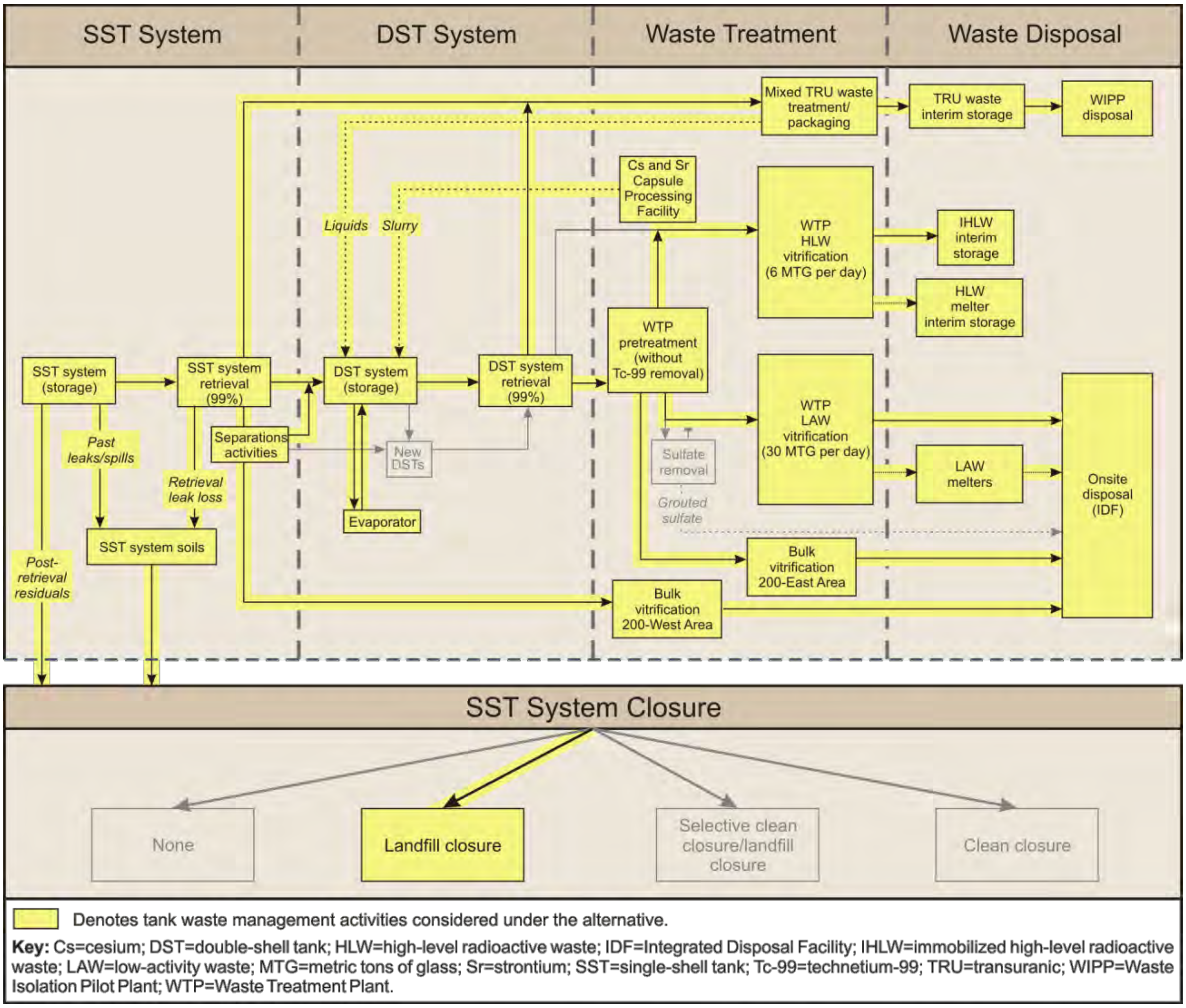


Figure 2–38. Tank Closure Alternative 3A Primary Components

Treatment. The existing WTP configuration (two HLW melters and two LAW melters) would be used, representing a vitrification TMC of 6 metric tons of glass IHLW per day and 30 metric tons of glass ILAW per day. All of the waste streams routed to the WTP would be pretreated, although technetium-99 removal would not occur as part of WTP pretreatment. Under Tank Closure Alternative 3A, the WTP would produce a total of 27,840 metric tons of glass IHLW (approximately 8,700 canisters, as well as 340 canisters from treatment of cesium and strontium capsules) and 171,040 metric tons of glass ILAW (approximately 28,510 containers). The cesium and strontium capsules would be retrieved from the WESF and de-encapsulated in a new Cesium and Strontium Capsule Processing Facility located adjacent to the WTP; their contents would be treated in the WTP. Both the ETF and 242-A Evaporator would be replaced once under this subalternative.

WTP capacity under Tank Closure Alternative 3A would be supplemented by construction and operation of a thermal supplemental treatment facility to immobilize a portion of the LAW. This supplemental treatment of the LAW would occur in both the 200-East and 200-West Areas and would produce 256,840 metric tons of glass bulk vitrification waste (approximately 6,030 containers). In the 200-East Area, the waste feed would be pretreated, excluding technetium-99 removal, in the WTP. In the 200-West Area, the waste feed would be pretreated in a new Solid-Liquid Separations Facility. In addition, a separate portion of the tank waste (approximately 11.8 million liters [3.1 million gallons]) would be designated as mixed TRU waste. This mixed TRU waste would be treated and packaged using mobile CH-Mixed TRU Waste Facilities located in both the 200-East and 200-West Areas and a single, fixed RH-Mixed TRU Waste Facility in the 200-East Area.

Disposal. IHLW glass would be stored in the completed CSB and in up to four new IHLW Interim Storage Modules until disposition decisions are made and implemented. LAW immobilized at the WTP would be disposed of on site in an IDF, as would LAW immobilized external to the WTP through the bulk vitrification process. Mixed TRU waste would be packaged and stored on site in a new TRU Waste Interim Storage Facility pending disposal at WIPP.

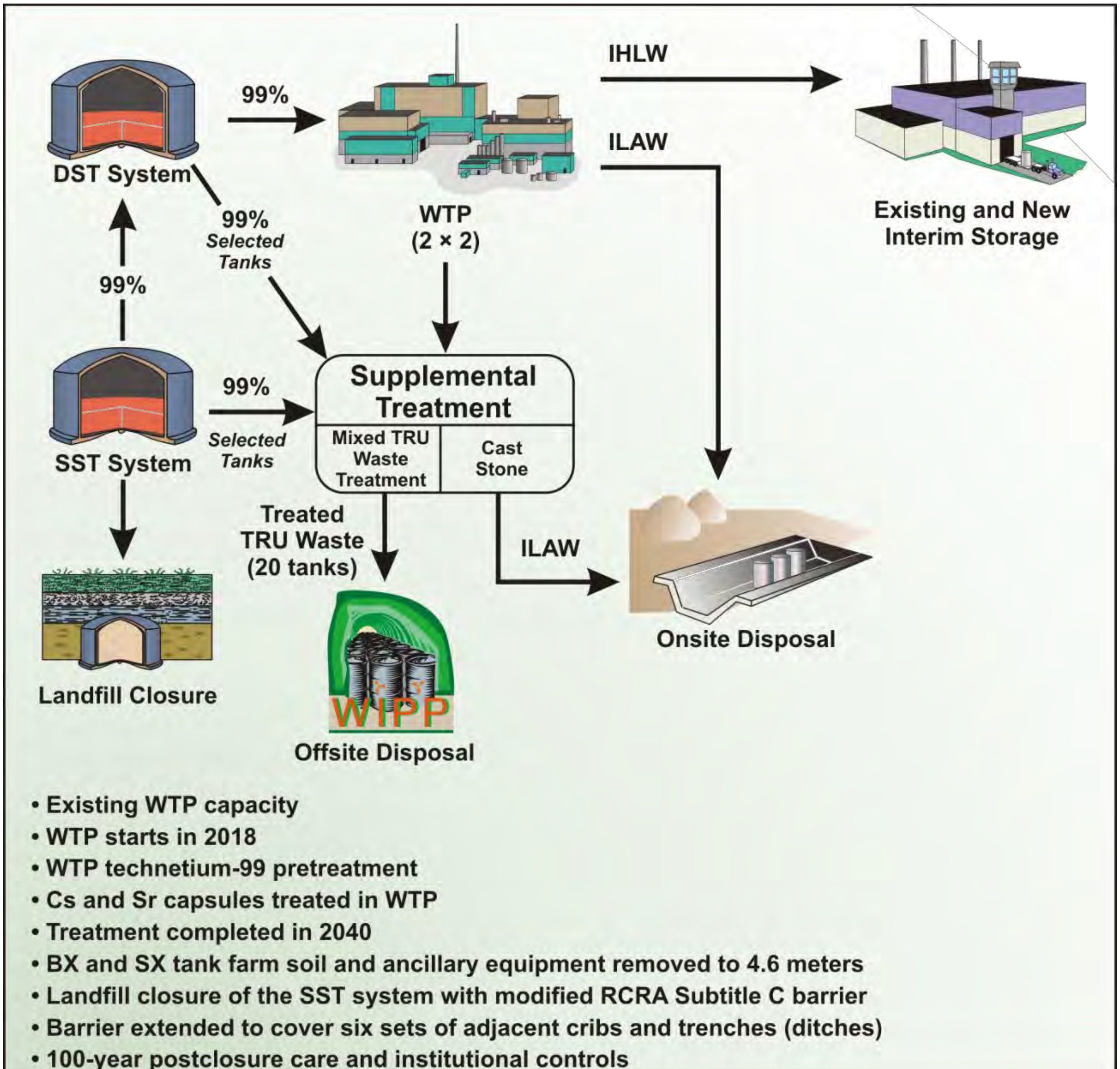
Closure. As operations are completed, the SST system at Hanford would be either closed as an RCRA hazardous waste landfill unit under WAC 173-303 and DOE Order 435.1, as applicable, or decommissioned under DOE Order 430.1B. The tanks and ancillary equipment would be filled with grout to immobilize the residual waste, prevent long-term degradation of the tanks, and discourage intruder access. Contaminated soil at the BX and SX tank farms would be removed down to 4.6 meters (15 feet) and replaced with clean soil from onsite sources. The 4.6-meter (15-foot) depth would allow for removal of all ancillary equipment prior to closure of the BX and SX tank farms. Contaminated soil and ancillary equipment would be disposed of on site in the proposed RPPDF, a new disposal facility similar to an IDF. The closed tank system and six sets of adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier, followed by postclosure care for 100 years. SST system ancillary equipment located outside the boundary of the modified RCRA Subtitle C barrier would be remediated or removed to meet landfill closure requirements.

2.5.2.3.2 Tank Closure Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure

As shown in Figure 2–39, this subalternative evaluates retrieval and treatment of 99 percent of the waste volume from the Hanford 200-East and 200-West Area tank farms using a combination of WTP vitrification and supplemental technologies. A portion of the overall tank waste volume would be segregated into one of two waste streams during WTP pretreatment: (1) an HLW stream that would be vitrified to form IHLW glass or (2) a LAW stream that would be vitrified to form ILAW glass. Under Tank Closure Alternative 3B, technetium-99 would be removed from the LAW stream during WTP pretreatment, and the portion of the tank waste not vitrified using the WTP would be treated using the following supplemental technologies:

- Mixed TRU waste supplemental treatment
- Nonthermal supplemental treatment (cast stone)

Mixed TRU waste supplemental treatment would be used to separately treat a select number of tanks that are currently believed to contain only mixed TRU waste by 2019. Cast stone is the nonthermal supplemental treatment technology analyzed under this subalternative. The balance of the tank waste (amounts not vitrified in the WTP or treated as mixed TRU waste) would be directed to the 200-East and 200-West Area Cast Stone Facilities for treatment through 2039.



Note: To convert meters to feet, multiply by 3.281.

Key: Cs=cesium; DST=double-shell-tank; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; RCRA=Resource Conservation and Recovery Act; Sr=strontium; SST=single-shell tank; TRU=transuranic; WIPP=Waste Isolation Pilot Plant; WTP=Waste Treatment Plant.

Figure 2–39. Tank Closure Alternative 3B Overview

Following construction and a 2018 start, WTP operations under Tank Closure Alternative 3B would extend through 2040. Landfill closure of the SST system was evaluated under this alternative, including completion of a modified RCRA Subtitle C barrier over the tank system by 2041, followed by postclosure care for 100 years (through 2141). The proposed schedule for implementing Tank Closure Alternative 3B is presented in Figure 2–40.

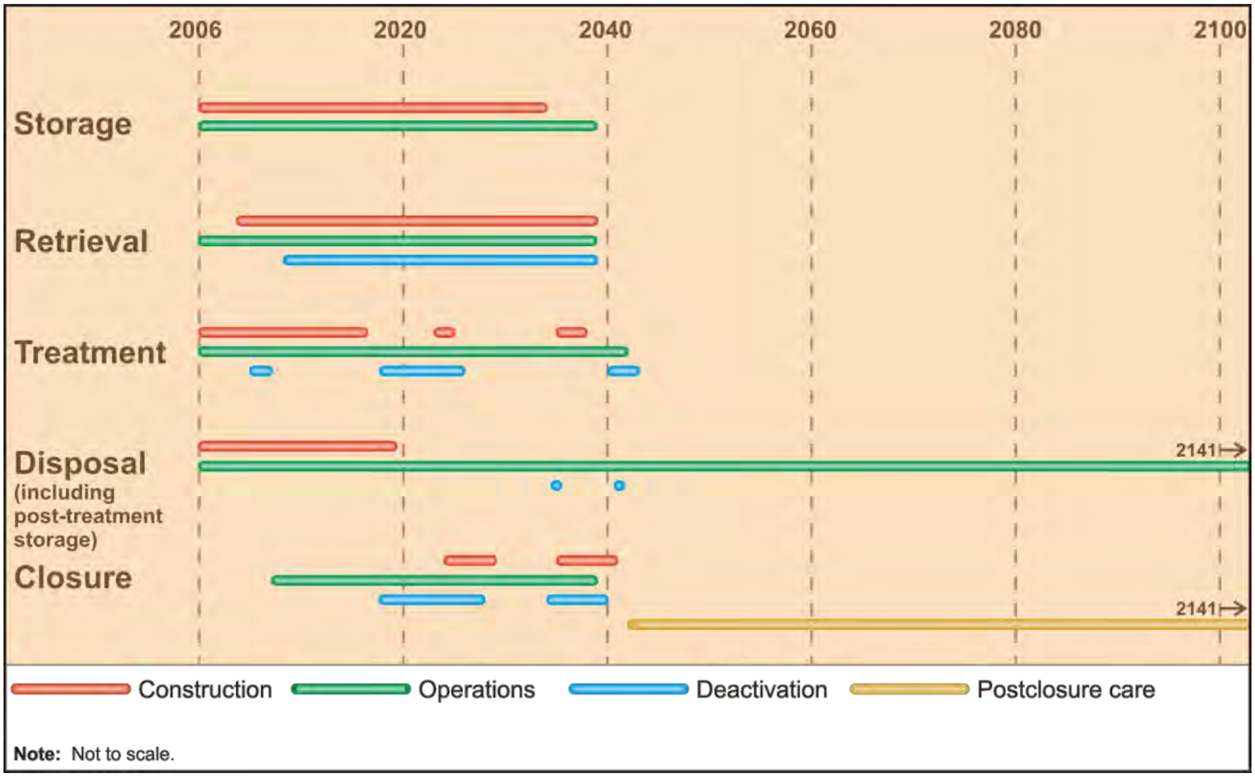


Figure 2–40. Tank Closure Alternative 3B Proposed Schedule

The following storage, retrieval, treatment, disposal, and closure actions, as depicted in Figure 2–41, would occur under Tank Closure Alternative 3B.

Storage. DOE would continue current waste management operations using existing tank storage facilities. No new DSTs would be required, but four WRFs would be constructed. Each WRF would contain three 568,000-liter (150,000-gallon) tanks.

Retrieval. Waste would be retrieved to the TPA Milestone M-45-00 minimum goal (Ecology, EPA, and DOE 1989), i.e., residual waste would not exceed 10.2 cubic meters (360 cubic feet) for 100-series tanks or 0.85 cubic meters (30 cubic feet) for 200-series tanks, which would correspond to 99 percent retrieval using currently available liquid-based waste retrieval and leak detection systems. Under Tank Closure Alternative 3B, waste from approximately 101 tanks (28 DSTs and 73 nonleaking 100-series SSTs) would be retrieved using the modified sluicing technology; waste from approximately 60 tanks (100-series SSTs that are known or suspected leakers) would be retrieved using the MRS technology; and waste from 89 tanks (61 MUSTs, 16 SSTs [200-series], and 12 WRF tanks) would be retrieved using the VBR technology.

Treatment. The existing WTP configuration (two HLW melters and two LAW melters) would be used, representing a vitrification TMC of 6 metric tons of glass IHLW per day and 30 metric tons of glass ILAW per day. All of the waste streams routed to the WTP would be pretreated, and technetium-99 would be removed from the LAW stream. Under Tank Closure Alternative 3B, the WTP would produce a total of 27,840 metric tons of glass IHLW (approximately 8,700 canisters, as well as 340 canisters from treatment of cesium and strontium capsules) and 171,040 metric tons of glass ILAW (approximately 28,510 containers). The cesium and strontium capsules would be retrieved from the WESF and de-encapsulated in a new Cesium and Strontium Capsule Processing Facility located adjacent to the WTP; their contents would be treated in the WTP. Both the ETF and 242-A Evaporator would be replaced once under this subalternative.

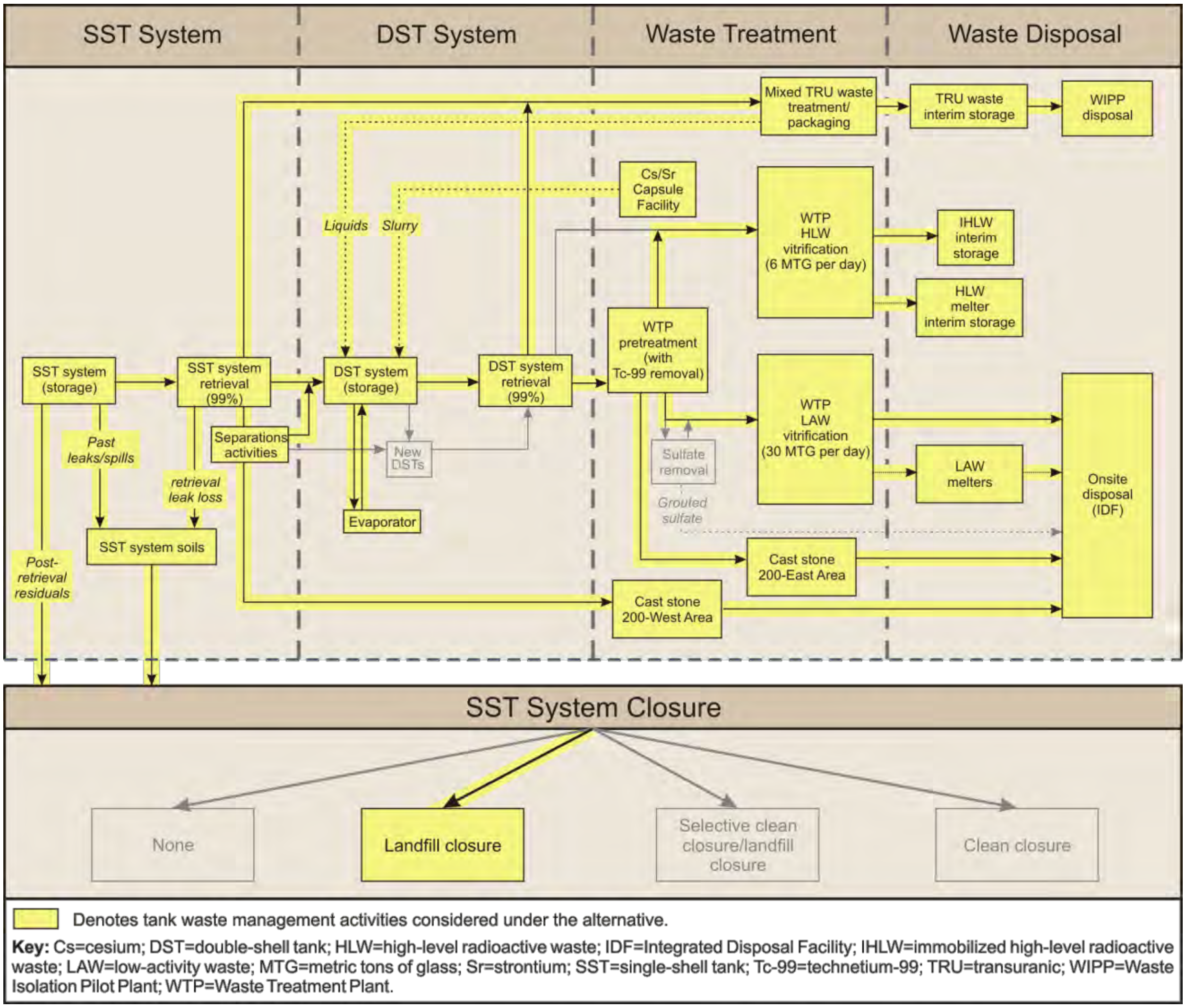


Figure 2–41. Tank Closure Alternative 3B Primary Components

WTP capacity under Tank Closure Alternative 3B would be supplemented by construction and operation of a new Cast Stone Facility in both the 200-East and 200-West Areas to immobilize a portion of the LAW. This supplemental treatment for the LAW would produce 465,560 metric tons of cast stone waste (approximately 23,270 containers). In the 200-East Area, the waste feed would be pretreated, including technetium-99 removal, in the WTP. In the 200-West Area, the waste feed would be pretreated in a new Solid-Liquid Separations Facility. In addition, a separate portion of the tank waste (approximately 11.8 million liters [3.1 million gallons]) would be designated as mixed TRU waste. This mixed TRU waste would be treated and packaged using mobile CH-Mixed TRU Waste Facilities located in both the 200-East and 200-West Areas and a single, fixed RH-Mixed TRU Waste Facility in the 200-East Area.

Disposal. IHLW glass would be stored in the completed CSB and in up to four new IHLW Interim Storage Modules until disposition decisions are made and implemented. LAW immobilized via the WTP would be disposed of on site in an IDF, as would LAW immobilized external to the WTP through the cast stone treatment process. Mixed TRU waste would be packaged and stored on site in a new TRU Waste Interim Storage Facility pending disposal at WIPP.

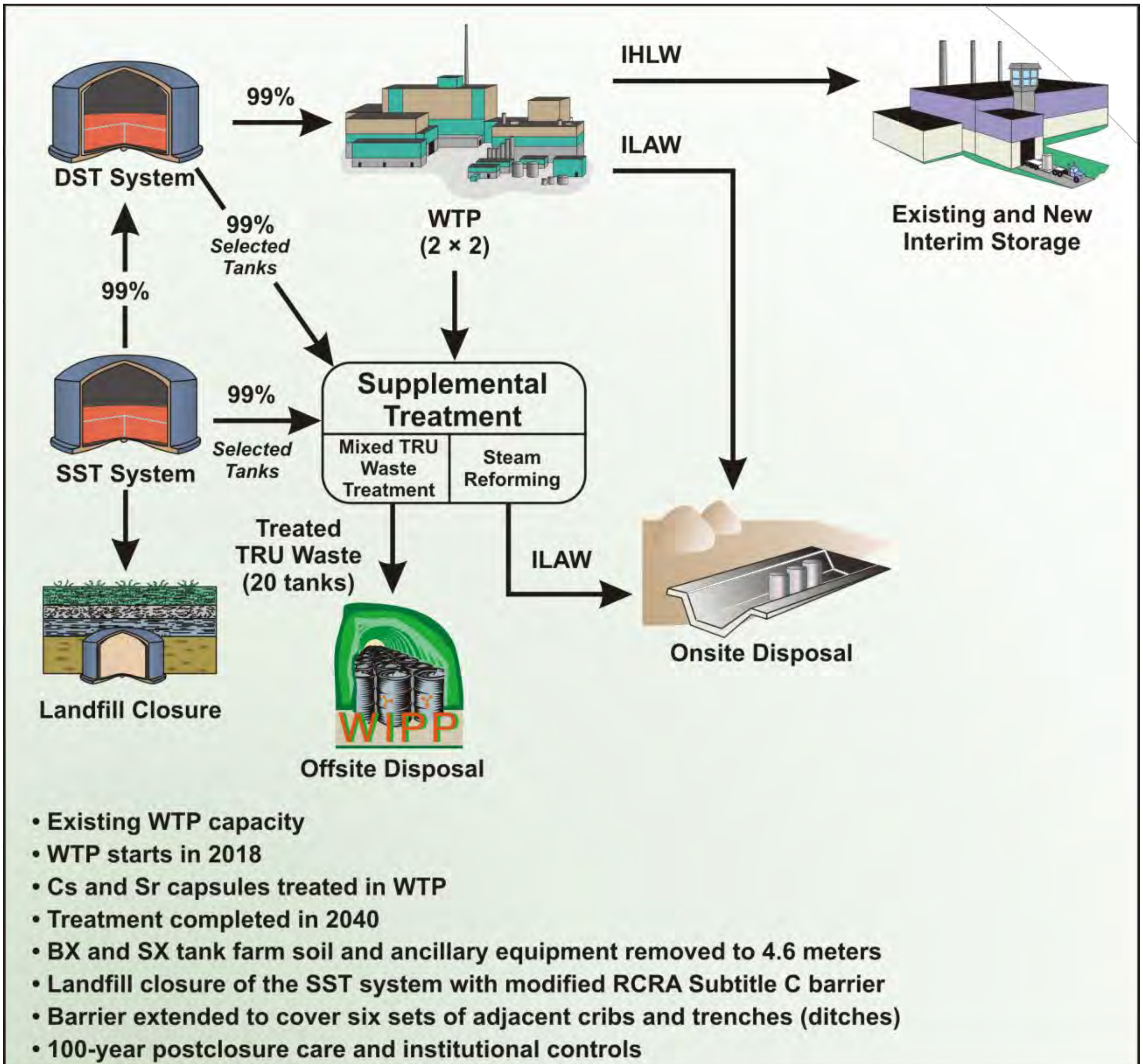
Closure. As operations are completed, the SST system at Hanford would be either closed as an RCRA hazardous waste landfill unit under WAC 173-303 and DOE Order 435.1, as applicable, or decommissioned under DOE Order 430.1B. The tanks would be filled with grout to immobilize the residual waste, prevent long-term degradation of the tanks, and discourage intruder access. Contaminated soil would be removed down to 4.6 meters (15 feet) at the BX and SX tank farms and replaced with clean soil from onsite sources. The 4.6-meter (15-foot) depth would allow the removal of all ancillary equipment prior to closure of the BX and SX tank farms. Contaminated soil and ancillary equipment would be disposed of on site in the proposed RPPDF, a new disposal facility similar to an IDF. The closed tank system and six sets of adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier, followed by postclosure care for 100 years. SST system ancillary equipment located outside the boundary of the modified RCRA Subtitle C barrier would be remediated or removed to meet landfill closure requirements.

2.5.2.3.3 Tank Closure Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

As shown in Figure 2–42, this subalternative evaluates retrieval and treatment of 99 percent of the waste volume from the Hanford 200-East and 200-West Area tank farms using a combination of WTP vitrification and supplemental technologies. A portion of the overall tank waste volume would be segregated into one of two waste streams: (1) an HLW stream that would be pretreated in the WTP and vitrified to form IHLW glass or (2) a LAW stream that would be pretreated in the WTP and vitrified to form ILAW glass. Technetium-99 removal would not occur as part of WTP pretreatment. Under Tank Closure Alternative 3C, the portion of the tank waste not vitrified using the WTP would be treated using the following supplemental technologies:

- Mixed TRU waste supplemental treatment
- Thermal supplemental treatment (steam reforming)

Mixed TRU waste supplemental treatment would be used to separately treat a select number of tanks believed to currently contain only mixed TRU waste by 2019. Steam reforming is the thermal supplemental treatment technology analyzed under this subalternative. The balance of the tank waste (that waste not being vitrified in the WTP or treated as mixed TRU waste) would be directed to the new 200-East and 200-West Area Steam Reforming Facilities through 2039.



Note: To convert meters to feet, multiply by 3.281.

Key: Cs=cesium; DST=double-shell-tank; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; RCRA=Resource Conservation and Recovery Act; Sr=strontium; SST=single-shell tank; TRU=transuranic; WIPP=Waste Isolation Pilot Plant; WTP=Waste Treatment Plant.

Figure 2–42. Tank Closure Alternative 3C Overview

Following construction and a 2018 start, WTP operations under Tank Closure Alternative 3C would extend through 2040. Landfill closure of the SST system was evaluated under this alternative, including completion of a modified RCRA Subtitle C barrier over the tank system by 2041, followed by postclosure care for 100 years (through 2141). The proposed schedule for implementing Tank Closure Alternative 3C is presented in Figure 2–43.

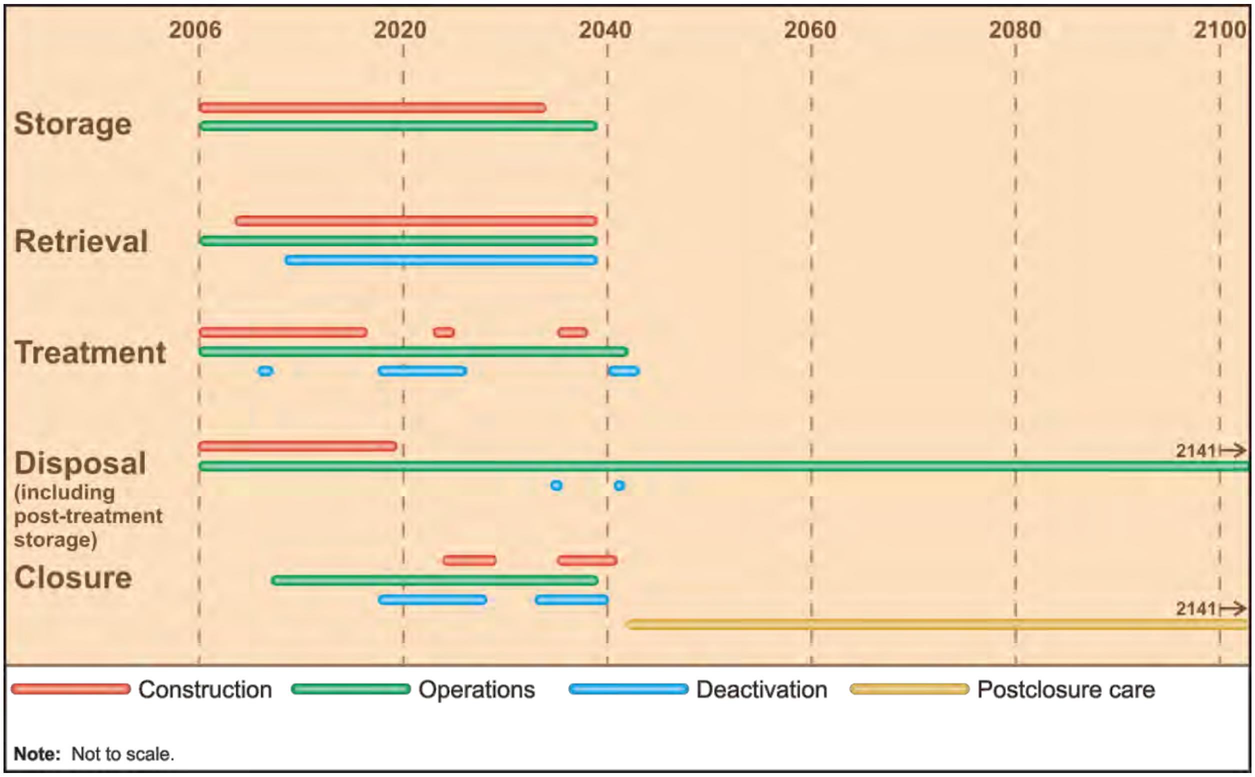


Figure 2–43. Tank Closure Alternative 3C Proposed Schedule

The following storage, retrieval, treatment, disposal, and closure actions, as depicted in Figure 2–44, would occur under Tank Closure Alternative 3C.

Storage. DOE would continue current waste management operations using existing tank storage facilities. No new DSTs would be required, but four new WRFs would be constructed. Each WRF would contain three 568,000-liter (150,000-gallon) tanks.

Retrieval. Waste would be retrieved to the TPA Milestone M-45-00 minimum goal (Ecology, EPA, and DOE 1989), i.e., residual waste would not exceed 10.2 cubic meters (360 cubic feet) for 100-series tanks or 0.85 cubic meters (30 cubic feet) for 200-series tanks, which would correspond to 99 percent retrieval using currently available liquid-based waste retrieval and leak detection systems. Under Alternative 3C, waste from approximately 101 tanks (28 DSTs and 73 nonleaking 100-series SSTs) would be retrieved using the modified sluicing technology; waste from approximately 60 tanks (100-series SSTs that are known or suspected leakers) would be retrieved using the MRS technology; and waste from 89 tanks (61 MUSTs, 16 SSTs [200-series], and 12 WRF tanks) would be retrieved using the VBR technology.

Treatment. The existing WTP configuration (two HLW melters and two LAW melters) would be used, representing a vitrification TMC of 6 metric tons of glass IHLW per day and 30 metric tons of glass ILAW per day. All of the waste streams routed to the WTP would be pretreated, but no technetium-99 removal would occur. Under Tank Closure Alternative 3C, the WTP would produce a total of 27,840 metric tons of glass IHLW (approximately 8,700 canisters, as well as 340 canisters from treatment of cesium and strontium capsules) and 171,040 metric tons of glass ILAW (approximately 28,510 containers). The cesium and strontium capsules would be retrieved from the WESF and de-encapsulated in a new Cesium and Strontium Capsule Processing Facility located adjacent to the WTP; their contents would be treated in the WTP. Both the ETF and 242-A Evaporator would be replaced once under this subalternative.

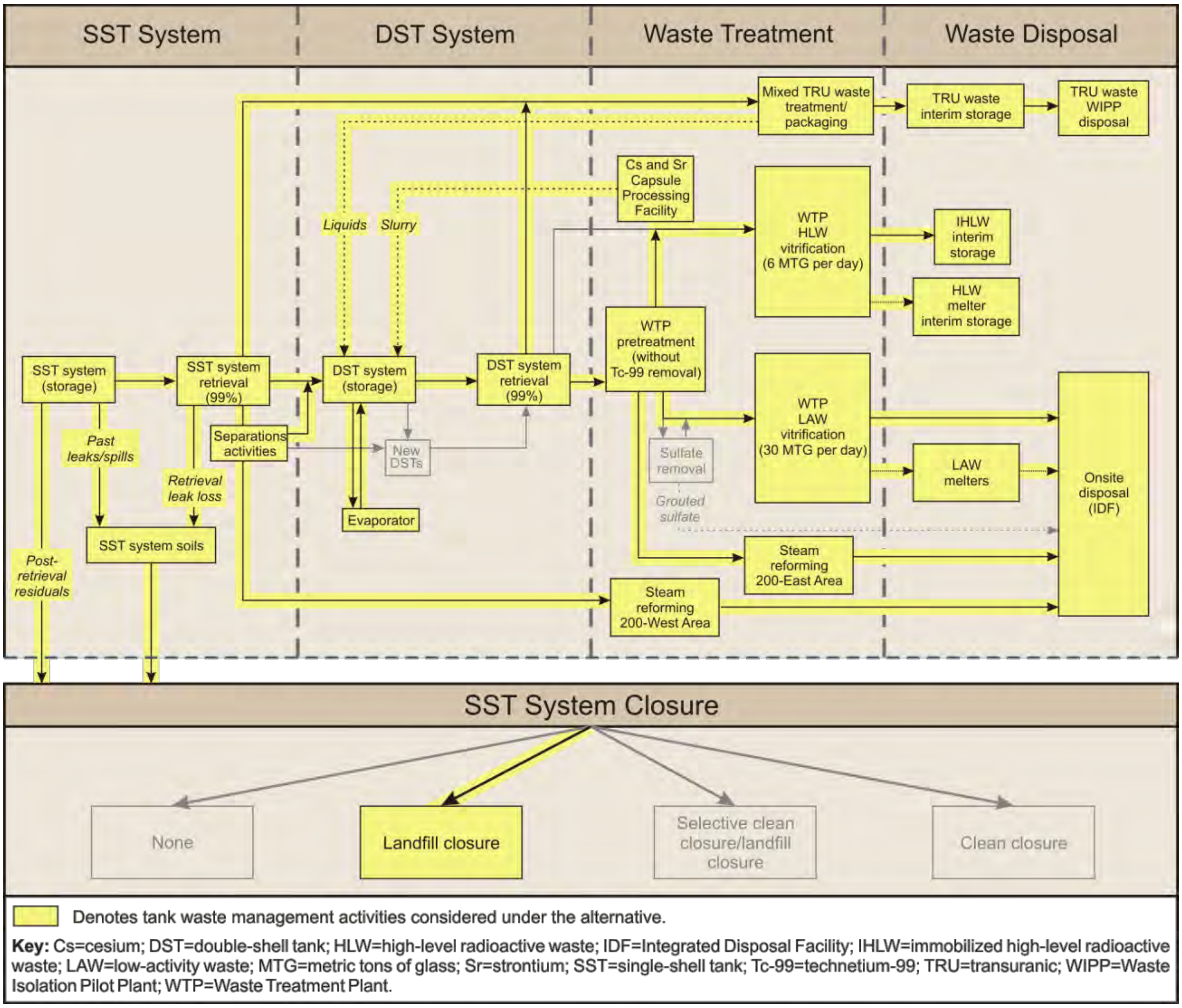


Figure 2–44. Tank Closure Alternative 3C Primary Components

WTP capacity under Tank Closure Alternative 3C would be supplemented by construction and operation of a Steam Reforming Facility in both the 200-East and 200-West Areas to immobilize a portion of the LAW. This supplemental treatment for the LAW would produce 260,920 metric tons of steam reforming waste (approximately 115,960 containers). In the 200-East Area, the waste feed would be pretreated in the WTP without removing technetium-99. In the 200-West Area, the waste feed would be pretreated in a new Solid-Liquid Separations Facility. In addition, a separate portion of the tank waste (approximately 11.8 million liters [3.1 million gallons]) would be designated as mixed TRU waste that would be treated and packaged using mobile CH-Mixed TRU Waste Facilities located in both the 200-East and 200-West Areas and a single, fixed RH-Mixed TRU Waste Facility in the 200-East Area.

Disposal. IHLW glass would be stored in the completed CSB and in up to four new IHLW Interim Storage Modules until disposition decisions are made and implemented. LAW immobilized in the WTP would be disposed of on site in an IDF, as would LAW immobilized external to the WTP using the steam reforming process. Mixed TRU waste would be packaged and stored on site in a new TRU Waste Interim Storage Facility pending disposal at WIPP.

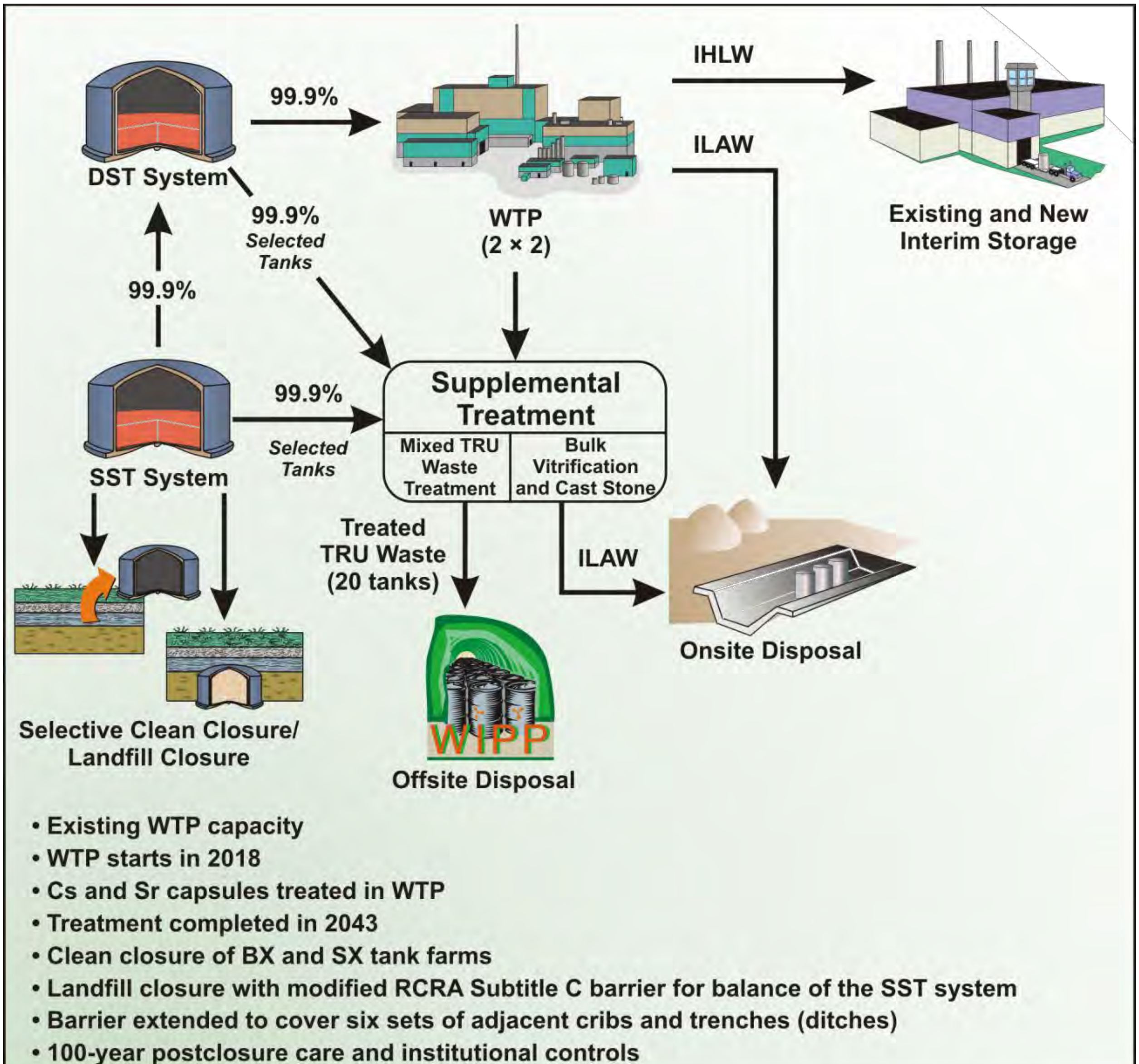
Closure. As operations are completed, the SST system at Hanford would be closed as an RCRA hazardous waste landfill unit under WAC 173-303 and DOE Order 435.1, as applicable, or decommissioned under DOE Order 430.1B. The tanks and ancillary equipment would be filled with grout to immobilize the residual waste, prevent long-term degradation of the tanks, and discourage intruder access. Contaminated soil would be removed down to 4.6 meters (15 feet) for the BX and SX tank farms and replaced with clean soil from onsite sources. The 4.6-meter (15-foot) depth would allow removal of all of the ancillary equipment in the BX and SX tank farms prior to closure. Contaminated soil and ancillary equipment would be disposed of on site in the proposed RPPDF, a new disposal facility similar to an IDF. The closed tank system and six sets of adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier, followed by postclosure care for 100 years. SST system ancillary equipment outside the boundary of the modified RCRA Subtitle C barrier would be remediated or removed to meet landfill closure requirements.

2.5.2.4 Tank Closure Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

As shown in Figure 2–45, under Tank Closure Alternative 4, treatment of 99.9 percent of the waste volume in the Hanford 200-East and 200-West Area tank farms would occur using a combination of WTP vitrification and supplemental treatment technologies. A portion of the overall tank waste volume would be pretreated in the WTP and segregated into two waste streams during WTP pretreatment: (1) an HLW stream that would be vitrified to form IHLW glass and (2) a LAW stream that would be vitrified to form ILAW. Under this alternative, technetium-99 removal would not occur as part of WTP pretreatment; however, the cesium and strontium capsules would be treated. The portion of the tank waste not vitrified using the WTP would be treated using the following supplemental technologies:

- Mixed TRU waste supplemental treatment
- Bulk vitrification supplemental treatment
- Cast stone supplemental treatment

Mixed TRU waste supplemental treatment would be used to separately treat a select number of tanks believed to currently contain only mixed TRU waste by 2019. The balance of the tank waste (that waste not vitrified in the WTP or treated as mixed TRU waste) would be apportioned into two groups. One group would be routed to a Cast Stone Facility in the 200-East Area, and the other would be routed to a Bulk Vitrification Facility in the 200-West Area. The Cast Stone and Bulk Vitrification Facilities would operate through 2039.



Key: Cs=cesium; DST=double-shell-tank; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; RCRA=Resource Conservation and Recovery Act; Sr=strontium; SST=single-shell tank; TRU=transuranic; WIPP=Waste Isolation Pilot Plant; WTP=Waste Treatment Plant.

Figure 2–45. Tank Closure Alternative 4 Overview

Following completion of construction and a 2018 start, WTP operations under Tank Closure Alternative 4 are projected to be complete in 2043. This alternative evaluates the clean closure of two tank farms (BX and SX) and the landfill closure of the remaining 10 SST farms. Clean closure of the BX and SX tank farms would encompass tank, ancillary equipment, and contaminated soil removal and backfilling with clean fill. Landfill closure of the remaining tank farms and six adjacent cribs and trenches (ditches) would include the construction of a closure barrier (modified RCRA Subtitle C barrier) over these areas. The clean closure of the BX and SX tank farms and construction of the closure barrier would be completed in 2044, followed by postclosure care for 100 years, through 2144. The proposed schedule for implementing Alternative 4 is presented in Figure 2–46.

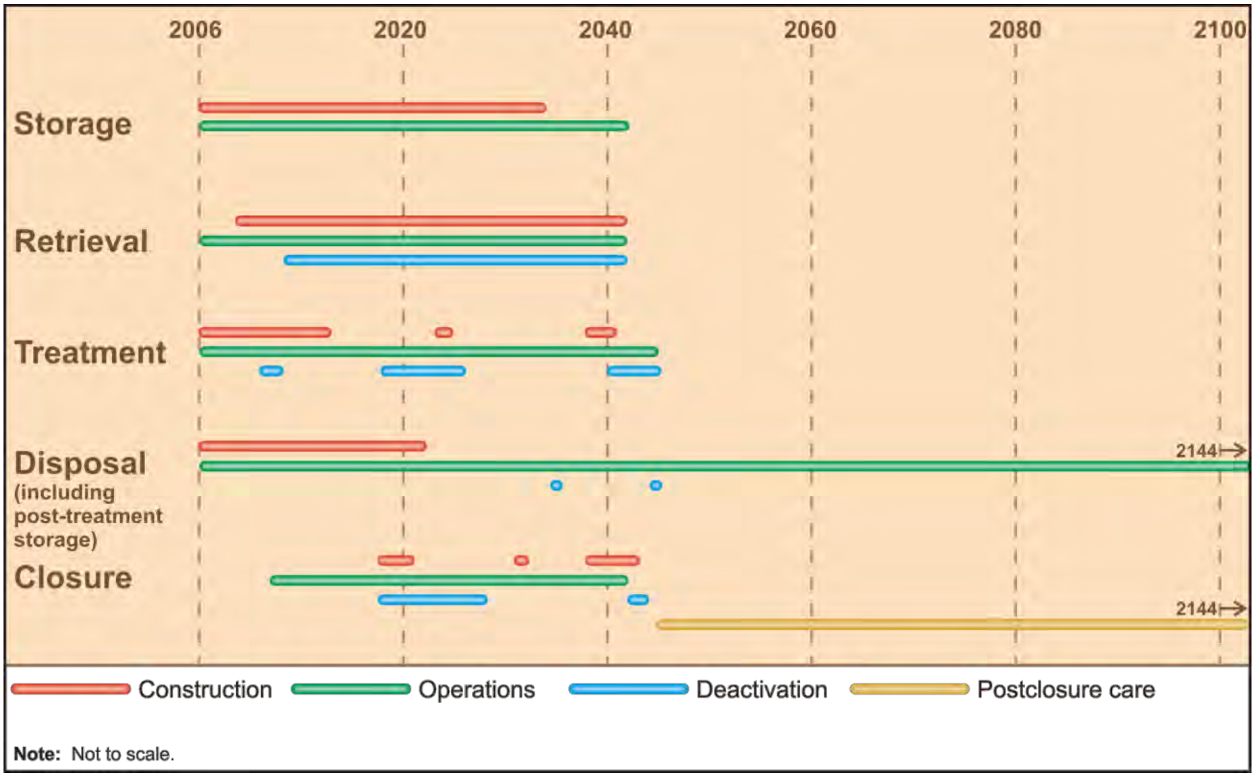


Figure 2–46. Tank Closure Alternative 4 Proposed Schedule

The following storage, retrieval, treatment, disposal, and closure actions, as depicted in Figure 2–47, would occur under Tank Closure Alternative 4.

Storage. DOE would continue current waste management operations using existing tank storage facilities. No new DSTs would be required, but four new WRFs would be constructed. Each WRF would contain three 568,000-liter (150,000-gallon) tanks.

Retrieval. Waste would be retrieved to 99.9 percent, exceeding the TPA Milestone M-45-00 minimum goal of 99 percent (Ecology, EPA, and DOE 1989). This level of retrieval would correspond to residual tank waste of no more than 1 cubic meter (36 cubic feet) for 100-series tanks or 0.08 cubic meters (3 cubic feet) for 200-series tanks. An additional tank chemical wash process and enhanced in-tank and ex-tank leak detection systems would be used to accomplish this higher percentage of waste volume retrieval. Under Tank Closure Alternative 4, waste from approximately 161 tanks (28 DSTs, 73 nonleaking 100-series SSTs, and 60 SSTs [100-series] that are known or suspected leakers) would be retrieved using the MRS technology, and waste from 89 tanks (61 MUSTs, 16 SSTs [200-series], and 12 WRF tanks) would be retrieved using the VBR technology. All 250 tanks would then undergo chemical washing to meet the 99.9 percent retrieval goal.

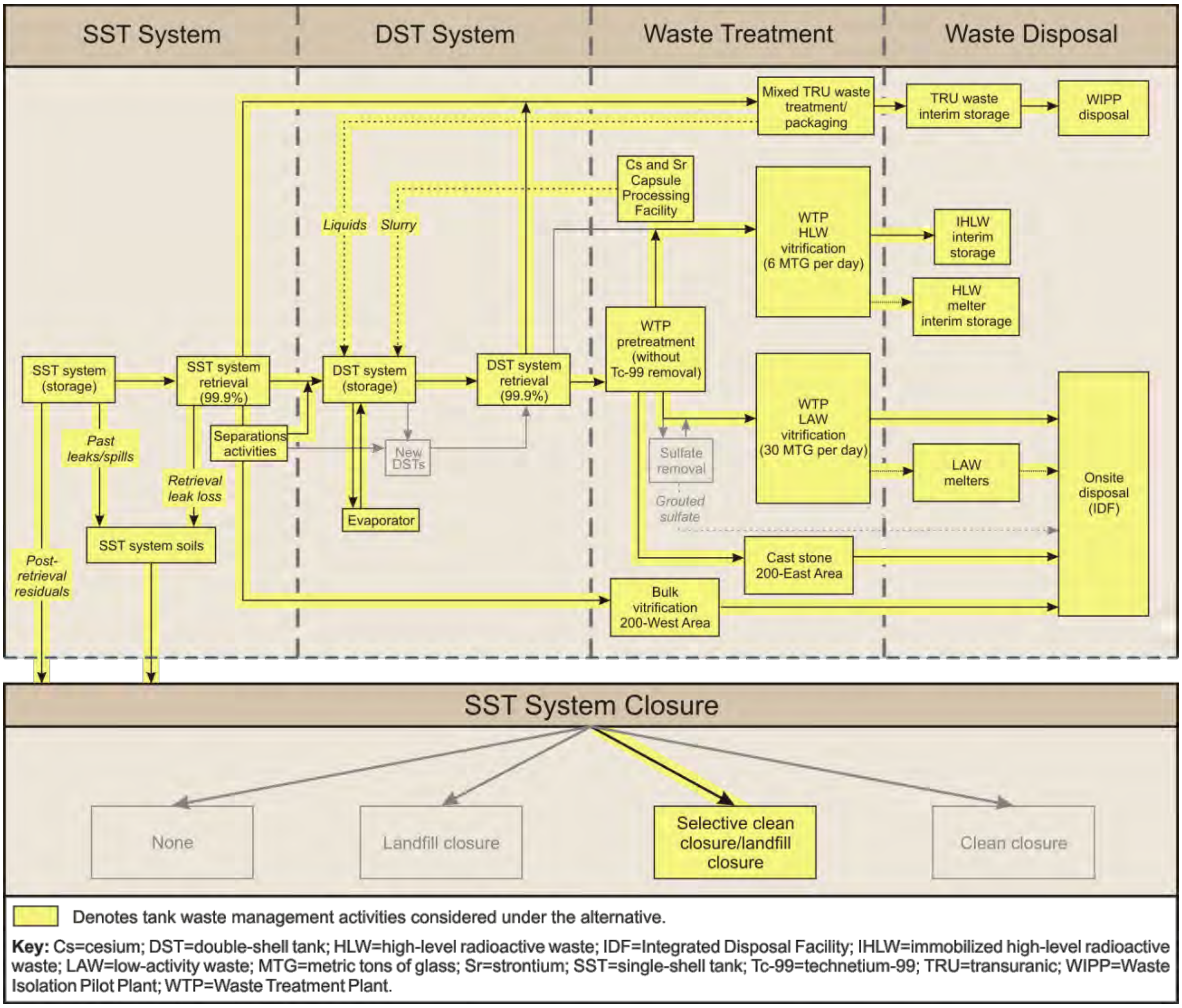


Figure 2–47. Tank Closure Alternative 4 Primary Components

Treatment. The existing WTP configuration (two HLW melters and two LAW melters) would be used, representing a vitrification TMC of 6 metric tons of glass IHLW per day and 30 metric tons of glass ILAW per day. Both HLW and LAW treatment would end in approximately 2037. However, the WTP would be required to operate through 2043 to treat the cesium and strontium capsules and the highly contaminated waste stream resulting from clean closure activities of the BX and SX tank farms. All of the waste streams routed to the WTP would be pretreated; technetium-99 would not be removed during WTP pretreatment. Under Tank Closure Alternative 4, the WTP would produce a total of 34,570 metric tons of glass IHLW (approximately 10,800 canisters, as well as 340 canisters from treatment of cesium and strontium capsules) and 172,140 metric tons of glass ILAW (approximately 28,690 containers). The cesium and strontium capsules would be retrieved from the WESF and de-encapsulated in a new Cesium and Strontium Capsule Processing Facility located adjacent to the WTP; their contents would be treated in the WTP. Both the ETF and the 242-A Evaporator would be replaced once under Tank Closure Alternative 4.

WTP capacity under Tank Closure Alternative 4 would be supplemented by construction and operation of Bulk Vitrification and Cast Stone Facilities to immobilize a portion of the LAW. Bulk vitrification would occur in the 200-West Area and produce 101,340 metric tons of glass bulk vitrification waste (approximately 2,380 containers). The waste feed for bulk vitrification would be pretreated in a new

Solid-Liquid Separations Facility. Cast stone treatment would occur in the 200-East Area and produce 287,540 metric tons of cast stone waste (approximately 14,380 containers). The waste feed for the 200-East Area Cast Stone Facility would be pretreated in the WTP, excluding technetium-99 removal. In addition, approximately 11.8 million liters (3.1 million gallons) of the tank waste would be designated as mixed TRU waste. This mixed TRU waste would be treated and packaged using mobile CH-Mixed TRU Waste Facilities located in both the 200-East and 200-West Areas and a single, fixed RH-Mixed TRU Waste Facility in the 200-East Area.

Disposal. IHLW glass would be stored in the completed CSB in up to six new IHLW Interim Storage Modules until disposition decisions are made and implemented. LAW immobilized via the WTP would be disposed of on site in an IDF, as would LAW immobilized external to the WTP through the bulk vitrification and cast stone supplemental treatment processes. Mixed TRU waste would be packaged and stored on site in a new TRU Waste Interim Storage Facility pending disposal at WIPP.

Closure. Tank Closure Alternative 4 includes clean closure of the BX tank farm (200-East Area) and the SX tank farm (200-West Area), as well as landfill closure of the remaining 10 SST farms and six sets of adjacent cribs and trenches (ditches). As described in Section 2.2.4.3, clean closure of the BX and SX tank farms was evaluated to determine the impacts of increased remediation at one representative tank farm in each of the 200-East and 200-West Areas. Clean closure at these tank farms would involve removal of the SSTs, ancillary equipment, and soil to a depth of 3 meters (10 feet) below the tank base. Removed tanks, ancillary equipment, and soil would be treated in the PPF, as appropriate, resulting in MLLW and a highly contaminated waste stream. The MLLW would be disposed of on site in the proposed RPPDF, a new facility similar to an IDF that would be built between the 200-East and 200-West Areas. The highly contaminated liquid waste stream would be treated in the WTP, resulting in additional IHLW (approximately 2,100 canisters). Where necessary, deep soil excavation would be conducted to remove contamination plumes within the soil column. Highly contaminated soil from deep soil excavation would be treated in the PPF, which would generate a contaminated liquid waste stream that would be processed as LAW in the WTP, resulting in additional ILAW (approximately 220 containers). The washed soil would be disposed of in the proposed RPPDF. The tank farms would then be backfilled with clean soil from onsite sources. Clean closure of these tank farms would preclude the need for postclosure care.

As operations at the balance of the tank farms are completed, the SST system and six sets of adjacent cribs and trenches (ditches) at Hanford would be closed as an RCRA hazardous waste landfill unit under WAC 173-303 and DOE Order 435.1, as applicable, or decommissioned under DOE Order 430.1B. The tanks would be filled with grout to immobilize the residual waste, prevent long-term degradation of the tanks, and discourage intruder access. The closed tank system and six sets of adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier followed by postclosure care for 100 years through 2144. SST system ancillary equipment outside the boundary of the modified RCRA Subtitle C barrier would be remediated or removed to meet landfill closure requirements.

2.5.2.5 Tank Closure Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

As shown in Figure 2–48, under Tank Closure Alternative 5, retrieval and treatment of 90 percent of the tank waste from the Hanford 200-East and 200-West Area tank farms was evaluated, but on an accelerated treatment schedule and using a combination of expanded WTP vitrification and supplemental technologies. A portion of the overall tank waste volume would be pretreated in the WTP and segregated into two waste streams: (1) an HLW stream that would be vitrified to form IHLW glass and (2) a LAW stream that would be vitrified to form ILAW glass. Under this alternative, no technetium-99 removal would occur as part of WTP pretreatment; however, a sulfate removal process would be employed following WTP pretreatment to allow higher waste loading in the ILAW glass.

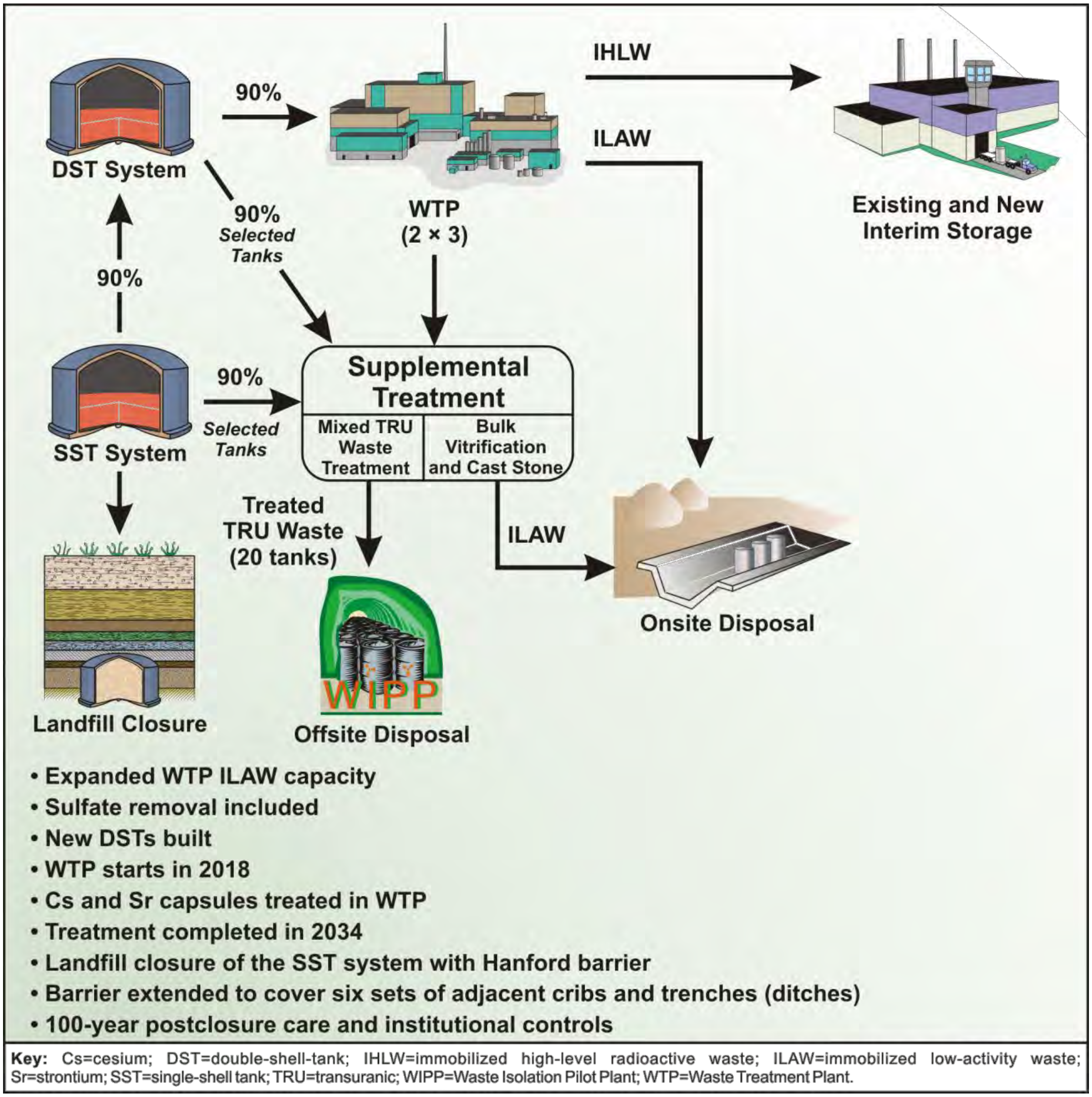


Figure 2–48. Tank Closure Alternative 5 Overview

Under Tank Closure Alternative 5, the portion of the tank waste not vitrified in the WTP would be treated using the following supplemental technologies:

- Mixed TRU waste supplemental treatment
- Thermal supplemental treatment (bulk vitrification)
- Nonthermal supplemental treatment (cast stone)

Mixed TRU waste supplemental treatment would be used to separately treat a select number of tanks believed to currently contain only mixed TRU waste by 2019. The balance of the tank waste (waste not being vitrified in the WTP or treated as mixed TRU waste) would be apportioned into two groups: one that would be routed to a Cast Stone Facility in the 200-East Area and the other that would be routed to a Bulk Vitrification Facility in the 200-West Area. The Cast Stone and Bulk Vitrification Facilities would operate through 2033.

Following construction of the WTP and a 2018 start, WTP operations under Tank Closure Alternative 5 would extend through 2034. Landfill closure of the SST system was evaluated under Alternative 5, including completion of a more robust Hanford barrier over the tank system by 2039, followed by postclosure care for 100 years through 2139. The proposed schedule for implementing Alternative 5 is presented in Figure 2–49.

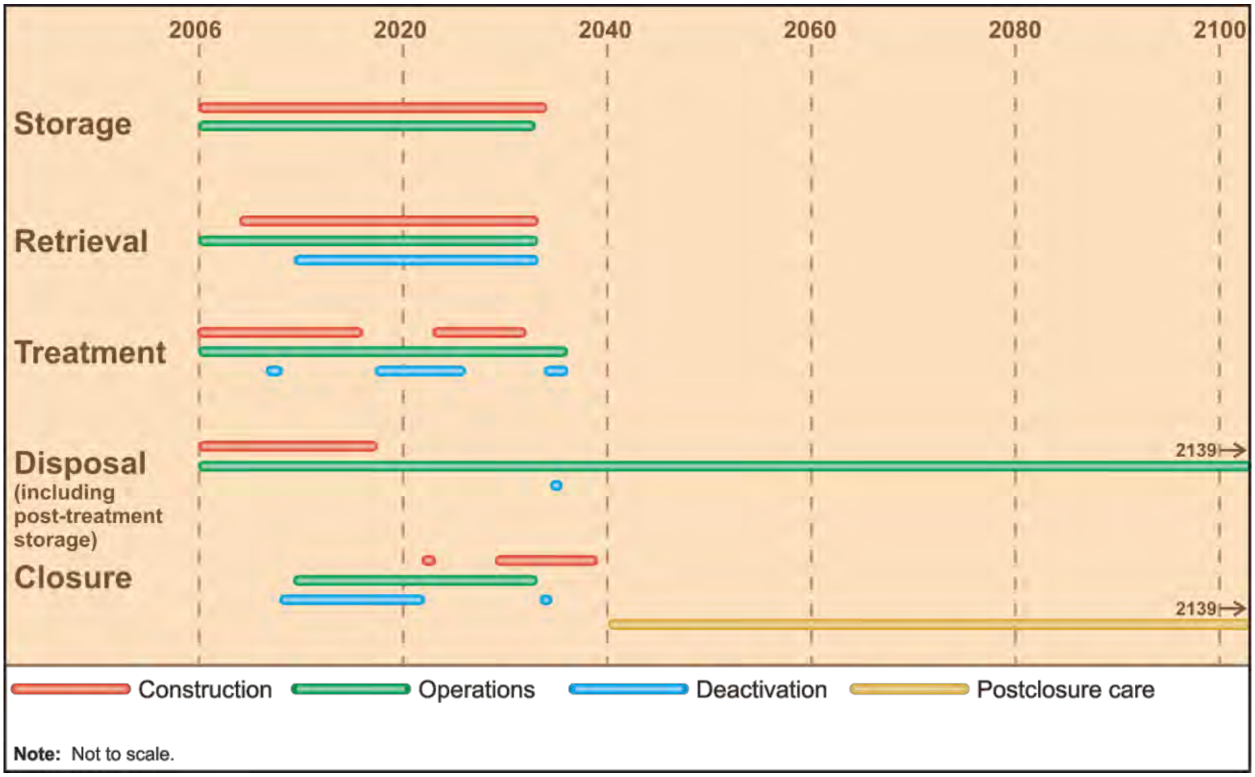


Figure 2–49. Tank Closure Alternative 5 Proposed Schedule

The following storage, retrieval, treatment, disposal, and closure actions, as depicted in Figure 2–50, would occur under Tank Closure Alternative 5.

Storage. DOE would continue current waste management operations using existing tank storage facilities. The accelerated treatment schedule associated with Alternative 5 would require the construction and operation of four new DSTs and four new WRFs to facilitate waste retrieval operations.

Retrieval. Waste would be retrieved to 90 percent, less than the TPA Milestone M-45-00 minimum goal of 99 percent, which represents a programmatic risk analysis process for the tank farms as defined by Appendix H of the TPA, "Single Shell Tank Waste Retrieval Criteria Procedure" (Ecology, EPA, and DOE 1989). This level of retrieval would correspond to residual tank waste of no more than 102 cubic meters (3,600 cubic feet) for the 100-series tanks or 8.5 cubic meters (300 cubic feet) for the 200-series tanks. Waste would be retrieved using currently available liquid-based waste retrieval and leak detection systems. A study of the feasibility of tank closure supports this aggressive retrieval schedule, which assumes retrieval completion in 2033 (CEES 2003). Under Tank Closure Alternative 5, waste would be retrieved from approximately 73 tanks (nonleaking 100-series SSTs) using the modified sluicing technology; waste from approximately 60 tanks (100-series SSTs that are known or suspected leakers) would be retrieved using the MRS technology; and waste from 89 tanks (61 MUSTs, 16 SSTs [200-series], and 12 WRF tanks) would be retrieved using the VBR technology. Existing in-tank mixer pumps would accomplish 90 percent retrieval of waste from the DSTs, making additional waste retrieval from those tanks unnecessary.

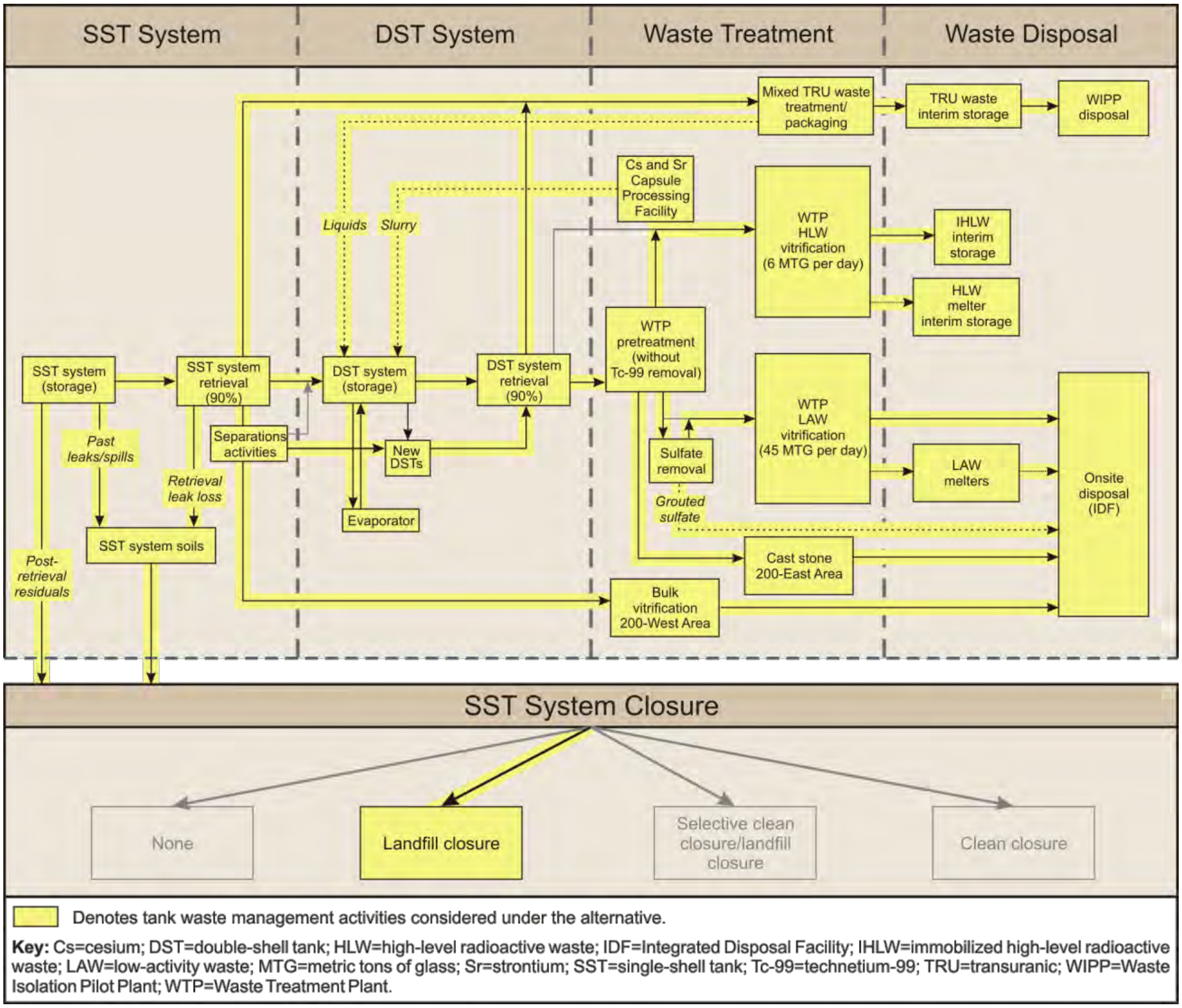


Figure 2–50. Tank Closure Alternative 5 Primary Components

Treatment. An additional LAW melter would be added to the existing WTP configuration (two HLW melters and two LAW melters) to expand LAW vitrification capacity. This new WTP configuration would provide a vitrification TMC of 6 metric tons of glass IHLW per day and an expanded vitrification TMC of 45 metric tons of glass ILAW per day. All of the waste streams routed to the WTP would be pretreated, but without technetium-99 removal. However, this alternative would implement a sulfate removal technology following WTP pretreatment, which would reduce the amount of glass produced in the WTP by increasing the waste loading in the ILAW glass. Under Tank Closure Alternative 5, the WTP would produce 24,960 metric tons of glass IHLW (approximately 7,800 canisters, as well as 340 canisters from treatment of cesium and strontium capsules); 186,590 metric tons of glass ILAW (approximately 31,100 containers); and 35,700 metric tons of sulfate grout (approximately 6,120 containers).

WTP capacity under Tank Closure Alternative 5 would be supplemented by construction and operation of a Cast Stone Facility in the 200-East Area and a Bulk Vitrification Facility in the 200-West Area to immobilize a portion of the LAW. Cast stone supplemental treatment would produce 100,080 metric tons of cast stone waste (approximately 5,000 containers). Bulk vitrification supplemental treatment would produce 91,490 metric tons of glass bulk vitrification waste (approximately 2,150 containers). The waste stream feed for the 200-East Area Cast Stone Facility would be pretreated in the WTP, excluding technetium-99 removal. In the 200-West Area, the waste feed would be pretreated in a new

Solid-Liquid Separations Facility. Under Tank Closure Alternative 5, cesium and strontium capsules would be retrieved from the WESF and de-encapsulated in a new Cesium and Strontium Capsule Processing Facility located adjacent to the WTP; their contents would be treated in the WTP. Both the ETF and the 242-A Evaporator would be replaced once under Tank Closure Alternative 5.

In addition, a separate portion of the tank waste (approximately 11.8 million liters [3.1 million gallons]) would be designated as mixed TRU waste. This mixed TRU waste would be treated and packaged using mobile CH-Mixed TRU Waste Facilities located in both the 200-East and 200-West Areas and a single, fixed RH-Mixed TRU Waste Facility in the 200-East Area.

Disposal. IHLW glass would be stored in the completed CSB and in up to three new IHLW Interim Storage Modules until disposition decisions are made and implemented. LAW immobilized via the WTP would be disposed of on site in an IDF, as would LAW immobilized external to the WTP through the bulk vitrification and cast stone supplemental treatment processes. Mixed TRU waste would be packaged and stored on site in a new TRU Waste Interim Storage Facility pending disposal at WIPP. The strontium sulfate precipitate would be immobilized in grout and disposed of as MLLW on site in an IDF.

Closure. As operations are completed, the SST system at Hanford would be closed as an RCRA hazardous waste landfill unit under WAC 173-303 and DOE Order 435.1, as applicable, or decommissioned under DOE Order 430.1B. The tanks would be filled with grout to immobilize the residual waste, prevent long-term degradation of the tanks, and discourage intruder access. The closed tank system and the six sets of adjacent cribs and trenches (ditches) would be covered with an engineered Hanford barrier, followed by postclosure care for 100 years.

To support the schedule for this alternative, no contaminated soil would be removed at the BX or SX tank farm. Similarly, SST system ancillary equipment outside the boundary of the Hanford barrier would be neither remediated nor removed.

2.5.2.6 Tank Closure Alternative 6: All Waste as Vitrified HLW

Under Tank Closure Alternative 6, all vitrified waste produced in the WTP would be managed as HLW (IHLW) under various retrieval and treatment scenarios. Three subalternatives were separately evaluated. Under Tank Closure Alternative 6A, 99.9 percent of the waste volume would be retrieved from Hanford's 200-East and 200-West Area tank farms and vitrified in the WTP using an expanded IHLW production capacity. The resulting IHLW glass would be stored in IHLW Interim Storage Modules and managed as IHLW pending further disposition. Under Tank Closure Alternative 6B, 99.9 percent of the waste volume would be retrieved from the tank farms, pretreated in the WTP, separated into HLW and LAW streams, and vitrified into IHLW and ILAW glass. Both vitrified waste streams would be stored on site and managed as IHLW pending further disposition. Under Tank Closure Alternative 6C, only 99 percent of the waste volume would be retrieved from the tank farms. Like Alternative 6B, this waste volume would be pretreated in the WTP, separated into HLW and LAW streams, and vitrified into IHLW and ILAW glass. Both vitrified waste streams would be stored on site and managed as IHLW pending further disposition. No technetium-99 removal would occur under Tank Closure Alternatives 6A, 6B, or 6C, but the contents of the cesium and strontium capsules would be treated in the WTP under all three subalternatives.

Note that a higher waste volume percentage (99.9 percent) would be retrieved from the tank farms under both Alternatives 6A and 6B than under Alternative 6C and most of the other alternatives. Removal of this higher waste volume would be accomplished by using various retrieval technologies, including an additional in-tank chemical wash process during retrieval operations.

Regarding closure of the SST system, Tank Closure Alternatives 6A and 6B would employ clean closure, and Tank Closure Alternative 6C would employ landfill closure. Landfill closure of the six sets of cribs and trenches (ditches) located adjacent to the SST system also is evaluated under all three of these subalternatives. In addition, Tank Closure Alternatives 6A and 6B each evaluate an Option Case that would employ clean closure of the six sets of adjacent cribs and trenches (ditches).

2.5.2.6.1 Tank Closure Alternative 6A: All Vitrification/No Separations; Clean Closure (Base and Option Cases)

As shown in Figure 2–51, under Tank Closure Alternative 6A, 99.9 percent of the waste volume from the Hanford 200-East and 200-West Area tank farms would be retrieved and treated using a modified WTP with expanded HLW vitrification capacity. All of the retrieved tank waste would be vitrified in the WTP to form IHLW glass. No WTP pretreatment or technetium-99 removal would occur, and no supplemental treatment technologies would be employed.

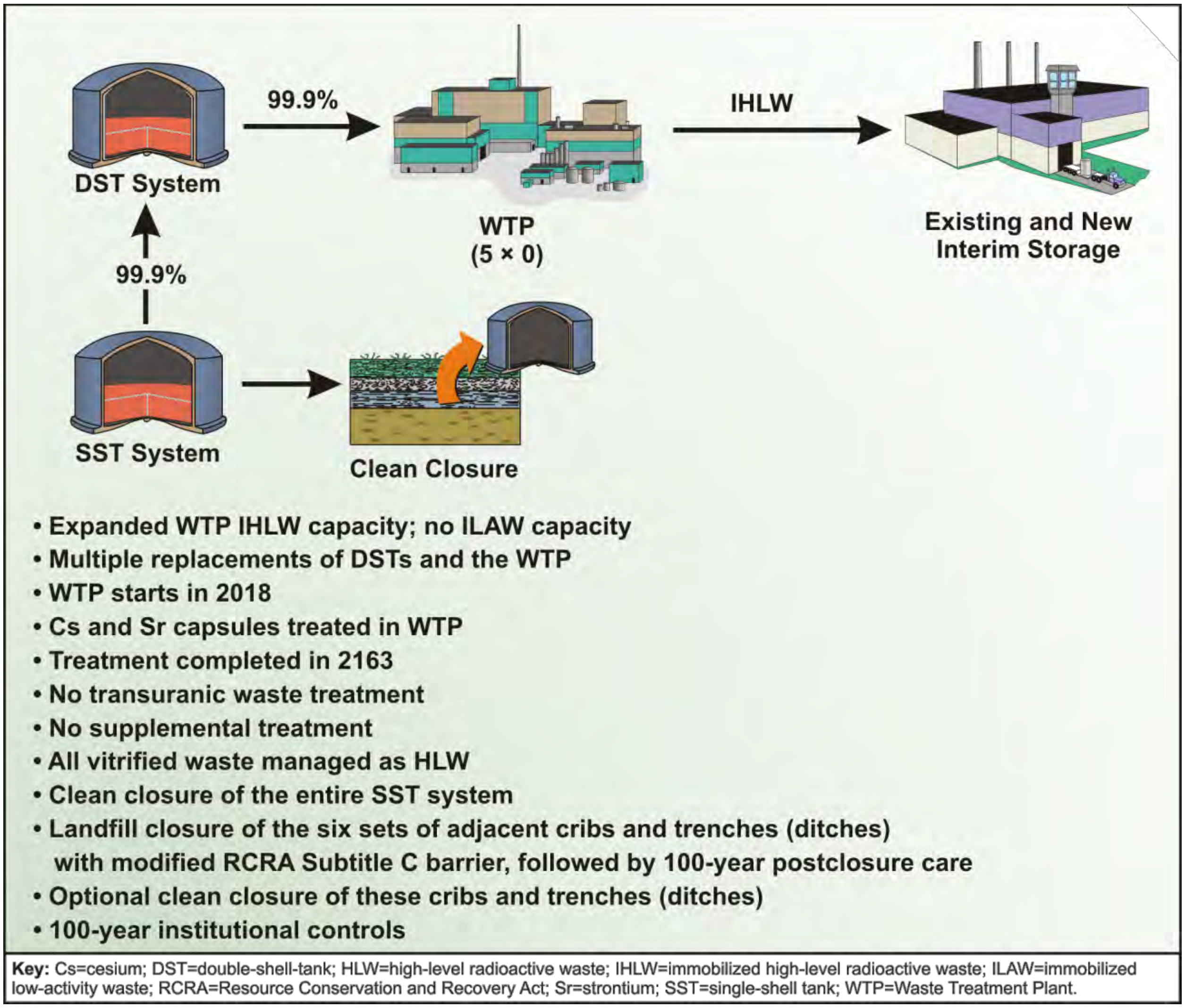


Figure 2–51. Tank Closure Alternative 6A Overview

Following construction and a 2018 start, WTP vitrification operations under Tank Closure Alternative 6A would extend through 2163. Institutional controls would be maintained for 100 years (through 2262) after completion of vitrification operations. No separate tank mixed TRU waste treatment capability would be provided under this alternative. The SST system would be clean-closed, meaning the tanks and ancillary equipment would be removed and managed as HLW. Contaminated soil plumes would be removed (to the depth of groundwater, where necessary) from tank farms showing evidence of deep soil contamination, and the soil would be treated to support onsite disposal. Clean closure of the tank farms would preclude the need for postclosure care. Under Tank Closure Alternative 6A, Base Case, the six sets of adjacent cribs and trenches (ditches) would undergo landfill closure (see Section 2.2.2.4.1 for a description) and be covered with an engineered modified RCRA Subtitle C barrier, followed by postclosure care for 100 years. Under the Option Case, these cribs and trenches (ditches) would be clean-closed (see Section 2.2.2.4.2). The proposed schedule for implementing Alternative 6A is presented in Figure 2–52.[11]

Figure 2–52. Tank Closure Alternative 6A Proposed Schedule

The following storage, retrieval, treatment, disposal, and closure actions, as depicted in Figure 2–53, would occur under Tank Closure Alternative 6A.

Storage. DOE would continue its current waste management operations using existing tank storage facilities. Because retrieval operations would be spread over a 150-year period, no WRFs would be required. However, the extended timeframe associated with this alternative would exceed the 40-year design life of each of the 28 existing DSTs operating in the tank farms and require three phased replacements (beginning in 2029, 2069, and 2109), for a total of 84 new DSTs.

[11] Some activities under this alternative could possibly be completed in a shorter timeframe as DOE becomes more proficient and efficient at tank retrieval, treatment, and closure operations. However, additional NEPA analyses might be required.

Retrieval. Waste would be retrieved to 99.9 percent, exceeding the TPA Milestone M-45-00 minimum goal of 99 percent (Ecology, EPA, and DOE 1989). This level of retrieval would correspond to residual tank waste of no more than 1 cubic meter (36 cubic feet) for 100-series tanks or 0.08 cubic meters (3 cubic feet) for 200-series tanks. An additional tank chemical wash process and enhanced in-tank and ex-tank leak detection systems would be used to accomplish this higher percentage of waste volume retrieval. Under Tank Closure Alternative 6A, waste from approximately 245 tanks (28 existing DSTs, 84 replacement DSTs, 73 nonleaking 100-series SSTs, and 60 SSTs [100-series] that are known or suspected leakers) would be retrieved using the MRS technology, and waste from 77 tanks (61 MUSTs and 16 SSTs [200-series]) would be retrieved using the VBR technology. All 322 tanks would then undergo chemical washing to meet the 99.9 percent retrieval goal.

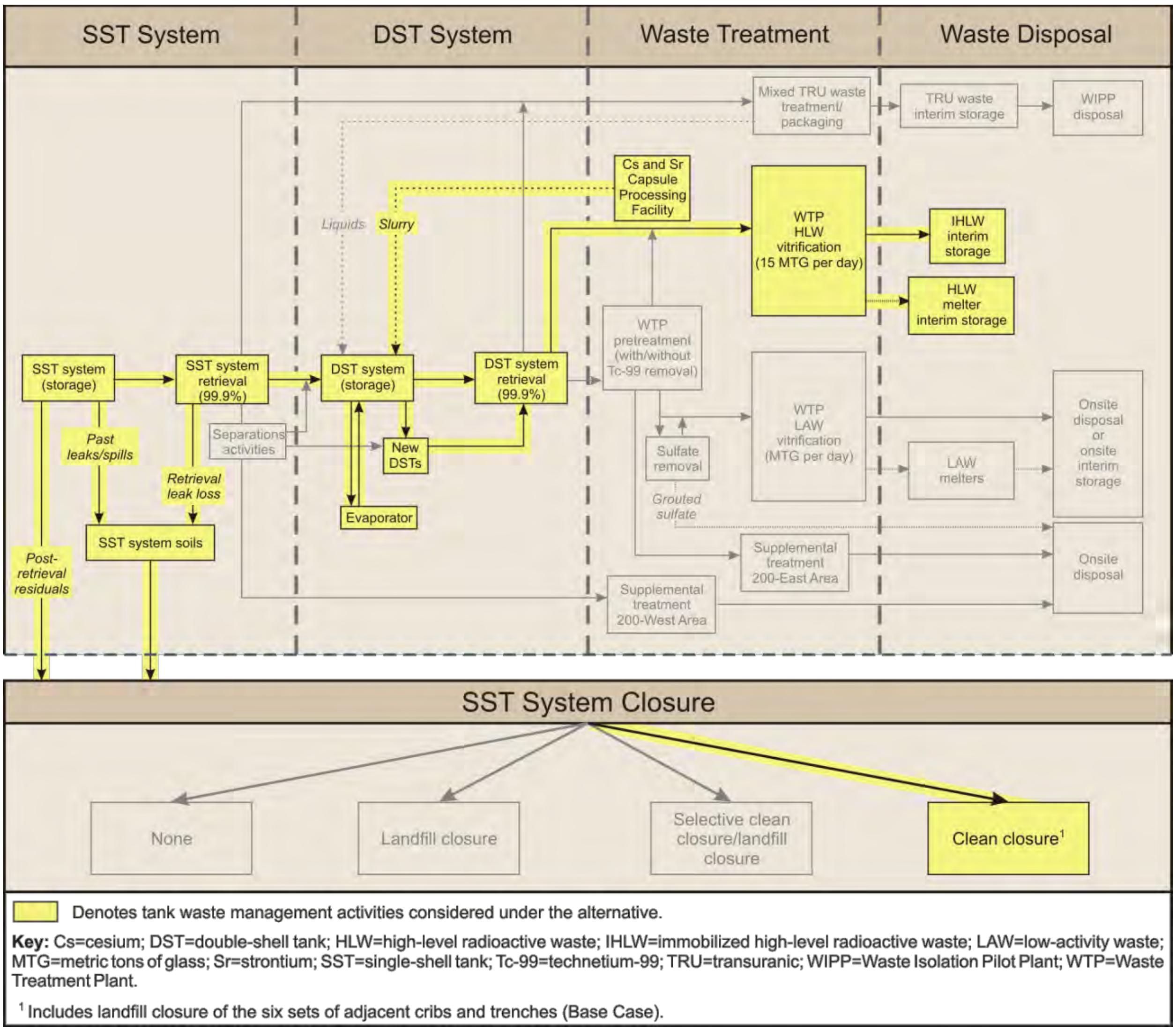


Figure 2–53. Tank Closure Alternative 6A Primary Components

Treatment. WTP HLW vitrification capacity would be expanded by changing the existing melter configuration (two HLW and two LAW melters) to five HLW melters and no LAW melters. This new WTP configuration would provide a total vitrification TMC of 15 metric tons of glass IHLW per day.[12] Because none of the tank waste would be separated into a LAW component, there would be no need to produce ILAW glass. Similarly, there would be no need to pretreat any of the tank waste or employ supplemental treatment technologies. Under Tank Closure Alternative 6A, the WTP would produce a total of 548,260 metric tons of glass IHLW (approximately 171,330 canisters, as well as 340 canisters from treatment of cesium and strontium capsules). Due to the extended timeframe (150 years) associated with this alternative, the WTP would exceed its 60-year design life and would have to be replaced twice. The underground transfer lines that support staging of waste feed to the WTP would need to be replaced once during this timeframe. Under this alternative, the cesium and strontium capsules would be retrieved from the WESF and de-encapsulated in a new facility adjacent to the WTP; their contents would be treated in the WTP. The ETF would be replaced five times and the 242-A Evaporator would be replaced six times.

Under Tank Closure Alternative 6A, Base Case, the highly contaminated deep soil waste stream generated from PPF soil washing would be thermally treated in the PPF. Approximately 4,170 metric tons of glass waste (700 containers) would be produced. The additional clean closure of the six adjacent cribs and trenches (ditches) that would occur under the Option Case would not require extension of the PPF operation schedule. However, throughput would be increased and 109,910 metric tons of glass waste (18,320 containers) would be produced.

Disposal. IHLW glass would be stored in the completed CSB and in up to 65 new IHLW Interim Storage Modules until disposition decisions are made and implemented. Due to the extended timeframe associated with this alternative, the canister storage facilities would require two partial replacements and one full replacement as the modules exceed their 60-year design life. The HLW shielded boxes (147,000) would be stored on site in 35 HLW Debris Storage Facilities. Should these HLW Debris Storage Facilities be required beyond 60 years, facility life extension measures would be required. Such measures are beyond the scope of this *TC & WM EIS*. Contaminated deep soils would be disposed of on site. PPF-generated glass that would perform equivalent to ILAW glass would also be disposed of on site.

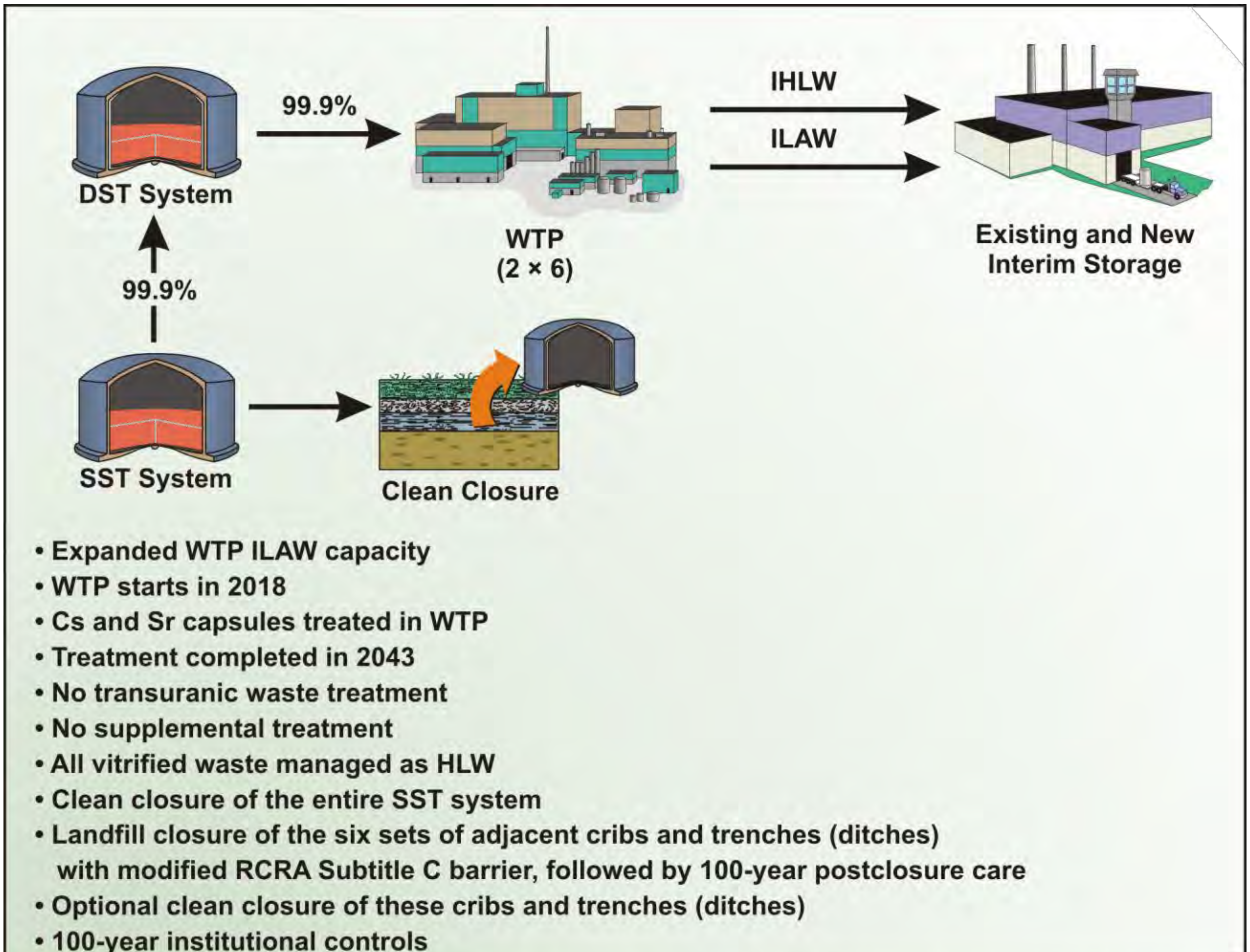
Closure. Tank Closure Alternative 6A includes clean closure of all 12 SST farms in the 200-East and 200-West Areas following deactivation. This alternative assumes that clean closure activities would be conducted at two tank farms simultaneously and would continue at this rate until clean closure of all the SST farms is completed. Clean closure of the tank farms would involve removing all SSTs, associated ancillary equipment, and contaminated soil to a depth of 3 meters (10 feet) below the tank base, all of which would be managed as HLW. These materials would be packaged for onsite storage in shielded boxes, resulting in approximately 0.83 million cubic meters (1.09 million cubic yards) of HLW packaged in approximately 147,000 shielded boxes. Where necessary, deep soil excavation would be conducted to remove contamination plumes within the soil column. Highly contaminated soil from deep soil excavation would be treated in the PPF to make it acceptable for onsite disposal. The liquid waste stream from PPF soil washing would be thermally treated in the PPF to produce a glass waste form (approximately 700 containers under the Base Case and 18,320 containers under the Option Case) with a long-term performance equivalent to ILAW glass. This PPF waste glass would be disposed of on site in an IDF. The washed soils would be disposed of in the proposed RPPDF, a new facility similar to an IDF. The tank farms would then be backfilled with clean soil from onsite sources. Clean closure of the SST system would preclude the need for conducting postclosure care. Under Tank Closure Alternative 6A,

[12] The HLW vitrification TMC initially considered for Tank Closure Alternatives 6A and 6B was 6 metric tons of glass per day (using two melters). This capacity matched the existing HLW configuration of the WTP. However, analysis indicated that, with this throughput, operations would be required to continue for over 300 years, and facility upgrades/replacements would be required every 60 years. This was considered unreasonable, so the alternative was revised to analyze implementing a vitrification TMC of 15 metric tons of glass per day (using five melters).

Base Case, the six sets of adjacent cribs and trenches (ditches) would undergo landfill closure and be covered with an engineered modified RCRA Subtitle C barrier, followed by postclosure care for 100 years. Under the Option Case, these cribs and trenches (ditches) would be clean-closed.

2.5.2.6.2 Tank Closure Alternative 6B: All Vitrification with Separations; Clean Closure (Base and Option Cases)

As shown in Figure 2–54, under Tank Closure Alternative 6B, 99.9 percent of the waste volume from the Hanford 200-East and 200-West Area tank farms would be retrieved and separated into two waste streams during WTP pretreatment: (1) an HLW stream that would be vitrified to form IHLW glass and (2) a LAW stream that would be vitrified to form ILAW glass. All vitrified waste (IHLW and ILAW) would be managed as HLW and stored on site until disposition decisions are made and implemented. Technetium-99 would not be removed during WTP treatment, and no supplemental treatment technologies would be employed. Like Alternative 6A, Alternative 6B would employ clean closure of the SST system.



Key: Cs=cesium; DST=double-shell-tank; HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; RCRA=Resource Conservation and Recovery Act; Sr=strontium; SST=single-shell tank; WTP=Waste Treatment Plant.

Figure 2–54. Tank Closure Alternative 6B Overview

Following construction and a 2018 start, WTP vitrification operations under Tank Closure Alternative 6B would extend through 2043 (HLW processing would be completed in 2040, and ILAW processing would be completed in 2043). Institutional controls would be maintained for 100 years following completion of PPF operations in 2099. No separate tank mixed TRU waste treatment capability would be provided under this alternative. The SST system would be clean-closed, meaning the tanks and ancillary equipment would be removed and managed as HLW. Contaminated soil plumes would be removed (to the depth of groundwater, where necessary) from tank farms showing evidence of deep soil contamination, and the soil would be treated to support onsite disposal. Clean closure of the tank farms would preclude the need for postclosure care. Under Tank Closure Alternative 6B, Base Case, the six sets of adjacent cribs and trenches (ditches) would undergo landfill closure (see Section 2.2.2.4.1 for a description) and be covered with an engineered modified RCRA Subtitle C barrier, followed by postclosure care for 100 years. Under the Option Case, these cribs and trenches (ditches) would be clean-closed (see Section 2.2.2.4.2). The proposed schedule for implementing Alternative 6B is presented in Figure 2–55.

Figure 2–55. Tank Closure Alternative 6B Proposed Schedule

The following storage, retrieval, treatment, disposal, and closure actions, as depicted in Figure 2–56, would occur under Tank Closure Alternative 6B.

Storage. DOE would continue current waste management operations using existing tank storage facilities. No new DSTs would be required, but four new WRFs would be constructed. Each WRF would contain three 568,000-liter (150,000-gallon) tanks.

Retrieval. Waste would be retrieved to 99.9 percent, exceeding the TPA Milestone M-45-00 minimum goal of 99 percent (Ecology, EPA, and DOE 1989). This level of retrieval would correspond to residual tank waste of no more than 1 cubic meter (36 cubic feet) for 100-series tanks or 0.08 cubic meters (3 cubic feet) for 200-series tanks. This higher percentage of waste volume retrieval would be accomplished by using an additional tank chemical wash process and enhanced in-tank and ex-tank leak detection systems. Under Tank Closure Alternative 6B, waste from approximately 161 tanks (28 existing DSTs, 73 nonleaking 100-series SSTs, and 60 SSTs [100-series] that are known or suspected leakers) would be retrieved using the MRS technology, and waste from 89 tanks (61 MUSTs, 16 SSTs [200-series], and 12 WRF tanks) would be retrieved using the VBR technology. All 250 tanks would then undergo chemical washing to meet the 99.9 percent retrieval goal.

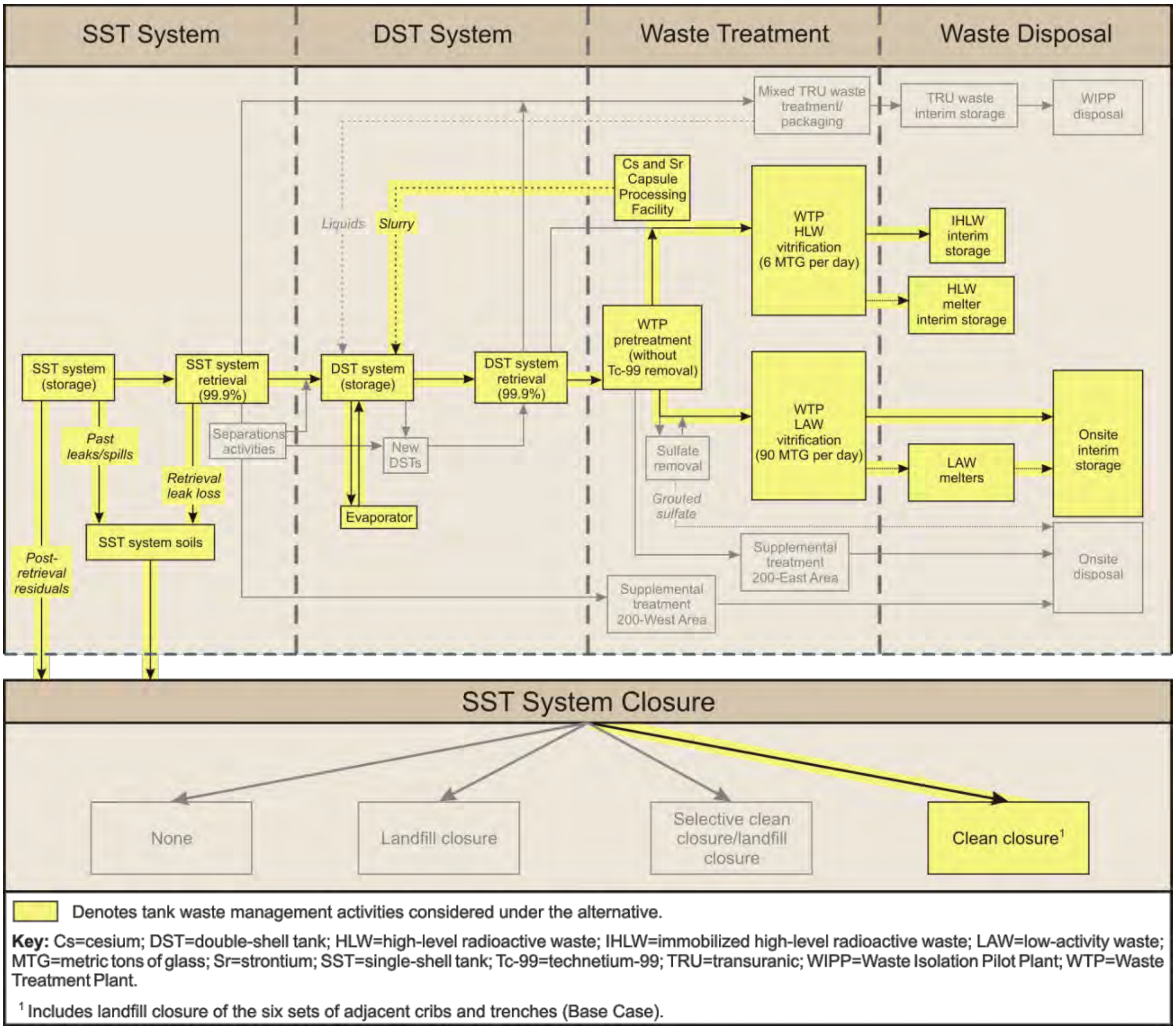


Figure 2–56. Tank Closure Alternative 6B Primary Components

Treatment. The existing WTP configuration (two HLW melters and two LAW melters) would be supplemented by the addition of four new LAW melters to expand LAW vitrification capacity. This new WTP configuration would provide a vitrification TMC of 6 metric tons of glass IHLW per day and an expanded vitrification TMC of 90 metric tons of glass ILAW per day. All waste streams routed to the WTP would be pretreated, but technetium-99 would not be removed from the LAW stream. Under Tank Closure Alternative 6B, the WTP would produce 38,400 metric tons of glass IHLW (approximately 12,000 canisters, as well as 340 canisters from treatment of cesium and strontium capsules) and 557,990 metric tons of glass ILAW (approximately 93,000 containers). The cesium and strontium capsules would be retrieved from the WESF and de-encapsulated in a new Cesium and Strontium Capsule Processing Facility adjacent to the WTP; their contents would be treated in the WTP. The ETF would be replaced twice and the 242-A Evaporator would be replaced once.

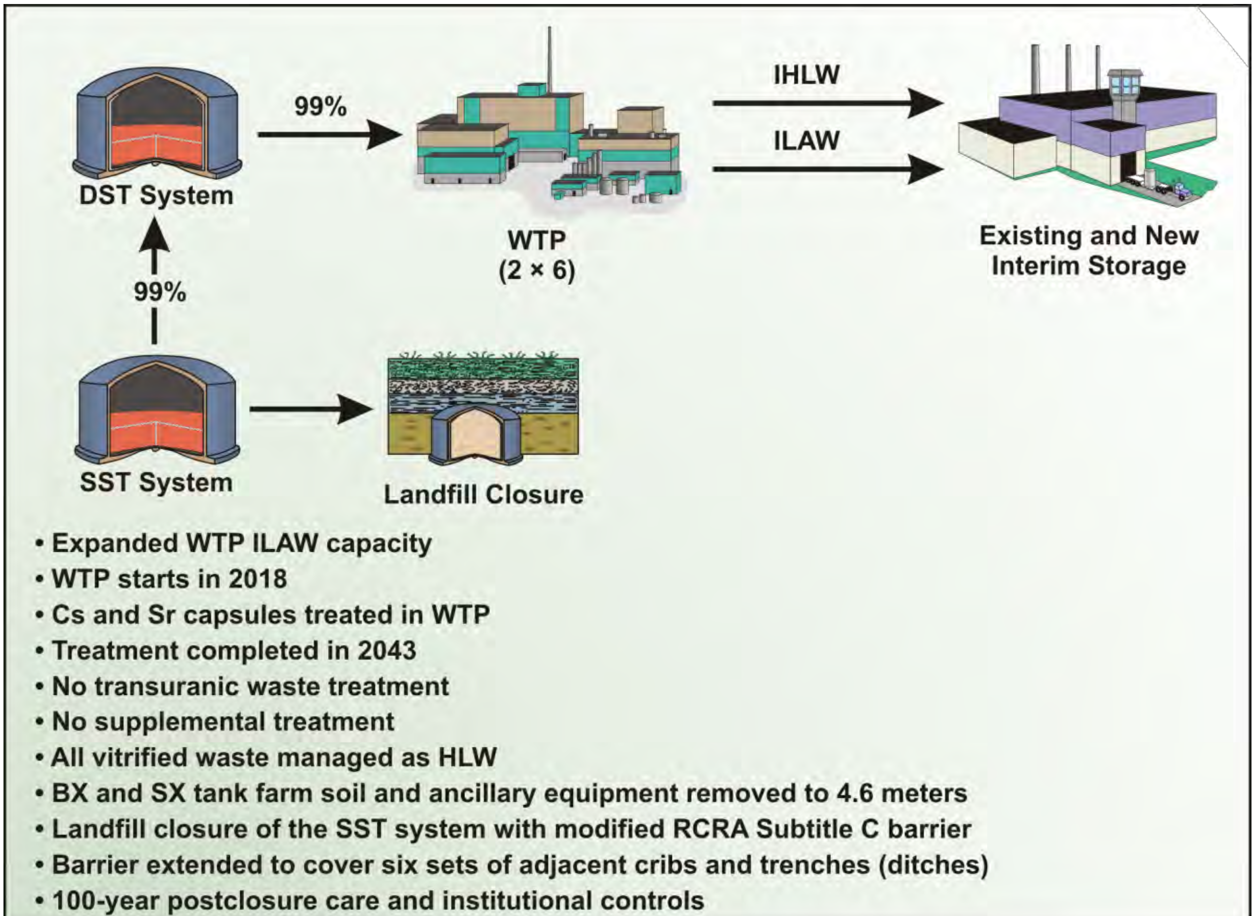
Under Tank Closure Alternative 6B, Base Case, the highly contaminated deep soil waste stream generated from PPF soil washing would be thermally treated in the PPF. Approximately 4,170 metric tons of glass waste (700 containers) would be produced. The additional clean closure of the six adjacent cribs and trenches (ditches) that would occur under the Option Case would not require extension of the PPF operation schedule. However, throughput would be increased and 109,910 metric tons of glass waste (18,320 containers) would be produced.

Disposal. IHLW glass would be stored in the existing CSB and in four additional IHLW Interim Storage Modules until disposition decisions are made and implemented. ILAW glass would be managed as HLW and stored on site in 46 new ILAW Interim Storage Facilities. Should these IHLW or ILAW Interim Storage Facilities be required beyond 60 years, facility life extension measures that are beyond the scope of this *TC & WM EIS* would be considered. Approximately 147,000 HLW shielded boxes would be stored on site in 35 other new HLW Debris Storage Facilities. Should these HLW Debris Storage Facilities be required beyond 60 years, facility life extension measures that are beyond the scope of this *TC & WM EIS* would be required. Contaminated deep soils would be disposed of on site. PPF-generated glass that would perform equivalent to ILAW glass would also be disposed of on site.

Closure. Under Tank Closure Alternative 6B, all 12 SST farms in the 200-East and 200-West Areas would be clean-closed following deactivation. This alternative assumes that clean closure activities would be conducted at four tank farms simultaneously and would continue at this rate until clean closure of the SST farms is completed. Clean closure of the tank farms would involve removal of all SSTs, associated ancillary equipment, and contaminated soil to a depth of 3 meters (10 feet) below the tank base; disposition would be as HLW. These materials would be packaged for long-term onsite storage in shielded boxes, resulting in approximately 0.83 million cubic meters (1.09 million cubic yards) of HLW packaged in approximately 147,000 shielded boxes. Where necessary, deep soil excavation would be conducted to remove contamination plumes within the soil column. Highly contaminated soil from deep soil excavation would be treated in the PPF to make it acceptable for onsite disposal. The liquid waste stream from the PPF soil washing would be thermally treated in the PPF to produce a glass waste form (approximately 700 containers under the Base Case and 18,320 containers under the Option Case) with a long-term performance equivalent to ILAW glass. This PPF glass would be disposed of on site in an IDF. The washed soils would be disposed of in the proposed RPPDF, a new disposal facility similar to an IDF. The tank farms would then be backfilled with clean soil from onsite sources. Clean closure of these tank farms would preclude the need for postclosure care. Under Tank Closure Alternative 6B, Base Case, the six sets of adjacent cribs and trenches (ditches) would undergo landfill closure and be covered with an engineered modified RCRA Subtitle C barrier, followed by postclosure care for 100 years. Under the Option Case, these cribs and trenches (ditches) would be clean-closed.

2.5.2.6.3 Tank Closure Alternative 6C: All Vitrification with Separations; Landfill Closure

Under Tank Closure Alternative 6C, 99 percent of the waste volume would be retrieved from the Hanford 200-East and 200-West Area tank farms and separated into two waste streams during WTP pretreatment: (1) an HLW stream that would be vitrified to form IHLW glass and (2) a LAW stream that would be vitrified to form ILAW glass. The ILAW glass would be managed as HLW and stored on site. Technetium-99 would not be removed from the LAW stream during WTP pretreatment, and no supplemental treatment technologies would be employed. As shown in Figure 2–57, Alternative 6C would employ landfill closure of the SST system and the six sets of adjacent cribs and trenches (ditches).



Note: To convert meters to feet, multiply by 3.281.

Key: Cs=cesium; DST=double-shell-tank; HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; RCRA=Resource Conservation and Recovery Act; Sr=strontium; SST=single-shell tank; WTP=Waste Treatment Plant.

Figure 2–57. Tank Closure Alternative 6C Overview

Following construction and a 2018 start, WTP vitrification operations under Tank Closure Alternative 6C would extend through 2043. No separate tank mixed TRU waste treatment capability would be provided under this alternative. Alternative 6C also includes landfill closure of the SST farms, including completion of a modified RCRA Subtitle C barrier over these areas and the six adjacent cribs and trenches (ditches) by 2045, followed by postclosure care for 100 years (through 2145). The proposed schedule for implementing Alternative 6C is presented in Figure 2–58.

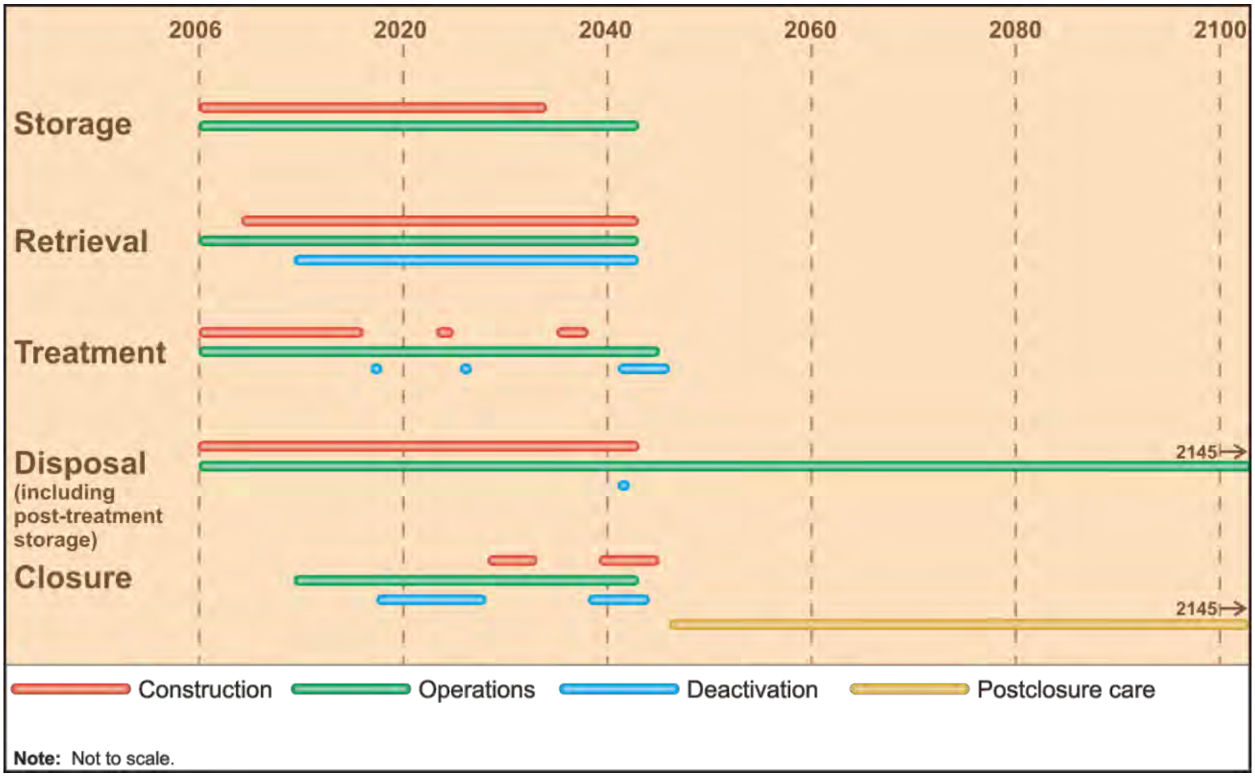


Figure 2–58. Tank Closure Alternative 6C Proposed Schedule

The following storage, retrieval, treatment, disposal, and closure actions, as depicted in Figure 2–59, would occur under Tank Closure Alternative 6C.

Storage. DOE would continue current waste management operations using existing tank storage facilities. No new DSTs would be required, but four new WRFs would be constructed. Each WRF would contain three 568,000-liter (150,000-gallon) tanks.

Retrieval. Waste would be retrieved to the TPA Milestone M-45-00 minimum goal (Ecology, EPA, and DOE 1989), i.e., residual waste would not exceed 10.2 cubic meters (360 cubic feet) for 100-series tanks or 0.85 cubic meters (30 cubic feet) for 200-series tanks, corresponding to 99 percent retrieval using currently available liquid-based waste retrieval and leak detection systems. Under Alternative 6C, waste from approximately 101 tanks (28 DSTs and 73 nonleaking, 100-series SSTs) would be retrieved using the modified sluicing technology; waste from approximately 60 SSTs (100-series SSTs that are known or suspected leakers) would be retrieved using the MRS technology; and waste from 89 tanks (61 MUSTs, 16 SSTs [200-series], and 12 WRF tanks) would be retrieved using the VBR technology.

Treatment. LAW vitrification capacity would be expanded by adding four new LAW melters to the existing WTP configuration (two HLW melters and two LAW melters). This new WTP configuration would provide a vitrification TMC of 6 metric tons of glass IHLW per day and an expanded vitrification TMC of 90 metric tons of glass ILAW per day. All waste streams routed to the WTP would be pretreated, but technetium-99 would not be removed from the LAW stream. Under Tank Closure Alternative 6C, the WTP would produce a total of 38,400 metric tons of glass IHLW (approximately 12,000 canisters, as well as 340 canisters from treatment of cesium and strontium capsules) and 553,510 metric tons of glass ILAW (approximately 92,250 containers). The cesium and strontium capsules would be retrieved from the WESF and de-encapsulated in a new Cesium and Strontium Capsule Processing Facility adjacent to the WTP; their contents would be treated in the WTP. Both the ETF and the 242-A Evaporator would be replaced once.

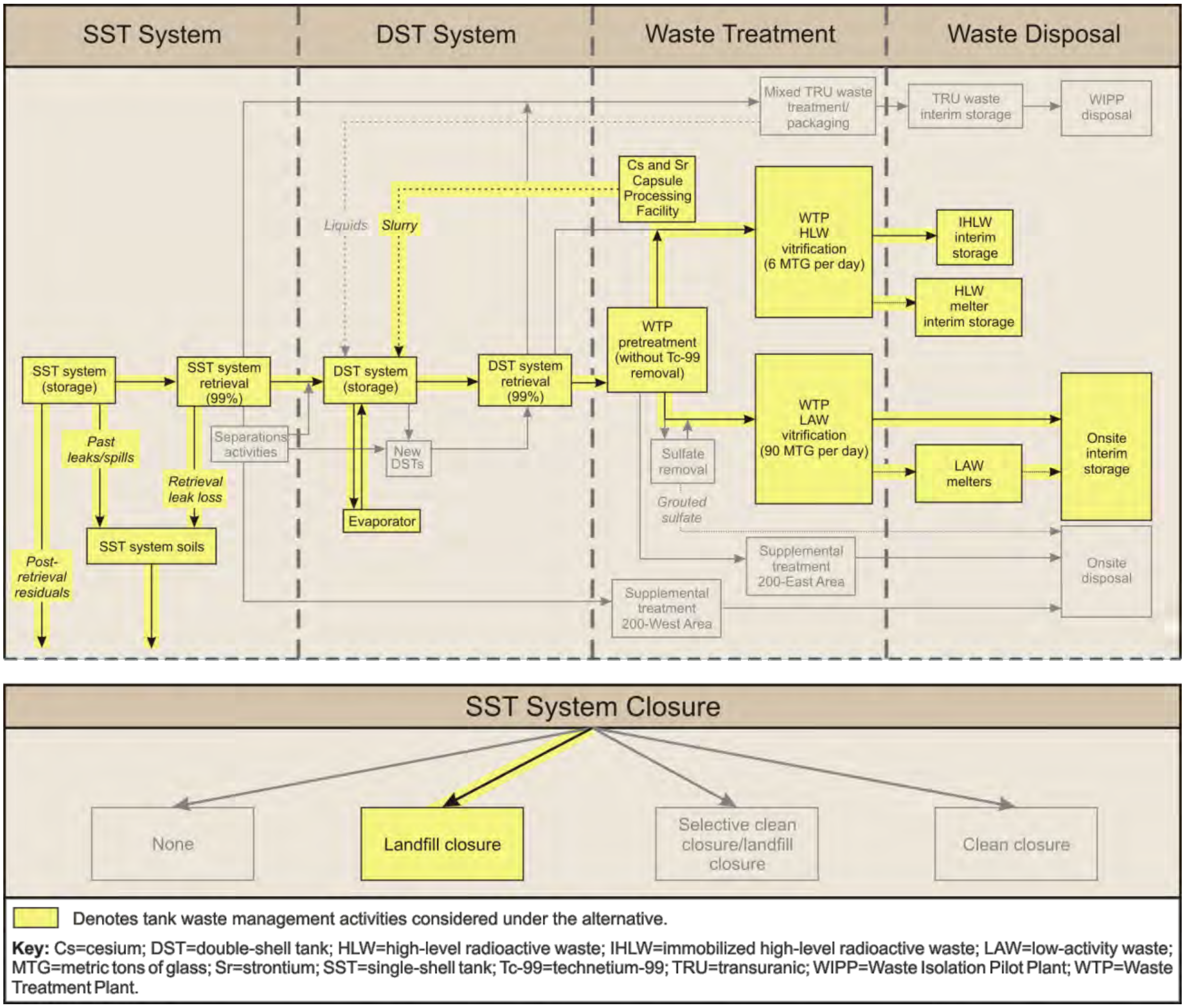


Figure 2–59. Tank Closure Alternative 6C Primary Components

Disposal. IHLW glass would be stored in the completed CSB and in four additional IHLW Interim Storage Modules until disposition decisions are made and implemented. ILAW glass would be managed as HLW and stored on site in 46 new ILAW Interim Storage Facilities. Should these IHLW or ILAW Interim Storage Facilities be required beyond 60 years, facility life extension measures that are beyond the scope of this *TC & WM EIS* would be considered.

Closure. Tank Closure Alternative 6C assumes that residual tank waste and contaminated facilities would be managed and closed as non-HLW. As operations are completed, the SST system at Hanford would be closed as an RCRA hazardous waste landfill unit under WAC 173-303 and DOE Order 435.1, as applicable, or decommissioned under DOE Order 430.1B. The tanks would be filled with grout to immobilize the residual waste, prevent long-term degradation of the tanks, and discourage intruder access. Contaminated soil would be removed down to 4.6 meters (15 feet) for the BX and SX tank farms and replaced with clean soils from onsite sources. The 4.6-meter (15-foot) depth would allow removal of all of the ancillary equipment prior to closure. Contaminated soil and ancillary equipment would be disposed of on site in the proposed RPPDF, a new facility similar to an IDF. The closed tank system and the six sets of adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier, followed by postclosure care for 100 years. SST system ancillary equipment outside the boundary of the modified RCRA Subtitle C barrier would be remediated or removed to meet landfill closure requirements.

2.5.3 FFTF Decommissioning Alternatives

The FFTF Decommissioning alternatives are described in detail in this section. A summary of these alternatives by mission components is provided in Table 2–3.

Table 2–3. FFTF Decommissioning Alternatives – Summary by Mission Component

Mission Component	Range of Action	Alternative		
		1	2	3
Facility disposition	Reactor vessel, piping systems, and tanks left in place under inert gas blanket	X		
	Dismantlement of RCB and adjacent support buildings		X	X
	Removal of reactor vessel, internal piping and equipment, and attached depleted-uranium shield			X
	Onsite disposal of reactor vessel, internal piping and equipment, and attached depleted-uranium shield			X
	Removal and onsite disposal of radioactive or chemical waste	X	X	X
	Ancillary facility areas backfilled and revegetated		X	
	Property Protected Area backfilled and revegetated			X
	RCRA Subtitle C barrier over RCB		X	
	Administrative controls for 100 years	X		
	Postclosure care and/or institutional controls for 100 years		X	X
Disposition of remote-handled special components	Onsite removal and storage per FONSI	X	X	X
	Treatment at the Hanford Site		X	X
	Treatment at Idaho National Laboratory		X	X
	Onsite disposal		X	X
	Offsite disposal		X	X
Disposition of bulk sodium	Onsite storage	X	X	X
	Onsite conversion to a caustic sodium hydroxide solution		X	X
	Offsite conversion to a caustic sodium hydroxide solution		X	X
	Caustic shipped to the Waste Treatment Plant for use in processing tank waste		X	X

Key: FFTF=Fast Flux Test Facility; FONSI=Finding of No Significant Impact; RCB=Reactor Containment Building; RCRA=Resource Conservation and Recovery Act.

2.5.3.1 FFTF Decommissioning Alternative 1: No Action

As shown in Figure 2–60, the FFTF Decommissioning No Action Alternative would complete ongoing activities that are consistent with previous DOE NEPA decisions. Final decommissioning of FFTF would not occur. Deactivation activities for the FFTF complex and support buildings, as described in the *Environmental Assessment, Sodium Residuals Reaction/Removal and Other Deactivation Work Activities,* *Fast Flux Test Facility (FFTF) Project, Hanford Site, Richland, Washington* (DOE 2006a), would be conducted through 2016. Deactivation activities would include removal and packaging of the four RH-SCs (the sodium cold trap, cesium trap, and two sodium vapor traps), followed by storage in the 400 Area, as described in the Finding of No Significant Impact (FONSI) dated March 31, 2006 (DOE 2006b).

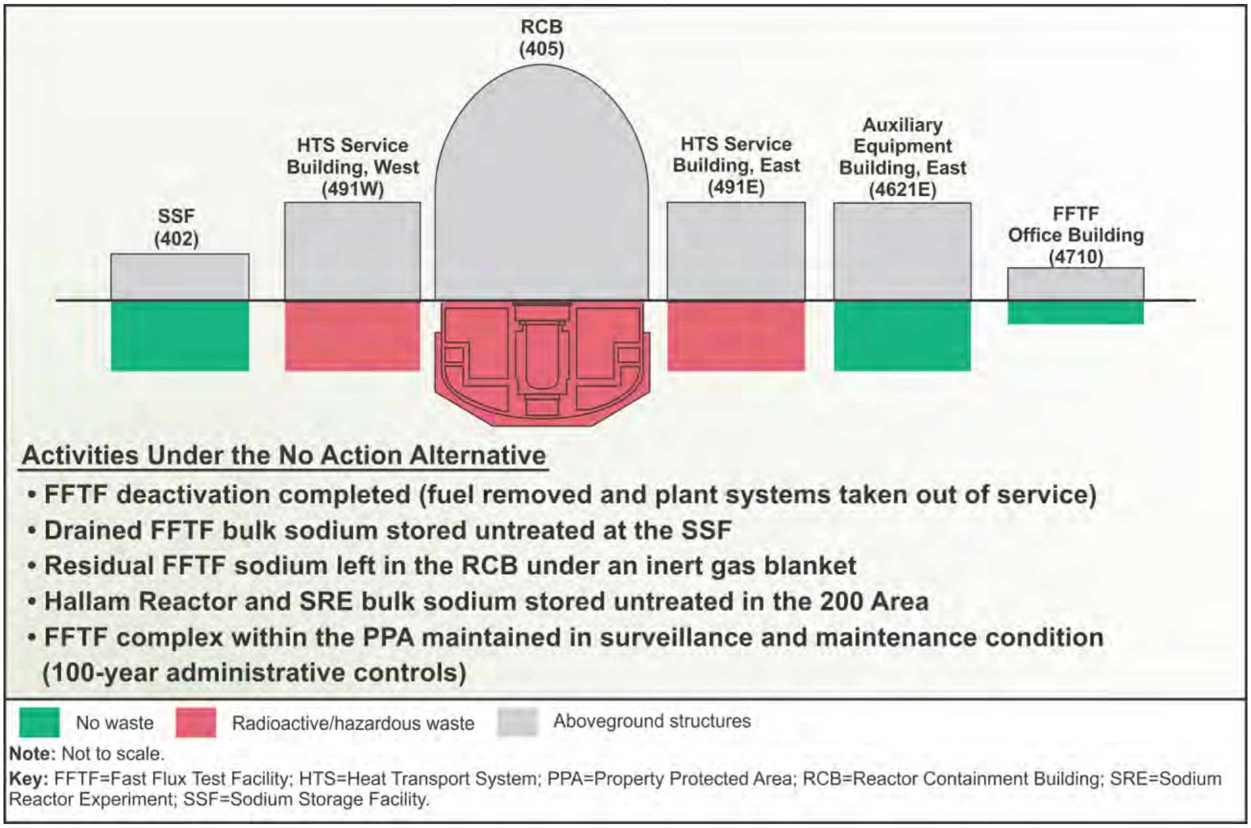


Figure 2–60. FFTF Decommissioning Alternative 1 Overview

The FFTF RCB (Building 405), along with the rest of the buildings within the 400 Area PPA, would be maintained through 2107 (100 years) under administrative controls (site security and management). After 2107, administrative controls would cease and the remaining waste was assumed to become available for release to the environment. The reactor vessel, piping systems, and tanks would be left in place under an inert gas blanket. SNF would have been removed, and systems not associated with maintaining safety-related functions would be deactivated or de-energized and isolated according to the deactivation plans. Other radioactive or chemical waste and materials would have been removed under the deactivation activities. Small amounts of waste generated during the surveillance and monitoring activities would be disposed of in an IDF. The proposed schedule for implementing the FFTF Decommissioning No Action Alternative is presented in Figure 2–61.

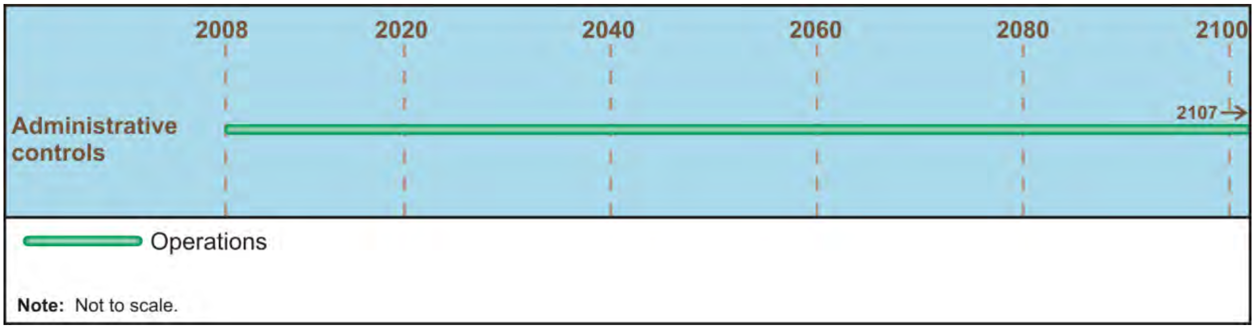


Figure 2–61. FFTF Decommissioning Alternative 1 Proposed Schedule

FFTF bulk sodium (approximately 916,000 liters [242,000 gallons]) removed from reactor systems during deactivation activities would be stored as a solid in tanks in the SSF in the 400 Area. The small amount of sodium potassium alloy would be blended with the contents of the bulk sodium storage containers. After 2107, administrative controls would cease and the FFTF bulk sodium was assumed to become available for release to the environment. Similarly, the Hallam and SRE sodium stored in the 200-West Area would remain there and was likewise assumed to become available for release into the environment after 2107 when administrative controls would cease. Figure 2–62 illustrates the primary components of the FFTF Decommissioning No Action Alternative.

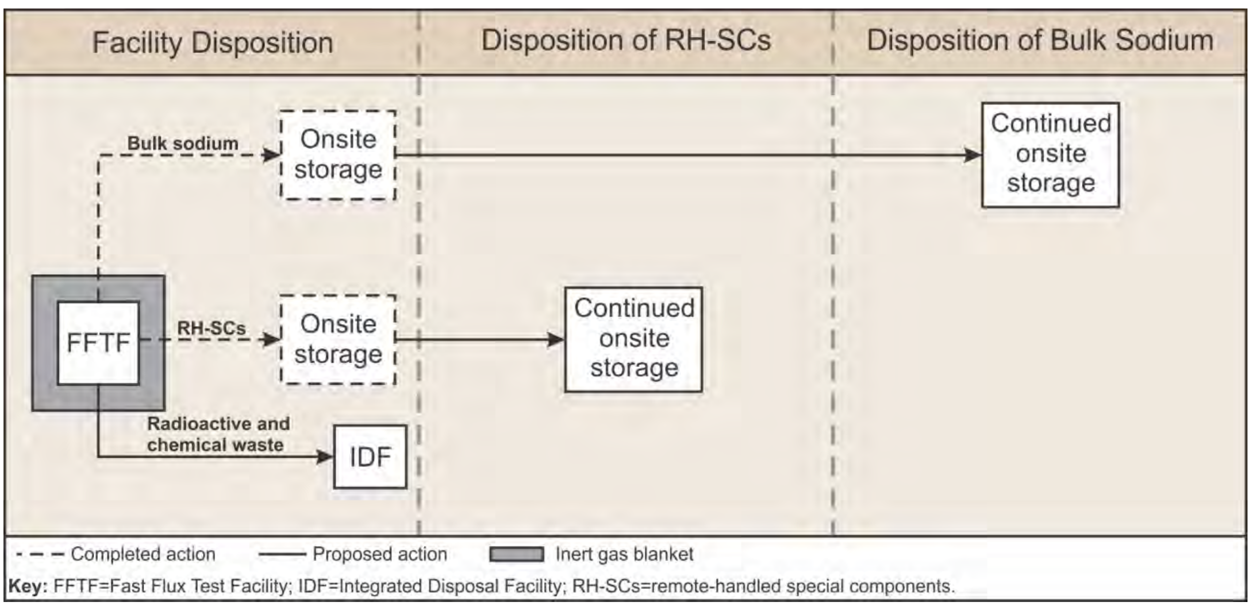


Figure 2–62. FFTF Decommissioning Alternative 1 Primary Components

2.5.3.2 FFTF Decommissioning Alternative 2: Entombment

As shown in Figure 2–63, under FFTF Decommissioning Alternative 2, all of the above-grade (168 meters [550 feet] above mean sea level) structures that are part of the main FFTF reactor building and two adjacent support facilities would be dismantled. Demolition waste would be consolidated in below-grade spaces and stabilized with grout. Small-diameter piping and any sodium residuals would be removed or treated in place. RH-SCs would be removed and treated at either Hanford or INL, and then be disposed of in a Hanford IDF or at NNSS, depending on the treatment option selected. Completion of decommissioning activities is projected in 2020. Under FFTF Decommissioning Alternative 2, the FFTF site would be regraded and revegetated. A modified RCRA Subtitle C barrier would be constructed over the filled area (projected to be complete in 2021), followed by postclosure care and institutional controls for 100 years (through 2121).

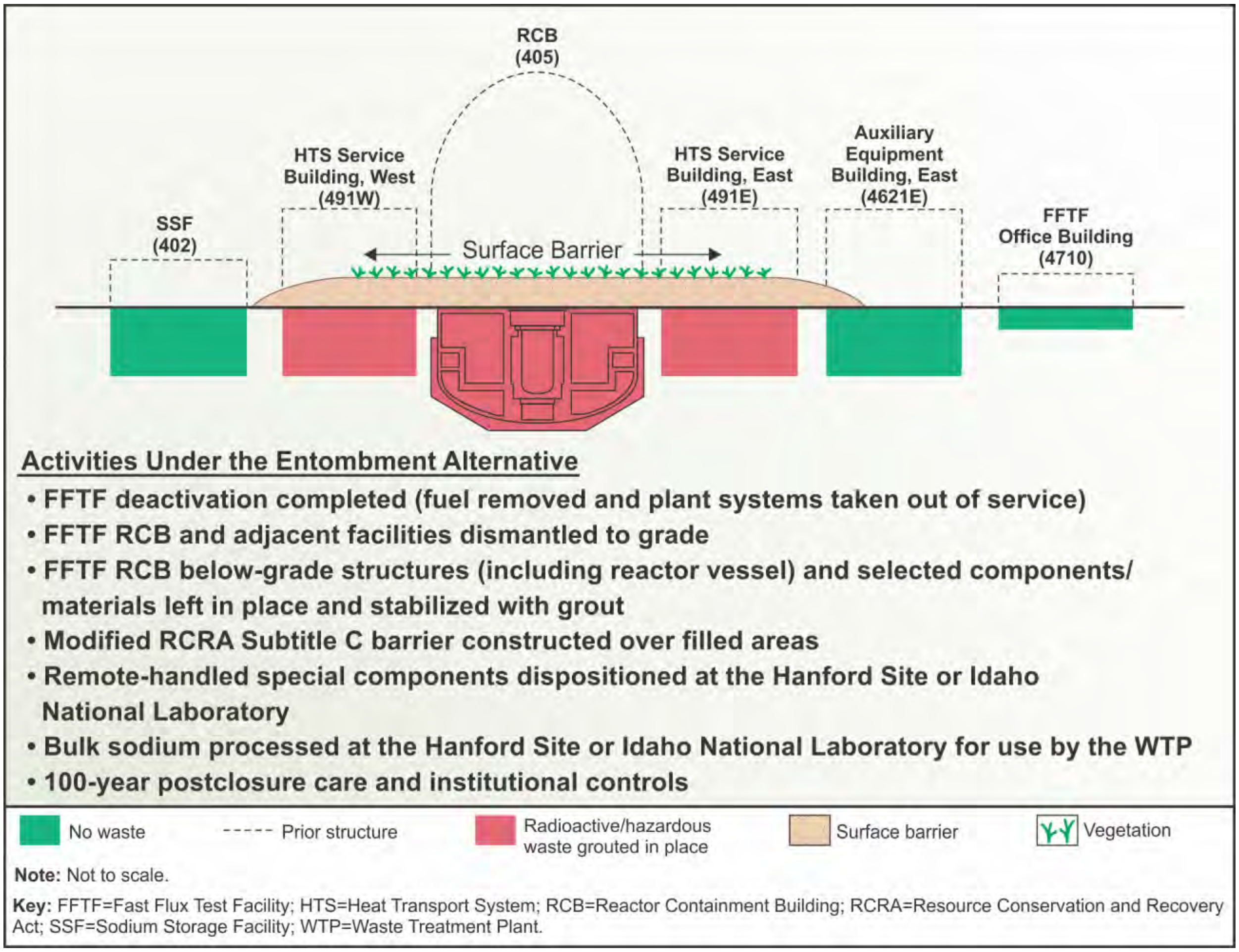


Figure 2–63. FFTF Decommissioning Alternative 2 Overview

Under FFTF Decommissioning Alternative 2, Hanford's bulk sodium inventory would be converted to a caustic sodium hydroxide solution for reuse at Hanford. This inventory includes approximately 916,000 liters (242,000 gallons) of radioactively contaminated bulk sodium drained from FFTF, 128,700 liters (34,000 gallons) from the Hallam Reactor, and 26,500 liters (7,000 gallons) from the SRE. Options for converting the sodium include modifying the SPF at INL, with completion scheduled in 2014, or using the SRF proposed for construction at Hanford, with completion scheduled in 2016. The proposed schedule for implementing FFTF Decommissioning Alternative 2 is presented in Figure 2–64.

Figure 2–64. FFTF Decommissioning Alternative 2 Proposed Schedule

The following activities associated with facility disposition, disposition of RH-SCs, and disposition of bulk sodium, as depicted in Figure 2–65, would occur under FFTF Decommissioning Alternative 2.

Facility disposition. All of the aboveground structures of the RCB and the two immediately adjacent support facilities (Buildings 491E and 491W) would be dismantled. Minimal removal of below-grade structures, equipment, and materials would occur to comply with regulatory standards. The RCB would be demolished and removed to grade, and auxiliary facilities would be removed to 0.91 meters (3 feet) below grade. Equipment, piping, and components containing hazardous and radioactive materials would be removed from below-grade structures only as necessary for treatment to meet regulatory requirements. Any other necessary treatment of equipment or components would occur in place (without removing them from the facilities). Some of the components removed for treatment could be returned to below-grade spaces and be grouted in place with the remaining structures and equipment to stabilize them and minimize void space. Contaminated demolition debris would be disposed of in an IDF. A modified RCRA Subtitle C barrier would be constructed over the RCB and any other remaining below-grade structures (including the reactor vessel) that contain residual radioactive and treated hazardous materials. The area previously occupied by the ancillary facilities would be backfilled, compacted, contoured, and revegetated. Postclosure care and institutional controls would be maintained for 100 years after revegetation is complete. Equipment to be removed under this alternative would include RH-SCs, which contain sufficient quantities of metallic sodium and radionuclides to prevent their treatment and entombment in the RCB with the remaining materials.

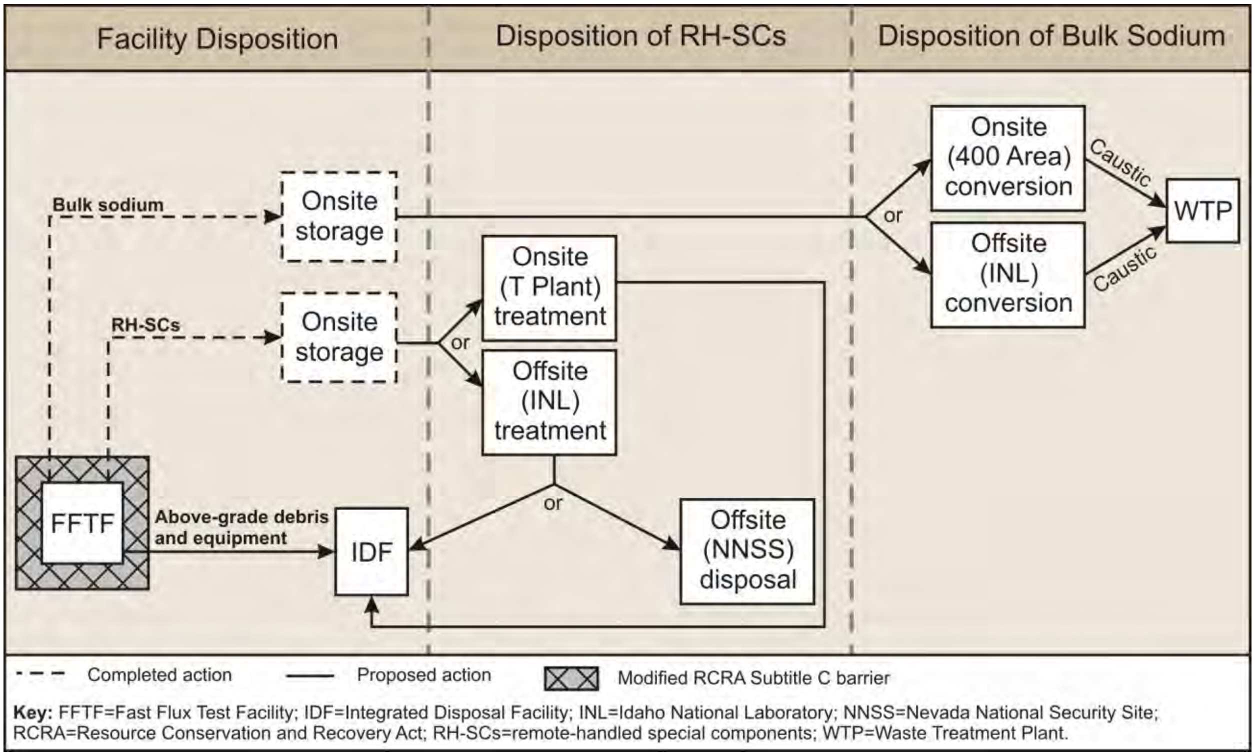


Figure 2–65. FFTF Decommissioning Alternative 2 Primary Components

Disposition of remote-handled special components. RH-SCs, including the primary sodium cold trap, a cesium trap, and two sodium vapor traps, would be removed, treated, and disposed of in an IDF. Removal and storage of these four RH-SCs in the SSF in the 400 Area are covered in the FONSI dated March 31, 2006 (DOE 2006b). These RH-SCs would be treated either in RTP comprising modified hot cells at INTEC at INL, or in a similar RTP proposed for construction near Hanford's T Plant in the 200-West Area. These two options are described below.

- **Hanford Option.** The RH-SCs would be stored in the Hanford 400 Area pending construction of the proposed RTP near Hanford's T Plant. After construction is complete, the RH-SCs would be shipped to the new RTP via truck. Following treatment, the RH-SCs and sodium residuals would be disposed of in an IDF.

- **Idaho Option.** The RH-SCs would be stored in the Hanford 400 Area pending modification of existing facilities for the RTP at INL. When this RTP is complete, the RH-SCs would be shipped to INL via truck and/or rail. The INL RTP is planned to treat RH components that contain comparable levels of radioactive materials, as well as metallic sodium. An environmental assessment has been prepared at INL to evaluate this proposed treatment (DOE 2009a). Following treatment at this RTP, the FFTF RH-SCs and sodium residuals would be either disposed of with other INL waste at NNSS or returned to Hanford for disposal in an IDF.

Disposition of bulk sodium. Hanford's radioactively contaminated bulk sodium inventory consists of approximately 1.1 million liters (300,000 gallons) of metallic sodium, including sodium from the Hallam Reactor and the SRE, as well as sodium drained from the FFTF cooling systems during deactivation. The Hallam and SRE sodium are currently stored in solid form in the Hanford 200-West Area's 2727-W Building and the CWC, respectively. Sodium from FFTF is stored in solid form in the 400 Area within the SSF. The bulk sodium would be converted to a caustic sodium hydroxide solution for product reuse in processing tank waste at the WTP, or for supporting Hanford tank corrosion controls. Two options are being considered for managing Hanford's bulk sodium inventory, as follows:

- **Hanford Reuse Option.** The bulk sodium inventory would be stored in its current locations until it is shipped to the proposed 400 Area SRF for processing. Following processing, the resulting caustic sodium hydroxide solution would be transferred to the WTP in the 200-East Area.

- **Idaho Reuse Option.** The bulk sodium would be stored in its current locations until it is shipped via truck and/or rail to INL for processing. The Hallam sodium would be transported from the 200-West Area to the 400 Area, where it would be transferred into shipping tanks at the SSF before being transported to INL. The capability to process bulk metallic sodium currently exists at INL's SPF, which was previously used to process metallic sodium from EBR-II and other facilities. Following processing, the caustic sodium hydroxide solution would be returned to Hanford.

2.5.3.3 FFTF Decommissioning Alternative 3: Removal

As shown in Figure 2–66, under FFTF Decommissioning Alternative 3, all above-grade structures around the main RCB and the two adjacent support facilities would be dismantled. The RCB would be demolished to grade and the support facilities to 0.91 meters (3 feet) below grade. Contaminated demolition waste would be disposed of in an IDF. The reactor vessel, its internal piping and equipment, and its attached depleted-uranium shielding would be filled with grout, removed, packed, and disposed of in an IDF. All other radioactively contaminated equipment and hazardous materials, including asbestos and lead shielding, also would be removed for disposal.

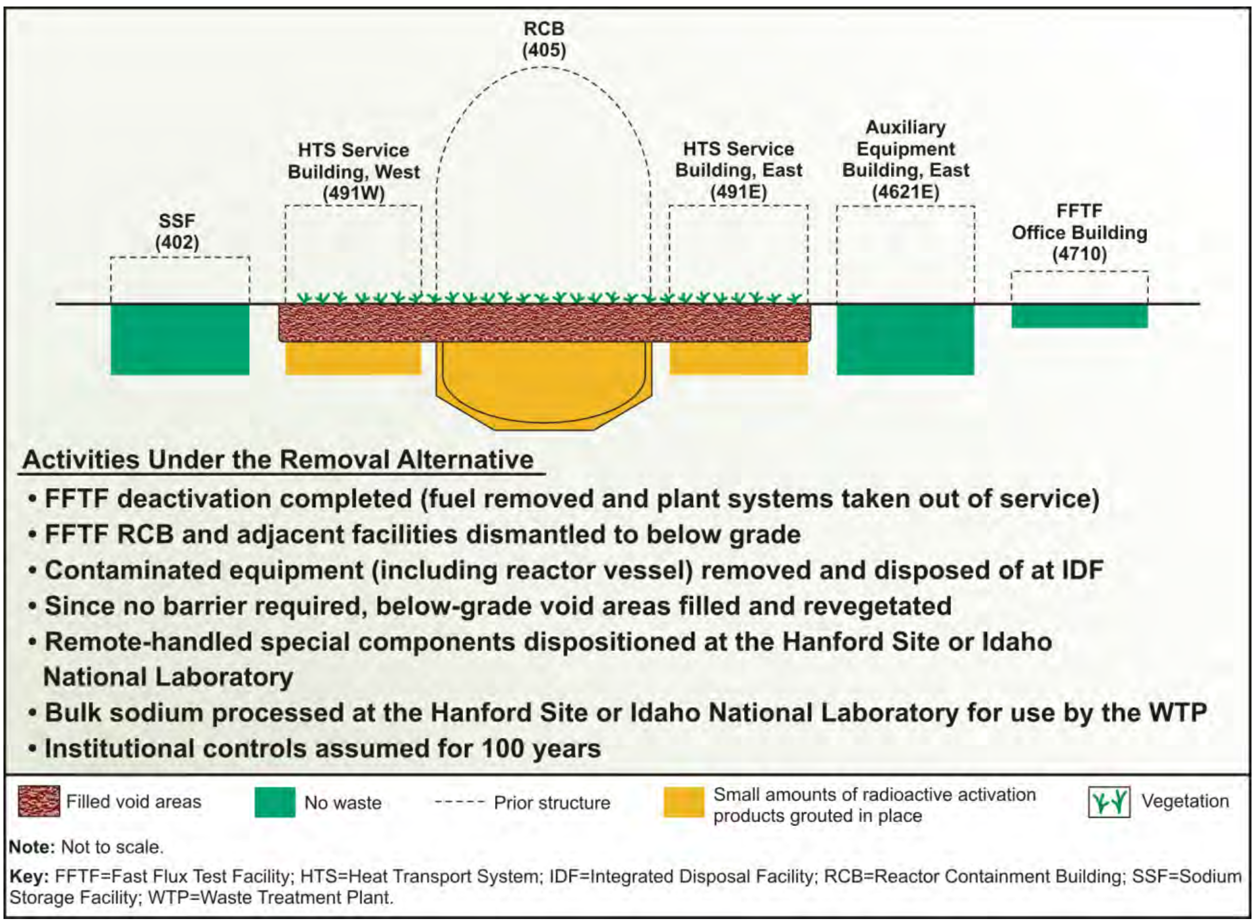


Figure 2–66. FFTF Decommissioning Alternative 3 Overview

In addition, all small-diameter piping would be removed, treated in the 400 Area to remove sodium residuals, and disposed of on site in an IDF. Similar to FFTF Decommissioning Alternative 2, the RH-SCs would be removed and treated at either Hanford or INL and be disposed of in an IDF at Hanford or at NNSS, depending on the treatment option. The remaining lower portion of the RCB concrete shell would be backfilled with either soil or grout to minimize void space. Decommissioning activities are projected to be complete in 2020. Under FFTF Decommissioning Alternative 3, the FFTF site would be regraded and revegetated in 2021, with no barrier required. Institutional controls, which potentially could include postclosure care, may be established and continue for 100 years (through 2121) after revegetation of the area is complete.

Under FFTF Decommissioning Alternative 3, Hanford's bulk sodium inventory would be converted to a caustic sodium hydroxide solution for use in the WTP. As under FFTF Decommissioning Alternative 2, options for converting the sodium include modifying the SPF at INL (construction scheduled for completion in 2014) or using the SRF proposed for construction at Hanford (construction scheduled for completion in 2016). The proposed schedule for implementing FFTF Decommissioning Alternative 3 is presented in Figure 2–67.

Figure 2–67. FFTF Decommissioning Alternative 3 Proposed Schedule

The following activities associated with facility disposition, disposition of RH-SCs, and disposition of bulk sodium, as depicted in Figure 2–68, would occur under FFTF Decommissioning Alternative 3.

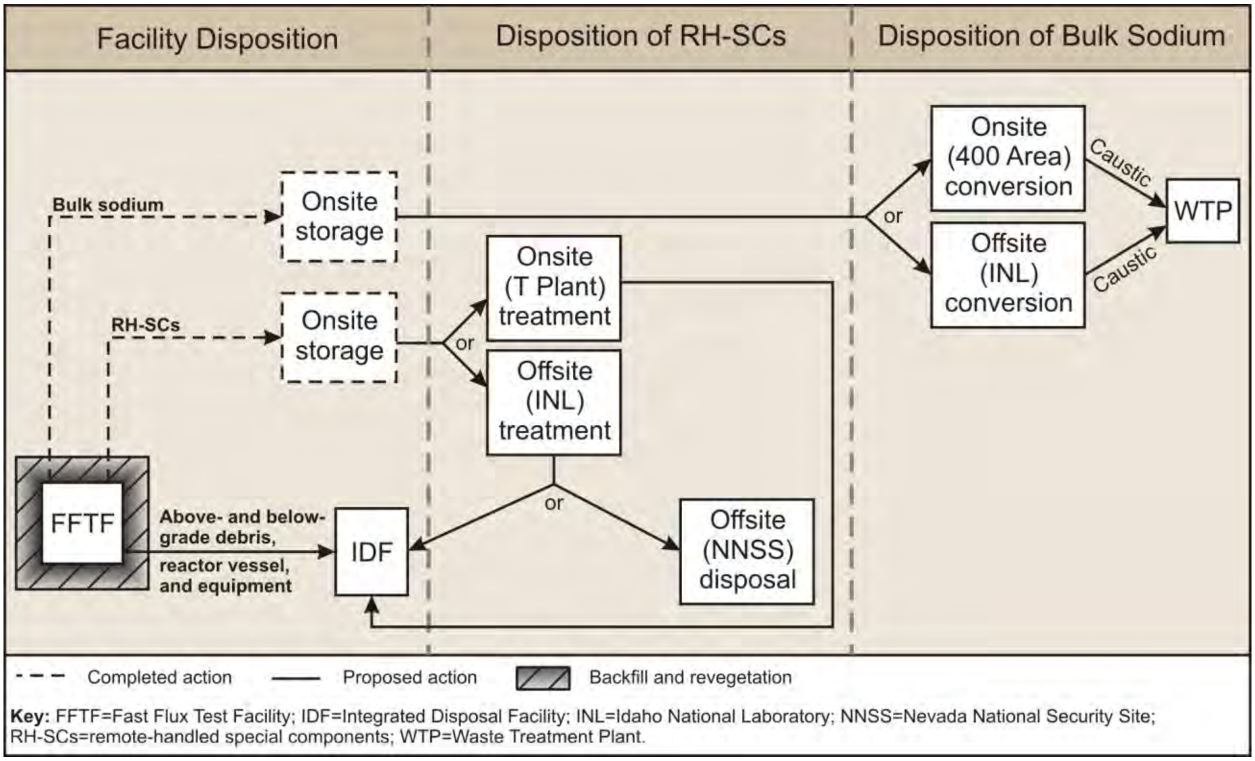


Figure 2–68. FFTF Decommissioning Alternative 3 Primary Components

Facility disposition. All of the aboveground structures of the RCB and the two adjacent support facilities (Buildings 491E and 491W) would be dismantled. The reactor vessel, as well as any internal piping and equipment and attached depleted-uranium shielding, would be filled with grout, removed, packaged, and disposed of in an IDF. All other radioactively contaminated equipment and hazardous materials down to 0.91 meters (3 feet) below grade, including asbestos and lead shielding and contaminated demolition debris, would also be removed and disposed of in an IDF. The remaining structures and equipment, consisting mainly of the external RCB structure and associated components, as well as uncontaminated below-grade portions of the auxiliary facilities, would be backfilled or grouted to minimize void space. The PPA would be backfilled to grade, contoured, and revegetated as necessary to stabilize the ground surface or to prepare the site for future industrial use. Institutional controls would be maintained for 100 years after revegetation is complete.

Disposition of remote-handled special components. The two options considered under FFTF Decommissioning Alternative 2 are also considered under FFTF Decommissioning Alternative 3. The RH-SCs would be removed, treated, and disposed of in an IDF. Removal and storage of the four RH-SCs in the SSF in the 400 Area are covered in the FONSI dated March 31, 2006 (DOE 2006b). These RH-SCs would be treated either in RTP comprising modified hot cells at INTEC at INL, or in a similar RTP proposed for construction near Hanford's T Plant in the 200-West Area. These two options are described below.

- **Hanford Option.** The RH-SCs would be stored in the Hanford 400 Area pending construction of the proposed RTP near Hanford's T Plant. After construction is complete, the RH-SCs would be shipped to the new RTP via truck. Following treatment, the RH-SCs and sodium residuals would be disposed of in an IDF.

- **Idaho Option.** The RH-SCs would be stored in the Hanford 400 Area pending modification of existing facilities for the RTP at INL. When this RTP is complete, the RH-SCs would be shipped to INL via truck and/or rail. The INL RTP is planned to treat RH components that contain comparable levels of radioactive materials, as well as metallic sodium. An environmental assessment has been prepared at INL to evaluate this proposed treatment (DOE 2009a). Following treatment at this RTP, the FFTF RH-SCs and sodium residuals would be either disposed of with other INL waste at NNSS or returned to Hanford for disposal in an IDF.

Disposition of bulk sodium. The two options considered for disposition of radioactively contaminated bulk sodium under FFTF Decommissioning Alternative 2 are also considered under FFTF Decommissioning Alternative 3. Hanford's bulk sodium inventory would be converted to a caustic sodium hydroxide solution for product reuse in processing tank waste at the WTP or for supporting Hanford tank corrosion controls. The two options being considered for managing Hanford's bulk sodium inventory are as follows:

- **Hanford Reuse Option.** The bulk sodium inventory would be stored in its current locations until it can be shipped to the proposed 400 Area SRF for processing. Following processing, the caustic sodium hydroxide solution would be transferred to the WTP in the 200-East Area.

- **Idaho Reuse Option.** The bulk sodium would be stored in its current locations until it can be shipped via truck and/or rail to INL for processing in the SPF. The Hallam sodium would be transported from the 200-West Area to the 400 Area, where it would be transferred into shipping tanks at the SSF before being transported to INL. The capability to process bulk metallic sodium currently exists at INL's SPF, which was previously used to process metallic sodium from the EBR-II and other facilities. Following processing, the caustic sodium hydroxide solution would be returned to Hanford.

2.5.4 Waste Management Alternatives

The Waste Management alternatives are described in detail in this section. A summary of these alternatives by mission components is provided in Table 2–4.

Table 2–4. Waste Management Alternatives – Summary by Mission Component

Mission Component	Range of Action	Alternative		
		1	2	3
Storage	Existing storage at CWC for LLW, MLLW, and TRU waste	X		
	Expanded storage at CWC for LLW, MLLW, and TRU waste		X	X
	Existing storage of onsite LLW, MLLW, and TRU waste on site at WRAP and T Plant	X		
	Expanded storage of onsite LLW, MLLW, and TRU waste on site at WRAP and T Plant		X	X
Treatment	Existing CWC treatment (LLW, MLLW, and TRU waste)	X		
	Expanded CWC treatment (LLW, MLLW, and TRU waste)		X	X
	Existing WRAP and T Plant treatment (LLW, MLLW, and TRU waste)	X		
	Expanded WRAP and T Plant treatment (LLW, MLLW, and TRU waste)		X	X
Disposal	Continued onsite disposal of onsite non-CERCLA, nontank LLW and MLLW in LLBG 218-W-5, trenches 31 and 34	X	X	X
	200-East Area IDF construction terminated and facility deactivated	X		
	Disposal of tank, onsite non-CERCLA, FFTF decommissioning, waste management, and offsite LLW and MLLW at 200-East Area IDF		X	
	Disposal of tank waste only at 200-East Area IDF and onsite non-CERCLA, FFTF decommissioning, waste management, and offsite LLW and MLLW at 200-West Area IDF			X
	Disposal of rubble, ancillary equipment, and soils (not highly contaminated) from closure activities in RPPDF		X	X
Closure	None	X		
	Landfill closure of IDF(s) and RPPDF		X	X
	Administrative control for 100 years	X		
	Postclosure care for 100 years		X	X

Key: CERCLA=Comprehensive Environmental Response, Compensation, and Liability Act; CWC=Central Waste Complex; FFTF=Fast Flux Test Facility; IDF=Integrated Disposal Facility; LLBG=low-level radioactive waste burial ground; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WRAP=Waste Receiving and Processing Facility.

2.5.4.1 Waste Management Alternative 1: No Action

The scope of the Waste Management No Action Alternative is based on the requirements of the TPA (Ecology, EPA, and DOE 1989); the Memorandum of Understanding between DOE and Ecology (dated January 6, 2006) (DOE and Ecology 2006); and the ROD (69 FR 39449; June 30, 2004) for the *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington (HSW EIS)* (DOE 2004b). As shown in Figure 2–69, the Waste Management No Action Alternative includes continued storage of LLW, MLLW, and TRU waste at the CWC (Building 2403-WD) in the 200-West Area, with no expanded storage capacity required. At the CWC, the LLW and MLLW would be processed for disposal in LLBG 218-W-5, trenches 31 and 34. These trenches are the only lined trenches in the LLBGs and would receive onsite non-CERCLA, nontank LLW and MLLW until this waste stream is no longer generated (until 2035).[13] TRU waste would be shipped to and disposed of in WIPP. The proposed schedule for implementing Waste Management Alternative 1 is presented in Figure 2–70.

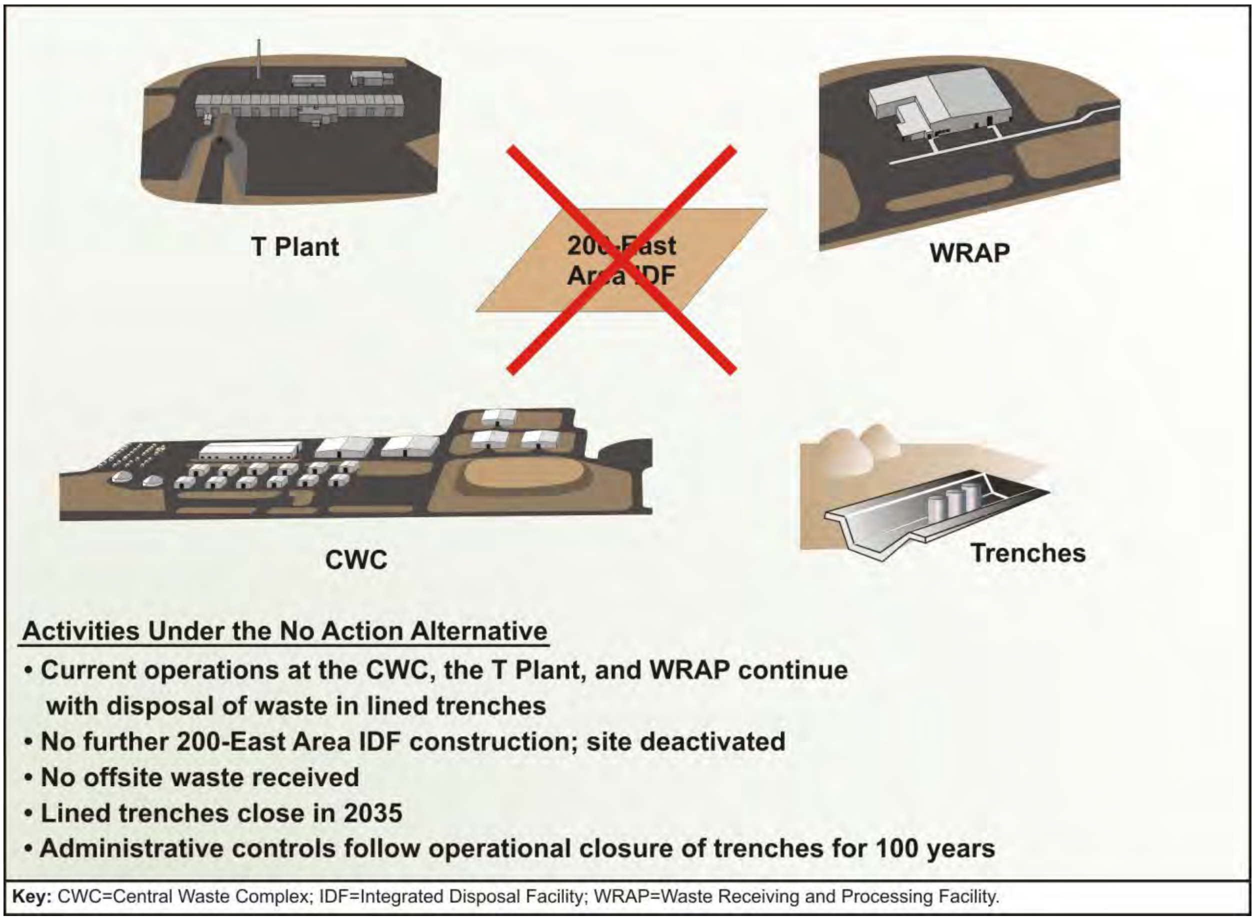


Figure 2–69. Waste Management Alternative 1 Overview

[13] Retrieval, treatment, storage, and packaging of retrievably stored radioactive waste buried before 1970 was not analyzed as a discrete component of the *TC & WM EIS* Waste Management alternatives; however, this waste was addressed in Appendix E, Section E.3.3.1. Shipment of TRU waste to WIPP was analyzed in the *WIPP SEIS-II* (DOE 1997b).

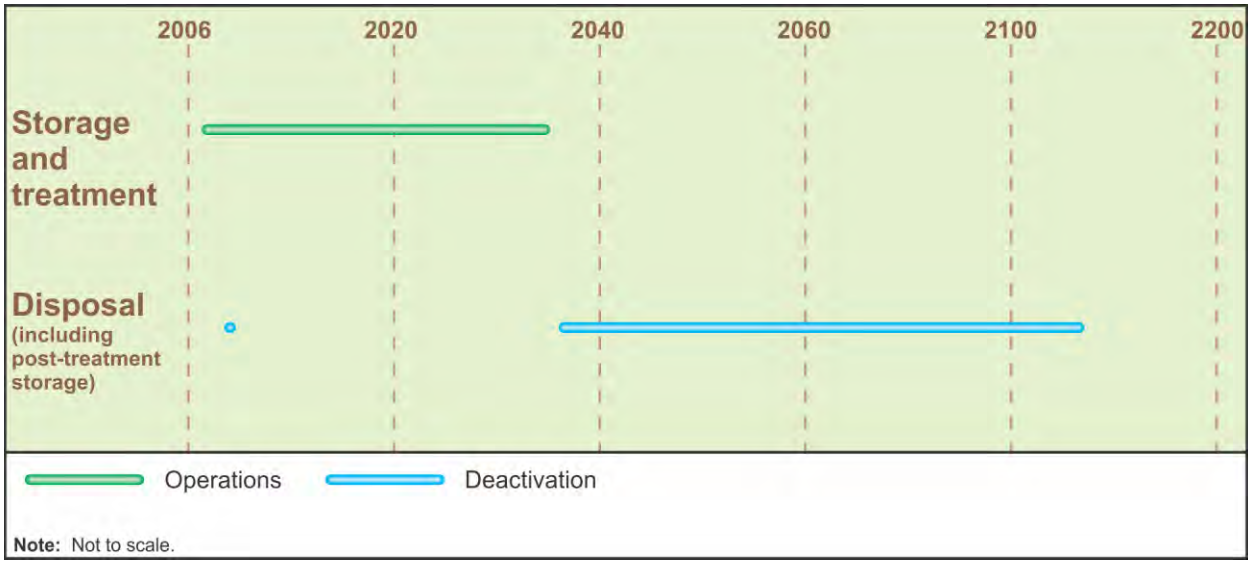


Figure 2–70. Waste Management Alternative 1 Proposed Schedule

Onsite LLW, MLLW, and TRU waste would continue to be stored and treated at WRAP and the T Plant complex. Limited shipments of offsite LLW, MLLW, or TRU waste would continue to be sent to Hanford, consistent with the January 6, 2006, enforceable Settlement Agreement with the State of Washington (as amended on June 5, 2008) regarding *State of Washington v. Bodman* (Civil No. 2:03-cv-05018-AAM), signed by DOE, Ecology, the Washington State Attorney General's Office, and the U.S. Department of Justice (see Chapter 8, Section 8.1.1). Under the Waste Management No Action Alternative, further construction of IDF-East would discontinue in 2008, and IDF-East would be deactivated in 2009. Deactivation would include removing the liner and backfilling the excavated site. No barriers would be constructed over LLBG 218-W-5 trenches 31 and 34 or the CWC, WRAP, or T Plant complex. There would be a 100-year administrative control period through 2135. Figure 2–71 illustrates the primary components of the Waste Management No Action Alternative.

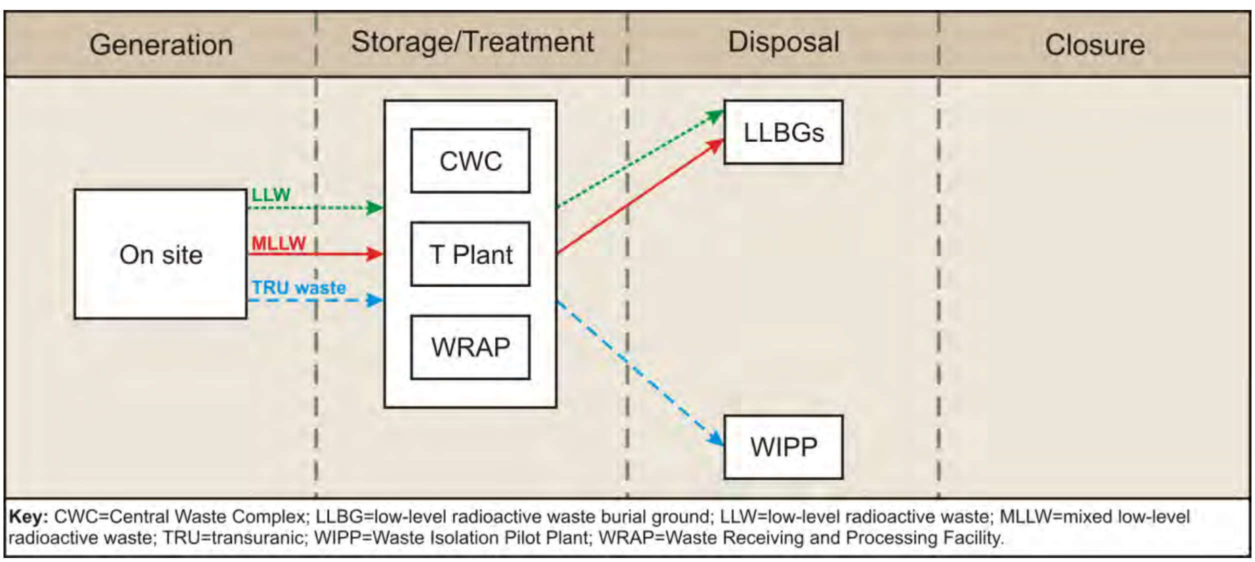
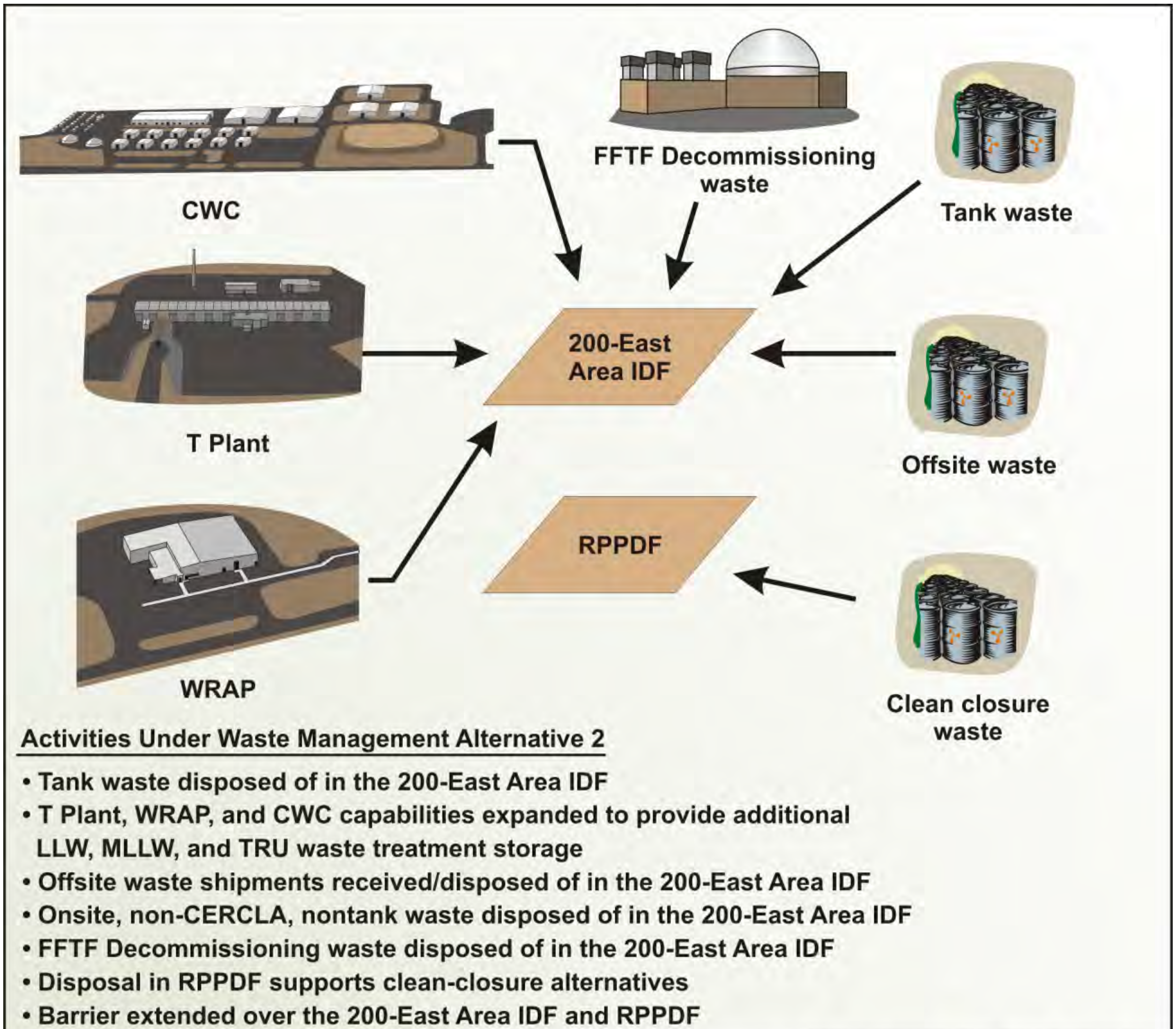


Figure 2–71. Waste Management Alternative 1 Primary Components

2.5.4.2 Waste Management Alternative 2: Disposal in IDF, 200-East Area Only

As shown in Figure 2–72, Waste Management Alternative 2 evaluates continued storage and processing of LLW, MLLW, and TRU waste through 2050 using existing and expanded capabilities at the CWC, T Plant complex, and WRAP. Construction of expanded storage/processing facilities would be completed by 2018, and these facilities would be deactivated in 2051. Under Waste Management Alternative 2, disposal of LLW and MLLW in LLBG 218-W-5 trenches 31 and 34 would continue until they are filled in 2050. IDF-East and the proposed RPPDF would accept waste for disposal until as late as 2165, after which these disposal facilities would be covered with modified RCRA Subtitle C barriers, followed by postclosure care for 100 years (through as late as 2267). The proposed schedule for implementing Waste Management Alternative 2 is presented in Figure 2–73.



Key: CERCLA=Comprehensive Environmental Response, Compensation, and Liability Act; CWC=Central Waste Complex; FFTF=Fast Flux Test Facility; IDF=Integrated Disposal Facility; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WRAP=Waste Receiving and Processing Facility.

Figure 2–72. Waste Management Alternative 2 Overview

Figure 2–73. Waste Management Alternative 2 Proposed Schedule

The following storage, disposal, and closure activities, as depicted in Figure 2–74, would occur under Waste Management Alternative 2.

Storage. DOE would continue to store and process LLW, MLLW, and TRU waste at the CWC until disposal. A new storage facility with a capacity of 17,500 drums of waste would be constructed in Building 2403-WD. Two expansions of WRAP would be constructed and operated: (1) additional CH-LLW, CH-MLLW, and CH-TRU waste processing capability at the CWC to match the current WRAP's existing capability and (2) an RH-TRU waste processing capability at the WRAP site. The T Plant also would be expanded to handle oversized CH-LLW and CH-MLLW packages (duplicating the capabilities of the 2706-T/TA/TB Facility).

Offsite LLW and MLLW would be treated off site by the generator or commercial treatment operations prior to shipment to Hanford. No offsite TRU waste would be shipped to Hanford. Offsite-waste shipments would be limited to a total volume of 82,000 cubic meters (107,000 cubic yards), including 62,000 cubic meters (81,000 cubic yards) of LLW and 20,000 cubic meters (26,000 cubic yards) of MLLW.

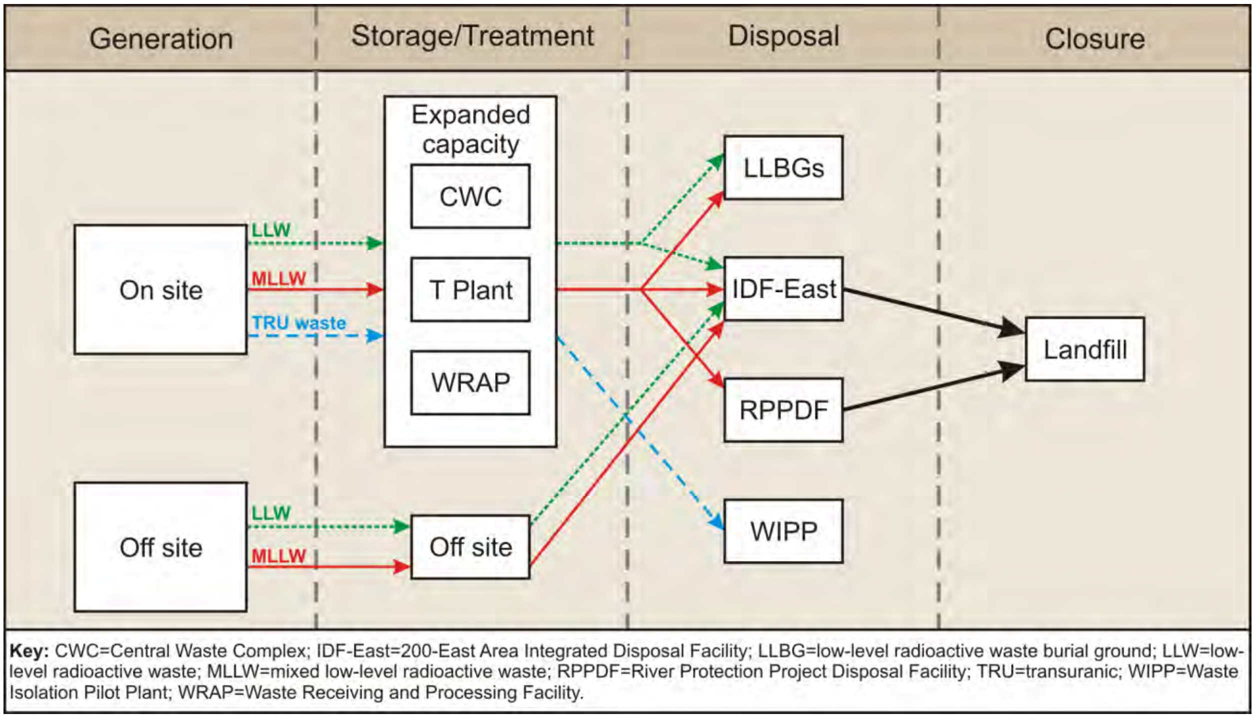


Figure 2–74. Waste Management Alternative 2 Primary Components

Disposal. DOE would continue disposing of onsite non-CERCLA, nontank LLW and MLLW in LLBG 218-W-5, trenches 31 and 34, until they are filled in 2050. IDF-East would be used for disposal of tank, onsite non-CERCLA, FFTF decommissioning, waste management, and offsite LLW and MLLW. The RPPDF would be used for disposal of lightly contaminated equipment and soils resulting from closure activities. TRU waste would be disposed of in WIPP. Three disposal groups were analyzed under Waste Management Alternative 2:

- Disposal Group 1: IDF-East would have a capacity of 1.2 million cubic meters (1.57 million cubic yards), and the proposed RPPDF would have a capacity of 1.08 million cubic meters (1.41 million cubic yards). Both facilities would operate through 2050. The following alternatives are associated with this disposal group: Tank Closure Alternatives 2B, 3A, 3B, 3C, 4, 5, and 6C and FFTF Decommissioning Alternatives 2 and 3.

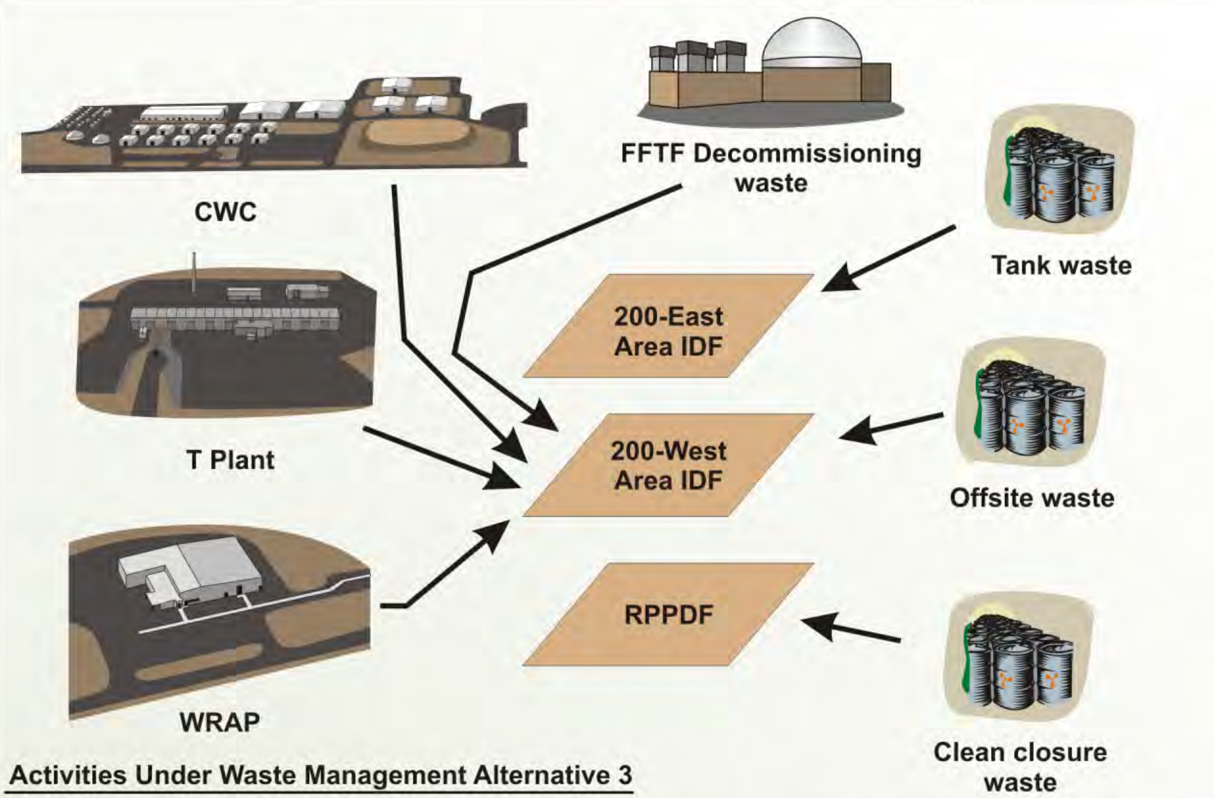
- Disposal Group 2: IDF-East would have a capacity of 425,000 cubic meters (556,000 cubic yards), and the proposed RPPDF would have a capacity of 8.37 million cubic meters (10.9 million cubic yards). Both facilities would operate through 2100. The following alternatives are associated with this disposal group: Tank Closure Alternatives 2A and 6B and FFTF Decommissioning Alternatives 2 and 3.

- Disposal Group 3: IDF-East would have a capacity of 425,000 cubic meters (556,000 cubic yards), and the proposed RPPDF would have a capacity of 8.37 million cubic meters (10.9 million cubic yards). Both facilities would operate through 2165. The following alternatives are associated with this disposal group: Tank Closure Alternative 6A and FFTF Decommissioning Alternatives 2 and 3.

Closure. IDF-East and the proposed RPPDF would be covered with engineered modified RCRA Subtitle C barriers to reduce water infiltration and the potential for intrusion. A 100-year postclosure care period would follow.

2.5.4.3 Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas

Waste Management Alternative 3 is similar to Waste Management Alternative 2 in that it would continue storage and processing of LLW, MLLW, and TRU waste through 2050 using existing and expanded capabilities at the CWC, T Plant complex, and WRAP. As shown in Figure 2–75, expanded storage and processing facilities would be constructed by 2018 and deactivated in 2051. Under Waste Management Alternative 3, disposal of LLW and MLLW would continue in LLBG 218-W-5, trenches 31 and 34, until they are filled in 2050. Both IDF-East and the proposed RPPDF would accept waste for disposal until as late as 2165. Under Waste Management Alternative 3, however, IDF-West would also be constructed and operated. IDF-East would be used for disposal of tank waste only; IDF-West would be used for disposal of onsite non-CERCLA and offsite LLW and MLLW, as well as FFTF decommissioning and waste management wastes. When closed, these disposal facilities would be covered with engineered modified RCRA Subtitle C barriers, followed by a postclosure care period of 100 years (through as late as 2267). The proposed schedule for implementing Waste Management Alternative 3 is presented in Figure 2–76.



Activities Under Waste Management Alternative 3

- **Tank waste disposed of in the 200-East Area IDF**
- **T Plant, WRAP, and CWC capabilities expanded to provide additional LLW, MLLW, and TRU waste treatment storage for waste disposal in the 200-West Area IDF**
- **Offsite waste shipments received/disposed of in the 200-West Area IDF**
- **Onsite, non-CERCLA, nontank waste disposed of in the 200-West Area IDF**
- **FFTF Decommissioning waste disposed of in the 200-West Area IDF**
- **Disposal in RPPDF supports clean-closure alternatives**
- **Barrier extended over IDFs and RPPDF**

Key: CERCLA=Comprehensive Environmental Response, Compensation, and Liability Act; CWC=Central Waste Complex; FFTF=Fast Flux Test Facility; IDF=Integrated Disposal Facility; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WRAP=Waste Receiving and Processing Facility.

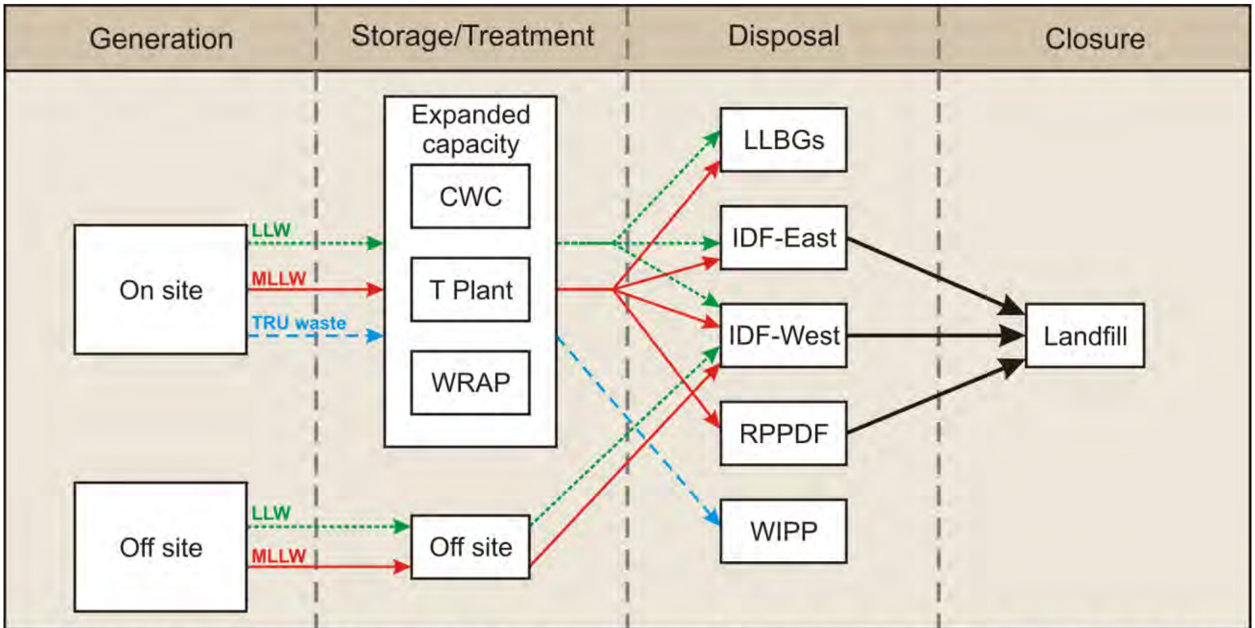
Figure 2–75. Waste Management Alternative 3 Overview

Figure 2–76. Waste Management Alternative 3 Proposed Schedule

The following storage, disposal, and closure activities, as depicted in Figure 2–77, would occur under Waste Management Alternative 3.

Storage. DOE would continue storing and processing LLW, MLLW, and TRU waste at the CWC until disposal. A new storage facility with a capacity of 17,500 drums of waste would be constructed in Building 2403-WD. WRAP would be expanded to provide additional LLW, MLLW, and CH-TRU waste processing capabilities at the CWC to match the existing capability at the current WRAP, as well as an RH-TRU waste processing capability at the WRAP site. Under Waste Management Alternative 3, the T Plant also would be expanded to accommodate oversized CH-LLW and CH-MLLW packages (a duplication of the 2706-T/TA/TB Facility).

Offsite LLW and MLLW would be treated off site by the generator or commercial treatment operations prior to shipment to Hanford. No offsite TRU waste would be shipped to Hanford. Offsite-waste shipments would be limited to a total volume of 82,000 cubic meters (107,000 cubic yards), including 62,000 cubic meters (81,000 cubic yards) of LLW and 20,000 cubic meters (26,000 cubic yards) of MLLW.



Key: CWC=Central Waste Complex; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; LLBG=low-level radioactive waste burial ground; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WIPP=Waste Isolation Pilot Plant; WRAP=Waste Receiving and Processing Facility.

Figure 2–77. Waste Management Alternative 3 Primary Components

Disposal. DOE would continue disposing of onsite non-CERCLA, nontank LLW and MLLW in LLBG 218-W-5, trenches 31 and 34, until they are filled in 2050. After construction, IDF-East and IDF-West would undergo operations, deactivation, closure, and postclosure care. IDF-East would be used for disposal of waste from tank treatment operations. Onsite non-CERCLA, FFTF decommissioning, waste management, and offsite waste would be disposed of in IDF-West cells. The RPPDF would be constructed and operated for disposal of lightly contaminated equipment and soils resulting from closure activities. TRU waste would be disposed of in WIPP. Three disposal groups were analyzed under Waste Management Alternative 3:

- Disposal Group 1: IDF-East would have a capacity of 1.1 million cubic meters (1.43 million cubic yards), IDF-West would have a capacity of 90,000 cubic meters (118,000 cubic yards), and the proposed RPPDF would have a capacity of 1.08 million cubic meters (1.41 million cubic yards). All three facilities would operate through 2050. The following alternatives are associated with this disposal group: Tank Closure Alternatives 2B, 3A, 3B, 3C, 4, 5, and 6C and FFTF Decommissioning Alternatives 2 and 3.

- Disposal Group 2: IDF-East would have a capacity of 340,000 cubic meters (445,000 cubic yards), IDF-West would have a capacity of 90,000 cubic meters (118,000 cubic yards), and the proposed RPPDF would have a capacity of 8.37 million cubic meters (10.9 million cubic yards). IDF-East and the proposed RPPDF would operate through 2100. IDF-West would operate through 2050. The following alternatives are associated with this disposal group: Tank Closure Alternatives 2A and 6B and FFTF Decommissioning Alternatives 2 and 3.

- Disposal Group 3: IDF-East would have a capacity of 340,000 cubic meters (445,000 cubic yards), IDF-West would have a capacity of 90,000 cubic meters (118,000 cubic yards), and the proposed RPPDF would have a capacity of 8.37 million cubic meters (10.9 million cubic yards). IDF-East and the proposed RPPDF would operate through 2165. IDF-West would operate through 2050. The following alternatives are associated with this disposal group: Tank Closure Alternative 6A and FFTF Decommissioning Alternatives 2 and 3.

Closure. When closed, these disposal facilities would be covered with engineered modified RCRA Subtitle C barriers. Closure activities would occur at the two IDFs and RPPDF only and would include a 100-year postclosure care period.

2.6 TECHNOLOGIES AND OPTIONS CONSIDERED BUT NOT EVALUATED IN DETAIL

In developing the range of reasonable alternatives for tank closure, FFTF decommissioning, and waste management, DOE examined numerous technologies and options. The technologies and options discussed in this section were initially considered, but were subsequently dismissed as reasonable alternatives under NEPA for meeting DOE's purpose and need. The following sections provide a brief discussion of these technologies and options as applicable to the three sets of proposed actions, as well as the bases for why they were deemed unreasonable and were not considered further. A discussion has also been added to address the Oregon State Department of Energy's proposal that DOE add an additional Tank Closure alternative (see Section 2.6.4).

2.6.1 Tank Closure

Evaluation of tank waste disposal alternatives has been ongoing since waste storage in underground tanks was first recognized as a temporary solution to a long-term problem. Numerous technologies and approaches have been examined for the storage, retrieval, treatment, and disposal of tank waste, as well as closure of the SST system. This section summarizes the alternatives and technologies that were considered but not evaluated in detail in this *TC & WM EIS*. The following criteria were used to determine whether an alternative or technology would be appropriate for detailed evaluation:

- Is the alternative or technology relevant to the purpose and need for agency action in this EIS?
- Is the alternative or technology technically viable and practicable?
- Can the alternative or technology be designed to be protective of human health and the environment, with practicable mitigative measures?
- Is the technology sufficiently mature to allow detailed evaluation? Would the costs and time required to develop the technology for application at Hanford be feasible?
- Is the technology appreciably different from an alternative already included in this EIS, or does it offer potential advantages in terms of effectiveness, costs, or impacts on human health and the environment?

If the answer to any of the above questions was no, DOE determined that the alternative or technology was not reasonable for further consideration and evaluation in this *TC & WM EIS*.[14] Therefore, the following waste storage, retrieval, treatment, and disposal and tank closure approaches were deemed unreasonable and were not evaluated in detail. A more indepth discussion of these technologies is provided in Appendix E, Section E.1.3.

[14] Additionally, in 2007, DOE conducted a Technology Readiness Assessment to determine the maturity level of the LAW treatment technologies considered for use under the *TC & WM EIS* alternatives (WTP vitrification, bulk vitrification, cast stone, and steam reforming). Appendix E, Section E.1.3.3.1, summarizes this assessment.

Waste storage. Some alternatives may require additional storage capacity above and beyond the current DST capacity. The selected storage arrangement is the construction of new below-grade DSTs. The following storage options were considered but not evaluated:

- Modification of existing canyon facilities – This option was not evaluated in detail because (1) the existing canyon facilities are not designed for storage of large volumes of liquid waste; (2) the existing radiation and contamination levels would result in elevated personnel exposure; (3) the low volume of storage space would not be cost-effective; and (4) environmental permitting is highly uncertain.

- New above-grade DSTs – This option was not evaluated in detail because (1) there are technical disadvantages associated with shielding large (3.8-million-liter [1-million-gallon]) aboveground tanks and (2) the resources required for construction and operation of new aboveground tanks would be similar to those associated with below-grade tanks.

- Staging of retrieved waste in SSTs – This option was not evaluated in detail in this *TC & WM EIS* due to several factors, one being that the SSTs have been declared unfit for use and cannot readily be made compliant with current regulations. However, DOE is considering staging waste in SSTs as an option to building additional DSTs. Ecology has identified a number of factors that would influence its potential acceptance of this approach, including (1) upgrades of systems with additional leak detection, monitoring, and mitigation capabilities; (2) replacement of waste transfer pumps, transfer lines, and ventilation systems; (3) maintenance of the interim stabilization criteria after the waste is staged; (4) development of a liquid waste management plan; and (5) agreement on selection criteria for the tanks to be used. At present, criteria for determining which tanks are suitable for staging have not been identified. Infrastructure needs have been identified at a system level, but specific design information related to a particular tank or tank farm has not been identified. In addition, liquid waste management issues associated with meeting the interim stabilization criteria would need to be addressed. If these issues were addressed, SST staging would be similar to the proposed waste transfers and waste storage activities for WRFs and/or DSTs. Near-term actions associated with these activities, as well as their impacts, are evaluated under Tank Closure Alternatives 2 through 6.

Waste retrieval. A number of technologies were initially considered to retrieve waste from the SSTs. Each of these technologies is flexible regarding the general equipment configuration, fluid velocities and flow rates, and methods of operation. Some are better suited to tank-specific considerations such as riser availability, waste condition, or in-tank interferences. Although the following technologies were not considered reasonable for detailed analysis in this *TC & WM EIS*, this does not preclude their future consideration as potentially viable approaches for retrieving waste from the SSTs.

- Past-practice sluicing, fluidic mixing, and salt cake dissolution – These retrieval technologies were addressed in the *TWRS EIS*. However, they are very similar to, and are effectively encompassed by, the retrieval technologies evaluated in this *TC & WM EIS*.

Treatment technologies. The following treatment and pretreatment technologies were initially considered but were eliminated from detailed consideration in this *TC & WM EIS*:

- Active metal reduction – This LAW treatment technology was not evaluated in detail in this *TC & WM EIS* due primarily to its relative technical immaturity and complexities, as well as operational safety issues related to flammable gas generation.

- Fractional crystallization – This technology was not evaluated in detail as a supplemental pretreatment process due to concerns over waste form performance with respect to nitrate, difficulty of operations, complexity of the process, and lack of data demonstrating applicability to actual tank waste.

- HLW and LAW vitrification with phosphate glass – This technology was not evaluated in detail because the phosphate glass formula has not been proven compatible with production-scale melters, and the resulting product glass has not been shown to meet the waste acceptance technical requirements for DOE's Civilian Radioactive Waste Management System (DOE 2007). Other WTP melter configurations and waste forms were not evaluated in detail in this *TC & WM EIS* because of DOE's intention to construct and operate the WTP as currently designed, using current melter technology and glass formulations.

- Preprocessing tank waste with a plasma mass separator – This technology was not evaluated in detail in this *TC & WM EIS* due to its present immaturity and the need for further testing and demonstration of its applicability to managing Hanford tank waste.

Disposal. The following disposal approaches were initially considered, but were eliminated from detailed evaluation in this *TC & WM EIS*:

- The *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE 1997a) provided analysis of potential environmental impacts of broad alternatives for DOE's waste management program to provide a basis for DOE decisions on programmatic configurations of sites for waste management activities. One of DOE's decisions based on this EIS addressed disposal of LLW and MLLW, and DOE decided that Hanford would dispose of its own LLW and MLLW on site (65 FR 10061). There is no new information that would compel reconsideration of this decision. Therefore, the option of disposing of these wastes off site was eliminated from further consideration in this EIS.

- An option considered for the disposal of the HLW melters taken out of service was onsite disposal. As the HLW melters have not been installed or operated, a high degree of uncertainty exists about their operation, lifespan, waste characterization, and waste classification. As a result, this *TC & WM EIS* assumed a conservative (i.e., economically and with consideration of the human health impacts of melter storage, transportation, and disposal) disposition of the melters; the HLW melters would be stored on site until disposition decisions are made and implemented. Thus, onsite disposal was eliminated from further consideration in this EIS.

Tank system closure and facility D&D. The following technologies, each of which could provide in situ soil remediation and offer alternatives to support tank farm closure, were considered but not selected for detailed analysis in this *TC & WM EIS*:

- Subsurface barriers – This option was not evaluated in detail because (1) use of subsurface barriers would reduce only a small amount of the risk associated with waste retrieval, tank stabilization, and surface-barrier technologies; (2) the performance of subsurface barriers is highly uncertain, so their use is expected to have a limited impact on risk, but would carry a high cost–benefit ratio; and (3) the potential risks to workers involved in implementing subsurface barrier approaches would increase substantially compared with the risks associated with using surface barriers and waste retrieval.

- In situ soil remediation – A variety of in situ soil remediation technologies were initially considered but were not evaluated in detail in this *TC & WM EIS* because of the difficulties and uncertainties associated with placement of treatment zones and their performance verification. In situ treatment generally requires long periods of time and provides questionable uniformity of treatment because of the variability in soil and aquifer characteristics. The overall efficacy of in situ processes is also relatively difficult to verify.

- Gravel filling of tanks – Although gravel or grout could be used to adequately stabilize waste tanks structurally, and both are considered viable as a potential corrective action or emergency response, this *TC & WM EIS* does not evaluate this option in detail for closure purposes, primarily because the gravel would not prevent water intrusion and possible mobilization of contaminants from stabilized residual waste. In addition, the use of grout, rather than gravel, represents a more conservative estimate for commitment of resources.

2.6.2 Fast Flux Test Facility

This section describes the potential alternatives that were considered, but not evaluated in detail, for decommissioning the FFTF complex, managing and disposing of one or more of the FFTF waste streams, or disposing of Hanford's radioactively contaminated bulk sodium inventory. These alternatives were not evaluated in detail because DOE determined they are not reasonable due to current Hanford activities, likely environmental impacts, public and worker safety considerations, and implementation issues and concerns.

Restart FFTF to support isotope production or research missions. On the basis of previous NEPA evaluations, DOE decided to shut down and deactivate FFTF (DOE 1995, 2000). Deactivation of the facility is currently in progress; therefore, restart is not considered to be a reasonable alternative.

Turn the FFTF complex into a museum or find another alternative use. During the public scoping meetings for this *TC & WM EIS*, some of the comments received suggested cleaning out FFTF and turning it into a publicly accessible museum. Because the structures would need to be maintained for an indefinite period of time, this approach would be closely analogous to the No Action Alternative. This suggestion was not considered a reasonable alternative due to the radiological and unique chemical hazards associated with the facility, the age of the buildings, and the lack of a financial sponsor. However, any documentation necessary to preserve information regarding FFTF's historic aspects will be developed in conjunction with the State Historic Preservation Officer and applicable regulations.

Interim safe storage. The production reactors along the Columbia River are undergoing a cleanout process, referred to as "interim safe storage." As part of that process, all SNF is being removed, surrounding buildings are being demolished, the main reactor building is being cleaned and partially dismantled (to the shield walls), and a new roof is being installed. In the interim safe storage configuration, storage and maintenance costs are very low and the reactor can be left for up to 75 years, allowing radionuclides to decay before further action would be needed, thus reducing worker exposure during disposition of the waste. With respect to decommissioning FFTF, the interim safe storage approach would be closely analogous to the No Action Alternative, with enhanced isolation of the RCB. Because of the chemical hazards associated with the reactive sodium coolant and the relatively low doses associated with the proposed decommissioning activities, as well as DOE's desire to accelerate and complete the required cleanup actions, this approach was not deemed a reasonable alternative.

Recycle debris. One option for disposal of some of the demolition debris would be to recycle the steel and concrete. The potential presence of radioactivity and hazardous chemicals and the expense required to decontaminate the debris and ensure its suitability for unrestricted release made this option impractical. Therefore, it was not considered a reasonable alternative.

Convert bulk sodium to a solid waste. DOE previously decided to convert Hanford's bulk sodium to a caustic sodium hydroxide solution for use in tank waste processing at the WTP (Ecology, EPA, and DOE 2002), thus avoiding the expense of converting the reactive sodium to a solid form and disposing of it as radioactive waste, as well as the cost of procuring additional resources needed to treat Hanford's tank waste. DOE did not consider this option, primarily based on the loss of a beneficial use of the sodium, to be a reasonable alternative that required further evaluation.

Alternative barrier concepts. Under the Entombment Alternative, an engineered closure barrier would be constructed over the FFTF buildings in accordance with applicable regulations. Because the final design of the barrier is still to be determined, various design options were considered. For the *TC & WM EIS* analysis, the modified RCRA Subtitle C barrier was assumed.

2.6.3 Waste Management

As discussed in Chapter 1, Section 1.1, DOE and Washington State executed a Settlement Agreement on January 6, 2006 (amended on June 5, 2008), ending the NEPA litigation (*State of Washington v. Bodman* [Civil No. 2:03-cv-05018-AAM]) regarding the state's concerns about the groundwater-related and other analyses presented in the *HSW EIS* (DOE 2004b). This agreement and the concurrent Memorandum of Understanding between DOE and Ecology (DOE and Ecology 2006) directed DOE to revise or update analyses from the *HSW EIS*, as appropriate, in the new *TC & WM EIS*. The new EIS would also ensure that all waste types addressed in the *HSW EIS* alternatives and cumulative impact analyses are integrated. The alternatives evaluated in this *TC & WM EIS* represent the range of reasonable alternatives covering a full spectrum of tank closure, FFTF decommissioning, and waste management activities. In addition, any combination of the Waste Management No Action Alternative with waste-generating Tank Closure or FFTF Decommissioning alternatives was considered unreasonable, and therefore activities necessary to support such alternative combinations were not evaluated in this *TC & WM EIS*.

2.6.4 The Oregon Proposal

On January 4 and March 18, 2010, the Oregon State Department of Energy submitted comments on the *Draft TC & WM EIS* that included a proposal (which they referred to as the "Oregon proposal") to combine various tank closure elements to form a new Tank Closure alternative and suggested that this proposed new alternative be analyzed in this *TC & WM EIS*.

DOE has reviewed Oregon's proposal for a new Tank Closure alternative and has determined that the proposal is technically infeasible as defined. Accordingly, the Oregon proposal cannot be considered a reasonable alternative and was not analyzed in detail in this *TC & WM EIS*. In its entirety, the Oregon proposal fails to account for the required tradeoffs inherent in the design, capacity, and implementation schedule associated with its storage, retrieval, treatment, disposal, and closure elements. DOE reached this conclusion based upon a number of factors. The WTP, which is currently designed and more than 62 percent constructed, has inadequate waste treatment throughput capacity to support completing the processing of the tank waste through LAW treatment by the year 2040, as suggested in the Oregon proposal. Technical and resource shortcomings for meeting the required waste throughput in 18 years of operation include inadequate tank waste storage, retrieval, and pretreatment capacity. The Oregon proposal also assumes the implementation of iron phosphate (i.e., phosphate glass) and fractional crystallization treatment technologies. However, both of these technologies have been assessed by DOE repeatedly over the last decade, with the conclusion remaining that they are not mature enough for implementation and therefore do not merit further analysis in this EIS. Additional discussions on these two treatment technologies are included in Appendix E, Section E.1.3.3.3. Further, the Oregon proposal assumes that DOE is making a decision on the closure of the cribs and trenches (ditches) through this EIS; however, their closure is not within the scope of the EIS proposed actions, as described in Chapter 1, Section 1.4.2, of this EIS.

Several elements of the Oregon proposal were included in the alternatives analyses, sensitivity analyses, and/or potential mitigation measures. These include additional tank waste storage capacity, dry storage of the cesium and strontium capsules, onsite interim storage of all IHLW canisters, and selective clean closure of a number of SST farms, as well as clean closure of all the SST farms. Clean closure of the cribs and trenches (ditches) is analyzed in the cumulative impacts analysis sections of this EIS.

2.7 COMPARISON OF ALTERNATIVES

The following sections present an overview of the key parameters associated with each of the Tank Closure, FFTF Decommissioning, and Waste Management alternatives, including the methodology for developing the alternatives so as to provide comparisons of how parameter differences may affect potential impacts. A discussion of specific technical and programmatic uncertainties associated with the alternatives is also presented.

Detailed discussions of the short- and long-term environmental impacts associated with each of the alternatives are presented in Chapters 4 and 5 of this *TC & WM EIS*, respectively. Summaries of these respective impact discussions are presented in Sections 2.8 and 2.9.

2.7.1 Tank Closure Alternatives

The Tank Closure action alternatives described in this *TC & WM EIS* represent the range of reasonable approaches to storing Hanford tank waste; removing the waste from the tanks to the extent technically and economically feasible; treating the waste through vitrification in the existing WTP, in an expanded WTP, and/or in conjunction with one or more supplemental treatment technologies; packaging the waste for onsite storage or disposal or offsite shipment and disposal; and closing the SST system to permanently reduce the potential risk to human health and the environment. Table 2–5 outlines the key technical parameters under each of the five RPP mission components (storage, retrieval, treatment, disposal, and closure) and compares these parameters by alternative.

The Tank Closure action alternatives were developed in part to allow comparisons of the short-term impacts of the construction, operations, and deactivation of the additional facilities proposed for storage, retrieval, treatment, and disposal of waste from the SST system and closure of the SST system. These action alternatives were also developed to allow similar comparisons of the long-term water quality, human health, and ecological risk impacts resulting from completion of these activities. Following is a brief comparative discussion of the Tank Closure alternatives (by RPP mission component).

Table 2–5. Comparison of the Tank Closure Alternatives

	Alternative 1: No Action	Alternative 2A: Existing WTP Vitrification; No Closure	Alternative 2B: Expanded WTP Vitrification; Landfill Closure	Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure	Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure	Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure	Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/ Landfill Closure	Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure	Alternative 6A: All Vitrification/No Separations; Clean Closure	Alternative 6B: All Vitrification with Separations; Clean Closure	Alternative 6C: All Vitrification with Separations; Landfill Closure
Storage											
Existing	✓										
New WRFs			✓	✓	✓	✓	✓	✓		✓	✓
New DSTs		✓						✓	✓		
Retrieval											
90 percent								✓			
99 percent		✓	✓	✓	✓	✓					✓
99.9 percent							✓		✓	✓	
Treatment											
WTP											
Existing vitrification only		✓		✓	✓	✓	✓				
Expanded LAW vitrification			✓					✓		✓	✓
Expanded HLW vitrification									✓		
Replacement of WTP		✓							✓		
Technetium-99 removal			✓		✓						
Sulfate removal								✓			
Cesium and strontium capsules		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Non-WTP											
Tank mixed TRU waste supplemental treatment				✓	✓	✓	✓	✓			
Thermal supplemental treatment				✓		✓	✓	✓			
Nonthermal supplemental treatment					✓		✓	✓			
Disposal (including post-treatment storage)											
On Site											
ILAW		✓	✓	✓	✓	✓	✓	✓		(a)	(a)
IHLW[b]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sulfate grout								✓			
Contaminated soil			✓	✓	✓	✓	✓		✓	✓	✓
SSTs							(c)		(d)	(d)	
Off Site											
Tank mixed TRU waste to WIPP				✓	✓	✓	✓	✓			
Closure											
Clean closure									✓	✓	
Selective clean closure/landfill closure							✓				
Landfill closure			✓	✓	✓	✓		✓			✓
Modified RCRA Subtitle C barrier			✓	✓	✓	✓	✓		(e)	(e)	✓
Hanford barrier								✓			

a Under Alternatives 6B and 6C, ILAW glass would be interim-stored on site and managed as IHLW glass.
b Although disposition decisions have not been made and implemented, these alternatives do not assume the inventory in the IHLW canisters remains on site. However, the number of storage facilities needed to store all the IHLW is one more than the number of canister storage facilities analyzed under Tank Closure Alternative 2B.
c Under Alternative 4, SSTs at the BX and SX tank farms would be removed and treated in the Preprocessing Facility.
d Under Alternatives 6A and 6B, all SSTs would be removed and packaged in shielded boxes for onsite storage pending disposition.
e Base Case: Construct modified RCRA Subtitle C barrier over six sets of cribs and trenches (ditches) in B and T Areas. Option Case: Remove six sets of cribs and trenches (ditches) in the B and T Areas and remediate their deep-soil plumes.

Key: DST=double-shell tank; HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low-activity waste; RCRA=Resource Conservation and Recovery Act; SST=single-shell tank; TRU=transuranic; WIPP=Waste Isolation Pilot Plant; WRF=waste receiver facility; WTP=Waste Treatment Plant.

Tank farm storage. Tank farm storage operations would be required under each Tank Closure alternative. Tank Closure Alternative 1 would continue storage of the tank waste in the existing SST system without treating the waste. Tank Closure Alternatives 2A and 6A would require construction of new DSTs to replace the existing DSTs to provide safe storage over the extended time period needed for tank waste treatment. Tank Closure Alternative 5 would require construction of new DSTs to facilitate a shorter time period for waste treatment. Tank Closure Alternatives 2B, 3A, 3B, 3C, 4, 5, 6B, and 6C would require the construction of WRFs to facilitate waste treatment.

Tank waste retrieval. The Tank Closure alternatives allow a range of retrieval options to be evaluated. Under Tank Closure Alternative 1, the tank waste would not be retrieved. Under Tank Closure Alternative 5, retrieval of 90 percent of the waste would occur. Tank Closure Alternatives 2A, 2B, 3A, 3B, 3C, and 6C would achieve 99 percent retrieval. Tank Closure Alternatives 4, 6A, and 6B would retrieve 99.9 percent of the tank waste.

Tank waste treatment. Use of the WTP would be required under each of the Tank Closure action alternatives. The configuration of the WTP would vary among the action alternatives, however, and different combinations of supplemental treatment technologies would be combined with waste treatment in the WTP under some alternatives.

The various WTP configurations under each of the Tank Closure action alternatives are as follows:

- Under Tank Closure Alternative 1, construction of the WTP would not be completed and no tank waste would be treated.
- Tank Closure Alternatives 2A, 3A, 3B, 3C, and 4 would use the existing WTP configuration, which would provide a TMC of 6 metric tons of glass IHLW per day (using two HLW melters) and 30 metric tons of glass ILAW per day (two LAW melters).
- Tank Closure Alternatives 2B, 5, 6B, and 6C would use the existing WTP configuration supplemented with expanded ILAW capacity. Under Alternatives 2B, 6B, and 6C, the expanded WTP configuration would provide a vitrification TMC of 6 metric tons of glass IHLW per day (using two HLW melters) and 90 metric tons of glass ILAW per day (using six LAW melters). Under Alternative 5, the expanded WTP configuration would provide a vitrification TMC of 6 metric tons of glass IHLW per day (using two HLW melters) and 45 metric tons of glass ILAW per day (using three LAW melters).
- Tank Closure Alternative 6A would require modification of the WTP to provide a vitrification TMC of 15 metric tons of glass IHLW per day (using five HLW melters) and no LAW vitrification capacity.

As discussed above, under some of the alternatives, supplemental treatment technologies would be combined with the WTP treatment.

- Tank Closure Alternatives 2A, 2B, 6A, 6B, and 6C are all-vitrification scenarios that would not use any supplemental treatment technologies.
- Tank Closure Alternatives 3A, 3B, 3C, 4, and 5 would add various supplemental treatment technologies to WTP treatment of the tank waste.

The Tank Closure alternatives also were developed to evaluate a range of supplemental thermal and nonthermal treatment choices and their associated project impacts. The thermal supplemental treatment technologies are represented in this EIS by bulk vitrification and steam reforming; the nonthermal supplemental treatment technology is represented by cast stone. In addition, analysis of treatment in the 200-West Area, as well as the 200-East Area, was desired. As proposed under some alternatives, tank waste treatment in the 200-West Area would target tanks that had undergone previous treatment to remove cesium-137 and strontium-90. An additional Solid-Liquid Separations Facility would be used prior to supplemental treatment in the 200-West Area. The various supplemental treatment technology configurations for each of the alternatives that utilize these technologies are as follows:

- Tank Closure Alternative 3A – Thermal (bulk vitrification) supplemental treatment in both the 200-East and 200-West Areas
- Tank Closure Alternative 3B – Nonthermal (cast stone) supplemental treatment in both the 200-East and 200-West Areas
- Tank Closure Alternative 3C – Thermal (steam reforming) supplemental treatment in both the 200-East and 200-West Areas
- Tank Closure Alternatives 4 and 5 – Thermal (bulk vitrification) supplemental treatment in the 200-West Area and nonthermal (cast stone) supplemental treatment in the 200-East Area

Under Tank Closure Alternative 5, an additional sulfate removal technology would be used after pretreatment to increase the waste loading of ILAW glass, thereby reducing the amount of ILAW glass produced in the WTP and allowing earlier completion of treatment. This alternative was developed to determine the environmental impact of a shorter treatment timeframe.

Under Tank Closure Alternatives 3A, 3B, 3C, 4, and 5, the waste in some selected tanks would be managed as mixed TRU waste. These alternatives were developed to determine the environmental impacts related to that approach.

The Tank Closure action alternatives were also developed to compare WTP pretreatment with or without technetium-99 removal. Tank Closure Alternatives 2B and 3B include technetium-99 removal during WTP pretreatment, but Tank Closure Alternatives 2A, 3A, 3C, 4, 5, and 6A through 6C do not.

Tank waste disposal. No tank waste would be disposed of under the No Action Alternative (Tank Closure Alternative 1). However, tank waste disposal is required under all Tank Closure action alternatives. The waste disposal options and the amount of waste vary among these alternatives based on the type of waste generated, the specific program (i.e., treatment method, closure), and the assumptions made regarding disposal requirements. The tank waste disposal options are summarized as follows:

- Under all Tank Closure action alternatives, IHLW glass would be stored on site until disposition decisions are made and implemented.
- Under Tank Closure Alternatives 6B and 6C, ILAW glass would be managed as HLW and stored on site until disposition decisions are made and implemented.
- Under Tank Closure Alternatives 3A, 3B, 3C, 4, and 5, tank mixed TRU waste would be disposed of at WIPP.
- Under Tank Closure Alternatives 2A, 2B, 3A, 3B, 3C, 4, and 5, ILAW would be disposed of on site in an IDF.
- Under Tank Closure Alternatives 3A, 3C, 4, and 5, LAW treated using thermal supplemental treatment technologies (bulk vitrification or steam reforming) would be disposed of on site in an IDF.

- Under Tank Closure Alternatives 3B, 4, and 5, LAW treated using nonthermal supplemental treatment technology (cast stone) would be disposed of on site in an IDF.

- Under Tank Closure 5, sulfate grout from the sulfate removal process would be disposed of on site in an IDF.

- Under Tank Closure Alternatives 6A and 6B, PPF glass from soil washing would be disposed of on site in an IDF.

- Under Tank Closure Alternatives 2B, 3A, 3B, 3C, 4, and 6A through 6C, contaminated soils would be disposed of on site in the proposed RPPDF.

Several Tank Closure action alternatives were developed in part to compare the performance of thermal and nonthermal supplemental treatment waste forms to be disposed of on site at Hanford. The waste forms evaluated under each of these alternatives are summarized as follows:

- Tank Closure Alternative 3A would produce an all-thermally treated waste form after WTP pretreatment and bulk vitrification.

- Tank Closure Alternative 3B would produce an all-nonthermally treated waste form after WTP pretreatment and cast stone treatment.

- Tank Closure Alternative 3C would produce an all-thermally treated waste form after WTP pretreatment and steam reforming.

- Tank Closure Alternatives 4 and 5 would produce both thermally and nonthermally treated waste forms after WTP pretreatment and bulk vitrification and cast stone treatment.

Another issue considered in the development of the Tank Closure action alternatives was onsite versus offsite waste disposal, particularly to better understand the potential impacts on groundwater due to waste form performance (assuming onsite disposal) and the potential impacts on groundwater resulting from past releases (contamination in the vadose zone), retrieval of sodium residuals, and closure of the SST system. Tank Closure Alternatives 6A through 6C assume that the treated waste form would be managed as HLW and would not be disposed of on site. Tank Closure Alternatives 2A, 2B, 3A through 3C, 4, and 5 assume that the treated waste forms would be disposed of on site.

The Tank Closure action alternatives were also developed to compare the long-term performance of different treated waste forms with or without technetium-99 removal. The following is brief discussion of this issue under the various Tank Closure action alternatives.

- Under Tank Closure Alternatives 2A and 2B, the waste streams would be treated in the WTP. Tank Closure Alternative 2A assumes technetium-99 removal would not occur during WTP pretreatment; as a result, the ILAW glass would contain most of the technetium-99. In contrast, Tank Closure Alternative 2B assumes that technetium-99 removal would be conducted as part of the WTP pretreatment process; as a result, a large fraction (approximately 99 percent) of the technetium-99 would be removed from the ILAW glass waste stream and treated as part of the IHLW glass waste stream. Under both of these alternatives, the ILAW glass would be disposed of on site in an IDF. These alternatives would allow a demonstration of the long-term impacts on groundwater of ILAW glass with or without technetium-99.

- Under Tank Closure Alternatives 3A and 3C, the waste streams would be treated in the WTP and/or by using a thermal supplemental treatment (bulk vitrification or steam reforming). Both of these alternatives assume that technetium-99 removal would not be conducted in the WTP pretreatment process; as a result, the WTP and bulk vitrification glass or steam reforming waste would contain most of the technetium-99, which would be disposed of on site in an IDF. These alternatives would allow a demonstration of the long-term impacts on groundwater of supplemental treatment waste forms that include technetium-99.

- Under Tank Closure Alternative 3B, the waste streams would be treated in the WTP and/or by using a nonthermal supplemental treatment (cast stone). Because previous grout data showed that technetium-99 removal would be required for long-term waste form performance, Tank Closure Alternative 3B assumes that technetium-99 removal would be conducted as part of the WTP pretreatment process; as a result, a large fraction (approximately 99 percent) of the technetium-99 would be removed from the ILAW glass and the cast stone waste treated in the 200-East Area. Conversely, no technetium-99 would be removed from the cast stone waste treated in the 200-West Area. Both the ILAW glass and cast stone waste would be disposed of on site in an IDF. This alternative would allow a demonstration of the long-term impacts on groundwater of a cast stone waste form, portions of which would or would not include technetium-99.

- Under Tank Closure Alternatives 4 and 5, the waste streams would be treated in the WTP and/or by using a thermal or nonthermal supplemental treatment (bulk vitrification or cast stone). These alternatives assume that technetium-99 removal would not be conducted as part of the WTP pretreatment process; as a result, the ILAW glass, bulk vitrification glass, and cast stone waste would contain most of the technetium-99 and would be disposed of on site in an IDF. These alternatives would allow a comparison of a range of closure conditions relative to the long-term impacts on groundwater of bulk vitrification and cast stone waste forms that include technetium-99.

Under all of the Tank Closure action alternatives, cesium and strontium capsules would be retrieved from the WESF and de-encapsulated in the new Cesium and Strontium Capsule Processing Facility adjacent to the WTP; their contents would be treated in the WTP.

A comparison of the total waste volumes and waste containers associated with each of the Tank Closure alternatives is presented in Appendix E, Table E–12.

Tank farm closure. Tank farm closure is evaluated under all Tank Closure alternatives except Tank Closure Alternatives 1 and 2A. These alternatives were partially developed to compare the long-term impacts on groundwater relative to the range of retrieval benchmarks and the type of closure barrier used (engineered modified RCRA Subtitle C barrier or Hanford barrier).

- Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C assume a retrieval benchmark of 99 percent and that the SST system would be closed as a landfill under an engineered modified RCRA Subtitle C barrier.

- Tank Closure Alternative 4 assumes a retrieval benchmark of 99.9 percent and that the SST system, except for two representative tank farms, would be closed as a landfill under an engineered modified RCRA Subtitle C barrier. The two representative tank farms (BX and SX) would be clean-closed.

- Tank Closure Alternative 5 assumes a retrieval benchmark of 90 percent and that the SST system would be closed, without ancillary equipment removal, as a landfill under a Hanford barrier.

- Tank Closure Alternatives 6A and 6B assume a retrieval benchmark of 99.9 percent and clean closure of the SST system. Under the Base Case for each alternative, a modified RCRA Subtitle C barrier would be built over the six sets of cribs and trenches (ditches) in the B and T Areas. Under the Option Case for each alternative, these cribs and trenches (ditches) would be removed and the deep-soil plumes would be remediated.

The Tank Closure alternatives were also developed to compare the long-term impacts on groundwater of closing the SST system. Proposed closure options range from clean closure or selective clean closure/landfill closure to landfill closure with or without any contaminated soil removal. The relationships of these closure scenarios to Tank Closure alternatives are summarized as follows:

- Tank Closure Alternatives 1 and 2A assume no closure of the SST system.

- Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C assume landfill closure using an engineered modified RCRA Subtitle C barrier and removal of 4.6 meters (15 feet) of contaminated soils (which includes ancillary equipment) from two tank farms (BX and SX).

- Tank Closure Alternative 4 assumes selective clean closure of two tank farms (BX and SX) and landfill closure of the remaining tank farms using an engineered modified RCRA Subtitle C barrier.

- Tank Closure Alternative 5 assumes landfill closure using a Hanford barrier without removal of contaminated soils or ancillary equipment.

- Tank Closure Alternatives 6A and 6B assume clean closure of the SST system. The Base Cases would place an engineered modified RCRA Subtitle C barrier over the six sets of cribs and trenches (ditches) in the B and T tank farms, and the Option Cases include deep soil removal and remediation.

2.7.2 FFTF Decommissioning Alternatives

The FFTF Decommissioning alternatives represent the range of reasonable approaches to dismantling and removing structures, equipment, and materials within the 400 Area PPA; treating and disposing of these components and equipment as necessary; treating RH-SCs; converting Hanford bulk sodium to a caustic sodium hydroxide solution for use in the WTP; and closing the area to permanently reduce the potential risk to human health and the environment and/or to prepare the area for future industrial use. Table 2–6 outlines the key technical parameters under each of the three mission components (disposition of facilities, RH-SCs, and bulk sodium) and compares these parameters by alternative. A brief comparison discussion of the alternatives by mission component follows the table.

Facility disposition. The FFTF Decommissioning alternatives were structured to allow a range of facility disposition options. Under FFTF Decommissioning Alternative 1: No Action, the facilities would be left in place and stabilized under a blanket of inert gas. In contrast, under FFTF Decommissioning Alternatives 2 and 3, radioactive materials would be removed, but in varying degrees. FFTF Decommissioning Alternative 2 would remove and dispose of a minimal amount of radioactive materials and entomb the rest. All above-grade RCB and adjacent support facilities would be dismantled and either consolidated or entombed in below-grade spaces, or disposed of in an IDF. FFTF Decommissioning Alternative 3 would remove nearly all radioactive materials, including the reactor vessel, internal piping and equipment, and attached depleted-uranium shield, and dispose of these materials on site in an IDF.

Table 2–6. Comparison of the FFTF Decommissioning Alternatives

	Alternative 1: No Action	Alternative 2: Entombment	Alternative 3: Removal
Facility Disposition			
Facility equipment and components left in place under inert gas blanket	✓		
Dismantlement of RCB and adjacent support buildings		✓	✓
Removal of reactor vessel (internal piping and equipment, attached depleted-uranium shield)			✓
Onsite disposal of reactor vessel (internal piping and equipment, attached depleted-uranium shield)			✓
Removal and onsite disposal of radioactive or chemical waste	✓	✓	✓
Backfill and revegetation of ancillary facility areas		✓	
Backfill and revegetation of PPA			✓
Modified RCRA Subtitle C barrier over RCB		✓	
Administrative controls for 100 years	✓		
Postclosure care and/or institutional controls for 100 years		✓	✓
Disposition of Remote-Handled Special Components			
Removal and storage on site per FONSI	✓	✓	✓
Treatment at the Hanford Site		✓	✓
Treatment at Idaho National Laboratory		✓	✓
Onsite disposal		✓	✓
Offsite disposal		✓	✓
Disposition of Bulk Sodium			
Onsite storage	✓	✓	✓
Onsite conversion to caustic sodium hydroxide solution		✓	✓
Offsite conversion to caustic sodium hydroxide solution		✓	✓
Caustic sodium hydroxide solution shipped to the Waste Treatment Plant		✓	✓

Key: FFTF=Fast Flux Test Facility; FONSI=Finding of No Significant Impact; PPA=Property Protected Area; RCB=Reactor Containment Building; RCRA=Resource Conservation and Recovery Act.

Small-diameter pipes would be treated before disposal under both FFTF Decommissioning Alternatives 2 and 3. Under FFTF Decommissioning Alternative 2: Entombment, some materials would be treated in place and used to fill void space in the below-grade spaces, while some materials would be treated in the 400 Area and disposed of in an IDF. In contrast, under FFTF Decommissioning Alternative 3: Removal, all materials would be removed and treated in the 400 Area, then disposed of in an IDF. No components would be left in place under Alternative 3.

Both FFTF Decommissioning Alternatives 2 and 3 include backfilling, compacting, contouring, and revegetation of the area. Alternative 2 would require construction of an engineered modified Subtitle C barrier, followed by postclosure care for 100 years. Alternative 3, however, would not need a barrier constructed because all structures and equipment would be removed. Because no barrier would be constructed under FFTF Decommissioning Alternatives 1 and 3, administrative or institutional controls would be put in place for 100 years.

Disposition of remote-handled special components. Under FFTF Decommissioning Alternative 1, the RH-SCs that would have been removed and packaged for storage under deactivation activities would be left in place in the 400 Area under an inert gas blanket. No treatment or disposal would occur under this alternative. Under FFTF Decommissioning Alternatives 2 and 3, however, two options are proposed for treatment (decontamination and sodium removal) and disposal, as follows:

- **Hanford Option.** RH-SCs would be stored in the 400 Area pending construction of the proposed RTP near Hanford's T Plant. After construction is complete, the RH-SCs would be shipped to the new RTP via truck. Following treatment, the RH-SCs and sodium residuals would be disposed of in an IDF.

- **Idaho Option.** RH-SCs would be stored in the 400 Area pending modification of existing facilities for the RTP at the INL INTEC. When this RTP is complete, the RH-SCs would be shipped to INL via truck and/or rail. Following treatment in the INL RTP, the FFTF RH-SCs would be either disposed of with other INL wastes at NNSS or returned to Hanford for disposal in an IDF.

Disposition of bulk sodium. Under FFTF Decommissioning Alternative 1, FFTF bulk sodium would be left untreated as a solid in onsite storage tanks in the 400 Area SSF under deactivation activities, while Hallam and SRE sodium would remain stored in the 200-West Area. Under FFTF Decommissioning Alternatives 2 and 3, the bulk sodium would be converted into a caustic sodium hydroxide solution for use in the WTP. Both Alternatives 2 and 3 analyze the same reuse options for conversion, as follows:

- **Hanford Reuse Option.** The bulk sodium inventory would be stored in its current locations until it is shipped to the proposed 400 Area SRF for processing. Following processing, the resulting caustic sodium hydroxide solution would be transferred for use at the WTP.

- **Idaho Reuse Option.** The bulk sodium would be stored in its current locations until it is shipped via truck and/or rail to INL for processing. The capability to process bulk metallic sodium currently exists at INL's SPF. Following processing, the caustic sodium hydroxide solution would be returned to Hanford for use in tank waste processing at the WTP.

2.7.3 Waste Management Alternatives

The Waste Management alternatives described in this *TC & WM EIS* represent the range of reasonable approaches to storing and treating onsite LLW, MLLW, and TRU waste; disposing of onsite and offsite LLW and MLLW (at Hanford); shipping and disposing of onsite TRU waste (at WIPP); and closing the disposal facilities to reduce water infiltration and the potential for intrusion. Table 2–7 outlines the key technical parameters under each of the RPP mission components (storage, treatment, disposal, and closure) and compares these parameters by alternative.

The Waste Management alternatives were developed partly to compare the short-term impacts of the expansion of existing facilities and construction of new facilities, as well as the operation and deactivation of facilities used to store, treat, and dispose of waste. The Waste Management alternatives were also developed to compare the long-term water quality, human health, and ecological risk impacts resulting from these activities. The following is a brief comparison of the alternatives by mission component.

Table 2–7. Comparison of the Waste Management Alternatives

	Alternative 1: No Action	Alternative 2: Disposal in IDF, 200-East Area Only	Alternative 3: Disposal in IDF, 200-East and 200-West Areas
Storage and Treatment			
Existing storage and treatment of LLW, MLLW, and TRU waste at CWC	✓		
Expanded storage and treatment of LLW, MLLW, and TRU waste at CWC		✓	✓
Existing storage and treatment of LLW, MLLW, and TRU waste at WRAP and T Plant	✓		
Expanded storage and treatment of LLW, MLLW, and TRU waste at WRAP and T Plant		✓	✓
Disposal			
Continued disposal of onsite non-CERCLA, nontank LLW and MLLW in onsite lined trenches	✓	✓	✓
Construction of 200-East Area IDF terminated and facility deactivated	✓		
Disposal of tank, onsite non-CERCLA, FFTF decommissioning, waste management, and offsite LLW and MLLW at 200-East Area IDF		✓	
Disposal of tank waste only at 200-East Area IDF and onsite non-CERCLA, FFTF decommissioning, waste management, and offsite LLW and MLLW at 200-West Area IDF			✓
Disposal of rubble, ancillary equipment, and soils (not highly contaminated) from closure activities in the proposed RPPDF		✓	✓
Closure			
None	✓		
Landfill closure of IDF(s) and RPPDF		✓	✓
Administrative control for 100 years	✓		
Postclosure care for 100 years		✓	✓

Key: CERCLA=Comprehensive Environmental Response, Compensation, and Liability Act; CWC=Central Waste Complex; FFTF=Fast Flux Test Facility; IDF=Integrated Disposal Facility; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; RPPDF=River Protection Project Disposal Facility; TRU=transuranic; WRAP=Waste Receiving and Processing Facility.

Waste storage and treatment. Storage and processing of LLW, MLLW, and TRU waste until disposal would be required under each Waste Management alternative. Waste Management Alternative 1 would continue storage and processing of wastes at the existing CWC, WRAP, and T Plant. Waste Management Alternatives 2 and 3 would require construction, expansion, and continued operation of these existing storage facilities. Both Waste Management Alternatives 2 and 3 include construction and operation of a new storage facility in Building 2403-WD, as well as two expansions of WRAP: one that would increase the capability to process LLW, MLLW, and CH-TRU waste and another to process RH-TRU waste. Waste Management Alternatives 2 and 3 also include construction and operation of a duplicate of the 2706-T/TA/TB Facility (a T Plant expansion) for oversized CH-LLW and CH-MLLW packages.

No offsite TRU waste would be received under any of the Waste Management alternatives. No shipments of LLW or MLLW would be received under Waste Management Alternative 1. Under Waste Management Alternatives 2 and 3, offsite shipments of up to 62,000 cubic meters (81,000 cubic yards) of LLW and 20,000 cubic meters (26,000 cubic yards) of MLLW would be received. However, under both alternatives, this offsite waste would be treated off site by either the generator or a commercial treatment facility.

Disposal. Waste disposal would be required under all three Waste Management alternatives. The disposal options for waste and the amount of waste vary among the alternatives. Waste Management Alternative 1 would continue disposal of onsite non-CERCLA, nontank LLW and MLLW in lined trenches 31 and 34 until the waste is no longer generated (by about 2035). For conservative analysis purposes, both Waste Management Alternatives 2 and 3 would continue operation of these trenches through 2050, though the waste would be sent to an onsite IDF.

Construction of new onsite facilities for waste disposal would occur under Waste Management Alternatives 2 and 3. No new construction would occur under Waste Management Alternative 1: No Action, and ongoing construction of IDF-East would be discontinued in 2008, with deactivation activities (e.g., removal of the liner and backfilling of the site) occurring in 2009. Under Waste Management Alternatives 2 and 3, IDF construction would continue. However, the number and location of IDFs constructed and the types of waste disposed of in each facility would be different based on the particular alternative. Waste Management Alternative 2 would complete IDF-East construction for disposal of tank, onsite non-CERCLA, FFTF decommissioning, waste management, and offsite LLW and MLLW. Waste Management Alternative 3 would dispose of these waste types in two IDFs: IDF-East and IDF-West. Only waste from tank treatment operations would be disposed of in IDF-East. All other wastes would be disposed of in IDF-West. Both Waste Management Alternatives 2 and 3 would construct and operate the proposed RPPDF for disposal of lightly contaminated equipment and soils from closure activities.

Because of the large number of combinations of IDF and proposed RPPDF configurations, three waste disposal groups were analyzed under Waste Management Alternatives 2 and 3. Table 2–8 depicts the similarities and differences among the disposal groups and between Waste Management Alternatives 2 and 3. As shown in Table 2–8, the same disposal group would support the same Tank Closure and FFTF Decommissioning alternatives under Waste Management Alternative 2 or 3. Because the number of IDFs analyzed differs between Waste Management Alternatives 2 and 3, the amounts, types of waste disposed of, and facility operations schedules differ under the disposal groups. The proposed RPPDF capacities and operations schedules under each of the disposal groups are the same for both Waste Management Alternatives 2 and 3.

Closure. Closure activities would take place under both Waste Management Alternatives 2 and 3. Under Waste Management Alternative 1: No Action, there would be a 100-year administrative control period, but no barriers would be constructed over disposal facilities or trenches. Both Waste Management Alternatives 2 and 3 analyze covering the IDF(s) (IDF-East under Waste Management Alternative 2 and both IDF-East and -West under Waste Management Alternative 3) and the proposed RPPDF with engineered modified RCRA Subtitle C barriers. Both alternatives also include a 100-year postclosure care period.

Table 2–8. Comparison of Disposal Groups by Waste Management Alternative

	Waste Management Alternative 2: Disposal in IDF, 200-East Area Only	Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas
Disposal Group 1		
Alternatives Supported		
Tank Closure	2B, 3A, 3B, 3C, 4, 5, and 6C	2B, 3A, 3B, 3C, 4, 5, and 6C
FFTF Decommissioning	2 and 3	2 and 3
Total Capacity		
IDF	1,200,000 m^3	1,100,000 m^3 (IDF-East) 90,000 m^3 (IDF-West)
RPPDF	1,080,000 m^3	1,080,000 m^3
Operations Schedule (Year Operations Would Be Completed)		
IDF	2050	2050
RPPDF	2050	2050
Disposal Group 2		
Alternatives Supported		
Tank Closure	2A and 6B	2A and 6B
FFTF Decommissioning	2 and 3	2 and 3
Total Capacity		
IDF	425,000 m^3	340,000 m^3 (IDF-East) 90,000 m^3 (IDF-West)
RPPDF	8,370,000 m^3	8,370,000 m^3
Operations Schedule (Year Operations Would Be Completed)		
IDF	2100	2100 (IDF-East) 2050 (IDF-West)
RPPDF	2100	2100
Disposal Group 3		
Alternatives Supported		
Tank Closure	6A	6A
FFTF Decommissioning	2 and 3	2 and 3
Total Capacity		
IDF	425,000 m^3	340,000 m^3 (IDF-East) 90,000 m^3 (IDF-West)
RPPDF	8,370,000 m^3	8,370,000 m^3
Operations Schedule (Year Operations Would Be Completed)		
IDF	2165	2165 (IDF-East) 2050 (IDF-West)
RPPDF	2165	2165

Note: Waste Management Alternative 1 would support only Tank Closure Alternative 1. To convert cubic meters to cubic yards, multiply by 1.308.

Key: FFTF=Fast Flux Test Facility; IDF=Integrated Disposal Facility; IDF-East=200-East Area IDF; IDF-West=200-West Area IDF; m^3=cubic meters; RPPDF=River Protection Project Disposal Facility.

2.7.4 Uncertainties

The following sections describe the technical and regulatory uncertainties inherent in the analysis of the Tank Closure, FFTF Decommissioning, and Waste Management alternatives evaluated in this *TC & WM EIS*. The individual analyses of environmental impacts in Chapters 4 and 5 and the corresponding appendices provide additional details regarding the uncertainties unique to each resource area, where applicable.

TANK CLOSURE

Even with the knowledge and experience gained over the past decade of managing Hanford's tank system, there are still many technical and regulatory uncertainties. Some of these uncertainties cannot be fully resolved until tank waste storage, retrieval, treatment, and disposal and tank closure activities have been demonstrated. A major focus of the RPP is managing these uncertainties while making progress toward tank closure. The following is a brief discussion, by mission activity, of the overarching technical and programmatic uncertainties facing the RPP in its tank waste management program.

Storage. There is uncertainty associated with tank waste inventories in terms of both chemical and radioactive contaminants. A prioritized sampling and estimation process, termed the "Best-Basis Inventory" process, was developed for estimation of the inventories present in the HLW tanks. However, in some cases, the number of available measurements was limited and estimates of the tank inventories for some waste constituents were supplemented by process modeling techniques. Thus, due to the spatial variability in the characteristics and concentrations of the waste, as well as gaps in knowledge of separations processes and waste management conditions, uncertainty exists regarding the estimated waste inventories in the HLW tanks. In addition, records that were kept on the waste that was put into the tanks, waste that was transferred between tanks, and waste that was decanted off and discharged into shallow subsurface cribs and trenches (ditches) were not always complete. Although the overall quantities of radionuclides generated at Hanford are relatively well known, the actual amounts in specific waste sites are more uncertain. Also, the tank waste contains a complex mix of chemical and radioactive constituents that is constantly changing as chemical reactions and radioactive decay occur. This results in an uncertain and continuously changing inventory of waste. This *TC & WM EIS* addresses this uncertainty by making conservative assumptions regarding the waste inventories based on process knowledge, assay results of sampled waste, or other available information from waste generators.

Retrieval. The efficiency and effectiveness of current methods for retrieving waste from the tanks (e.g., modified sluicing) and the quantity of liquid waste that might be released to the environment during retrieval are uncertain. For example, it is not certain whether the modified sluicing technique can retrieve all types of sludge or the dense, highly compacted waste on the tank bottom. Using large volumes of liquids during modified sluicing also may cause liquids to be released through cracks in the tanks. Other retrieval techniques such as the MRS, VBR, and chemical washing have been used on only a limited basis at Hanford and other DOE sites, so those technologies carry potential uncertainties as well.

Treatment. Separation of waste into HLW and LAW streams and vitrification of these waste streams have been conducted at other DOE sites. However, these treatment processes have not been performed on Hanford tank waste on a production scale; therefore, the impacts and operating efficiencies are uncertain. Full-scale production of ILAW using the LAW melter, bulk vitrification, cast stone, and steam reforming processes has not been conducted anywhere within the DOE complex. As a result, uncertainties exist regarding waste loading and waste-form quality and performance. The adequacy of the ETF to treat anticipated secondary waste from the WTP and supplemental treatment facilities is also uncertain.

Disposal. The final waste classifications of certain waste streams have not yet been determined by DOE. For analysis purposes, this *TC & WM EIS* assumes for some of the alternatives that historical processing data will support management of some of the tank waste as non-HLW. For other alternatives (e.g., Alternatives 6A and 6B), the opposite is assumed (i.e., all tank waste is assumed to be HLW).

An IHLW glass disposal location has not been established at this time. This EIS assumed the use of a thin-wall IHLW glass canister to maximize the volume of IHLW put into each canister and minimize the number of canisters needed. Due to uncertainties regarding final canister design and capacity, as well as offsite shipping schedules, the EIS analysis included assumptions for onsite (interim) storage of IHLW glass until disposition decisions are made and implemented.

The impacts associated with disposal of ILAW are also uncertain at this time. Because the release rates for ILAW glass are low and are supported by experiment, there is less uncertainty regarding this waste form compared with bulk vitrification glass, cast stone waste, and steam reforming waste. Of these supplemental treatment ILAW forms, the least amount of characterization and testing has been performed for steam reforming waste. Thus, the greatest degree of uncertainty relative to waste form performance is associated with the steam reforming waste.

Closure. Clean closure of the tank farms would require construction and use of containment structures during the removal of 149 SSTs, ancillary equipment, and deep soil. There is substantial uncertainty associated with the technical feasibility, schedules, costs, and worker impacts associated with these clean closure activities. This *TC & WM EIS* evaluated the use of engineered structures, including shielding and remote equipment, to minimize worker exposure when removing the tanks. Even with these mitigation measures, the worker radiation dose would be an order of magnitude higher than that under landfill closure. Containment of air releases would be needed to mitigate impacts due to tank, ancillary equipment, and soil removal, requiring construction of movable containment structures. Although the technology for installation of such containment structures is understood, there is a large degree of uncertainty concerning the feasibility of installing these structures over a large area the size of a tank farm and, under some alternatives, of constructing and using multiple structures. There is also uncertainty related to the pathway identified for disposition of the tanks, which would need to be cut up and packaged. This EIS assumed that the tanks would be packaged and disposed of on site; however, they would have to go through the DOE Manual 435.1-1 process to determine the appropriate disposition pathway (i.e., whether waste is HLW, TRU waste, or LLW).

Selective clean closure/landfill closure, as evaluated in Tank Closure Alternative 4, would remove two of the tank farms, one in the 200-East Area and one in the 200-West Area, thereby reducing the volume of material that would be removed. However, this volume reduction would not lessen the high degree of technical uncertainties related to how soils would be removed and treated, or the infrastructure and additional capability needed to manage the new waste generated from the removal. Although not to the same levels as those for clean closure, the following technical uncertainties exist: characteristics of borrow material, land and terrestrial resource disturbances, waste generation, and worker safety and health issues.

The technical uncertainties associated with tank removal and deep soil remediation beneath the tanks under the selective clean closure and clean closure alternatives would need to be weighed against the order(s) of magnitude increase in short-term impacts on resource areas that would result by implementing these alternatives.

The *TC & WM EIS* analyses rely on various modeling approaches to predict the consequences of RPP mission activities that DOE may undertake in the future. Some of these models are complex and rely on assumptions that are subject to a large degree of uncertainty, particularly when trying to predict potential impacts out to 10,000 years. One such uncertainty is how waste moves in the vadose zone and groundwater. The *TC & WM EIS* analyses assumed that both the groundwater flow field and infiltration rate will remain constant over 10,000 years, and that the location of the river channel will remain the same over the same period. These assumptions affect the ability to accurately predict when groundwater impacts would reach their peak. Long-term impacts analysis indicates that the largest potential impact on human health may be due to past-practice discharges to cribs and trenches (ditches) and past leaks from SSTs. Contaminant movement rates through the vadose zone for such releases strongly depend on the area saturated by the initial release and subsequent horizontal spreading of the released volume of liquid. These two sensitive variables cannot be known with certainty and, coupled with natural variability in precipitation, recharge, and vadose zone hydraulic conditions, make any estimate of a rate of release to the unconfined aquifer highly uncertain. Contaminant movement rates in the unconfined aquifer were projected with greater certainty by measuring past and current contaminant concentrations and calibrating the water-movement models to hydraulic-head measurements.

FFTF DECOMMISSIONING

It was assumed under FFTF Decommissioning Alternatives 2 and 3 that Hanford's bulk sodium inventory would be converted to a caustic solution for use in processing tank waste at the WTP or for Hanford tank corrosion control. However, there is uncertainty regarding whether these processing or corrosion control demands would require reuse of the entire available inventory or whether an alternative disposition pathway for this material would be necessary. There is also uncertainty regarding the potential shipment of RH-SCs for processing, as no NRC-licensed transportation cask currently exists with the capacity to handle these components for shipment. For analysis purposes, this EIS assumes that a suitable transportation cask or other shielded container would be available at the time of removal to transport these components.

WASTE MANAGEMENT

There is substantial uncertainty associated with the sources, volumes, and potential long-term performance of radiological and chemical offsite waste inventories forecast for disposal at Hanford. Because similar uncertainties also exist regarding potential volumes and characteristic of the waste that would be generated on site, it was assumed for analysis purposes that proposed expansions to the Hanford waste management facilities (e.g., the CWC, T Plant, WRAP) would be required as soon as possible following issuance of the ROD for this *TC & WM EIS*.

2.8 SUMMARY OF SHORT-TERM ENVIRONMENTAL IMPACTS

The following sections provide a summary-level comparison of the potential short-term environmental impacts of implementing each of the *TC & WM EIS* alternatives. Short-term impacts of Tank Closure alternatives are summarized in Section 2.8.1 and Table 2–9; of FFTF Decommissioning alternatives, in Section 2.8.2 and Table 2–10; and of Waste Management alternatives, in Section 2.8.3 and Table 2–11. Short-term impacts are associated with the active project phase during which construction, operations, deactivation, and closure activities would take place and extend through the applicable 100-year administrative control, institutional control, or postclosure care period. The comparison of impacts is presented to aid the decisionmakers and public in understanding the potential short-term environmental consequences of proceeding with each of these alternatives. The information presented in the following discussions and tables is based on the detailed information on potential impacts presented in Chapter 4. Mitigation measures that could be used to avoid or reduce environmental impacts resulting from implementation of the alternatives are described in Chapter 7, Section 7.1.

2.8.1 Tank Closure Alternatives: Short-Term Environmental Impacts

2.8.1.1 Land Resources

Land use includes the land on and adjacent to Hanford, the physical features that influence current or proposed uses, pertinent land use plans and regulations, and land ownership and availability. Under the No Action Alternative, there would be no additional impact on land use during the administrative control period. However, the 17 hectares (42 acres) of land comprising the existing 18 tank farms would be committed to waste management use indefinitely, as no tank farm closure would be performed. Under the action alternatives, project activities would impact the land within the 200 Areas and Borrow Area C. These areas are designated as Industrial-Exclusive and Conservation (Mining), respectively. Implementation of Alternatives 2 through 5 and 6C would necessitate a total land commitment within the

200 Areas and Borrow Area C ranging from 80.1 hectares (198 acres) under Alternative 2A to 250 hectares (618 acres) under Alternative 6C. Considerably more land would be required to implement Alternatives 6A and 6B, with the land needed ranging from 384 hectares (949 acres) under Alternative 6B, Base Case, to as much as 668 hectares (1,650 acres) under Alternative 6A, Option Case. Under Alternative 6A, Base and Option Cases, it would be necessary to utilize 86.2 hectares (213 acres) to the east of the WTP. This land is not within the Industrial-Exclusive land use designation and is presently designated as Conservation (Mining) consistent with the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (and supplement analysis) (DOE 1999, 2008) and RODs (64 FR 61615; 73 FR 55824).

Visual resources are the natural and manmade features that give a particular landscape its character and aesthetic quality. There would be little change in the overall visual setting within the 200 Areas and Borrow Area C under the No Action Alternative. Under Alternatives 2 through 5, there would also be little change to the visual character of the 200 Areas due to their present highly developed state. However, the greater land area affected under the Alternative 6 options would result in a noticeable increase in the industrial nature of the 200 Areas as viewed from nearby higher elevations (i.e., Gable Mountain, Gable Butte, and Rattlesnake Mountain). With respect to visual impacts resulting from mining activities at Borrow Area C, Alternatives 2A and 2B would result in a moderate change to the area as viewed from nearby higher elevations (principally Rattlesnake Mountain) and State Route 240. Due to the greater acreage affected, the remaining alternatives would result in a highly noticeable change to the appearance of Borrow Area C.

2.8.1.2 Infrastructure

Site infrastructure includes physical resources encompassing the utility systems required to support the construction, operations, and deactivation of facilities associated with tank waste storage, retrieval, treatment, and disposal and tank closure. It includes the electric power supply system, natural gas and liquid fuel (i.e., fuel oil, diesel fuel, and gasoline) availability and delivery capacity (see Table 2–9), and water supply system capacity. From the standpoint of total resource use, Alternative 6A would have the highest demand for all utility infrastructure resources, with the Option Case having slightly higher total demands for electricity and diesel fuel than the Base Case. This is because this alternative would have the highest total utility demands coupled with the longest period of WTP operations, 145 years, as well as clean closure of the SST system. It would be necessary to construct replacement WTP facilities twice as the predecessor facilities reach the end of their operational lifetimes. Other activities that support the waste retrieval and treatment activities would likewise be extended for longer time periods than would be the case under the other alternatives. In total, the active project phase would span 161 years.

Of Alternatives 1 through 5, Alternative 2A would have the highest demand for all utility infrastructure resources. Demands would be driven by 75 years of WTP operations, with a 90-year active project phase during which WTP and other facilities would be replaced once. Consequently, total electricity and water usage, for example, would be about two times greater under Alternative 2A on average than under Alternatives 1 through 5. The projected resource requirements among Alternatives 2B, 3A–3C, 4, 5, and 6C fall within relatively narrow ranges for most utilities. Total projected electricity requirements range from 12.1 to 20.1 million megawatt-hours. Projected water usage ranges from 77,000 million to 92,500 million liters (20,340 million to 24,440 million gallons). Total diesel fuel consumption would range from 1,860 million to 4,110 million liters (491 million to 1,086 million gallons). Overall, compared with Alternative 1, Alternative 3B would have the lowest total electricity requirement, Alternatives 3A through 3C would have the lowest total water requirements, and Alternative 3A would have the lowest total diesel fuel requirement. For electricity, projected peak annual demands under Alternative 6A, Base and Option Cases, would exceed the current capacity of the Hanford transmission system. Peak annual water demand would not exceed the capacity of the Hanford export water system under any alternative and would be substantially less than the 200 Areas' historical average annual water use. Liquid fuels are not considered to be a limiting resource, as additional supplies can be trucked to the point of use as needed from offsite suppliers. Under Alternatives 2B, 3A–3C, 4, 5, and 6C, the WTP would operate for 26, 22, 25, 16, and 26 years, respectively. Alternative 2A would not include SST system closure, while Alternatives 2B, 3A–3C, 5, and 6C evaluate landfill closure of the SST system. Alternative 4 evaluates selective clean closure/landfill closure.

2.8.1.3 Noise and Vibration

Noise is undesirable sound that interferes negatively with the human or natural environment. Noise may disrupt normal activities (e.g., hearing, sleep), damage hearing, or diminish the quality of the environment. Noise impacts may result from construction, operations, deactivation, and closure activities, including increased traffic. Noise impacts of onsite activities under all alternatives would be negligible. Following the end of WTP construction under the No Action Alternative, some reduction in noise levels could result, and traffic noise levels could decrease. Noise impacts of traffic would be highest under Alternative 6B, Option Case, which would have the highest peak employment and employee vehicle traffic associated with WTP operation and PPF construction. The increase in employee traffic noise along the roads to the site during peak hours (shift changes) could be noticeable to residents along these routes. Alternative 3C would have the highest offsite truck traffic associated with steam reforming operations. Noise impacts of onsite activities and traffic under other alternatives would be negligible to minor.

2.8.1.4 Air Quality

Air pollution refers to any substance in the air that could harm human or animal populations, vegetation, or structures or that unreasonably interferes with the comfortable enjoyment of life and property. As modeled, nonradioactive air pollutant concentrations under all alternatives would exceed the applicable 24-hour ambient standards for particulate matter with an aerodynamic diameter less than or equal to 2.5 micrometers ($PM_{2.5}$) and 10 micrometers (PM_{10}); would exceed the 1-hour standard for nitrogen dioxide; and, under Alternatives 2A, 2B, 3A, 3B, 3C, and 5, would exceed the carbon monoxide applicable 1-hour ambient standard. Nonradiological air quality impacts of $PM_{2.5}$ and PM_{10} would be highest under Alternatives 5 and 6B, Base Case. Under these alternatives, $PM_{2.5}$ and PM_{10} (24-hour averaging) concentrations in the peak year would be attributable primarily to fugitive dust from heavy-equipment operations during modified RCRA Subtitle C barrier construction.

Particulate matter emissions estimated for construction-type activities include fugitive dust emissions from construction areas and take into account dust suspended by equipment and vehicle activity and by wind. The emission factor used for these estimates is intended to provide a gross estimate of total suspended particulate emissions when detailed engineering data that would allow for a more refined estimate of dust emissions are not available. For the purpose of this analysis, $PM_{2.5}$ and PM_{10} emissions from general construction activities were assumed to be the same as the total suspended particulate emissions. This results in a substantial overestimate of $PM_{2.5}$ and PM_{10} emissions. Further, the analysis did not consider appropriate emission controls that could be applied in the construction areas, as discussed in Chapter 7, Section 7.1. A refined analysis of emissions, based on more-detailed engineering data on the construction activities and application of appropriate control technologies, is expected to result in substantially lower projected emissions and ambient concentrations from the major construction activities under these alternatives. Maximum air quality impacts of particulate matter are expected to occur along State Route 240, along or near the Hanford boundary to the east to southeast, or along the Hanford boundary to the southwest.

The Clean Air Act, as amended (40 U.S.C. 7401 et seq.), requires that Federal actions conform to the host state's "state implementation plan." A state implementation plan provides for the implementation, maintenance, and enforcement of National Ambient Air Quality Standards (NAAQS) for the six criteria pollutants: sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. Its purpose is to eliminate or reduce the severity and number of NAAQS violations and to expedite the attainment of these standards. "No department, agency, or instrumentality of the Federal Government shall engage in or support in any way or provide financial assistance for, license or permit, or approve any activity that does not conform to an applicable implementation plan." The final rule for "Determining Conformity of General Federal Actions to State or Federal Implementation Plans" (40 CFR 51, Subpart W) took effect on January 31, 1994. Hanford is within an area currently designated as attainment for criteria air pollutants. Therefore, the alternatives considered in this EIS do not require a conformity determination under the provisions of this rule (40 CFR 81.348).

Acceptable source impact levels are used during the permitting process to demonstrate that emissions from a new toxic air pollutant source are sufficiently low to protect human health and safety from potential carcinogenic and/or other toxic effects. Comparison of the estimated concentrations to acceptable source impact levels indicates that emissions under all Tank Closure alternatives except Alternatives 2B, 6B (Base and Option Cases), and 6C would be sufficiently low to protect human health and safety. Specifically, maximum concentrations of nonradioactive toxic air pollutants off site and in areas to which the public has access would be lower than the state's acceptable source impact levels, except for mercury, under Alternatives 2B, 6B (Base and Option Cases), and 6C. Impacts of radioactive air emissions are summarized in Section 2.8.1.10.

2.8.1.5 Geology and Soils

Geologic resources include consolidated and unconsolidated earth materials, including rock and mineral assets such as ore and aggregate materials (e.g., sand, gravel) and fossil fuels such as coal, oil, and natural gas. Soil resources include the loose surface materials of the earth in which plants grow. Impacts on geology and soils under the Tank Closure alternatives would generally be directly proportional to the total area of land disturbed by site grading and soil compaction and by the depth of excavation associated with construction of new facilities and to support tank farm closure. Consumption of geologic resources would constitute the major indirect impact on geology and soils. Incremental impacts on geology and soils under Alternative 1 would be negligible, as ongoing facility construction and tank farm upgrades would be confined to previously disturbed areas. Somewhat similarly to that described above for land use, new permanent land disturbance would be similar under Alternatives 2B through 5, ranging from 110 hectares (271 acres) to 138 hectares (340 acres), with short-term construction impacts on geology and soils resulting principally from wind and water erosion expected to be small. Impacts associated with Alternatives 2A and 6C would fall below and beyond the range described, respectively. Alternatives 6A and 6B would result in the greatest land disturbance and potential for impacts on geology and soils, with new permanent land disturbance ranging from 359 hectares (886 acres) under Alternative 6B, Base Case, to 668 hectares (1,650 acres) under Alternative 6A, Option Case. Potential impacts on geology and soils would be greatest under Alternatives 6A and 6B due to the larger facility construction demands and the extensive excavation work required for clean closure of all tank farms, requiring multiple deep soil excavations ranging from 20 meters (65 feet) to as much as 78 meters (255 feet) in depth. Projected requirements for geologic resources, including rock/basalt, sand, gravel, and soil for such uses as concrete aggregate or grout materials and borrow material for backfill and landfill barrier construction, as appropriate, would be relatively similar under Alternatives 2B through 5, ranging from 4,240,000 cubic meters (5,510,000 cubic yards) under Alternative 3B to 5,380,000 cubic meters (7,037,000 cubic yards) under Alternative 5. Geologic resource requirements would be highest under Alternative 6A, Option Case, at 20,900,000 cubic meters (27,200,000 cubic yards) due to extensive facility construction combined with clean closure requirements. While the volume of aggregate and other borrow materials would be very large under some alternatives, the demands are not expected to deplete Hanford reserves of these materials under any alternative, as they are widely available in the Hanford region.

2.8.1.6 Water Resources

Water resources are the surface and subsurface waters that are suitable for human consumption, aquatic or wildlife use, agricultural purposes, irrigation, or industrial/commercial purposes. No additional impacts on availability or quality of surface-water or groundwater resources are expected in the short term under Alternative 1. No direct disturbance to surface-water features, including the Columbia River, is expected to occur in the short term under any alternative, as there are no natural, perennial surface-water drainages on the Central Plateau of Hanford. Construction-related land disturbance would expose soils and sediments to possible erosion, and stormwater runoff from exposed areas could convey soil, sediments, and other pollutants from construction sites. Adherence to appropriate soil erosion and sediment control measures would serve to minimize any potential water quality impacts, as described in the water resources sections of Chapter 4, Section 4.1.6. There would be no direct discharge of effluents to either surface waters or groundwater during construction, operations, deactivation, or closure activities under any alternative. Effluents would be managed by appropriate Hanford treatment facilities. Water would be required during all project phases. Under all action alternatives, peak annual water demands would be substantially less than the production capacity of the Hanford export water system that withdraws water from the Columbia River. Demand is not expected to have a substantial impact on the availability of surface water from the Columbia River for downstream users.

Facility construction, operations, deactivation, and landfill closure would be unlikely to have any impact on groundwater hydrology or existing contaminant plumes under any alternative except Alternatives 4, 6A, and 6B. Deep excavation to effect clean closure of the BX and SX tank farms under Alternative 4 and clean closure of all 12 tank farms under Alternatives 6A and 6B may require construction dewatering and could locally affect groundwater flow and existing contaminant plumes beneath the tank farms. During normal operations in the short term, impacts on the vadose zone and groundwater in the 200 Areas would be due to leaks from the tank system during retrieval operations and from effluent disposal. These additional retrieval releases would be essentially recovered under Alternatives 6A and 6B, but would add to other historical releases under all other alternatives. Landfill barriers constructed under Alternatives 2B, 3A, 3B, 3C, 4, 5, and 6C would delay, but not prevent, downgradient movement of contaminants over the long term to the unconfined aquifer system and ultimately to the Columbia River, as further summarized in Section 2.9.1.

While portions of the probable maximum flood zone associated with Cold Creek lie within the confines of Borrow Area C, production operations associated with material extraction to support tank closure and waste management activities would be conducted to avoid impacting the watercourse and associated floodplain. Any changes in the extent and nature of predicted mining that could impact the floodplain would be evaluated, and a floodplain assessment would be prepared as required by Executive Order 11988, *Floodplain Management*, and Federal regulations (10 CFR 1022).

2.8.1.7 Ecological Resources

Ecological resources include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Sagebrush habitat is an important regional community that is considered a priority habitat within Washington State and a Level III resource under the *Hanford Site Biological Resources Management Plan* (DOE 2001). In most cases, mitigation in the form of replacement at a rate of from 1:1 to 3:1 would be required. Sagebrush habitat would not be disturbed within the 200 Areas under the No Action Alternative; however, it would be impacted under the remaining alternatives. Under Alternative 2A, 14.2 hectares (35 acres) would be affected, while Alternatives 2B through 5 would impact from 1.2 to 6.4 hectares (3 to 15.8 acres). The Alternative 6 subalternatives would disrupt the greatest area of sagebrush habitat, ranging from 46.1 hectares (114 acres) under Alternative 6C to 184 hectares (455 acres) under Alternative 6A, Option Case. Because there is no sagebrush habitat within Borrow Area C, it would not be disturbed under any of the alternatives.

Because at present no federally or state-listed threatened or endangered species are recorded as occurring within the 200 Areas or Borrow Area C, this group of species would not be affected under any alternative. Under the No Action Alternative, no state-listed special status species would be affected within the 200 Areas; however, the potential exists to impact four such species within Borrow Area C. In fact, each of the remaining alternatives has the potential to impact the same four species within Borrow Area C, with those alternatives requiring more acreage having the greater potential. Within the 200 Areas, two state-listed special status species could be affected under Alternative 2B, four under Alternative 6B (Base and Option Cases), and six under the remaining alternatives.

Due to the lack of wetlands and aquatic resources within the 200 Areas and Borrow Area C, there would be no impact on these resources under any of the alternatives.

2.8.1.8 Cultural and Paleontological Resources

Cultural resources are the indications of human occupation and use of property, as defined and protected by a series of Federal laws, regulations, and guidelines, and are categorized as prehistoric resources, historic resources, and American Indian interests. Prehistoric resources are the physical remains of human activities that predate written records. Historic resources consist of physical remains that postdate the emergence of written records. American Indian interests include sites, areas, and materials important to American Indians for religious or heritage reasons. Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geologic age and may be sources of information on ancient environments and the evolutionary development of plants and animals.

Under the Tank Closure alternatives, there would be no impact on prehistoric or paleontological resources, as none are located in the project area. None of the proposed alternatives would have an impact on prehistoric or historic resources at Hanford that are either listed or eligible for listing on the National Register of Historic Places. Sites containing early historic resources (i.e., cans and bottles) could be impacted under the Alternative 6 subalternatives; however, these sites are not eligible for listing on the National Register of Historic Places. The viewscape from nearby higher elevations (i.e., Gable Mountain, Gable Butte, and Rattlesnake Mountain) is important to American Indians with cultural ties to Hanford. There would be little change in the overall visual setting under the No Action Alternative. The greater the land area affected, the more noticeable increase there would be in industrial appearance as viewed from these higher elevations. Alternatives 6A, 6B, and 6C would have the greatest impact on the viewshed.

2.8.1.9 Socioeconomics

Socioeconomic impacts are defined in terms of changes to demographic and economic characteristics of a region. The socioeconomic environment is generally made up of regional economic indicators and demographic characteristics of the area. Economic indicators include employment, the civilian labor force, and unemployment rates. Demographic characteristics include population, housing, education, and health information. In addition, the projected workforce and work activities could potentially impact the local transportation and result in level-of-service impacts on the roads in the region of influence (ROI) (i.e., Benton and Franklin Counties).

Except for the No Action Alternative, all other alternatives have a potential for socioeconomic impacts in the ROI. The impacts would be greatest under Alternative 6A, Option Case (10,200 full-time equivalents [FTEs] annually in 2041), and under Alternative 6B, Option Case (10,200 FTEs annually in 2021 and 2022). These peak year workforce requirements would be primarily in support of WTP operations and PPF construction needed for clean closure. Under Alternative 3C, the number of daily offsite truck loads could potentially be higher in support of the steam reforming supplemental treatment activities. The increase in direct employment at Hanford under these alternatives and associated indirect employment in the region would result in appreciable changes in the socioeconomic ROI, including increases in population, demand and cost for housing and community services, and level-of-service impacts on local transportation systems in the Tri-Cities area.

2.8.1.10 Public and Occupational Health and Safety—Normal Operations

A description of the radionuclide releases resulting from construction, operations, deactivation, and closure activities under each alternative is provided in Chapter 4 of this *TC & WM EIS*. The impacts on both the public and workers are estimated. For the public, impacts on the population near Hanford, the maximally exposed individual (MEI), and an onsite MEI are evaluated; for workers, the focus is on impacts on radiation workers. The measure of impact is the number or risk of health effects (e.g., latent cancer fatalities [LCFs]) among the public or workers. Potential impacts on workers from exposure to chemicals are also addressed.

> **Maximally Exposed Individual (MEI)**
>
> A hypothetical individual whose location and habits result in the highest total radiological or chemical exposure (and thus dose) from a particular source for all exposure routes (e.g., inhalation, ingestion, direct exposure). As used in this environmental impact statement, the MEI refers to an individual located off site, unless characterized otherwise in terms of time or location.
>
> **Latent Cancer Fatalities**
>
> Deaths from cancer resulting from, and occurring sometime after, exposure to ionizing radiation or other carcinogens.
>
> **Rem**
>
> A rem is a unit of dose equivalent that allows comparison of the biological effects of radionuclides that emit different types of radiation.
>
> **Person-rem**
>
> A person-rem is a unit of collective radiation dose applied to populations or groups; it is a unit for expressing dose when summed across all persons in a specified population or group.

The largest radiological impact on the public within 80 kilometers (50 miles) of the 200 Areas over the life of the project is estimated to be under Alternatives 2A, 3C, 6A (Base and Option Cases), and 6B (Base and Option Cases) (1,700 to 1,800 person-rem). The estimated dose is higher for these alternatives because of the long periods during which there would be radioactive air emissions (Alternative 2A), emissions from treatment technologies, and from the retrieval and processing of contaminated soil. Of the action alternatives, Alternative 3B would result in the smallest radiological impact on the public (1,200 person-rem). The smaller impact compared with other action alternatives is due to the use of the nonthermal cast stone process for treating a portion of the tank waste and the associated low emissions. Public doses over the life of the project from the remaining alternatives would range from about 1,400 person-rem (Alternatives 4 and 5) to about 1,600 person-rem (Alternatives 2B, 3A, and 6C). The projected number of LCFs calculated to occur in the population would be 0 under the No Action Alternative and 1 under all of the action alternatives. Projections of an LCF in the population surrounding Hanford are based on a large number of people receiving small doses over many years—for some alternatives, the doses are received over several generations.

Risk to individual members of the public would be less than the calculated dose and risk to an MEI. The estimated dose to an MEI in the year of peak impact under all alternatives is equal to or less than the National Emission Standards for Hazardous Air Pollutants limit of 10 millirem per year (40 CFR 61, Subpart H). The smallest impact (0.041 millirem per year) would be associated with Alternative 1, under which no waste processing would occur; impacts of the other alternatives would range from 8.5 to 10 millirem per year, with the peak occurring in the year that materials from the cesium and strontium capsules are processed through the WTP. The largest annual incremental risk of an LCF to an MEI would be 6×10^{-6} (about 1 in 170,000). In those cases where projections indicate that doses would be at or approaching 10 millirem per year, DOE would take action to ensure that emissions are controlled so that the total site impact remains below the regulatory limit. Impacts of nonradioactive air emissions are summarized in Section 2.8.1.4.

Impacts on an onsite MEI, defined as a member of the public who spends a normal workday at a facility on Hanford that is not under the auspices of DOE, were also evaluated. The maximum annual impact on an onsite MEI, assumed to be at the Columbia Generating Station, the Laser Interferometer Gravitational-Wave Observatory (LIGO), or the US Ecology Commercial LLW Disposal Site, would be 0.033 millirem under Alternative 1 (risk of an LCF of about 1 in 50 million) and about 1.4 millirem (risk of an LCF of about 1 in 1.2 million) under Alternatives 2A, 3A, 3B, 3C, 4, 5, and 6A (Base and Option Cases). Under Alternatives 2B, 6B, and 6C, the maximum annual dose would be about 1.6 to 1.7 millirem per year (risk of an LCF of about 1 in 1 million).

The collective radiation dose to workers over the life of the project would be lowest (280 person-rem) under Alternative 1. Collective worker doses for about half of the alternatives (2B, 3A, 3B, 3C, 5, and 6C) would range from 8,500 to 11,000 person-rem. Based on the dose-to-risk factor of 0.0006 LCFs per person-rem, these doses could result in 5 to 7 LCFs in the worker population. Alternative 2A would result in a collective worker dose of about 22,000 person-rem due to the longer time period during which waste processing would occur; this dose could result in 13 LCFs among the workers. The largest collective worker doses would be associated with alternatives that include removal of tanks and contaminated soil—Alternative 4 (43,000 person-rem), Alternative 6A (120,000 person-rem under both the Base and Option Cases), and Alternative 6B (82,000 person-rem under the Base Case and 85,000 person-rem under the Option Case). Statistically, applying the risk coefficient of 0.0006 LCFs per person-rem would result in 26 additional LCFs under Alternative 4; 72 and 75 under Alternative 6A, Base and Option Cases, respectively; and 49 and 51 under Alternative 6B, Base and Option Cases, respectively. It should be noted that for the larger doses and risks, the project extends over several generations of workers and that individual worker doses would be maintained less than the Administrative Control Level of 500 millirem per year (DOE Standard 1098-2008).

Estimated average annual radiation worker doses are based on 2,080 hours per year of radiation work, but do not necessarily represent expected doses to individual radiation workers; a larger number of workers may be employed to complete work than the worker years imply, resulting in lower average doses to the actual workers. Estimated average doses per radiation worker per year range from 140 to 170 millirem under all alternatives except Alternatives 4, 6A, and 6B. The average annual risk of an individual developing an LCF from these doses would be 1 in 10,000 to 11,000. Alternative 4 (530 millirem per year), Alternative 6A (420 millirem per year), and Alternative 6B (890 millirem per year), which involve tanks and soil removal, would have the highest average annual radiation worker doses. The corresponding annual risks to an individual of developing an LCF would be 1 in 2,000 to 5,000. DOE and its contractors would employ engineering and administrative controls to manage individual radiation worker doses and ensure that they remain below the DOE Administrative Control Level of 500 millirem per year (DOE Standard 1098-2008).

Calculated doses to a noninvolved worker in the year of peak impact would be low under all alternatives. The conservatively calculated annual doses to the noninvolved workers would be 3.6 millirem or less, well below the DOE Administrative Control Level of 500 millirem per year (DOE Standard 1098-2008).

Occupational hazards and possible exposure agents associated with work activities under the EIS alternatives are generally considered to be typical of DOE operations. No unique or extra-hazardous operations were identified during this evaluation. There have been, however, concerns about, and investigations into, exposure of tank farm workers to chemicals emitted from the tanks, as further discussed in Appendix K.

2.8.1.11 Public and Occupational Health and Safety—Facility Accidents

Processing any hazardous material creates a risk of accidents impacting involved workers (workers directly involved in facility processes), noninvolved workers (workers on the site but not directly involved in facility processes), and members of the public. The consequences of such accidents could involve the release of radioactive materials, toxic chemicals, or hazardous (e.g., explosive) energy beyond the intended confines of the process. Risk is determined by the development of a representative spectrum of postulated accidents, each of which is conservatively characterized by a likelihood (i.e., expected frequency of occurrence) and a consequence. For the Tank Closure alternatives presented in Table 2–9, the projected accident consequences are conditional on an accident's occurrence and therefore do not reflect an accident's frequency of occurring. Shown in this table is the accident with the highest projected consequences under each alternative. For Tank Closure Alternative 1, the event selected to represent a severe accident is the seismically induced waste tank dome collapse, whereas for all other alternatives it is a seismically induced collapse and failure of the WTP. For this latter accident, the contents of the HLW Vitrification Facility's melter feed-preparation vessels would be the largest contributors to consequences under the action alternatives. As a result, Tank Closure Alternatives 2A through 5, 6B, and 6C, each of which is based on an HLW Vitrification Facility TMC of 6 metric tons of glass per day, would have the highest (identical) consequences. Tank Closure Alternative 6A would have considerably lower consequences for this accident because there would be no pretreatment of the waste and therefore no Pretreatment Facility or LAW Vitrification Facility contributions to the accident source term. In addition, the contents of the HLW melter feed-preparation vessels would be diluted with LAW. The frequency of this accident is estimated to be 0.0005 per year (once in 2,000 years).

The accident risks shown in Table 2–9 take into account an accident's frequency. The annual risk value reflects the annual frequency of the accident. The risk over the life of the project reflects the duration of WTP operations, ranging from 16 to 145 years, during which that accident could occur. The risk over the life of the project from the seismically induced WTP collapse would be highest under Alternative 2A and lowest under Alternative 6A.

In accordance with DOE orders, DOE protects against intentional destructive acts aimed at its facilities and materials. Regardless of those protections, this EIS evaluates the potential impacts of intentional destructive acts in addition to conventional facility accident scenarios. Detonation of explosives in an underground storage tank was hypothesized; the radiological impacts of this scenario would be about 4 times greater than the impacts of the most severe accident scenario that involves the same inventory of radioactive material (seismically induced waste tank dome collapse—unmitigated). An aircraft or ground vehicle crash or explosions initiated by an insider at the HLW Vitrification Facility would result in radiological impacts about one-tenth of those calculated for the most severe accident scenario that involves the same inventory of radioactive material (seismically induced WTP collapse and failure—unmitigated). An intentional explosion causing massive damage to the WTP ammonia tank could result in life-threatening health effects or death at distances about 10 times farther than for the accident scenario that involves the same chemical inventory (tank failure with release of entire contents in 30 minutes). The potential for, and consequences of, the intentional destructive act scenarios are essentially the same under each of the alternatives except Alternative 1: No Action, for which the scenarios involving the WTP would not apply. More-detailed discussion of intentional destructive act impacts associated with Tank Closure alternatives is provided in Chapter 4, Section 4.1.11.12.

2.8.1.12 Public and Occupational Health and Safety—Transportation

Transportation of any commodity involves a risk to both transportation crewmembers and members of the public. The risk results directly from transportation-related accidents and indirectly from the levels of pollution from vehicle emissions, regardless of the cargo. The transportation of certain materials, such as hazardous or radioactive waste, can pose additional risk due to the unique nature of the material itself.

Except for the No Action Alternative, all alternatives would generate various radioactive waste materials that would require transport for disposition. Alternatives 2A, 2B, 6A (Base and Option Cases), 6B (Base and Option Cases), and 6C would require transport of waste to onsite locations within Hanford. Alternatives 3A, 3B, 3C, 4, and 5 would require transport of waste to onsite locations and to offsite locations, such as WIPP. In addition, all alternatives would require transport of various nonradioactive materials for construction and operational support. Table 2–9 summarizes the transportation risks to the workers (transport drivers) and the public in terms of traffic fatalities and LCFs. The risk to the public includes personnel put at risk from the transport of waste to onsite locations. Based on the results presented in this table, the following observations can be made:

- It is unlikely that the transportation of radioactive waste would cause an additional fatality as a result of radiation from either incident-free operations or postulated transportation accidents.
- The highest radiological risk to the public would be under Tank Closure Alternatives 3A, 3C, and 4, where about 3,600 truck shipments of TRU waste would be transported to WIPP, and up to 142,000 shipments of various radioactive waste materials would be transported to onsite waste burial and storage locations over the duration of the alternatives.
- The lowest radiological risk to the public would be under Tank Closure Alternatives 2A, 2B, 6A (Base Case), and 6C, where 105,000 to 874,000 shipments of various radioactive waste materials would be transported to onsite waste burial and storage locations over the duration of the alternatives.
- The nonradiological accident risks (the potential for fatalities as a direct result of traffic accidents) present the greatest risks. The number of projected traffic accident fatalities ranges from 1 to 9 for the action alternatives. Considering that the transportation activities analyzed in this *TC & WM EIS* would occur from about 20 to over 150 years and the average number of traffic fatalities in the United States is about 40,000 per year, the traffic fatality risks under all alternatives would be relatively small.

2.8.1.13 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs Federal agencies to identify and address, as appropriate, disproportionately high and adverse human health and environmental effects of their programs, policies, and activities on minority and low-income populations. Potential risks to human health from normal facility operations and postulated facility accidents are not expected to pose disproportionately high and adverse effects on minority or low-income populations surrounding Hanford under any Tank Closure alternative.

2.8.1.14 Waste Management

Tank waste retrieval, treatment, and disposal and tank closure would generate several types of waste: HLW, mixed TRU waste, LLW, MLLW, hazardous waste, and nonhazardous waste. The generation of waste could have an impact on existing Hanford facilities devoted to TSD. As described in Chapter 4, either the current waste management capacity is sufficient or the new infrastructure would be constructed under the alternative. Projected waste generation rates for the proposed activities were compared with Hanford's capacity to manage the waste, including the additional waste disposal capacity that is proposed to be constructed. Projected waste generation rates for the proposed activities were compared with site processing rates and capacities of those TSD facilities likely to be involved in managing the additional waste. Potential impacts of waste generated as a result of site environmental restoration activities unrelated to Tank Closure, FFTF Decommissioning, or Waste Management alternatives are not within the scope of this analysis. Where additional disposal capacity would be needed, the land use impacts are addressed in the appropriate sections of Chapter 4. The estimated full inventories of waste forms disposed of on site are included in the analyses of long-term impacts presented in Chapter 5 of this *TC & WM EIS*.

IHLW. Under all the alternatives, the IHLW glass canisters would be stored in new onsite facilities. Onsite canister storage capacity would be constructed under these alternatives, so there would be no impacts on the existing Hanford waste management system.

Other HLW. Under Tank Closure Alternatives 6A and 6B, other HLW would be generated. Under both alternatives, other HLW would consist of tank parts, equipment, and debris arising from the demolition and removal of all the SSTs. Under Alternative 6B, other HLW would also consist of vitrified waste in canisters that would come from the LAW Vitrification Facility. Because sufficient onsite storage capacity would be constructed under these alternatives, there would be no additional impacts on the existing Hanford waste management system.

Cesium and strontium capsules. Under all Tank Closure alternatives except Alternative 1, the cesium and strontium capsules would be processed for de-encapsulating and preparing the waste into a suitable WTP slurry feed. The waste slurry would then be stored in a DST prior to treatment through the WTP. This EIS analyzes the immobilization of the cesium and strontium slurry feed as a separate, 1-year-long WTP campaign; however, the cesium and strontium slurry feed could be mixed with the late-stage tank waste feed.

Under Tank Closure Alternative 1, the cesium and strontium capsules would continue to be stored indefinitely in the WESF; therefore, construction of a new Cesium and Strontium Capsule Processing Facility would be unnecessary. Under all other alternatives analyzed in this EIS, the cesium and strontium waste would be vitrified in the WTP. It is estimated that an additional 340 canisters would be produced during the cesium and strontium treatment campaign.

WTP melters. Under all Tank Closure alternatives except Alternative 1, WTP HLW melters and LAW melters (and, in the case of Alternatives 6A, 6B, and 6C, PPF melters) would become a waste stream following service.

It is anticipated that the HLW melters would be stored on site. The LAW melters would be disposed of as MLLW under Tank Closure Alternatives 2A, 2B, 3A, 3B, 3C, 4, and 5, and as HLW under Alternatives 6B and 6C. Storage of HLW melters is expected to result in no releases to the environment. Impacts of constructing and operating facilities with sufficient storage capacity under these Tank Closure alternatives for the WTP HLW and LAW melters are evaluated in the appropriate sections of this *TC & WM EIS*.

The LAW melters that are disposed of as MLLW would be disposed of in an RCRA-compliant, onsite IDF. The impacts of providing disposal capacity in an IDF are included in the disposal capacities of the corresponding Waste Management alternatives.

The PPF melters generated from processing soils contaminated by past tank leaks would be disposed of on site in an IDF as MLLW. Disposal of the PPF melters is included in the disposal capacity of the corresponding Waste Management alternatives.

CH- and RH-mixed TRU waste. Sources of CH- and RH-mixed TRU waste would include secondary waste and, under Alternatives 3A, 3B, 3C, 4, and 5, waste forms derived from supplemental treatment of mixed TRU waste retrieved from the underground storage tanks.

The CH-mixed TRU waste would be treated and packaged using mobile units. The remainder of the mixed TRU waste has a high level of activity, necessitating use of a shielded facility and remote processing for treatment. A single facility for remotely processing the high-activity waste would be constructed in the 200-East Area. Impacts of constructing and operating facilities with additional mixed TRU waste treatment and certification capacity are evaluated in the appropriate sections of this *TC & WM EIS*.

For analysis purposes, it was assumed that all of the TRU waste would be disposed of at WIPP. The *WIPP SEIS-II* evaluated the receipt and disposal of 57,000 cubic meters (74,600 cubic yards) of CH- and 29,000 cubic meters (37,900 cubic yards) of RH-mixed TRU waste from Hanford (DOE 1997b). The waste generated under all alternatives would be within the capacities allocated to Hanford in the *WIPP SEIS-II*. As reported in the *WIPP SEIS-II*, the Consultation and Cooperation Agreement with the State of New Mexico currently limits the volume of RH-TRU waste shipped to WIPP from all DOE sites to 7,080 cubic meters (9,260 cubic yards) (DOE 1997b).

LLW and MLLW. Secondary LLW (e.g., personal protective equipment, tools, filters, empty containers) would be generated during routine operations and the administrative control period. LLW is typically not treated or only minimally treated (e.g., compacted) before disposal. Therefore, this waste treatment would cause no impacts on the Hanford waste management system. The LLW would be sent directly to disposal. Therefore, long-term storage facilities would not be required.

Secondary MLLW (e.g., personal protective equipment, tools, job waste, soil from closure activities) would be generated during operations, deactivation, and closure. Using a combination of on- and offsite capabilities, secondary MLLW would be treated to meet RCRA land-disposal-restriction treatment standards prior to disposal.

Also included as MLLW are the PPF glass canisters generated from treatment of soils in the PPF under Tank Closure Alternatives 6A and 6B. The process would generate a liquid waste stream containing radionuclides and chemicals removed from the soils. A melter cell would be installed in the PPF to process this liquid waste into a PPF glass suitable for onsite disposal. This waste would be disposed of as MLLW on site in an IDF.

Under Tank Closure Alternatives 2B, 3A, 3B, 3C, 4, 5, and 6C, Waste Management Alternative 2, Disposal Group 1, or Waste Management Alternative 3, Disposal Group 1, would be chosen for the disposal of tank waste and all other LLW and MLLW. As described under Waste Management Alternative 2, IDF-East would be constructed and operated for the disposal of tank waste and all other LLW and MLLW; under Waste Management Alternative 3, two IDFs would be constructed and operated: IDF-East for tank waste only and IDF-West for the other LLW and MLLW. The proposed RPPDF would be constructed and operated for disposal of lightly contaminated equipment and soils resulting from closure activities. Under Waste Management Alternative 2, Disposal Group 1, IDF-East and proposed RPPDF operations would be completed in 2050, with IDF-East capacity at 1.2 million cubic meters (1.57 million cubic yards) and proposed RPPDF capacity at 1.08 million cubic meters (1.41 million cubic yards). Under Waste Management Alternative 3, Disposal Group 1, IDF-East, IDF-West, and proposed RPPDF operations would be completed in 2050. IDF-East's capacity would be at 1.1 million cubic meters (1.43 million cubic yards); IDF-West's at 90,000 cubic meters (118,000 cubic yards); and the proposed RPPDF's at 1.08 million cubic meters (1.41 million cubic yards). Under Waste Management Alternatives 2 and 3, the IDF(s) and proposed RPPDF would be covered with engineered modified RCRA Subtitle C barriers to reduce water infiltration and potential for intrusion. A 100-year postclosure care period would follow.

Under Tank Closure Alternatives 2A and 6B, Waste Management Alternative 2, Disposal Group 2, or Waste Management Alternative 3, Disposal Group 2, would be chosen for disposal of tank waste and all other LLW and MLLW. As described under Waste Management Alternative 2, IDF-East would be constructed and operated for the disposal of tank waste and all other LLW and MLLW; under Waste Management Alternative 3, two IDFs would be constructed and operated: IDF-East for tank waste only and IDF-West for the other LLW and MLLW. Under Alternative 6B, the proposed RPPDF would be constructed and operated for disposal of lightly contaminated equipment and soils resulting from clean closure activities. Under Waste Management Alternative 2, Disposal Group 2, IDF-East and proposed RPPDF operations would be completed in 2100, with IDF-East capacity at 425,000 cubic meters (556,000 cubic yards) and proposed RPPDF capacity at 8.37 million cubic meters (10.9 million cubic yards). Under Waste Management Alternative 3, Disposal Group 2, IDF-East and proposed RPPDF operations would be completed in 2100, and IDF-West operations in 2050. IDF-East's capacity would be at 340,000 cubic meters (445,000 cubic yards); IDF-West's at 90,000 cubic meters (118,000 cubic yards); and the proposed RPPDF's at 8.37 million cubic meters (10.9 million cubic yards). Under both Waste Management action alternatives, the IDF(s) and proposed RPPDF would be covered with engineered modified RCRA Subtitle C barriers to reduce water infiltration and potential for intrusion. A 100-year postclosure care period would follow.

Under Tank Closure Alternative 6A, Waste Management Alternative 2, Disposal Group 3, or Waste Management Alternative 3, Disposal Group 3, would be chosen for disposal of tank waste and all other LLW and MLLW. As described under Waste Management Alternative 2, IDF-East would be constructed and operated for the disposal of tank waste and all other LLW and MLLW; under Waste Management Alternative 3, two IDFs would be constructed and operated: IDF-East for tank waste only and IDF-West for the other LLW and MLLW. Under Alternative 6C, the proposed RPPDF would be constructed and operated for disposal of lightly contaminated equipment and soils resulting from closure activities. Under Waste Management Alternative 2, Disposal Group 3, IDF-East and proposed RPPDF operations would be completed in 2100, with IDF-East capacity at 425,000 cubic meters (556,000 cubic yards) and proposed RPPDF capacity at 8.37 million cubic meters (10.9 million cubic yards). Under Waste Management Alternative 3, Disposal Group 3, IDF-East and proposed RPPDF operations would be completed in 2165, and IDF-West operations in 2050. IDF-East's capacity would be at 340,000 cubic meters (445,000 cubic yards); IDF-West's, at 90,000 cubic meters (118,000 cubic yards); and the proposed RPPDF's, at 8.37 million cubic meters (10.9 million cubic yards). Under both Waste Management Alternatives 2 and 3, the IDF(s) and RPPDF would be covered with engineered modified RCRA Subtitle C barriers to reduce water infiltration and potential for intrusion. A 100-year postclosure care period would follow.

Under Waste Management Alternatives 1, 2, and 3, trenches 31 and 34 and the existing LLBGs would continue to receive LLW and MLLW from onsite non-CERCLA generators. Under Waste Management Alternative 1, waste would be received until 2035, and under Waste Management Alternatives 2 and 3, waste would be received until the trenches were filled to capacity but not later than 2050. No construction activities would be necessary because the trenches are in current operation.

Hazardous waste. Hazardous waste is dangerous waste as defined in WAC 173-303. Hazardous waste generated during construction and operations would be packaged in DOT-approved containers and shipped off site to permitted commercial recycling, treatment, and disposal facilities. Under all Tank Closure alternatives except Alternative 1, during the period of active construction, operations, and closure, similar quantities of hazardous waste would be generated. Management of the additional waste generated under the Tank Closure alternatives would require additional planning, coordination, and establishment of satellite accumulation areas, but because the waste would be treated and disposed of at offsite commercial facilities, the additional waste load would have a minor impact at Hanford.

Nonhazardous waste. Any nonhazardous solid waste generated during facility construction, operations, deactivation, and closure under the Tank Closure alternatives would be packaged and transported in conformance with standard industrial practice. Solid waste such as office paper, metal cans, and plastic and glass bottles that can be recycled would be sent off site for that purpose. The remaining nonhazardous solid waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

Liquid process waste. Process waste, including liquid secondary LLW, would be generated by the activities performed to retrieve, separate, and treat tank waste. Process waste and dilute process waste, such as cooling waters or steam condensates, would be routed to the Hanford facilities, whose mission it is to manage such wastes, as applicable. It is assumed that the ETF and the TEDF, or their equivalents, would continue to be available to manage process liquids generated under the Tank Closure alternatives.

2.8.1.15 Industrial Safety

In addition to facility accident risks, estimates of potential industrial safety impacts on workers during construction, operations, deactivation, and closure activities under each alternative were evaluated based on the DOE complex–wide CAIRS [Computerized Accident/Incident Reporting System] database (see Appendix K, Section K.4). These impacts correlate with the number of labor hours required to support each Tank Closure alternative and are classified into two groups: total recordable cases (TRCs) and fatalities. Recordable cases include work-related deaths, as well as work-related illnesses or injuries leading to loss of consciousness, lost workdays, or transfer to another job, and/or requiring medical treatment beyond first aid.

Table 2–9 summarizes the potential number of TRCs and fatalities resulting from the construction, operations, deactivation, and closure activities that would be conducted under each Tank Closure alternative. The fewest projected industrial safety impacts would occur under Tank Closure Alternative 1, as the No Action Alternative would require the least amount of worker labor. Under the Tank Closure action alternatives, the fewest projected impacts would occur under Tank Closure Alternative 5, which is expected to result in approximately 3,250 TRCs and no worker fatalities. In contrast, the greatest projected impacts would occur under Tank Closure Alternative 6A, Option Case, which could result in approximately 21,300 TRCs and approximately three fatalities.

Table 2–9. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts

Parameter/ Resource	Tank Closure Alternative										
	1 **No Action**	**2A** **Existing WTP Vitrification; No Closure**	**2B** **Expanded WTP Vitrification; Landfill Closure**	**3A** **Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure**	**3B** **Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure**	**3C** **Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure**	**4** **Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure**	**5** **Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure**	**6A Base** ***6A Option*** **All Vitrification/No Separations; Clean Closure**	**6B Base** ***6B Option*** **All Vitrification with Separations; Clean Closure**	**6C** **All Vitrification with Separations; Landfill Closure**
Land Resources											
Land use (Percent of total land commitment within either the Industrial -Exclusive Zone or Borrow Area C, as appropriate)	17 hectares (0.3 percent) committed to tank closure within the Industrial-Exclusive Zone.	51 hectares (1 percent) committed to tank closure within the Industrial-Exclusive Zone.	101 hectares (2 percent) committed to tank closure within the Industrial-Exclusive Zone.	100 hectares (2 percent) committed to tank closure within the Industrial-Exclusive Zone.	102 hectares (2 percent) committed to tank closure within the Industrial-Exclusive Zone.	101 hectares (2 percent) committed to tank closure within the Industrial-Exclusive Zone.	80.5 hectares (1.6 percent) committed to tank closure within the Industrial-Exclusive Zone.	104 hectares (2.1 percent) committed to tank closure within the Industrial-Exclusive Zone.	149 hectares (2.9 percent) committed to tank closure within the Industrial-Exclusive Zone. 86.2 hectares required outside of the Industrial-Exclusive Zone.	144 hectares (2.9 percent) committed to tank closure within the Industrial-Exclusive Zone.	146 hectares (2.9 percent) committed to tank closure within the Industrial-Exclusive Zone.
	2 hectares (0.2 percent) affected within Borrow Area C.	29.1 hectares (3.1 percent) affected within Borrow Area C.	95.1 hectares (10 percent) affected within Borrow Area C.	100 hectares (11 percent) affected within Borrow Area C.	92.3 hectares (10 percent) affected within Borrow Area C.	92.7 hectares (10 percent) affected within Borrow Area C.	102 hectares (11 percent) affected within Borrow Area C.	117 hectares (13 percent) affected within Borrow Area C.	381 hectares (41 percent) affected within Borrow Area C.	240 hectares (26 percent) affected within Borrow Area C.	104 hectares (11 percent) affected within Borrow Area C.
									Option Case *126 hectares (2.5 percent) committed to tank closure within the Industrial-Exclusive Zone. 86.2 hectares required outside of the Industrial-Exclusive Zone.* *458 hectares (49 percent) affected within Borrow Area C.*	*Option Case* *121 hectares (2.4 percent) committed to tank closure within the Industrial-Exclusive Zone.* *316 hectares (34 percent) affected within Borrow Area C.*	

Table 2–9. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative: 1 No Action	2A Existing WTP Vitrification; No Closure	2B Expanded WTP Vitrification; Landfill Closure	3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure	3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure	3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure	4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure	5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure	6A Base *6A Option* All Vitrification/No Separations; Clean Closure	6B Base *6B Option* All Vitrification with Separations; Clean Closure	6C All Vitrification with Separations; Landfill Closure
Land Resources *(continued)*											
Visual resources	Little change in the overall visual character of the 200 Areas and Borrow Area C.	Little change in the overall visual character of the 200 Areas and moderate change to Borrow Area C.	Little change in the overall visual character of the 200 Areas and a highly noticeable change to Borrow Area C, especially as seen from State Route 240 and nearby higher elevations.						Highly noticeable change in the visual character of both the 200 Areas and Borrow Area C, especially as seen from State Route 240 and nearby higher elevations.	Noticeable change to the visual character of the 200 Areas and a highly noticeable change to Borrow Area C, especially as seen from State Route 240 and nearby higher elevations.	
Infrastructure											
Total Requirements											
Electricity (million megawatt-hours)	0.12	35.6	17.9	14.1	12.1	20.1	14.8	12.2	185 *188*	21.1 *23.8*	17.9
Diesel fuel (million liters)	35.9	4,960	4,040	1,860	1,870	1,980	2,050	4,110	23,000 *23,100*	4,360 *4,440*	4,040
Gasoline (million liters)	4.61	221	156	116			133	124	714 *711*	216 *212*	156
Water (million liters)	3,300	208,000	86,300	77,000		77,300	82,200	92,500	643,000 *643,000*	92,600 *92,800*	86,300
Peak Annual Demand											
Electricity (million megawatt-hours)	0.035	0.56	1.18	0.79	0.48	0.84	0.55	0.63	1.93 *1.97*	1.25 *1.30*	1.18
Diesel fuel (million liters)	11.8	112	271	80.8	81.2	86.1	76.2	229	232 *235*	255 *259*	271
Gasoline (million liters)	1.0	5.36	8.23	5.03			10.9	5.89	8.92 *7.49*	6.61 *6.63*	8.23
Water (million liters)	1,090	3,720	3,590	2,200		2,210	2,180	3,830	6,570 *6,580*	3,530 *3,530*	3,590

Table 2–9. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative 1 No Action	2A Existing WTP Vitrification; No Closure	2B Expanded WTP Vitrification; Landfill Closure	3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure	3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure	3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure	4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure	5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure	6A Base *6A Option* All Vitrification/No Separations; Clean Closure	6B Base *6B Option* All Vitrification with Separations; Clean Closure	6C All Vitrification with Separations; Landfill Closure
Noise and Vibration											
	Current noise levels reduced following WTP construction.	Negligible offsite impact of onsite activities. Minor traffic noise impacts.									
Air Quality											
Peak Year Incremental Criteria Pollutant Concentrations as Compared with Most Stringent Guideline or Standard (micrograms per cubic meter)[a]											
Carbon monoxide (1-hour) standard=40,000	23,300	**44,900**	**40,500**	**60,900**	**62,000**	**61,900**	40,000	**51,600**	35,100 *26,100*	38,500 *38,500*	37,900
Nitrogen oxides (1-hour) standard=188	**15,200**	**36,500**	**35,200**	**37,800**	**38,000**		**28,400**	**38.600**	**36,400** ***27,000***	**33,200** ***26,200***	**35,300**
PM_{10} (24-hour) standard=150	**546**	**1,990**	**4,910**				**3,360**	**5,320**	**5,150** ***3,880***	**5,510** ***2,080***	**4,960**
$PM_{2.5}$ (24-hour) standard=35	**546**	**1,990**	**4,910**				**3,360**	**5,320**	**5,150** ***3,880***	**5,510** ***2,080***	**4,960**
Sulfur oxides (1-hour) standard=197	24.0	70.7	105	132	88.2	87.6	77.9	112	58.9 *47.4*	71.5 *76.4*	105
Peak Year Incremental Toxic Chemical Concentrations (micrograms per cubic meter)[a]											
Ammonia (24-hour) ASIL[b]=70.8	26.1	19.9	12.0	12.2		12.3	12.1	12.3	10.5 *10.2*	12.2 *12.2*	11.7
Benzene (annual) ASIL[b]=0.0345	0.00252	0.00588	0.00459	0.00597	0.00622	0.00598	0.00354	0.00601	0.0048 *0.00311*	0.00460 *0.0037*	0.0046
Mercury (24-hour) ASIL[b]=0.09	0.0	0.0059	**0.117**	0.0169	0.00786	0.0129	0.013	0.0182	0.00237 *0.00236*	**0.117** ***0.117***	**0.117**
Toluene (24-hour) ASIL[b]=5,000	1.69	4.3	3.62	6	6.26	6	3	5.42	3.72 *2.56*	3.96 *2.8*	3.63

Table 2–9. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative										
	1 No Action	**2A Existing WTP Vitrification; No Closure**	**2B Expanded WTP Vitrification; Landfill Closure**	**3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure**	**3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure**	**3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure**	**4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure**	**5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure**	**6A Base *6A Option* All Vitrification/No Separations; Clean Closure**	**6B Base *6B Option* All Vitrification with Separations; Clean Closure**	**6C All Vitrification with Separations; Landfill Closure**
Air Quality *(continued)*											
Xylene (24-hour) ASIL[b]=NL	0.506	1.29	1.1	1.78	1.86	1.78	0.896	1.62	1.14 *0.747*	1.2 *0.84*	1.11
Geology and Soils											
Construction impacts	Negligible, incremental impact on geology and soils.	Small impact of construction, including potential for short-term soil erosion. Excavation depths limited to 12 meters.					Similar to Alternatives 2A through 3C, except extensive excavation work required for clean closure of BX and SX tank farms, with excavation depths of 20 meters to as much as 78 meters.	Similar to Alternatives 2A through 3C.	Similar to Alternatives 2A through 3C, except extensive excavation work required for clean closure of all tank farms, with excavation depths of 20 meters to as much as 78 meters.		Similar to Alternatives 2A through 3C.
New permanent land disturbance (hectares)	2	63.1	112	116	110	110	122	138	591 *668*	359 *437*	166
Geologic resource requirements, i.e., fill from Borrow Area C (cubic meters)	92,800	1,320,000	4,360,000	4,570,000	4,240,000	4,230,000	4,650,000	5,380,000	17,400,000 *20,900,000*	10,900,000 *14,400,000*	4,780,000

Table 2–9. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative										
	1 No Action	**2A Existing WTP Vitrification; No Closure**	**2B Expanded WTP Vitrification; Landfill Closure**	**3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure**	**3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure**	**3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure**	**4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure**	**5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure**	**6A Base *6A Option* All Vitrification/No Separations; Clean Closure**	**6B Base *6B Option* All Vitrification with Separations; Clean Closure**	**6C All Vitrification with Separations; Landfill Closure**
Water Resources											
Surface water	No additional impact on surface water in the short term. Water use and wastewater generation and discharges would decrease from current levels.	Short-term increase in stormwater runoff during construction, but no direct disturbance to surface-water features. No direct, routine discharge of effluents during operations to surface waters or to the subsurface. Water use would not exceed site capacity. Activities in Borrow Area C could encroach on the probable maximum flood zone associated with Cold Creek, especially under Alternatives 6A and 6B.									
Vadose zone and groundwater	No additional impact in the short term.	Potential for SST retrieval leaks in the short term without any recovery once in the subsurface. Groundwater mounds could begin to re-expand due to increased discharge of sanitary wastewater, nonhazardous process wastewater, and treated radioactive liquid effluents to onsite treatment and disposal facilities during waste treatment.					Potential for retrieval leaks similar to Alternatives 2A through 3B. Deep soil excavation for selective clean closure would require dewatering and could locally affect groundwater flow and contaminant plumes.	Similar to Alternatives 2A through 3C.	Potential for SST retrieval leaks in the short term. Deep soil excavation for clean closure would require dewatering and could locally affect groundwater flow and contaminant plumes.		Similar to Alternatives 2A through 3C.

Table 2–9. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	1 No Action	2A Existing WTP Vitrification; No Closure	2B Expanded WTP Vitrification; Landfill Closure	3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure	3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure	3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure	4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure	5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure	6A Base *6A Option* All Vitrification/No Separations; Clean Closure	6B Base *6B Option* All Vitrification with Separations; Clean Closure	6C All Vitrification with Separations; Landfill Closure
Ecological Resources											
Terrestrial resources	No additional disturbance to sagebrush habitat in the 200 Areas.	14.2 hectares of sagebrush habitat affected in the 200 Areas.	1.2 hectares of sagebrush habitat affected in the 200 Areas.	4 hectares of sagebrush habitat affected in the 200 Areas.	4.9 hectares of sagebrush habitat affected in the 200 Areas.	4.8 hectares of sagebrush habitat affected in the 200 Areas.	6.3 hectares of sagebrush habitat affected in the 200 Areas.	4.4 hectares of sagebrush habitat affected in the 200 Areas.	182 hectares of sagebrush habitat affected within the 200 Areas under the Base Case. 184 hectares of sagebrush habitat affected within the 200 Areas under the Option Case.	100 hectares of sagebrush habitat affected within the 200 Areas under the Base Case. 102 hectares of sagebrush habitat affected within the 200 Areas under the Option Case.	46.1 hectares of sagebrush habitat affected in the 200 Areas.
	No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.	No sagebrush habitat affected within Borrow Area C.
Wetlands	No impact on wetlands within 200 Areas or Borrow Area C.										
Aquatic resources	No impact on aquatic resources within 200 Areas or Borrow Area C.										

Table 2–9. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative: 1 No Action	2A Existing WTP Vitrification; No Closure	2B Expanded WTP Vitrification; Landfill Closure	3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure	3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure	3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure	4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure	5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure	6A Base *6A Option* All Vitrification/No Separations; Clean Closure	6B Base *6B Option* All Vitrification with Separations; Clean Closure	6C All Vitrification with Separations; Landfill Closure
Ecological Resources *(continued)*											
Threatened and endangered species	No impact on any federally or state-listed threatened or endangered species.	No impact on any federally or state-listed threatened or endangered species.	No impact on any federally or state-listed threatened or endangered species.	No impact on any federally or state-listed threatened or endangered species.					No impact on any federally or state-listed threatened or endangered species under both Base and Option Cases.		No impact on any federally or state-listed threatened or endangered species.
	No impact on state-listed species within the 200 Areas.	Potential impacts on 4 state-listed species.	Potential impacts on 2 state-listed species.	Potential impacts on 6 state-listed special status species.					Potential impacts on 6 state-listed special status species under both Base and Option Cases.		Potential impacts on 4 state-listed special status species.
	Minimum potential for impact on 4 state-listed species within Borrow Area C.	Potential impacts on 4 state-listed species within Borrow Area C.	Potential impacts on 4 state-listed species within Borrow Area C.	Potential impacts on 4 state-listed special status species within Borrow Area C.					Potential impacts on 4 state-listed special status species within Borrow Area C under both Base and Option Cases.		Potential impacts on 4 state-listed special status species within Borrow Area C.
Cultural and Paleontological Resources											
Prehistoric resources	No impact on prehistoric resources.										
Historic resources	No impact on historic resources.								Impact on National Register–ineligible resources (i.e., areas where old cans and bottles were disposed of).		

Table 2–9. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative										
	1 No Action	**2A Existing WTP Vitrification; No Closure**	**2B Expanded WTP Vitrification; Landfill Closure**	**3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure**	**3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure**	**3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure**	**4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure**	**5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure**	**6A Base *6A Option* All Vitrification/No Separations; Clean Closure**	**6B Base *6B Option* All Vitrification with Separations; Clean Closure**	**6C All Vitrification with Separations; Landfill Closure**
Cultural and Paleontological Resources *(continued)*											
American Indian interests	The 2 hectares of Borrow Area C that would be excavated would be noticeable from higher elevations but would not dominate the view.	The 29.1 hectares excavated from Borrow Area C would be readily visible from Rattlesnake Mountain and higher elevations. Upon completion of work, the area would be recontoured and revegetated, lessening the visual impact.	The 200-East and 200-West Area containment structures and closure barriers would be visible from higher elevations. 95.1 hectares of Borrow Area C would be excavated. Upon completion of work, the area would be recontoured and revegetated, lessening the visual impact.	Impacts would be similar to Alternative 2B. An additional 4.9 hectares of land would be disturbed within Borrow Area C.	Impacts would be similar to Alternative 2B. Excavated land in Borrow Area C would be slightly less (2.8 hectares) but the visual impacts would be similar.	Impacts would be similar to Alternative 2B. Nearly the same amount of geologic material would be required from Borrow Area C (92.7 hectares).	Impacts would be similar to Alternative 2B. An additional 6.9 hectares of land would be disturbed.	Impacts would be similar to Alternative 2B. 117 hectares of Borrow Area C would be excavated. This would be readily visible from Rattlesnake Mountain and higher elevations. Upon completion of work, the area would be recontoured and revegetated, lessening the visual impact.	Construction of facilities would noticeably add to the industrial nature of the 200 Areas; 381 hectares of Borrow Area C would be excavated under the Base Case, and 458 hectares of Borrow Area C would be excavated under the Option Case. This would be readily visible from Rattlesnake Mountain. Upon completion of work, the area would be recontoured and revegetated, lessening the visual impact.	Impacts would be similar to, but less than, those under Alternative 6A, Base Case. Land impact of construction of facilities and material excavated from Borrow Area C would be approximately 63 percent as much as under 6A. This would be readily visible from Rattlesnake Mountain. Upon completion of work, the area would be recontoured and revegetated, lessening the visual impact.	There would be an overall increase to the industrial appearance of the 200 Areas. 104 hectares of Borrow Area C would be excavated. These areas would be visible from nearby higher elevations.

Table 2–9. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative										
	1 **No Action**	**2A** **Existing WTP Vitrification; No Closure**	**2B** **Expanded WTP Vitrification; Landfill Closure**	**3A** **Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure**	**3B** **Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure**	**3C** **Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure**	**4** **Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure**	**5** **Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure**	**6A Base** ***6A Option*** **All Vitrification/No Separations; Clean Closure**	**6B Base** ***6B Option*** **All Vitrification with Separations; Clean Closure**	**6C** **All Vitrification with Separations; Landfill Closure**
Cultural and Paleontological Resources *(continued)*											
									Option Case Impacts would be similar to those under the Base Case. An additional 76.5 hectares would be excavated from Borrow Area C, further impacting the viewshed.*	*Option Case* Impacts would be similar to those under the Base Case. An additional 76.5 hectares would be excavated from Borrow Area C, further impacting the viewshed.*	
Paleontological resources	No impact on paleontological resources.										
Socioeconomics											
Peak annual workforce (FTEs)	1,730	4,920	6,860	5,330	5,260	5,460	8,000	6,100	7,790 *10,200*	7,860 *10,200*	6,860
Peak daily commuter traffic (vehicles per day)	1,400	4,000	5,500	4,300	4,200	4,300	6,400	4,900	6,200 *8,100*		5,500
Peak daily truck loads – off site	4	15	48	24	36	142	64	57	49 *67*	66 *83*	50
Impact on the ROI	Potential for immediate decrease in FTEs.	Potential for change in the socioeconomic ROI, including increases in population, demand and cost for housing and community services, and level-of-service impacts on local transportation.									

Table 2–9. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative										
	1 **No Action**	**2A** **Existing WTP Vitrification; No Closure**	**2B** **Expanded WTP Vitrification; Landfill Closure**	**3A** **Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure**	**3B** **Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure**	**3C** **Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure**	**4** **Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure**	**5** **Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure**	**6A Base** ***6A Option*** **All Vitrification/No Separations; Clean Closure**	**6B Base** ***6B Option*** **All Vitrification with Separations; Clean Closure**	**6C** **All Vitrification with Separations; Landfill Closure**
Public and Occupational Health and Safety – Normal Operations											
Offsite Population Impact – Life of the Project											
Dose (person rem)	74	1,700	1,600		1,200	1,700	1,400		1,700 *1,800*	1,700 *1,700*	1,600
LCF[c]	0 (4×10^{-2})	1	1		1	1	1		1 *1*	1 *1*	1
Peak Year Maximally Exposed Individual Impact											
Dose (millirem per year)	0.041	8.5	10	8.6	8.5	8.6	8.5	8.6	8.6 *8.6*	9.8 *9.8*	9.7
Increased risk of an LCF	2×10^{-8}	5×10^{-6}	6×10^{-6}	5×10^{-6}					5×10^{-6} 5×10^{-6}	6×10^{-6} 6×10^{-6}	6×10^{-6}
Peak Year Onsite Maximally Exposed Individual Impact											
Dose (millirem per year)	0.033	1.4	1.7	1.4					1.4 *1.4*	1.7 *1.7*	1.6
Increased risk of an LCF	2×10^{-8}	8×10^{-7}	1×10^{-6}	8×10^{-7}					8×10^{-7} 8×10^{-7}	1×10^{-6} 1×10^{-6}	1×10^{-6}
Radiation Worker Population Impact – Life of the Project											
Dose (person-rem)	280	22,000	11,000	10,000	9,800	11,000	43,000	8,500	120,000 *120,000*	82,000 *85,000*	11,000
LCF[c]	0 (2×10^{-1})	13	7	6			26	5	72 *75*	49 *51*	7
Average Annual Impact per Radiation Worker											
Dose (millirem per year)	140	170	160				530	150	420 *400*	890 *800*	160
Increased risk of an LCF	9×10^{-5}	1×10^{-4}					3×10^{-4}	9×10^{-5}	2×10^{-4} 2×10^{-4}	5×10^{-4} 5×10^{-4}	1×10^{-4}
Peak Year Noninvolved Worker Impact											
Dose (millirem per year)	0.27	3.0	3.4	3.0					3.0 *3.0*	3.5 *3.6*	3.4
Increased risk of an LCF	2×10^{-7}	2×10^{-6}							2×10^{-6} 2×10^{-6}		2×10^{-6}

Table 2–9. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative: 1 No Action	2A Existing WTP Vitrification; No Closure	2B Expanded WTP Vitrification; Landfill Closure	3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure	3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure	3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure	4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure	5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure	6A Base *6A Option* All Vitrification/No Separations; Clean Closure	6B Base *6B Option* All Vitrification with Separations; Clean Closure	6C All Vitrification with Separations; Landfill Closure
Public and Occupational Health and Safety – Facility Accidents											
Offsite Population Consequences											
Dose (person-rem)	1.3	75,000							1,000	75,000	
Number of LCFs[c]	0 (8×10^{-4})	50							0 (6×10^{-1})	50	
Maximally Exposed Offsite Individual Consequences											
Dose (rem)	0.00021	4.3							0.058	4.3	
Increased risk of an LCF	1×10^{-7}	3×10^{-3}							4×10^{-5}	3×10^{-3}	
Noninvolved Worker Consequences											
Dose (rem)	0.22	13,000							180	13,000	
Increased risk of an LCF[d]	1×10^{-4}	1							2×10^{-1}	1	
Offsite Population Risk											
Annual number of LCFs[c]	0 (4×10^{-7})	0 (2×10^{-2})							0 (3×10^{-4})	0 (2×10^{-2})	
Number of LCFs over life of the project[c]	0 (4×10^{-5})	2	1	1			1	0 (4×10^{-1})	0 (4×10^{-2})	1	
Maximally Exposed Offsite Individual Risk											
Annual increased risk of an LCF	6×10^{-11}	1×10^{-6}							2×10^{-8}	1×10^{-6}	
Increased risk of an LCF over life of the project	6×10^{-9}	1×10^{-4}	3×10^{-5}					2×10^{-5}	3×10^{-6}	3×10^{-5}	
Noninvolved Worker Risk											
Annual increased risk of an LCF	7×10^{-8}	8×10^{-3}							1×10^{-4}	8×10^{-3}	
Increased risk of an LCF over life of the project	7×10^{-6}	6×10^{-1}	2×10^{-1}					1×10^{-1}	2×10^{-2}	2×10^{-1}	

Table 2–9. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

<table>
<tr><th rowspan="2">Parameter/
Resource</th><th colspan="11">Tank Closure Alternative</th></tr>
<tr><th>1
No Action</th><th>2A
Existing WTP Vitrification; No Closure</th><th>2B
Expanded WTP Vitrification; Landfill Closure</th><th>3A
Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure</th><th>3B
Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure</th><th>3C
Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure</th><th>4
Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure</th><th>5
Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure</th><th>6A Base
6A Option
All Vitrification/No Separations; Clean Closure</th><th>6B Base
6B Option
All Vitrification with Separations; Clean Closure</th><th>6C
All Vitrification with Separations; Landfill Closure</th></tr>
<tr><td colspan="12">**Public and Occupational Health and Safety – Transportation**</td></tr>
<tr><td>Traffic accidents[e] (nonradiological fatalities)</td><td>0
(0.01)</td><td>1
(0.69)</td><td>1
(0.89)</td><td>2
(1.57)</td><td>2
(1.58)</td><td>6
(5.69)</td><td>2
(2.0)</td><td>2
(1.53)</td><td>4
(3.95)
10
(9.55)</td><td>2
(1.95)
4
(3.85)</td><td>1
(0.97)</td></tr>
<tr><td colspan="12">***Offsite Population***</td></tr>
<tr><td>Dose (person-rem)</td><td>0</td><td colspan="2">73</td><td>350</td><td>270</td><td>340</td><td>300</td><td>260</td><td>60
100</td><td>89
130</td><td>73</td></tr>
<tr><td>LCFs</td><td>0</td><td colspan="2">4.4×10^{-2}</td><td>2.0×10^{-1}</td><td>1.6×10^{-1}</td><td>2.1×10^{-1}</td><td>1.8×10^{-1}</td><td>1.5×10^{-1}</td><td>4.0×10^{-2}
6.0×10^{-2}</td><td>5.0×10^{-2}
8.0×10^{-2}</td><td>4.0×10^{-2}</td></tr>
<tr><td colspan="12">***Worker***</td></tr>
<tr><td>Dose (person-rem)</td><td>0</td><td colspan="2">260</td><td>840</td><td>1,080</td><td>1,220</td><td>1,090</td><td>790</td><td>450
870</td><td>560
980</td><td>260</td></tr>
<tr><td>LCFs</td><td>0</td><td colspan="2">1.6×10^{-1}</td><td>5.0×10^{-1}</td><td>6.5×10^{-1}</td><td>7.3×10^{-1}</td><td>6.5×10^{-1}</td><td>4.7×10^{-1}</td><td>2.7×10^{-1}
5.2×10^{-1}</td><td>3.4×10^{-1}
5.9×10^{-1}</td><td>1.6×10^{-1}</td></tr>
<tr><td colspan="12">**Environmental Justice**</td></tr>
<tr><td>Human health impacts</td><td colspan="11">No disproportionately high and adverse human health impacts on minority or low-income populations due to normal facility operations or postulated facility accidents.</td></tr>
<tr><td colspan="12">**Waste Management (all values are in cubic meters unless otherwise noted; values rounded to no more than three significant digits)**</td></tr>
<tr><td colspan="12">***Disposed of Off Site and/or Stored On Site***</td></tr>
<tr><td>IHLW glass (Number of canisters)</td><td>N/A</td><td colspan="2">14,200
(12,000)</td><td colspan="3">10,300
(8,700)</td><td>12,800
(10,800)</td><td>9,240
(7,800)</td><td>203,000
(171,000)
203,000
(171,000)</td><td>14,200
(12,000)
14,200
(12,000)</td><td>14,200
(12,000)</td></tr>
<tr><td>IHLW cesium and strontium glass (Number of canisters)</td><td>N/A</td><td colspan="7">400
(340)</td><td colspan="2">400
(340)
400
(340)</td><td>400
(340)</td></tr>
<tr><td>Other HLW</td><td colspan="8">N/A</td><td colspan="2">337,000
337,000</td><td>N/A</td></tr>
<tr><td>HLW melters (Number of melters)</td><td>N/A</td><td>3,680
(30)</td><td>1,350
(11)</td><td colspan="3">1,100
(9)</td><td>1,230
(10)</td><td>858
(7)</td><td>17,800
(145)
17,800
(145)</td><td>1,350[f]
(11)
1,350
(11)</td><td>1,350[e]
(11)</td></tr>
</table>

Table 2–9. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative										
	1 No Action	2A Existing WTP Vitrification; No Closure	2B Expanded WTP Vitrification; Landfill Closure	3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure	3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure	3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure	4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure	5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure	6A Base *6A Option* All Vitrification/No Separations; Clean Closure	6B Base *6B Option* All Vitrification with Separations; Clean Closure	6C All Vitrification with Separations; Landfill Closure
Waste Management (all values are in cubic meters unless otherwise noted; values rounded to no more than three significant digits) ***(continued)***											
Mixed TRU waste (includes tank and secondary, CH and RH)	N/A	219	206	3,850			4,080	277	530 *530*	412 *412*	206
Hazardous waste	12	79,200	79,600	79,700			79,900	79,200	82,000 *82,000*	80,900 *81,000*	79,700
Disposed of On Site											
ILAW glass (Number of canisters)	N/A	213,000 (92,300)		65,800 (28,500)			66,200 (28,700)	71,800 (31,100)	N/A	215,000[g] (93,000) *215,000* *(93,000)*	213,000[g] (92,300)
PPF melters (Number of melters)	N/A								3,060 (25) *17,900* *(146)*	1,960 (16) *11,400* *(93)*	N/A
Bulk vitrification glass	N/A			103,000	N/A		40,500	36,600	N/A		
Cast stone waste	N/A				233,000	N/A	144,000	50,000	N/A		
Sulfate grout waste	N/A							19,800	N/A		
Steam reforming waste	N/A					261,000	N/A				
PPF glass (Number of canisters)	N/A								1,600 (700) *42,300* *(18,300)*		N/A
LAW melters (Number of melters)	N/A	7,700 (30)	8,000 (31)	2,260 (9)			2,570 (10)	2,460 (10)	N/A	8,000[f] (31) *8,000* *(31)*	8,000[f] (31)
LLW (secondary)	35	34,300	37,600	28,600	22,100	21,800	38,800	20,600	93,000 *136,000*	99,900 *143,000*	34,700

Table 2–9. Tank Closure Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/ Resource	Tank Closure Alternative										
	1 No Action	2A Existing WTP Vitrification; No Closure	2B Expanded WTP Vitrification; Landfill Closure	3A Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure	3B Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure	3C Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure	4 Existing WTP Vitrification with Thermal Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure	5 Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure	6A Base *6A Option* All Vitrification/No Separations; Clean Closure	6B Base *6B Option* All Vitrification with Separations; Clean Closure	6C All Vitrification with Separations; Landfill Closure
Waste Management (all values are in cubic meters unless otherwise noted; values rounded to no more than three significant digits) *(continued)*											
Liquid LLW (liters)	N/A	9,690							9,690 *9,690*		9,690
Closure LLW	N/A		679				2,400	N/A	4,070 *5,430*		53
MLLW (secondary)	21	39,200	36,900	41,700	35,100	21,100	43,500	22,600	109,000 *152,000*	105,000 *149,000*	40,000
Closure MLLW	N/A		468,000				1,010,000	3,060	2,410,000 *8,310,000*		468,000
Industrial Safety											
Worker Population Impact – Total Project											
Total recordable cases (fatalities)	163 (0)	7,080 (0.92)	3,880 (0.50)	3,490 (0.45)	3,440 (0.45)	3,570 (0.46)	4,500 (0.59)	3,250 (0.42)	20,600 (2.67) *21,300* *(2.77)*	5,150 (0.67) *5,720* *(0.74)*	3,890 (0.51)

[a] Concentrations exceeding applicable standards, discussed in the air quality sections of Chapter 4 of this *TC & WM EIS*, are presented in **bold** text. The Federal standard for $PM_{2.5}$ is 35 micrograms per cubic meter (24-hour average). No specific data for $PM_{2.5}$ were available, but for analysis purposes, concentrations were assumed to be the same as for PM_{10}. Radiological air quality impacts are included separately under the public and occupational health and safety sections.

[b] Acceptable Source Impact Levels (ASILs) are used by the state in the permitting process and represent concentrations sufficiently low to protect human health and safety from potential carcinogenic and other toxic effects (WAC 173-460).

[c] The number of LCFs in a population is presented as an integer; where the value is 0, the calculated value (dose × 0.0006 LCFs per person-rem) is presented in parentheses.

[d] Increased likelihood of a latent cancer fatality, assuming the accident occurs, except at high individual doses (hundreds of rem or more) where acute radiation injury may cause death within weeks. Value cannot exceed 1.

[e] Nearest whole integer (calculated value in parentheses).

[f] Under Alternatives 6B and 6C, HLW and LAW melters from the WTP would be managed as HLW.

[g] Under Alternatives 6B and 6C, ILAW glass would be produced but would be managed as IHLW.

Note: To convert cubic meters to cubic yards, multiply by 1.308; hectares to acres, by 2.471; liters to gallons, by 0.26417; meters to yards, by 1.0936.

Key: ASIL=Acceptable Source Impact Level; CH=contact-handled; FTE=full-time equivalent; HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; LAW=low-activity waste; LCF=latent cancer fatality; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; N/A=not applicable; NL=not listed; National Register=National Register of Historic Places; PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; PPF=Preprocessing Facility; RH=remote-handled; ROI=region of influence; SST=single-shell tank; *TC & WM EIS*=*Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*; TRU=transuranic; WTP=Waste Treatment Plant.

Source: Chapter 4 of this *TC & WM EIS*.

2.8.2 FFTF Decommissioning Alternatives: Short-Term Environmental Impacts

2.8.2.1 Land Resources

Land use includes the land on and adjacent to Hanford, the physical features that influence current or proposed uses, pertinent land use plans and regulations, and land ownership and availability. Under the FFTF Decommissioning No Action Alternative, there would be no change in land use within either the 400 Area or 200 Areas. Also, there would be no need to excavate geologic material from Borrow Area C. Under FFTF Decommissioning Alternative 2, facility disposition would lead to 2.1 hectares (5.3 acres) of land within the 400 Area becoming available for future development; the Industrial designation of the area would not change. To support actions taken under this alternative, 2.8 hectares (7 acres) within Borrow Area C would be mined. Disposition of RH-SCs and bulk sodium would have minimal impact on land use within the 200 Areas, within the 400 Area, or at INL. Impacts on land use under FFTF Decommissioning Alternative 3 would be similar to those under FFTF Decommissioning Alternative 2, although slightly more land would be affected within the 400 Area and slightly less within the MFC.

Visual resources are the natural and manmade features that give a particular landscape its character and aesthetic quality. Under the No Action Alternative, there would be no change in the visual character of either the 400 Area or 200 Areas. Facility disposition under both Alternatives 2 and 3 would lead to an overall improvement in the visual character of the 400 Area. However, it is possible that the area could be developed in the future. Due to the need to mine a limited volume of geologic material from Borrow Area C, there would be a minor change in the visual character of the area as seen from nearby higher elevations and State Route 240. There would be no impact on visual resources at INL since existing facilities would be used for the disposition of RH-SCs and bulk sodium.

2.8.2.2 Infrastructure

Site infrastructure includes physical resources encompassing the utility systems required to support necessary construction, operations, deactivation, closure, and decommissioning activities associated with the alternatives and options for implementation of the FFTF Decommissioning alternatives. Utility infrastructure resources considered include electricity, liquid fuels, and water (see Table 2–10). For the FFTF Decommissioning No Action Alternative, utility resource demands would be associated with those necessary to maintain the safety- and environmental protection–related systems of the FFTF complex and support buildings during a 100-year administrative control period. In particular, water demands would remain high due to the need to keep active and periodically test fire protection and other systems, with peak annual demands of 7.95 million liters (2.1 million gallons). Of the action alternatives for FFTF decommissioning, the Entombment Alternative would have the highest total and peak demands for diesel fuel and water. This is mainly attributable to the requirements associated with final grading of the site following grouting of below-grade structures and final construction of the modified RCRA Subtitle C barrier over the site. For the Removal (see Alternative 3) and Entombment (see Alternative 2) Alternatives, projected total diesel fuel requirements are 3.76 and 4.02 million liters (0.99 to 1.06 million gallons) and total water requirements are 18.9 and 19.6 million liters (4.99 and 5.17 million gallons), respectively. Overall, these demands would be a very small fraction of the capacity of the utility systems that supply these utility resources. Liquid fuels are not considered to be a limiting resource, as additional supplies can be trucked to the point of use as needed from offsite suppliers, but peak requirements to support decommissioning would be comparable to Hanford's current total annual liquid fuel consumption (see Chapter 3, Section 3.2.2).

Utility demands associated with the options for disposition of RH-SCs and bulk sodium would generally result in a small, incremental increase in utility resource requirements compared with those for facility disposition, regardless of the option selected. Utility infrastructure requirements, total and peak, for the Hanford and Idaho Options for disposition of RH-SCs would be essentially identical (see Table 2–10).

Incremental demands for implementation of the Hanford Reuse Option for disposition (processing) of bulk sodium would be substantially greater than those for the Idaho Reuse Option, as a new SRF would have to be constructed at Hanford in lieu of modifications to the existing SPF at INL.

2.8.2.3 Noise and Vibration

Noise is undesirable sound that interferes negatively with the human or natural environment. Noise may disrupt normal activities (e.g., hearing, sleep), damage hearing, or diminish the quality of the environment. Noise impacts may result from construction, operations, deactivation, and closure activities, including increased traffic. Noise impacts of onsite activities under each FFTF Decommissioning alternative would be negligible. Under the No Action Alternative, there would be negligible noise impacts of employee vehicle traffic. Noise impacts of traffic would be highest under Alternative 3, which would have the highest peak year employment and employee vehicle traffic. The increase in employee traffic noise along the roads to the site during peak hours (shift changes) is not expected to be noticeable to residents along these routes. FFTF Decommissioning Alternative 2 would have the highest offsite truck traffic associated with grout facility operation.

2.8.2.4 Air Quality

Air pollution refers to any substance in the air that could harm human or animal populations, vegetation, or structures or that unreasonably interferes with the comfortable enjoyment of life and property. As modeled, nonradioactive air pollutant concentrations under all FFTF Decommissioning alternatives would meet the applicable standards except for $PM_{2.5}$ and nitrogen dioxide under Alternatives 2 and 3. Nonradiological air quality impacts for $PM_{2.5}$ and PM_{10} would be highest under Alternative 3 for facility disposition. Under these alternatives, $PM_{2.5}$ and PM_{10} concentrations in the peak year would be attributable primarily to fugitive dust from heavy-equipment operations during Hanford RTP construction and grout facility deactivation. The 1-hour nitrogen dioxide standard would be exceeded for facility disposition under Alternatives 2 and 3.

Particulate matter emissions estimated for construction-type activities include fugitive dust emissions from construction areas and take into account dust suspended by equipment and vehicle activity and by wind. The emission factor used for these estimates is intended to provide a gross estimate of total suspended particulate emissions when detailed engineering data that would allow for a more refined estimate of dust emissions are not available. For the purpose of this analysis, $PM_{2.5}$ and PM_{10} emissions from general construction activities were assumed to be the same as the total suspended particulate emissions. This results in a substantial overestimate of PM_{10} emissions. Further, the analysis did not consider appropriate emission controls that could be applied in the construction areas, as discussed in Chapter 7, Section 7.1. A refined analysis of emissions based on more-detailed engineering data on the construction activities and application of appropriate control technologies is expected to result in substantially lower projected emissions and ambient concentrations from the major construction activities under these alternatives. Maximum air quality impacts of particulate matter are expected to occur along State Route 240, along or near the Hanford boundary to the east, south, or west.

The Clean Air Act, as amended (40 U.S.C. 7401 et seq.), requires that Federal actions conform to the host state's "state implementation plan." A state implementation plan provides for the implementation, maintenance, and enforcement of NAAQS for the six criteria pollutants: sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. Its purpose is to eliminate or reduce the severity and number of NAAQS violations and to expedite the attainment of these standards. "No department, agency, or instrumentality of the Federal Government shall engage in or support in any way or provide financial assistance for, license or permit, or approve any activity that does not conform to an applicable implementation plan." The final rule for "Determining Conformity of General Federal Actions to State or Federal Implementation Plans" (40 CFR 51, Subpart W) took effect on January 31, 1994. Hanford and

INL are within areas currently designated as attainment for criteria air pollutants (40 CFR 81.348 and 81.313, respectively). Therefore, the alternatives considered in this EIS do not require a conformity determination under the provisions of this rule.

Acceptable source impact levels are used during the permitting process to demonstrate that emissions from a new toxic air pollutant source are sufficiently low to protect human health and safety from potential carcinogenic and/or other toxic effects. Comparison of the estimated concentrations to acceptable source impact levels indicates that emissions under all FFTF Decommissioning alternatives would be sufficiently low to protect human health and safety. Specifically, maximum concentrations of nonradioactive toxic air pollutants off site and in areas to which the public has access would be less than 32 percent of the state's acceptable source impact levels. Maximum concentrations of carcinogenic toxic pollutants would be less than 32 percent of the state's acceptable source impact levels. Impacts of radioactive air emissions are summarized in Section 2.8.2.10.

2.8.2.5 Geology and Soils

Geologic resources include consolidated and unconsolidated earth materials, including rock and mineral assets such as ore and aggregate materials (e.g., sand, gravel) and fossil fuels such as coal, oil, and natural gas. Soil resources include the loose surface materials of the earth in which plants grow. Impacts on geology and soils would generally be directly proportional to the total area of land disturbed by facility decommissioning and demolition, site grading, excavation work, and construction of facilities to support facility disposition and related waste treatment options under the FFTF Decommissioning alternatives and options (see Table 2–10). Consumption of geologic resources would constitute the major indirect impact on geology and soils. Under the FFTF Decommissioning No Action Alternative, there would be no incremental impact on geology and soils because there would be no new, ground-disturbing activities and no geologic resources would be required to support surveillance and monitoring activities. Under the Removal (see Alternative 3) and Entombment (see Alternative 2) Alternatives, impacts would generally be minimal and would vary in relation to the nature of the excavation and exhumation work and associated ground disturbance necessary to support the decommissioning objectives of each alternative. Under the Entombment Alternative, following completion of above-grade facility demolition to a depth of 0.91 meters (3 feet) and backfill and grouting of remaining below-grade spaces, an approximately 0.7-hectare (1.7-acre) modified RCRA Subtitle C barrier would be constructed over the FFTF RCB and adjacent facilities. The potential for short-term wind and water erosion would exist in disturbed areas but would be minimized via the application of best management practices, as further discussed in Chapter 7, Section 7.1.5. Total permanent land disturbance associated with implementation of the Entombment Alternative would include the engineered barrier and excavation of a 2.8-hectare (7-acre) area of Borrow Area C to provide necessary geologic and soil resources, for a total of about 3.5 hectares (8.7 acres). Under the Removal Alternative, impacts would be similar to, but greater than, those described for the Entombment Alternative, as the RCB reactor vessel would be grouted and removed for disposal, rather than left in place. While no barrier would be constructed, geologic resource requirements would be higher than under the Entombment Alternative (143,000 cubic meters [187,000 cubic yards] versus 122,000 cubic meters [160,000 cubic yards]) due to the need for additional soil for use in backfilling exhumations and grading the entire site. Permanent land disturbance associated with the Removal Alternative would total 3.2 hectares (8 acres) associated with excavation in Borrow Area C to provide necessary geologic and soil resources (see Table 2–10).

Impacts on geology and soils associated with the Hanford Option under FFTF Decommissioning Alternative 2 or 3 for disposition of RH-SCs would be associated with construction of a new RTP in a previously disturbed part of the 200-West Area. Construction would permanently disturb only about 0.1 hectares (0.3 acres) of land, but excavation to a depth of 6 meters (20 feet) within Hanford formation sediments would be necessary. Under the Hanford Option for disposition of RH-SCs, the demand for geologic and soil resources would be 4,670 cubic meters (6,100 cubic yards). Under the Idaho Option, direct or indirect geologic and soils impacts would not occur. RH-SCs removed from the FFTF RCB would be stored at Hanford prior to shipment to INL, where these materials would be treated at an existing facility at INTEC. As a treatment facility currently exists, there would be no new construction; no geologic resources would be required; and no new facilities would be subject to potential seismically induced groundshaking.

Implementation of the Hanford Reuse Option under FFTF Decommissioning Alternative 2 or 3 for disposition of bulk sodium would have minimal effects on geology and soils in the Hanford 400 Area. Construction of the new SRF with a reinforced-concrete slab adjacent to the existing SSF would require minimal excavation work. The new SRF would permanently occupy about 0.1 hectares (0.2 acres) of land. Impacts on geology and soils within the MFC at INL and demands for geologic and soil resources would be less under the Idaho Reuse Option, as activities would be limited to modifications to the existing SPF to receive and process Hanford sodium, as reflected in Table 2–10.

2.8.2.6 Water Resources

Water resources are the surface and subsurface waters that are suitable for human consumption, aquatic or wildlife use, agricultural purposes, irrigation, or industrial/commercial purposes. Under FFTF Decommissioning Alternative 1: No Action, no additional impacts on availability or quality of surface-water or groundwater resources are expected in the short term following FFTF deactivation. Water use would be reduced following completion of deactivation and limited to that necessary to maintain critical systems as part of surveillance and monitoring of the FFTF complex. Any wastewater generated would be discharged to the existing systems that serve the 400 Area. No impacts on surface water are expected from implementation of either the Entombment or Removal Alternatives for FFTF decommissioning. While stormwater runoff could convey pollutants from demolition-related and other work sites, the potential to impact runoff quality beyond the 400 Area would be small. Also, appropriate soil erosion and sediment control measures, spill prevention and waste management practices, and National Pollutant Discharge Elimination System and state waste-discharge permitting requirements would be implemented to minimize any impacts on surface water, the vadose zone, and groundwater. The potential for short-term impacts on surface-water runoff quality and on the vadose zone would be somewhat greater under the Removal Alternative, as the FFTF reactor vessel would be removed and a slightly larger area would be regraded and revegetated following facility demolition than under the Entombment Alternative. Regardless, water use to support decommissioning and site closure activities under each alternative would be limited to that required to provide dust control and possibly to aid in soil compaction in backfilled areas, the mixing of concrete grout, and equipment washdown. These water demands could be easily supplied by trucking water to the point of use or via temporary utility service connections to the 400 Area's water supply wells. Water use would be somewhat greater under the Entombment Alternative to support construction of the modified RCRA Subtitle C barrier (see Section 2.8.2.2).

Under the Removal Alternative, the removal of the FFTF reactor vessel and other contaminated equipment would have positive impacts on the vadose zone and groundwater quality in the short-and-long term. In contrast, under the Entombment Alternative, installation of the modified RCRA Subtitle C barrier over the FFTF RCB and adjacent facilities would delay, but not prevent, contamination migration from the 400 Area over the longer term (see Section 2.9.2).

Construction of an RTP to treat RH-SCs under either the Hanford or Idaho Option would likely have no impact on surface-water features or quality, as no surface-water features would be directly disturbed and construction activities would occur in previously developed areas of the Hanford 200-West Area and of INTEC at INL, respectively. Process wastewater generated during facility operations would be discharged to existing treatment facilities that already service the Hanford 200 Areas and INTEC at INL. There would be no direct discharge of effluent to the vadose zone or groundwater.

Impacts of construction and operation of the new SRF under the Hanford Reuse Option for disposition of bulk sodium would be unlikely to have any impact on surface-water features or quality. This is due to the fact that there are no surface-water features that could be impacted in the Hanford 400 Area and there would be no direct discharge of effluents during operations to the vadose zone or groundwater. Effluents would be disposed of at appropriate onsite facilities. Potential impacts on water resources associated with implementing the Idaho Reuse Option would be negligible, as activities would be limited to modifications to the existing SPF to receive and process Hanford sodium. Similar to bulk sodium processing operations at Hanford, effluents from processing Hanford sodium at the SPF would be discharged to existing treatment facilities that already service the MFC.

2.8.2.7 Ecological Resources

Ecological resources include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Under the FFTF Decommissioning No Action Alternative, there would be no impact on ecological resources within the 400 Area or Borrow Area C. Because of the developed nature of the 400 Area and 200 Areas, and the use of existing facilities at INTEC and MFC, actions taking place under either Alternative 2 or 3 would not impact ecological resources, including threatened and endangered species, within those areas. While the mining of up to 3.2 hectares (8 acres) of land within Borrow Area C would impact the existing habitat of the site, no sagebrush habitat would be affected. Also, although no federally or state-listed threatened or endangered species would be affected by mining activities, there is minimal potential to disturb four state-listed special status species.

Due to the lack of wetlands and aquatic resources within the 200 Areas, Borrow Area C, INTEC, and the MFC, there would be no impact on these resources under any of the alternatives.

2.8.2.8 Cultural and Paleontological Resources

Cultural resources are the indications of human occupation and use of property, as defined and protected by a series of Federal laws, regulations, and guidelines, and are categorized as prehistoric resources, historic resources, and American Indian interests. Prehistoric resources are the physical remains of human activities that predate written records. Historic resources consist of physical remains that postdate the emergence of written records. American Indian interests include sites, areas, and materials important to American Indians for religious or heritage reasons. Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geologic age and may be sources of information on ancient environments and the evolutionary development of plants and animals. Under the FFTF Decommissioning alternatives and options, there would be no impact on prehistoric, historic, or paleontological resources. Under the No Action Alternative and the disposition of RH-SCs (both Hanford and Idaho Options) and bulk sodium (both Hanford Reuse and Idaho Reuse Options), there would be no impact on American Indian interests. Facility disposition under both FFTF Decommissioning Alternative 2: Entombment, and Alternative 3: Removal, would impact the view from higher elevations, including Rattlesnake Mountain.

2.8.2.9 Socioeconomics

Socioeconomic impacts are defined in terms of changes to demographic and economic characteristics of a region. The socioeconomic environment is generally made up of regional economic indicators and demographic characteristics of the area. Economic indicators include employment, the civilian labor force, and unemployment rates. Demographic characteristics include population, housing, education, and health information. In addition, the projected workforce and work activities could potentially impact the local transportation and result in level-of-service impacts on the roads in the ROI (i.e., Benton and Franklin Counties). Under all FFTF Decommissioning alternatives, any socioeconomic impacts on the ROI would be limited to the period from approximately 2013 through 2021. None of the peak workforce requirements would be more than 100 FTEs in a given year. The impacts on the region's economics, demographics, and housing and community services from this projected workforce would be small. In addition, the level of service on offsite roads is not expected to change.

2.8.2.10 Public and Occupational Health and Safety—Normal Operations

A description of the radionuclide releases that would result from FFTF decommissioning activities, including the disposition of RH-SCs and bulk sodium, is provided in Chapter 4 of this *TC & WM EIS*. The impacts on both the public and workers are estimated. For the public, impacts are presented for the population near Hanford, an MEI, and an onsite MEI. Public impacts would be very low under all alternatives. In addition to impacts at Hanford, options for disposition of the RH-SCs and bulk sodium could result in impacts on the population and an MEI near INL. For workers, the focus is on impacts on site radiation workers at both Hanford and INL.

Doses to the public under the No Action Alternative were conservatively calculated based on a continuation of current estimated emissions for 100 years of administrative control. Table 2–10 shows the radiological impacts of the three activities—facility disposition, disposition of RH-SCs, and disposition of bulk sodium—that compose the FFTF Decommissioning action alternatives. Of the three activities, disposition of the bulk sodium would have the largest impact on members of the public. Disposition of RH-SCs and/or bulk sodium could occur at Hanford or INL; the impacts of either activity would be slightly higher if conducted at Hanford. In all cases, the impacts on the population and the MEI would be very low. The largest radiological impact on the population within 80 kilometers (50 miles) over the life of the project would result under FFTF Decommissioning Alternative 2: Entombment, facility disposition accompanied by the Hanford options for disposition of the RH-SCs and bulk sodium. The sum of the population doses for these three activities would be 0.022 person-rem. Based on this dose, no LCFs are expected in the offsite population. Disposition of the RH-SCs and bulk sodium at INL would result in a dose to the population within 80 kilometers (50 miles) of INL of 0.0021 person-rem; no LCFs are expected as a result of this dose.

The largest annual MEI dose, under FFTF Decommissioning Alternative 2 with the Hanford options for disposition of the RH-SCs and bulk sodium, would be 0.00047 millirem. The annual risk of an LCF from this dose would be extremely unlikely, less than 1 in 3.6 billion. The dose and risk to an onsite MEI, assumed to be at LIGO, would be less than for the offsite MEI because the onsite MEI would be exposed for a shorter duration and through fewer pathways (e.g., no ingestion). Disposition of the RH-SCs and bulk sodium at INL would result in a maximum annual MEI impact of 0.00037 millirem, with an annual risk of an LCF of essentially zero (less than 1 in 4 billion).

Considering the doses for the duration of the project, facility disposition under the Removal Alternative would have the largest collective worker dose and under the Entombment Alternative would have the smallest collective dose. The No Action Alternative dose would be higher than the Entombment Alternative facility disposition dose because of the continued exposure of workers charged with facility monitoring and maintenance. The worker dose from disposition of RH-SCs would be the same regardless of whether the activity was performed at Hanford (Hanford Option) or INL (Idaho Option). The Hanford Reuse Option for disposition of bulk sodium would result in a slightly higher worker dose than the Idaho Reuse Option because it includes an additional work element. Whereas the facility for processing bulk sodium would remain available for use by others at INL under the Idaho Reuse Option, under the Hanford Reuse Option, the facility would be decommissioned, resulting in additional worker dose. The maximum project collective dose to workers—Removal Alternative facility disposition using the Hanford Option for disposition of the RH-SCs and the Hanford Reuse Option for bulk sodium—would be 11.2 person-rem. No additional LCFs are expected in the worker population as a result of this dose. The average annual dose to individual radiation workers would be 100 millirem or less for all activities; the corresponding annual risk of an LCF would be less than 1 in 17,000. Impacts on a noninvolved worker would be extremely small, with essentially no additional risk of an LCF.

2.8.2.11 Public and Occupational Health and Safety—Facility Accidents

Processing any hazardous material creates a risk of accidents impacting involved workers (workers directly involved in facility processes), noninvolved workers (workers on the site but not directly involved in facility processes), and members of the public. The consequences of such accidents could involve the release of radioactive materials, toxic chemicals, or hazardous (e.g., explosive) energy, beyond the intended confines of the process. Risk is determined by the development of a representative spectrum of postulated accidents, each of which is conservatively characterized by a likelihood (i.e., expected frequency of occurrence) and a consequence. For the FFTF Decommissioning alternatives presented in Table 2–10, the projected accident consequences are conditional on an accident's occurrence and therefore do not reflect an accident's frequency of occurrence. Shown in this table is the accident with the highest projected consequences under each alternative. Under all three alternatives, the accident involving sodium inventories that would have the highest consequences if it were to occur is the Hanford sodium storage tank failure. The frequency of this accident is estimated to be 0.00001 per year (once in 100,000 years). All three alternatives have the potential for accidents involving the sodium inventories stored in the Hanford sodium storage tank and elsewhere on Hanford. In addition, Alternatives 2 and 3 involve treatment of the FFTF RH-SCs, which contain sodium residuals and significant amounts of radionuclides. A fire involving an RH-SC could occur under either the Hanford Option or the Idaho Option and would have much higher consequences than the Hanford sodium storage tank failure. The frequency of the RH-SC fire accident is estimated to be 0.01 per year (once in 100 years). Under the Hanford Option, the RH-SC fire could occur only at Hanford. Under the Idaho Option, it could occur at Hanford during removal and preparation of the RH-SCs for shipment or at the INL site during storage or handling.

The accident risks shown in Table 2–10 take into account an accident's frequency. The annual risk value reflects the annual frequency of the accident. The risk over the life of the project reflects the duration of the activity that produces the accident potential, ranging from 5 to 100 years, during which that accident could occur. For bulk sodium, the risk over the life of the project would be highest under Alternative 1 due to the risk of a sodium inventory accident during 100 years of storage. Under FFTF Decommissioning Alternatives 2 and 3 in which the sodium is processed for reuse, a longer storage time results in higher life-of-project risks for the Hanford Reuse Option than for the Idaho Reuse Option. Risks over the life of the project for disposition of RH-SCs at Hanford are also slightly higher than for disposition under the Idaho Option.

In accordance with DOE orders, DOE protects against intentional destructive acts aimed at its facilities and materials. Regardless of those protections, this EIS evaluates the potential impacts of intentional destructive acts in addition to conventional facility accident scenarios. An intentional destructive act was postulated whereby the FFTF primary cold trap, containing cesium-137 and cobalt-60, is destroyed by an explosive or incendiary device during removal or handling. All of the radioactive material was assumed to aerosolize and be released to the atmosphere. Analysis results indicate that the radiological impacts would be about three times those calculated for the accident scenario that involves the same inventory of radioactive material (RH-SC fire). The scenario would apply to both action alternatives. More-detailed discussion of intentional destructive act impacts associated with FFTF Decommissioning alternatives is provided in Chapter 4, Section 4.2.11.4.

2.8.2.12 Public and Occupational Health and Safety—Transportation

Transportation of any commodity involves a risk to both transportation crewmembers and members of the public. The risk results directly from transportation-related accidents and indirectly from the levels of pollution from vehicle emissions, regardless of the cargo. The transportation of certain materials, such as hazardous or radioactive waste, can pose additional risk due to the unique nature of the material itself. Except for the No Action Alternative, FFTF decommissioning activities would generate various radioactive materials that would require transport to both off- and onsite locations for treatment and/or disposal. Radioactive materials would need to be transported off site if DOE decides to treat sodium or RH-SCs at INL. Table 2–10 summarizes the transportation risks to the workers (transport drivers) and the public in terms of traffic fatalities and LCFs. Based on the results presented in this table, the following conclusions have been reached:

- It is unlikely that transportation of radioactive waste would cause an additional fatality due to radiation resulting from either incident-free operations or postulated transportation accidents.
- The highest radiological risk to the public would be under options that treat the sodium and RH-SCs at INL. Alternative 3 would add additional risks for transport of radioactive materials for disposal in an IDF and transport of nonradioactive materials for disposal at a sanitary and hazardous waste landfill.
- The lowest radiological risk to the public would be under options that treat the sodium and RH-SCs at Hanford. FFTF Decommissioning Alternative 2 would add some risks for transport of the nonradioactive materials for disposal at a sanitary and hazardous waste landfill.
- Under Alternative 2, waste would be entombed, with the option of treating sodium at Hanford (Hanford Reuse Option) and RH-SCs at INL (Idaho Option).

2.8.2.13 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs Federal agencies to identify and address, as appropriate, disproportionately high and adverse human health and environmental effects of their programs, policies, and activities on minority and low-income populations. Potential risks to human health from normal facility operations and postulated facility accidents are not expected to pose disproportionately high and adverse effects on minority or low-income populations surrounding Hanford or INL under any FFTF Decommissioning alternative.

2.8.2.14 Waste Management

FFTF Decommissioning alternatives for facility disposition and options for disposition of RH-SCs and Hanford bulk sodium would generate several types of waste: LLW, MLLW, hazardous waste, nonhazardous waste, and liquid process waste. The generation of this waste could have little or minimal impact on existing Hanford facilities devoted to TSD. As described in Chapter 4, either the current waste management capacity is sufficient or the new infrastructure would be constructed as part of the alternative. Projected waste generation rates for the proposed activities were compared with Hanford's capacity to manage the waste, including the additional waste disposal capacity that is proposed to be constructed. Projected waste generation rates for the proposed activities were compared with site processing rates and capacities of those TSD facilities likely to be involved in managing the additional waste. Potential impacts of waste generated as a result of site environmental restoration activities unrelated to Tank Closure, FFTF Decommissioning, or Waste Management alternatives are not within the scope of this analysis. Where additional disposal capacity would be needed, the land use impacts are addressed in the appropriate sections of Chapter 4. The estimated full inventories of waste forms disposed of on site are included in the analyses of long-term impacts presented in Chapter 5 of this *TC & WM EIS*.

LLW and MLLW. LLW and MLLW (e.g., personal protective equipment, tools, filters, and empty containers) would be generated during routine operations, deactivation, decommissioning, and disposition activities associated with the action alternatives and options, as well as during routine surveillance and maintenance under FFTF Decommissioning Alternative 1: No Action. LLW is typically not treated or only minimally treated (e.g., compacted) before disposal. Using a combination of on- and offsite capabilities, secondary MLLW would be treated to meet RCRA land-disposal-restriction treatment standards prior to disposal. Therefore, this waste treatment would cause no or only minimal impacts on the Hanford waste management system. The LLW would be sent directly to disposal. The MLLW would be sent to disposal after treatment. All LLW and MLLW would be disposed of in an IDF.

Hazardous waste. Hazardous waste is dangerous waste as defined in the *Washington Administrative Code* (WAC 173-303). Hazardous waste generated during operations, deactivation, or monitoring would be packaged in DOT-approved containers and shipped off site to permitted commercial recycling, treatment, and disposal facilities. Management of the additional waste generated under the FFTF Decommissioning alternatives and options would require little, if any, additional planning. The waste would be treated and disposed of at offsite commercial facilities.

Nonhazardous waste. Any nonhazardous solid waste generated related to facility disposition activities or treatment facility construction, operations, or deactivation would be packaged and transported in conformance with standard industrial practice. Solid waste such as office paper, metal cans, and plastic and glass bottles that can be recycled would be sent off site for that purpose. The remaining nonhazardous solid waste would be sent for offsite disposal in a local landfill. This additional waste load would have only a minor impact on the handling and accumulation of nonhazardous solid waste at Hanford.

Liquid process waste. Process waste would be generated by FFTF disposition activities and would possibly be generated in association with RH-SC treatment, bulk sodium processing, and facility deactivation. Process waste, and dilute process waste such as cooling waters or steam condensates would be routed to the Hanford or INL facilities, as applicable, whose mission it is to manage such wastes. It is assumed that the ETF and TEDF, or their equivalents, would continue to be available to manage process liquids generated under the FFTF Decommissioning alternatives.

2.8.2.15 Industrial Safety

In addition to facility accident risks, estimates of potential industrial safety impacts on workers during construction, operations, deactivation, and closure activities under each FFTF Decommissioning alternative were evaluated based on the DOE complex–wide CAIRS database (see Appendix K, Section K.4). These impacts correlate with the number of labor hours required to support each FFTF Decommissioning alternative and are classified into two groups: TRCs and fatalities. Recordable cases include work-related deaths, as well as work-related illnesses or injuries leading to loss of consciousness, lost workdays, or transfer to another job, and/or requiring medical treatment beyond first aid.

Table 2–10 summarizes the potential number of TRCs and fatalities resulting from the construction, operations, deactivation, and closure activities that would be conducted under each FFTF Decommissioning alternative. The fewest projected industrial safety impacts would occur under FFTF Decommissioning Alternative 1; the No Action Alternative would require the least amount of worker labor. Under the action alternatives for FFTF decommissioning, the fewest projected impacts would occur under Alternative 2: Entombment, in conjunction with the Idaho options for disposition of RH-SCs and bulk sodium. The greatest projected impacts would occur under Alternative 3: Removal, in conjunction with the Hanford options for disposition of RH-SCs and bulk sodium, which could result in approximately 20 TRCs, but no fatalities.

Table 2–10. FFTF Decommissioning Alternatives – Summary of Short-Term Environmental Impacts

Parameter/Resource	FFTF Decommissioning Alternatives and Options						
				Alternative 2 or 3			
	Alternative 1: No Action	Alternative 2: Entombment–Facility Disposition	Alternative 3: Removal–Facility Disposition	Disposition of RH-SCs (Hanford Option)	Disposition of RH-SCs (Idaho Option)	Disposition of Bulk Sodium (Hanford Reuse Option)	Disposition of Bulk Sodium (Idaho Reuse Option)
Land Resources							
Land use (total land commitment)	No change in land use in the 400 Area, 200 Areas, or Borrow Area C.	2.1 hectares affected within the 400 Area. 2.8 hectares (0.3 percent) affected within Borrow Area C.	2.4 hectares affected within the 400 Area. 3.2 hectares (0.3 percent) affected within Borrow Area C.	0.1 hectares affected in 200-West Area.	No change in land use at INL.	0.1 hectares affected in 400 Area.	No change in land use at INL.
Visual resources	No change in the visual character of the 400 Area or 200 Areas.	Overall improvement in visual character of 400 Area. Minor change in visual character of Borrow Area C.		No meaningful change in the visual character of the 200-West Area.	No meaningful change in the visual character at INL.	No meaningful change in the visual character of the 400 Area.	No change in the visual character at INL.
Infrastructure							
Total Requirements							
Electricity (million megawatt-hours)	0.60	0.0032	0.0064	0.0000011		0.0013	
Diesel fuel (million liters)	0.0	4.02	3.76	0.24	0.0020	1.09	0.12
Gasoline (million liters)	0.11	0.36	0.37	0.090	0.0	0.42	0.012
Water (million liters)	795	19.6	18.9	8.53	1.04	2.92	2.72
Peak Annual Demand							
Electricity (million megawatt-hours)	0.006	0.0032		0.00000071		0.00069	0.00068
Diesel fuel (million liters)	0.0	1.74	1.11	0.12	0.0020	0.47	0.058
Gasoline (million liters)	0.0011	0.098	0.050	0.045	0.0	0.18	0.0088
Water (million liters)	79.5	11.4	10.5	3.75	0.69	1.36	
Noise and Vibration							
	Negligible offsite impact of onsite activities. Minor traffic noise impacts.						

Table 2–10. FFTF Decommissioning Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/Resource	FFTF Decommissioning Alternatives and Options						
				Alternative 2 or 3			
	Alternative 1: No Action	Alternative 2: Entombment–Facility Disposition	Alternative 3: Removal–Facility Disposition	Disposition of RH-SCs (Hanford Option)	Disposition of RH-SCs (Idaho Option)	Disposition of Bulk Sodium (Hanford Reuse Option)	Disposition of Bulk Sodium (Idaho Reuse Option)
Air Quality							
Peak Year Incremental Criteria Pollutant Concentrations as Compared with Most Stringent Guideline or Standard (micrograms per cubic meter)[a]							
Carbon monoxide (1-hour) standard=40,000	31.3	435	381	39.3	0	5,160	66.6
Nitrogen oxides (1-hour) standard=188	0.812	**3,590**	**2,570**	Does not occur in peak year	0	Does not occur in peak year	9.64
PM_{10} (24-hour) standard=150	0.00272	31.3	72	41.9	0	22.5	13.5
$PM_{2.5}$ (24-hour) standard=35	0.00272	31.3	**72**	**41.9**	0	22.5	13.5
Sulfur oxides (1-hour) standard=197	0.0419	30.6	50.4	0.062	0	6.97	0.0896
Peak Year Incremental Toxic Chemical Concentrations (micrograms per cubic meter)[a]							
Ammonia (24-hour) ASIL=70.8	0.000132	0.196	0.0264	0.0157	0	14.0	0.007
Benzene (annual) ASIL=5,000	0.00000327	0.0109		Does not occur in peak year	0	Does not occur in peak year	0.000805
Toluene (24-hour) ASIL=400	0.00338	11.3		Does not occur in peak year	0	Does not occur in peak year	0.0517
Xylene (24-hour) ASIL=NL	0.000954	3.18		Does not occur in peak year	0	Does not occur in peak year	0.0147

Table 2-10. FFTF Decommissioning Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/Resource	FFTF Decommissioning Alternatives and Options						
				Alternative 2 or 3			
	Alternative 1: No Action	Alternative 2: Entombment–Facility Disposition	Alternative 3: Removal–Facility Disposition	Disposition of RH-SCs (Hanford Option)	Disposition of RH-SCs (Idaho Option)	Disposition of Bulk Sodium (Hanford Reuse Option)	Disposition of Bulk Sodium (Idaho Reuse Option)
Geology and Soils							
Construction impacts	No incremental impact on geology and soils.	Minimal impact associated with facility demolition in previously disturbed area. Potential for short-term soil loss from wind and water erosion during demolition, backfilling, and barrier construction. Excavation depths generally limited to 0.91 meters in the 400 Area.	Similar to, but somewhat greater than, Alternative 2: Entombment, due to reactor vessel removal and greater demands for geologic and soil resources from Borrow Area C.	Impacts of construction limited to previously disturbed area in 200-West Area. Excavation depths to 6 meters within the Hanford formation.	Limited or no impact on geology and soils within INTEC at INL.	Limited impact on geology and soils in the Hanford 400 Area.	Minimal impact on geology and soils within the MFC at INL.
New permanent land disturbance (hectares)	0.0	3.5	3.2	0.1	0.0	0.1	<0.1
Geologic resource requirements (cubic meters)	0.0	122,000	143,000	4,670	0.0	202	35.5
Water Resources							
Surface water	No additional impacts on surface water in the short term. Wastewater generation and discharges would decrease from current levels.	No impact expected on surface-water features. Potential for contaminated runoff from demolition and work areas with no effect expected beyond the 400 Area.	Similar to, but somewhat greater than, Alternative 2: Entombment, due to reactor vessel removal and slightly larger area of disturbance and associated runoff.	Little or no impact on surface-water features or quality in the 200-West Area.	Little or no impact on surface-water features or quality within INTEC.	Limited impact on surface-water features or quality in the Hanford 400 Area.	No impacts on surface-water resources from construction and operations within the MFC at INL.

Table 2-10. FFTF Decommissioning Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/Resource	FFTF Decommissioning Alternatives and Options						
				Alternative 2 or 3			
	Alternative 1: No Action	Alternative 2: Entombment–Facility Disposition	Alternative 3: Removal–Facility Disposition	Disposition of RH-SCs (Hanford Option)	Disposition of RH-SCs (Idaho Option)	Disposition of Bulk Sodium (Hanford Reuse Option)	Disposition of Bulk Sodium (Idaho Reuse Option)
Water Resources *(continued)*							
Vadose zone and groundwater	No additional impact in the short term. Groundwater use would decrease following deactivation.	Barrier emplacement would delay contaminant migration from the 400 Area.	Short-term, positive impact of removal of sources of residual contamination associated with the FFTF RCB.	No direct discharge of effluents from facility operations to the vadose zone or groundwater.			
Ecological Resources							
Terrestrial resources	No impact within 400 Area or Borrow Area C.	No impact within 400 Area. No disturbance to sagebrush habitat within Borrow Area C.		No impact within the 200-West Area.	No impact at INL.	No impact within the 400 Area.	No impact at INL.
Wetlands	No impact within 400 Area or Borrow Area C.			No impact within the 200-West Area.	No impact at INL.	No impact within the 400 Area.	No impact at INL.
Aquatic resources	No impact within 400 Area or Borrow Area C.			No impact within the 200-West Area.	No impact at INL.	No impact within the 400 Area.	No impact at INL.
Threatened and endangered species	No impact on federally or state-listed threatened or endangered species within the 400 Area or Borrow Area C.	No impact on any federally or state-listed threatened or endangered species. No impact on state-listed special status species within the 400 Area. Minimal potential for impact on 4 state-listed special status species within Borrow Area C.		No impact on federally or state-listed threatened, endangered, or special status species within the 200-West Area.	No impact on federally or state-listed threatened, endangered, or special status species within INTEC at INL.	No impact on federally or state-listed threatened, endangered, or special status species within the 400 Area.	No impact on federally or state-listed threatened, endangered, or special status species within MFC at INL.

Table 2-10. FFTF Decommissioning Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/Resource	FFTF Decommissioning Alternatives and Options						
				Alternative 2 or 3			
	Alternative 1: No Action	Alternative 2: Entombment–Facility Disposition	Alternative 3: Removal–Facility Disposition	Disposition of RH-SCs (Hanford Option)	Disposition of RH-SCs (Idaho Option)	Disposition of Bulk Sodium (Hanford Reuse Option)	Disposition of Bulk Sodium (Idaho Reuse Option)
Cultural and Paleontological Resources							
Prehistoric resources	No impact on prehistoric resources.						
Historic resources	No impact on historic resources.						
American Indian interests	No impact on American Indian interests.	Excavation activities would impact the view from State Route 240 and higher elevations, including Rattlesnake Mountain.		No impact on American Indian interests.			
Paleontological resources	No impact on paleontological resources.						
Socioeconomics							
Peak annual workforce (FTEs)	1	50	85	53	40	65	55
Peak daily commuter traffic (vehicles per day)	1	40	68	43	40	52	55
Peak daily truck loads – off site	Less than 1	3	2	1	Less than 1	Less than 1	Less than 1
Impact on the ROI	Little or no impact on socioeconomic ROI.	The impact on the Hanford and INL socioeconomic ROIs would be small.					

Table 2-10. FFTF Decommissioning Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/Resource	FFTF Decommissioning Alternatives and Options						
				Alternative 2 or 3			
	Alternative 1: No Action	Alternative 2: Entombment–Facility Disposition	Alternative 3: Removal–Facility Disposition	Disposition of RH-SCs (Hanford Option)	Disposition of RH-SCs (Idaho Option)	Disposition of Bulk Sodium (Hanford Reuse Option)	Disposition of Bulk Sodium (Idaho Reuse Option)
Public and Occupational Health and Safety – Normal Operations							
Offsite Population Impact – Life of the Project							
Dose (person-rem)	0.027	0.00000067	(b)	0.00019	0.000048	0.022	0.0021
LCF[c]	0 (2×10^{-5})	0 (4×10^{-10})	(b)	0 (1×10^{-7})	0 (3×10^{-8})	0 (1×10^{-5})	0 (1×10^{-6})
Peak Year Maximally Exposed Individual Impact							
Dose (millirem per year)	0.000017	0.000000058	(b)	0.0000078	0.0000044	0.00046	0.00037
Increased risk of an LCF	1×10^{-11}	3×10^{-14}	(b)	5×10^{-12}	3×10^{-12}	3×10^{-10}	2×10^{-10}
Peak Year Onsite Maximally Exposed Individual Impact							
Dose (millirem per year)	0.000011	0.000000098	(b)	0.000018	N/A	0.00044	N/A
Increased risk of an LCF	6×10^{-12}	6×10^{-15}	(b)	1×10^{-11}	N/A	3×10^{-10}	N/A
Radiation Worker Population Impact – Life of the Project							
Dose (person-rem)	1	0.37	6.3	1.2		3.7	3.6
LCF[c]	0 (6×10^{-4})	0 (2×10^{-4})	0 (4×10^{-3})	0 (7×10^{-4})		0 (2×10^{-3})	
Average Annual Impact per Radiation Worker							
Dose (millirem per year)	50	100		20		39	
Increased risk of an LCF	3×10^{-5}	6×10^{-5}		1×10^{-5}		2×10^{-5}	
Peak Year Noninvolved Worker Impact							
Dose (millirem per year)	0.0000064	0.0000000059	(b)	0.011	0.00000029	0.00025	0.069
Increased risk of an LCF	4×10^{-12}	4×10^{-15}	(b)	6×10^{-9}	2×10^{-13}	2×10^{-10}	4×10^{-8}

Table 2-10. FFTF Decommissioning Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/Resource	FFTF Decommissioning Alternatives and Options						
				Alternative 2 or 3			
	Alternative 1: No Action	Alternative 2: Entombment–Facility Disposition	Alternative 3: Removal–Facility Disposition	Disposition of RH-SCs (Hanford Option)	Disposition of RH-SCs (Idaho Option)	Disposition of Bulk Sodium (Hanford Reuse Option)	Disposition of Bulk Sodium (Idaho Reuse Option)
Public and Occupational Health and Safety – Facility Accidents							
Offsite Population Consequences							
Dose (person-rem)	0.0064	(d)		4.3	0.30[e]	0.0064	0.000058[e]
Number of LCFs[c]	0 (4×10^{-6})	(d)		0 (3×10^{-3})	0 (2×10^{-4})[e]	0 (4×10^{-6})	0 (3×10^{-8})[e]
Maximally Exposed Offsite Individual Consequences							
Dose (rem)	0.0000011	(d)		0.00012	0.00025[e]	0.0000011	0.000000030
Increased risk of an LCF	6×10^{-10}	(d)		7×10^{-8}	2×10^{-7}[e]	6×10^{-10}	2×10^{-11}[e]
Noninvolved Worker Consequences							
Dose (rem)	0.00000087	(d)		0.00073	0.00018[e]	0.00000087	0.0000000039
Increased risk of an LCF	5×10^{-10}	(d)		4×10^{-7}	1×10^{-7}[e]	5×10^{-10}	2×10^{-12}[e]
Offsite Population Risk							
Annual number of LCFs[c]	0 (4×10^{-11})	(d)		0 (3×10^{-5})	0 (2×10^{-6})[e]	0 (4×10^{-11})	0 (3×10^{-13})[e]
Number of LCFs over the life of the project[c]	0 (4×10^{-9})	(d)		0 (1×10^{-4})	0 (9×10^{-6})[e]	0 (5×10^{-10})	0 (7×10^{-13})[e]
Maximally Exposed Offsite Individual Risk							
Annual increased risk of an LCF	6×10^{-15}	(d)		7×10^{-10}	2×10^{-9}[e]	6×10^{-15}	2×10^{-16}[e]
Increased risk of an LCF over the life of the project	6×10^{-13}	(d)		4×10^{-9}	8×10^{9}[e]	8×10^{-14}	4×10^{-16}[e]
Noninvolved Worker Risk							
Annual increased risk of an LCF	5×10^{-15}	(d)		4×10^{-9}	1×10^{-9}[e]	5×10^{-15}	2×10^{-17}[e]
Increased risk of an LCF over the life of the project	5×10^{-13}	(d)		2×10^{-8}	6×10^{-9}[e]	7×10^{-14}	5×10^{-17}[e]
Public and Occupational Health and Safety – Transportation							
Traffic accidents[f] (nonradiological fatalities)	0 (0.0004)	0 (0.034)		0 (0.005)	0 (0.00035)	0 (0.0006)	0 (0.0082)
Offsite Population							
Dose (person-rem)	0	(f)	0.003	0.005	0.33	0.01	0.96
LCFs	0	N/A	1.5×10^{-6}	2.9×10^{-6}	2.0×10^{-4}	6.7×10^{-6}	5.7×10^{-4}

Table 2-10. FFTF Decommissioning Alternatives – Summary of Short-Term Environmental Impacts *(continued)*

Parameter/Resource	FFTF Decommissioning Alternatives and Options						
				Alternative 2 or 3			
	Alternative 1: No Action	Alternative 2: Entombment–Facility Disposition	Alternative 3: Removal–Facility Disposition	Disposition of RH-SCs (Hanford Option)	Disposition of RH-SCs (Idaho Option)	Disposition of Bulk Sodium (Hanford Reuse Option)	Disposition of Bulk Sodium (Idaho Reuse Option)
Public and Occupational Health and Safety – Transportation *(continued)*							
Worker							
Dose (person-rem)	0	(g)	0.03	0.03	0.84	0.12	3.5
LCFs	0	N/A	2×10^{-5}	1.9×10^{-5}	5.0×10^{-4}	6.9×10^{-5}	2.1×10^{-3}
Environmental Justice							
Human health impacts	No disproportionately high and adverse human health impacts on minority or low-income populations due to normal facility operations or postulated facility accidents.						
Waste Management (cubic meters unless otherwise noted; values rounded to no more than three significant digits)							
Disposed of Off Site and/or Stored On Site							
LLW	1,700	7	692	68		10	N/A
MLLW	57	N/A	8	7		421	275
Hazardous	396	N/A	73	4		454	N/A
Liquid LLW (liters)	623,000	182,000	324,000	N/A			
Industrial Safety							
Worker Population Impact – Total Project							
Total recordable cases (fatalities)	0.42 (0)	8.1 (0)	9.5 (0)	4.7 (0)	0.9 (0)	5.8 (0)	2.0 (0)

[a] Concentrations exceeding applicable standards, discussed in the air quality sections of Chapter 4 of this *TC & WM EIS*, are presented in **bold** text. The Federal standard for $PM_{2.5}$ is 35 micrograms per cubic meter (24-hour average). No specific data for $PM_{2.5}$ were available, but for analysis purposes, concentrations were assumed to be the same as for PM_{10}. Radiological air quality impacts are included separately under the public and occupational health and safety sections.

[b] Impacts on remote receptors would be negligible under Alternatives l and 3.

[c] The number of LCFs in a population is presented as an integer; where the value is 0, the calculated value (dose × 0.0006 LCFs per person-rem) is presented in parentheses.

[d] Impacts of accidents associated with facility disposition (building entombment or removal) would be less than those for disposition of RH-SCs or bulk sodium.

[e] Impacts are only for accidents that could occur at INL. Impacts identified for disposition of RH-SCs or bulk sodium at Hanford could also occur under the Idaho options during removal and preparation of material for shipment.

[f] Nearest whole integer (calculated value in parentheses).

[g] All transported materials are sanitary and hazardous waste, not radioactive.

Note: To convert cubic meters to cubic yards, multiply by 1.308; hectares to acres, by 2.471; liters to gallons, by 0.26417; meters to yards, by 1.0936.

Key: ASIL=acceptable source impact level; FFTF=Fast Flux Test Facility; FTE=full-time equivalent; Hanford=Hanford Site; INL=Idaho National Laboratory; INTEC=Idaho Nuclear Technology and Engineering Center; LCF=latent cancer fatality; LLW=low-level radioactive waste; MFC=Materials and Fuels Complex; MLLW=mixed low-level radioactive waste; N/A=not applicable; NL=not listed; PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; RCB=Reactor Containment Building; RH-SCs=remote-handled special components; ROI=region of influence; *TC & WM EIS=Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*.

Source: Chapter 4 of this *TC & WM EIS*.

2.8.3 Waste Management Alternatives: Short-Term Environmental Impacts

2.8.3.1 Land Resources

Land use includes the land on and adjacent to Hanford, the physical features that influence current or proposed uses, pertinent land use plans and regulations, and land ownership and availability. Under the Waste Management No Action Alternative, there would be no change in land use within the 200 Areas or Borrow Area C. Under Alternative 2, the total land commitment within the 200 Areas would range from about 67 hectares (165 acres) under Disposal Group 1 to 250 hectares (618 acres) under Disposal Groups 2 and 3. Under Alternative 3, the total acreage required within the 200 Areas would be similar to that under Alternative 2 for all disposal groups. Because it would be necessary to mine geologic material under all alternative/disposal group combinations, land use within Borrow Area C would vary. Under Alternative 2, land commitment within Borrow Area C would range from 41.7 hectares (103 acres) under Disposal Group 1 to 159 hectares (392 acres) under Disposal Groups 2 and 3. Land commitment within Borrow Area C under Alternative 3 would range from 36.8 hectares (91 acres) under Disposal Group 1 to 157 hectares (388 acres) under Disposal Groups 2 and 3.

Visual resources are the natural and manmade features that give a particular landscape its character and aesthetic quality. Visual resources would not be affected under the No Action Alternative. However, there would be a noticeable change in the visual character of the 200 Areas and Borrow Area C under all alternative/disposal group combinations when viewed from nearby higher elevations and, in the case of Borrow Area C, State Route 240. In addition, ongoing construction, consolidation, operations, maintenance and deactivation of new or existing facilities on Rattlesnake and Gable Mountains would occur under each Waste Management alternative. These activities would result in short-term adverse impacts on land and visual resources, including the development or use of previously undisturbed land. However, the eventual consolidation or removal of unnecessary facilities/infrastructure on Rattlesnake and Gable Mountains would tend to improve the visual profile of the features, allow restoration of natural habitat, and enhance tribal religious and cultural experiences.

2.8.3.2 Infrastructure

Site infrastructure includes physical resources encompassing the utility systems required to support facility construction, operations, and closure activities associated with the Waste Management alternatives for waste storage, treatment, and disposal at Hanford (see Table 2–11). Utility infrastructure resources considered include electricity, liquid fuels, and water. Under Waste Management Alternative 1: No Action, ongoing waste storage, treatment, and disposal activities in LLBG 218-W-5 coupled with peak demands for deactivation of IDF-East would drive utility resource demands. Common to the action alternatives for waste management (see Alternatives 2 and 3) would be utility demands associated with construction, operations, and deactivation of new facility expansions to support ongoing Hanford waste treatment and storage activities. Otherwise, the magnitude of utility demands would vary primarily in direct relation to the size, number, and required lifespan of disposal facilities (i.e., the IDF(s) and proposed RPPDF) that would be constructed, operated, and ultimately closed under each disposal group scenario. Nevertheless, peak and total utility resource requirements would be very similar within a disposal group between Waste Management Alternatives 2 and 3, with the division of disposal capacity using one IDF under Alternative 2 versus two IDFs under Alternative 3 resulting in little change in overall total and peak annual utility demands. One exception is the demand for electricity, which is projected to be the same regardless of the disposal configuration, with a relatively constant demand of 0.00019 million megawatt-hours. However, this demand is mainly attributable to ongoing disposal operations in LLBG 218-W-5. Regardless, this requirement is minimal compared with the current capacity (1.74 million megawatt-hours annually) of the Hanford electric power distribution system. While not considered to be a limiting resource, as additional supplies of liquid fuels can be trucked to the point of use as needed from offsite suppliers, liquid fuel requirements to supply mobile equipment associated with disposal facility construction, operations, and closure would be substantial under the action alternatives compared with current Hanford consumption. Under Waste Management Alternatives 2 and 3, projected total diesel fuel requirements range from 215 million liters (56.8 million gallons) under Disposal Group 1 to 2,170 and 2,180 million liters (573 and 576 million gallons) under Alternative 3, Disposal Group 3, and Alternative 2, Disposal Group 3, respectively (see Table 2–11). Peak annual diesel fuel consumption would range from about 38.9 million liters (10.3 million gallons) under Alternative 3, Disposal Group 1, to 151 million liters (39.9 million gallons) under Alternative 2, Disposal Groups 2 and 3. Projected total water usage ranges from about 2,610 million liters (689 million gallons) under Alternative 3, Disposal Group 1, to 36,800 million liters (9,720 million gallons) under Alternative 2, Disposal Group 3. Peak annual water demand would range from about 66.7 million liters (17.6 million gallons) under Alternative 3, Disposal Group 1, up to 259 million liters (68.4 million gallons) under Alternative 2, Disposal Groups 2 and 3. The projected peak water demand of 259 million liters (68.4 million gallons) would be about 1.4 percent of the 18,500-million-liter (4,890-million-gallon) annual capacity of the Hanford Export Water System and about 32 percent of the approximately 816.6 million liters (215.7 million gallons) of water used annually at Hanford (see Chapter 3, Section 3.2.2).

2.8.3.3 Noise and Vibration

Noise is undesirable sound that interferes negatively with the human or natural environment. Noise may disrupt normal activities (e.g., hearing, sleep), damage hearing, or diminish the quality of the environment. Noise impacts may result from construction, operations, deactivation, and closure activities, including increased traffic. Noise impacts of onsite activities under all Waste Management alternatives would be negligible. Under the No Action Alternative, there would be negligible noise impact of employee vehicles. Noise impacts of traffic would be highest under Alternative 2, Disposal Groups 2 and 3, which would have the highest peak year employment and employee vehicle traffic. The increase in employee traffic noise along the roads to the site during peak hours (shift changes) could be noticeable to residents along these routes. Alternative 2, Disposal Group 2, would have the highest offsite truck traffic associated with RPPDF closure. Noise impacts of onsite activities and traffic under the other alternatives would be negligible to minor.

2.8.3.4 Air Quality

Air pollution refers to any substance in the air that could harm human or animal populations, vegetation, or structures or that unreasonably interferes with the comfortable enjoyment of life and property. As modeled, nonradioactive air pollutant concentrations would exceed the applicable 24-hour ambient standards for $PM_{2.5}$ and PM_{10} for all Waste Management alternatives and the annual standard for $PM_{2.5}$ and PM_{10} under Alternatives 2 and 3, Disposal Groups 2 and 3. The annual standard would also be exceeded under Alternatives 2 and 3, Disposal Group 1, for $PM_{2.5}$. Nonradiological air quality impacts of $PM_{2.5}$ and PM_{10} would be highest under Alternative 3, Disposal Groups 2 and 3. Under this alternative and disposal group, $PM_{2.5}$ and PM_{10} concentrations in the peak year would be attributable primarily to fugitive dust from heavy-equipment operations during RPPDF construction. The 1-hour nitrogen dioxide standard would be exceeded under all alternatives. The carbon monoxide 1-hour standard would be exceeded under Alternatives 2 and 3, Disposal Groups 1, 2, and 3, and the 8-hour standard would be exceeded under Disposal Groups 2 and 3.

Particulate matter emissions estimated for construction-type activities include fugitive dust emissions from construction areas and take into account dust suspended by equipment and vehicle activity and by wind. The emission factor used for these estimates is intended to provide a gross estimate of total suspended particulate emissions when detailed engineering data that would allow for a more refined estimate of dust emissions are not available. For the purpose of this analysis, $PM_{2.5}$ and PM_{10} emissions from general construction activities were assumed to be the same as the total suspended particulate emissions. This results in a substantial overestimate of $PM_{2.5}$ and PM_{10} emissions. Further, the analysis did not consider appropriate emission controls that could be applied in the construction areas, as discussed in Chapter 7, Section 7.1. A refined analysis of emissions based on more-detailed engineering data on the construction activities and application of appropriate control technologies is expected to result in substantially lower emissions and ambient concentrations from the major construction activities under these alternatives. Maximum air quality impacts of particulate matter are expected to occur along State Route 240, along or near the Hanford boundary.

The Clean Air Act, as amended (40 U.S.C. 7401 et seq.), requires that Federal actions conform to the host state's "state implementation plan." A state implementation plan provides for the implementation, maintenance, and enforcement of NAAQS for the six criteria pollutants: sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. Its purpose is to eliminate or reduce the severity and number of NAAQS violations and to expedite the attainment of these standards. "No department, agency, or instrumentality of the Federal Government shall engage in or support in any way or provide financial assistance for, license or permit, or approve any activity that does not conform to an applicable implementation plan." The final rule for "Determining Conformity of General Federal Actions to State or Federal Implementation Plans" (40 CFR 51, Subpart W) took effect on January 31, 1994. Hanford is within an area currently designated as attainment for criteria air pollutants (40 CFR 81.348). Therefore, the alternatives considered in this EIS do not require a conformity determination under the provisions of this rule.

Acceptable source impact levels are used during the permitting process to demonstrate that emissions from a new toxic air pollutant source are sufficiently low to protect human health and safety from potential carcinogenic and/or other toxic effects. Comparison of the estimated concentrations to acceptable source impact levels indicates that emissions under all Waste Management alternatives would be sufficiently low to protect human health and safety. Specifically, maximum concentrations of nonradioactive toxic air pollutants off site and in areas to which the public has access would be less than 98 percent of the state's acceptable source impact levels. Maximum concentrations of carcinogenic toxic pollutants would be less than 98 percent of the state's acceptable source impact levels. Impacts of radioactive air emissions are summarized in Section 2.8.3.10.

Chapter 6, Section 6.5.2, Global Climate Change, summarizes the estimated annual carbon dioxide emissions by *TC & WM EIS* alternative.

2.8.3.5 Geology and Soils

Geologic resources include consolidated and unconsolidated earth materials, including rock and mineral assets such as ore and aggregate materials (e.g., sand, gravel) and fossil fuels such as coal, oil, and natural gas. Soil resources include the loose surface materials of the earth in which plants grow. Impacts on geology and soils would generally be directly proportional to the total area of land disturbed by facility construction, operations, deactivation, and closure associated with the Waste Management alternatives for waste treatment, storage, and disposal (see Table 2–11). Consumption of geologic resources, including rock, mineral, and soil resources, would constitute the major indirect impact on geologic and soil resources. As for other areas of the impacts analysis, Hanford waste treatment and storage activities and commensurate geologic resource requirements would be identical under Waste Management Alternatives 2 and 3. Under Waste Management Alternative 1: No Action, interim waste storage, treatment, and disposal activities would have little additional impact on geology and soils. Deactivation of IDF-East under this alternative would involve backfilling the facility with stockpiled material. No new facilities would be constructed or expanded under Alternative 1, but geologic resources totaling 6,230 cubic meters (8,150 cubic yards) would be required from Borrow Area C to support ongoing waste disposal operations in trenches 31 and 34 in LLBG 218-W-5. Under both Alternatives 2 and 3, limited impacts on geology and soils would occur associated with the construction of new facilities or facility expansion in support of ongoing Hanford waste treatment and storage activities. Construction activities would permanently disturb about 2.7 hectares (6.6 acres), with excavations of up to 3 meters (10 feet) in depth. Work would occur in previously disturbed areas in the 200-West Area. Geologic resource requirements would total 10,600 cubic meters (13,860 cubic yards) (see Table 2–11).

For the three disposal groups under each action alternative (Waste Management Alternatives 2 and 3), impacts on geology and soils and associated demand for geologic resources would be relatively substantial and would vary primarily in direct relation to the size, number, and required lifespan of disposal facilities—i.e., the IDF(s) and proposed RPPDF—that would be constructed, operated, and ultimately closed under each disposal scenario. New permanent land disturbance would range from 108 hectares (268 acres) under Waste Management Alternative 2, Disposal Group 1, to a high of approximately 413 hectares (1,020 acres) under Waste Management Alternative 3, Disposal Groups 2 and 3. Permanent land disturbance includes that projected for the construction of new disposal facilities plus area excavated in Borrow Area C to supply geologic resources. The potential for short-term wind and water erosion would exist in disturbed areas but would be minimized via the application of best management practices. Disposal facility construction would require excavations to a depth of about 14 meters (45 feet), but the need for blasting is not expected due to the depth of the Hanford formation sediments across the areas in which new facilities would be constructed. Projected geologic resource requirements range from a total of 1,760,000 cubic meters (2,300,000 cubic yards) under Waste Management Alternative 3, Disposal Group 1, to 7,610,000 cubic meters (9,950,000 cubic yards) under Waste Management Alternative 2, Disposal Groups 2 and 3 (see Table 2–11). These requirements would consist primarily of materials needed for construction of a modified RCRA Subtitle C barrier over the IDF(s) and proposed RPPDF(s) to effect final closure.

2.8.3.6 Water Resources

Water resources are the surface and subsurface waters that are suitable for human consumption, aquatic or wildlife use, agricultural purposes, irrigation, or industrial/commercial purposes. Implementation of Waste Management Alternative 1 would have no additional impacts on surface water, the vadose zone, or groundwater. Increased stormwater runoff could occur during deactivation of IDF-East, but any effects would be confined to the 200 Areas. Under both Waste Management Alternatives 2 and 3, impacts on surface-water resources and quality associated with construction of expanded Hanford waste treatment and storage facilities would be negligible. The expanded facilities would be constructed in previously developed portions of the 200-West Area, with any effect on stormwater runoff quality likely to be very localized and of short duration and to have no incremental impacts on groundwater. Water would be required during construction, operations, and deactivation of new/expanded facilities (see Table 2–11). Effluents, generated from operation of the new/expanded facilities, would be discharged to existing treatment facilities that already service the 200 Areas.

For the three disposal groups under each action alternative (Waste Management Alternatives 2 and 3), impacts on surface water from new disposal facility construction would be limited to the very poorly defined drainage features that are present where the proposed RPPDF would be constructed between the 200-East and 200-West Areas. The potential exists for site clearing, grading, and facility excavation work during construction to expose soils and sediments to possible erosion by infrequent, heavy rainfall or by wind. This potential would be greater under Disposal Groups 2 and 3, where larger land areas would be affected, but any impacts would be localized and of short duration. Nevertheless, appropriate soil erosion and sediment control measures, spill prevention and waste management practices, and National Pollutant Discharge Elimination System and state waste-discharge permitting requirements would be implemented to minimize any impacts on surface water, the vadose zone, and groundwater. Construction also is not expected to affect groundwater flow in the vicinity of any disposal facilities.

Normal disposal facility operations, including the continued operation of trenches 31 and 34 in LLBG 218-W-5, are not expected to have any additional impact on water resources in the short term. The trenches are lined, RCRA-compliant disposal facilities equipped with a leachate collection system. Leachate would continue to be collected and disposed of at the ETF. The new IDF(s) and proposed RPPDF would incorporate appropriate stormwater management engineering and operational controls to collect, detain, and convey stormwater away from disposal areas, so as to minimize water quality impacts during operations. The new facilities would include a redundant (double) liner system, a leachate collection and removal system, and a leak detection system to protect subsurface-water quality. Collected leachate would be similarly detained and trucked to the ETF for treatment and disposal. Potential impacts of normal operations of the IDF(s) and proposed RPPDF would vary in proportion to facility size and the operational lifespan of each disposal group. Nevertheless, following completion of disposal activities in the IDF(s) and the proposed RPPDF under each disposal group, each facility would be closed with a modified RCRA Subtitle C barrier to minimize infiltration through emplaced waste in the short term, and each facility would be subject to a DOE-administered 100-year postclosure care period.

Water would be required to support waste management disposal activities, including dust control, soil compaction, and other activities, during disposal facility construction, operations, and closure, with demands generally varying based on the total size of the disposal facilities under each scenario. While water demands would be relatively substantial under all disposal scenarios, demands would not exceed site capacity (see Section 2.8.3.2).

2.8.3.7 Ecological Resources

Ecological resources include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. There would be no impact on ecological resources, including sagebrush habitat and threatened and endangered species, within the 200 Areas or Borrow Area C under the Waste Management No Action Alternative. However, sagebrush habitat within the 200 Areas would be affected under Waste Management Alternatives 2 and 3, and the total affected acreage would be similar under each alternative and waste disposal combination (i.e., ranging from about 63.9 hectares to 76.9 hectares [158 acres to 190 acres] under Disposal Group 1 and from about 247 hectares to 253 hectares [611 acres to 624 acres] under Disposal Groups 2 and 3 for Alternatives 2 and 3, respectively). While grassland habitat within Borrow Area C would be disturbed under all alternative and waste disposal combinations, no sagebrush habitat within that area would be affected.

No federally or state-listed threatened or endangered species would be affected under any alternative/disposal combination within either the 200 Areas or Borrow Area C. However, there is potential to impact a number of state-listed special status species under Alternatives 2 and 3. All disposal groups under Alternative 2 have the potential to impact four state-listed special status species in the 200 Areas and four in Borrow Area C; however, due to the greater acreage of habitat disturbed, the potential is greater under Disposal Groups 2 and 3. Under all disposal groups of Alternative 3, the potential exists to disturb five state-listed special status species within the 200 Areas and four within Borrow Area C. There is greater potential to impact these species under Disposal Groups 2 and 3 also, due to the greater acreage of habitat disturbed.

Due to the lack of wetlands and aquatic resources within the 200 Areas and Borrow Area C, there would be no impact on these resources under any of the alternatives.

2.8.3.8 Cultural and Paleontological Resources

Cultural resources are the indications of human occupation and use of property, as defined and protected by a series of Federal laws, regulations, and guidelines, and are categorized as prehistoric resources, historic resources, and American Indian interests. Prehistoric resources are the physical remains of human activities that predate written records. Historic resources consist of physical remains that postdate the emergence of written records. American Indian interests include sites, areas, and materials important to American Indians for religious or heritage reasons. Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geologic age and may be sources of information on ancient environments and the evolutionary development of plants and animals. Under the Waste Management alternatives and disposal groups, there would be no impact on prehistoric, historic, or paleontological resources. There would be no impact on American Indian interests under the No Action Alternative. There would be an impact on the viewshed from higher elevations, including Rattlesnake Mountain, from treatment and storage under Alternatives 2 and 3. Alternatives 2 and 3, Disposal Groups 1, 2, and 3, would all affect the viewshed from Rattlesnake Mountain and higher elevations. The greater the land disturbance, the more the viewshed would be affected. Alternatives 2 and 3, Disposal Groups 2 and 3, would disturb the greatest area of land for the expansion or construction of the IDF(s), construction of the proposed RPPDF, and excavation of Borrow Area C, thus having the most impact on the viewshed.

2.8.3.9 Socioeconomics

Socioeconomic impacts are defined in terms of changes to demographic and economic characteristics of a region. The socioeconomic environment is generally made up of regional economic indicators and demographic characteristics of the area. Economic indicators include employment, the civilian labor force, and unemployment rates. Demographic characteristics include population, housing, education, and health information. In addition, the projected workforce and work activities could potentially impact local transportation and result in level-of-service impacts on the roads in the ROI (i.e., Benton and Franklin Counties). Under Waste Management Alternatives 2 and 3, there would be potential for similar socioeconomic impacts in the ROI. The impacts would be greatest under Disposal Groups 2 and 3, where the projected workforce would be needed for construction of the barriers over IDF-East and the proposed RPPDF as late as 2101 and 2166, respectively. The near-term (less than 100 years) impacts would be minimal.

2.8.3.10 Public and Occupational Health and Safety—Normal Operations

A description of the radionuclide releases associated with Waste Management alternatives is provided in Chapter 4 of this *TC & WM EIS*. Radiological impacts on both the public and workers are estimated. For the public, impacts are presented for the population within 80 kilometers (50 miles) of the 200-West Area, an MEI, and an onsite MEI. Public impacts associated with the No Action Alternative are from existing, permitted facilities and are accounted for in currently reported dose impacts. Offsite impacts of the action alternatives would be dominated by radioactive air emissions from the treatment activities. Because waste handled during disposal operations would be packaged or have very low radioactivity, the contribution to remote receptors would be negligible compared with the emissions associated with treatment activities.

The incremental dose to the public (in addition to the dose from current waste management operations) would be the same under Waste Management Alternatives 2 and 3. The population dose over the life of the project would be 0.000077 person-rem; no additional LCFs are expected as a result of this dose. The incremental dose received by the MEI in the year of maximum impact would be 0.00000015 millirem; the increased risk of an LCF from this dose is negligible. The dose and risk to an onsite MEI, assumed to be at the US Ecology Commercial LLW Disposal Site, would be more than for the offsite MEI. Although the onsite MEI would be exposed for a shorter duration and through fewer pathways (e.g., no ingestion), the dose would be higher because of the proximity to the release site.

Doses to radiation workers would result from TSD operations. Under Waste Management Alternative 1: No Action, the worker population dose from continuing operations for 29 years would be 37 person-rem; no LCFs are expected as a result of this dose. Under Alternatives 2 and 3, average annual worker radiation doses would be the same for treatment and storage activities, as well as for each of the three disposal groups analyzed. Under Waste Management Alternative 2 or 3, Disposal Group 1, the collective worker dose from treatment, storage, and disposal of radioactive waste over the life of the project would be about 3,400 person-rem; only 360 person-rem of this dose would be from the 44 years of disposal operations. Statistically, this collective dose could result in two LCFs in the worker population. Alternative 2 or 3, Disposal Group 2, would result in a collective worker dose from treatment, storage, and disposal of radioactive waste over the life of the project of 6,600 person-rem; about half of this dose would be from 94 years of disposal operations. Statistically, this collective dose could result in four LCFs in the worker population. Alternative 2 or 3, Disposal Group 3, would result in a collective worker dose over the life of the project of 9,400 person-rem; about 6,400 person-rem of this dose would be from 159 years of disposal operations. Statistically, this collective dose could result in six LCFs in the worker population. The risk of LCFs occurring as a result of these doses should be considered in terms of the timeframe over which the doses occur and DOE's guidance for maintaining individual worker doses below the Administrative Control Level of 500 millirem per year (DOE Standard 1098-2008). Some of these doses would accrue over several generations of workers. Additionally, the estimated average annual dose to a radiation worker under any of the Waste Management alternatives would be 200 millirem per year. If this dose were received over a 40-year career, a worker would receive a dose of 8,000 millirem and the associated individual risk of an LCF would be 1 in 200.

Under Alternatives 2 and 3, the maximum annual dose to a nearby noninvolved worker assumed to be 100 meters (330 feet) from the treatment facility would be 0.00039 millirem. The risk of an LCF from this exposure would be negligible (less than 1 in 1 billion).

2.8.3.11 Public and Occupational Health and Safety—Facility Accidents

Processing any hazardous material creates a risk of accidents impacting involved workers (workers directly involved in facility processes), noninvolved workers (workers on the site but not directly involved in facility processes), and members of the public. The consequences of such accidents could involve the release of radioactive materials, toxic chemicals or hazardous (e.g., explosive) energy, beyond the intended confines of the process. Risk is determined by the development of a representative spectrum of postulated accidents, each of which is conservatively characterized by a likelihood (i.e., expected frequency of occurrence) and a consequence. For the alternatives presented in Table 2–11, the accident consequences are conditional on an accident's occurrence and therefore do not reflect an accident's frequency of occurrence.

All three Waste Management alternatives have the potential for accidents involving the waste inventories stored at the SWOC. Under Waste Management Alternative 1, construction of IDF-East would be discontinued in 2008. Therefore, accidents associated with the onsite disposal of ILAW are not applicable to Waste Management Alternative 1. Under Waste Management Alternatives 2 and 3, new facilities or expansions of existing facilities would be required, and there would be limited shipments of LLW and MLLW from other DOE sites to Hanford.

Under all three Waste Management alternatives, the accident that would have the highest consequences if it were to occur is the aircraft crash with ensuing fire at the Hanford SWOC. The frequency of this accident is estimated to be 0.00003 per year (once in 33,000 years). The consequences of a large fire (from other origins) involving waste containers stored outside at the SWOC would be only about 30 percent lower than for the aircraft crash accident; however, the estimated frequency of that fire is significantly greater than for the aircraft crash (0.01 compared with 0.00003 per year). As a result, the annual LCF risk to individuals and the population from the large waste-container fire would be greater than for the fire initiated by an aircraft crash. Accordingly, the accident scenario titled "large fire of waste containers outside facility (SWOC FIR-4)" is used as the basis for this summary comparison of alternatives (see Appendix K, Section K.3).

The accident risks shown in Table 2–11 take into account an accident's frequency. The annual risk value reflects the annual frequency of the accident. The risk over the life of the project reflects the duration of the activity that produces the accident potential, ranging from 29 to 159 years, during which that accident could occur. Under the Waste Management action alternatives, the risk over the life of the project from the large fire scenario would be highest under Alternatives 2 and 3, Disposal Group 3, which have the longest duration, and lowest under Alternatives 2 and 3, Disposal Group 1.

In accordance with DOE orders, DOE protects against intentional destructive acts aimed at its facilities and materials. Regardless of those protections, this EIS evaluates the potential impacts of intentional destructive acts in addition to conventional facility accident scenarios. The intentional crashing of a large aircraft into a SWOC storage building was assumed to damage all of the containers in the building. The radiological impacts would be about 18 times greater than those calculated for the aircraft crash accident scenario. This scenario applies to all Waste Management alternatives. More-detailed discussion of intentional destructive act impacts associated with Waste Management alternatives is provided in Chapter 4, Section 4.3.11.4.

2.8.3.12 Public and Occupational Health and Safety—Transportation

The various wastes generated at Hanford from tank closure and FFTF decommissioning activities, along with the waste transported from offsite DOE sources, are managed and disposed of in an IDF. Offsite waste would be accepted at Hanford only under Waste Management Alternatives 2 and 3. The onsite LLW and MLLW, excluding waste from tank closure and FFTF decommissioning activities, would be common to all alternatives. Transport and disposition of all other waste considered under the Waste Management alternatives were already evaluated under the Tank Closure and FFTF Decommissioning alternatives. Table 2–11 summarizes the transportation risks to the workers (transport drivers) and the public in terms of traffic fatalities and LCFs. Based on the results presented in this table, the following conclusions have been reached:

- It is unlikely that transportation of radioactive waste would cause an additional fatality as a result of radiation from either incident-free operations or postulated transportation accidents. It should be noted that the maximum annual dose to a transportation worker would be 100 millirem per year, unless the individual is a trained radiation worker, which would administratively limit the annual dose to 2 rem (DOE Standard 1098-2008). Exposure to a maximum annual dose of 2 rem per year would lead to an LCF risk of 1.2×10^{-3}. Assuming that an individual is exposed for 20 years to the same annual exposure, the cumulative LCF risk would be 2×10^{-2}.
- The highest radiological risk to the public would occur under Waste Management Alternative 2 or 3, where about 14,200 shipments of waste would be transported to Hanford from various DOE facilities.
- The lowest radiological risk to the public would occur under Waste Management Alternative 1, where no waste from other DOE facilities would be shipped to Hanford.

2.8.3.13 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs Federal agencies to identify and address, as appropriate, disproportionately high and adverse human health and environmental effects of their programs, policies, and activities on minority and low-income populations. Potential risks to human health from normal facility operations and postulated facility accidents are not expected to pose disproportionately high and adverse effects on minority or low-income populations surrounding Hanford under any Waste Management alternative.

2.8.3.14 Waste Management

Waste Management alternatives and disposal groups developed to manage the various waste volumes would generate several types of waste associated with the construction, operations, deactivation, and closure of expanded waste treatment and storage facilities and new waste disposal, including LLW, MLLW, and hazardous waste. Common to Waste Management Alternatives 2 and 3 is that Hanford waste treatment and storage activities would be expanded at the CWC, T Plant, and WRAP to provide greater capacity and throughput. Also common to all three Waste Management alternatives is the continued operation of trenches 31 and 34 for disposal of LLW/MLLW until filled. The generation of waste could have little or minimal impact on existing Hanford facilities devoted to TSD. As described in Chapter 4, the current waste management capacity is either sufficient or the new infrastructure would be constructed as part of the alternative. Projected waste generation rates for the proposed activities were compared with Hanford's capacity to manage the waste, including the additional waste disposal capacity that is proposed to be constructed. Projected waste generation rates for the proposed activities were compared with site processing rates and capacities of those TSD facilities likely to be involved in managing the additional waste. Potential impacts of waste generated as a result of site environmental restoration activities unrelated to Tank Closure, FFTF Decommissioning, or Waste Management proposed actions and alternatives are not within the scope of this analysis, but are included in the cumulative impacts analysis. Where additional disposal capacity would be needed, the land use impacts are addressed in the appropriate sections of Chapter 4. The projected full inventories of waste forms disposed of on site are included in the analyses of long-term impacts presented in Chapter 5 of this *TC & WM EIS*.

LLW. LLW would be generated during routine operations at the two MLLW trenches (trenches 31 and 34) in LLBG 218-W-5 and during operations of WRAP and the T Plant. LLW is typically not treated or only minimally treated (e.g., compaction) before disposal. Therefore, this waste treatment would cause no impacts on the Hanford waste management system. The LLW would be sent directly to disposal. Therefore, long-term storage facilities would not be required. All LLW would be disposed of in an IDF.

MLLW. MLLW would be generated during routine operations at WRAP and the T Plant. Using a combination of on- and offsite capabilities, MLLW would be treated to meet RCRA land-disposal-restriction treatment standards prior to disposal. All MLLW would be disposed of in an IDF.

Hazardous waste. Hazardous waste is dangerous waste as defined in the *Washington Administrative Code* (WAC 173-303). Hazardous waste generated during operations at the two MLLW trenches (trenches 31 and 34) in LLBG 218-W-5 and from postclosure care of the IDF(s) would be packaged in DOT-approved containers and shipped off site to permitted commercial recycling, treatment, and disposal facilities. Management of the additional waste generated under the Waste Management alternatives would require little, if any, additional planning. The waste would be treated and disposed of at offsite commercial facilities.

2.8.3.15 Industrial Safety

In addition to facility accident risks, estimates of potential industrial safety impacts on workers during construction, operations, deactivation, and closure activities under each Waste Management alternative were evaluated based on the DOE CAIRS complex-wide database (see Appendix K, Section K.4). These impacts correlate with the number of labor hours required to support each Waste Management alternative and are classified into two groups: TRCs and fatalities. Recordable cases include work-related deaths, as well as work-related illnesses or injuries leading to loss of consciousness, lost workdays, or transfer to another job, and/or requiring medical treatment beyond first aid.

Table 2–11 summarizes the potential number of TRCs and fatalities resulting from the construction, operations, deactivation, and closure activities that would be conducted under each Waste Management alternative. There would be no worker fatalities under any of the Waste Management alternatives. The fewest projected industrial safety impacts would occur under Waste Management Alternative 1; the No Action Alternative would require 1 million labor hours and would generate only 10 TRCs. Under the action alternatives for waste management, the fewest projected impacts would occur under Alternative 3, Disposal Group 1, which is expected to result in approximately 214 TRCs. The highest projected impacts would occur under Alternative 3, Disposal Group 3, which could result in 2,050 TRCs.

Table 2–11. Waste Management Alternatives – Summary of Short-Term Environmental Impacts[a]

Parameter/ Resource	Waste Management Alternatives and Disposal Groups							
	Alternative 1: No Action	**Alternatives 2 and 3: Treatment and Storage**	**Alternative 2: Disposal Group 1**	**Alternative 2: Disposal Group 2**	**Alternative 2: Disposal Group 3**	**Alternative 3: Disposal Group 1**	**Alternative 3 : Disposal Group 2**	**Alternative 3: Disposal Group 3**
Land Resources								
Land use (total land commitment)	No change in land use within the 200 Areas or Borrow Area C.	2.7 hectares affected within the 200-West Area.	63.9 hectares affected within and adjacent to the 200-East Area. 41.7 hectares affected within Borrow Area C.	247 hectares affected within and adjacent to the 200-East Area. 159 hectares affected within Borrow Area C.		76.9 hectares affected within and adjacent to the 200 Areas. 36.8 hectares affected within Borrow Area C.	253 hectares affected within and adjacent to the 200 Areas. 157 hectares affected within Borrow Area C.	
Visual resources	No change in the visual character of the 200 Areas.	No meaningful change in the visual character of the 200-West Area.	Noticeable change in the visual character of the 200 Areas and Borrow Area C, especially from nearby higher elevations, or, in the case of Borrow Area C, State Route 240.					
Infrastructure								
Total Requirements								
Electricity (million megawatt-hours)	0.0056	0.55	0.0085					
Diesel fuel (million liters)	13.9	42.0	215	1,420	2,180	215	1,410	2,170
Gasoline (million liters)	1.23	8.48	13.2	74.6	100	13.2	74.6	100
Water (million liters)	35.7	430	2,620	20,800	36,800	2,610	20,700	36,500
Peak Annual Demand								
Electricity (million megawatt-hours)	0.00019	0.018	0.00019					
Diesel fuel (million liters)	3.46	2.60	39.0	151		38.9	149	
Gasoline (million liters)	0.012	1.01	3.68	14.2		3.66	14.1	
Water (million liters)	25.5	23.9	67.0	259		66.7	256	
Noise and Vibration								
	Negligible offsite impact of onsite activities. Minor traffic noise impacts.							

Table 2–11. Waste Management Alternatives – Summary of Short-Term Environmental Impacts[a] *(continued)*

Parameter/ Resource	Waste Management Alternatives and Disposal Groups							
	Alternative 1: No Action	**Alternatives 2 and 3: Treatment and Storage**	**Alternative 2: Disposal Group 1**	**Alternative 2: Disposal Group 2**	**Alternative 2: Disposal Group 3**	**Alternative 3: Disposal Group 1**	**Alternative 3: Disposal Group 2**	**Alternative 3: Disposal Group 3**
Air Quality								
Peak Year Incremental Criteria Pollutant Concentrations as Compared with Most Stringent Guideline or Standard (micrograms per cubic meter)[b]								
Carbon monoxide (1-hour) standard=40,000	462	12,200	**49,800**	**257,000**		**50,300**	**256,000**	
Nitrogen oxides (1-hour) standard=188	**2,020**	**6,940**	**34,600**	**179,000**		**35,000**	**178,000**	
PM$_{10}$ (24-hour) standard=150	**507**	**717**	**3,360**	**17,200**		**3,420**	**17,300**	
PM$_{2.5}$ (24-hour) standard=35	**507**	**717**	**3,360**	**17,200**		**3,420**	**17,300**	
Sulfur oxides (1-hour) standard=197	0.723	16.5	68.4	**353**		69.2	**352**	
Peak Year Incremental Toxic Chemical Concentrations (micrograms per cubic meter)[b]								
Ammonia (24-hour) ASIL=70.8	0.216	0.874	3.84	20.0		3.91	19.9	
Benzene (annual) ASIL=0.345	0.000288	0.00128	0.00701	0.0323		0.00704	0.0321	
Toluene (24-hour) ASIL=5,000	0.0265	1.84	6.00	31.2		6.1	31.1	
Xylene (24-hour) ASIL=NL	0.00999	0.526	1.78	9.27		1.81	9.23	
Geology and Soils								
Construction impacts	Little additional impact on geology and soils.	Limited impact on geology and soils from construction of new/expanded facilities in previously disturbed areas. Excavation depths up to 3 meters.	Small-to-moderate impact of construction, including potential for short-term soil erosion. Excavation depths to 14 meters.	Impacts similar in nature to, but greater than, those under Alternative 2, Disposal Group 1. Excavation depths to 14 meters.	The impacts would be identical to those under Alternative 2, Disposal Group 2.	Similar to those under Alternative 2, Disposal Group 1, but impacts more dispersed across the 200 Areas.	Similar to those under Alternative 2, Disposal Group 2, but impacts more dispersed across the 200 Areas.	Similar to those under Alternative 2, Disposal Group 3, but impacts more dispersed across the 200 Areas.

Table 2–11. Waste Management Alternatives – Summary of Short-Term Environmental Impacts[a] *(continued)*

Parameter/ Resource	Waste Management Alternatives and Disposal Groups							
	Alternative 1: No Action	**Alternatives 2 and 3: Treatment and Storage**	**Alternative 2: Disposal Group 1**	**Alternative 2: Disposal Group 2**	**Alternative 2: Disposal Group 3**	**Alternative 3: Disposal Group 1**	**Alternative 3: Disposal Group 2**	**Alternative 3: Disposal Group 3**
Geology and Soils *(continued)*								
New permanent land disturbance (hectares)	0.0	2.7	108	409		117	413	
Geologic resource requirements (cubic meters)	6,230	10,600	1,980,000	7,610,000		1,760,000	7,550,000	
Water Resources								
Surface water	No additional impacts on surface water in the short term.	Negligible potential impact on surface water from stormwater runoff.	Short-term increase in stormwater runoff during construction, but little-to-no impact on surface-water features. Water use would not exceed site capacity.	Similar to those under Alternative 2, Disposal Group 1, with greater potential for stormwater runoff during construction. Longer period of operations than under Alternative 2, Disposal Group 1. Water use would not exceed site capacity.	Potential construction impacts would be similar to those under Alternative 2, Disposal Group 2. Longer period of operations than under Alternative 2, Disposal Group 2. Water use would not exceed site capacity.	Similar to those under Alternative 2, Disposal Group 1.	Similar to those under Alternative 2, Disposal Group 2.	Similar to those under Alternative 2, Disposal Group 3.
Vadose zone and groundwater	No additional impact in the short term.	No direct discharge of effluents from facility operations to the vadose zone or groundwater.	No impact on groundwater flow from construction. No impact on groundwater in the short term from collection and treatment of leachate.	Similar to those under Alternative 2, Disposal Group 1.	The potential for impacts during operations would increase proportionally to the lifespan of the disposal facilities.	Similar to those under Alternative 2, Disposal Group 1.	Similar to those under Alternative 2, Disposal Group 2.	Similar to those under Alternative 2, Disposal Group 3.

Table 2–11. Waste Management Alternatives – Summary of Short-Term Environmental Impacts[a] *(continued)*

Parameter/ Resource	Waste Management Alternatives and Disposal Groups							
	Alternative 1: No Action	Alternatives 2 and 3: Treatment and Storage	Alternative 2: Disposal Group 1	Alternative 2: Disposal Group 2	Alternative 2: Disposal Group 3	Alternative 3: Disposal Group 1	Alternative 3: Disposal Group 2	Alternative 3: Disposal Group 3
Ecological Resources								
Terrestrial resources	No impact within the 200 Areas or Borrow Area C.	0.4 hectares of sagebrush habitat affected in the 200 Areas. No sagebrush habitat affected within Borrow Area C.	63.9 hectares of sagebrush habitat affected in the 200 Areas. No sagebrush habitat affected within Borrow Area C.	247 hectares of sagebrush habitat affected in the 200 Areas. No sagebrush habitat affected within Borrow Area C.		76.9 hectares of sagebrush habitat affected in the 200 Areas. No sagebrush habitat affected within Borrow Area C.	253 hectares of sagebrush habitat affected in the 200 Areas. No sagebrush habitat affected within Borrow Area C.	
Wetlands	No impact on wetlands within the 200 Areas or Borrow Area C.							
Aquatic resources	No impact on aquatic resources within the 200 Areas or Borrow Area C.							
Threatened and endangered species	No impact on federally or state-listed threatened, endangered, or special status species.	No impact on federally or state-listed threatened, endangered, or special status species within the 200 Areas.	No impact on federally or state-listed threatened or endangered species. Potential impact on 4 state-listed special status species within the 200 Areas. Potential impact on 4 state-listed special status species within Borrow Area C.	No impact on federally or state-listed threatened or endangered species. Somewhat greater potential to impact 4 state-listed special status species within the 200 Areas than under Disposal Group 1, as more sagebrush habitat would be disturbed. Potential impact on 4 state-listed special status species within Borrow Area C.		No impact on federally or state-listed threatened or endangered species. Potential impact on 5 state-listed special status species within the 200 Areas. Potential impact on 4 state-listed special status species within Borrow Area C.	No impact on federally or state-listed threatened or endangered species. Somewhat greater potential impact on 5 state-listed special status species within the 200 Areas than under Disposal Group 1, as more sagebrush habitat would be disturbed. Potential impact on 4 state-listed special status species within Borrow Area C.	

Table 2–11. Waste Management Alternatives – Summary of Short-Term Environmental Impacts[a] *(continued)*

Parameter/ Resource	Waste Management Alternatives and Disposal Groups							
	Alternative 1: No Action	**Alternatives 2 and 3: Treatment and Storage**	**Alternative 2: Disposal Group 1**	**Alternative 2: Disposal Group 2**	**Alternative 2: Disposal Group 3**	**Alternative 3: Disposal Group 1**	**Alternative 3: Disposal Group 2**	**Alternative 3: Disposal Group 3**
Cultural and Paleontological Resources								
Prehistoric resources	No impact on prehistoric resources.							
Historic resources	No impact on historic resources.							
American Indian interests	No impact on American Indian interests.	Impacts on viewshed from higher elevations, including Rattlesnake Mountain.	Expansion of IDF-East and construction of the RPPDF would affect 62.3 hectares. Excavation of Borrow Area C would involve 41.7 hectares. This would change the viewscape from Rattlesnake Mountain and higher elevations.	Expansion of IDF-East and construction of the RPPDF would affect 240 hectares. Excavation of Borrow Area C would involve 159 hectares. This would change the viewscape from Rattlesnake Mountain and higher elevations.		The impact would be similar to those under Alternative 2, Disposal Group 1.	The impact would be similar to those under Alternative 2, Disposal Groups 2 and 3.	
Paleontological resources	No impact on paleontological resources.							
Socioeconomics								
Peak annual workforce (FTEs)	109	449	1,180	4,540		1,170	4,500	
Peak daily commuter traffic (vehicles per day)	88	360	943	3,640		940	3,600	
Peak daily truck loads – off site	Less than 1	2	28	34		28	33	
Impact on the ROI	Little impact on socioeconomic ROI.	Potential for change in the socioeconomic ROI, including level-of-service impacts on local transportation. Impacts would be similar under both alternatives.						

Table 2–11. Waste Management Alternatives – Summary of Short-Term Environmental Impacts[a] *(continued)*

Parameter/ Resource	Alternative 1: No Action	Alternatives 2 and 3: Treatment and Storage	Alternative 2: Disposal Group 1	Alternative 2: Disposal Group 2	Alternative 2: Disposal Group 3	Alternative 3: Disposal Group 1	Alternative 3: Disposal Group 2	Alternative 3: Disposal Group 3
Public and Occupational Health and Safety – Normal Operations[c]								
Offsite Population Impact – Life of the Project								
Dose (person-rem)	(d)	0.000077	(e)					
LCF[f]	(d)	0 (5×10^{-8})	(e)					
Peak Year Maximally Exposed Individual Impact								
Dose (millirem per year)	(d)	0.00000015	(e)					
Increased risk of an LCF	(d)	9×10^{-14}	(e)					
Peak Year Onsite Maximally Exposed Individual Impact								
Dose (millirem per year)	(d)	0.00000064	(e)					
Increased risk of an LCF	(d)	4×10^{-13}	(e)					
Radiation Worker Population Impact – Life of the Project								
Dose (person-rem)	37	3,000	360	3,600	6,400	360	3,500	6,400
LCF[f]	0 (2×10^{-2})	2	0 (2×10^{-1})	2	4	0 (2×10^{-1})	2	4
Average Annual Impact per Radiation Worker								
Dose (millirem per year)	200		200					
Increased risk of an LCF	1×10^{-4}		1×10^{-4}					
Peak Year Noninvolved Worker Impact								
Dose (millirem per year)	(d)	0.00039	(e)					
Increased risk of an LCF	(d)	2×10^{-10}	(e)					
Public and Occupational Health and Safety – Facility Accidents								
Offsite Population Consequences								
Dose (person-rem)	1,500	(g)	1,500					
Number of LCFs	1		1					
Maximally Exposed Offsite Individual Consequences								
Dose (rem)	0.25	(g)	0.25					
Increased risk of an LCF	1×10^{-4}		1×10^{-4}					
Noninvolved Worker Consequences								
Dose (rem)	260	(g)	260					
Increased risk of an LCF	3×10^{-1}		3×10^{-1}					

Table 2–11. Waste Management Alternatives – Summary of Short-Term Environmental Impacts[a] *(continued)*

Parameter/ Resource	Waste Management Alternatives and Disposal Groups							
	Alternative 1: No Action	Alternatives 2 and 3: Treatment and Storage	Alternative 2: Disposal Group 1	Alternative 2: Disposal Group 2	Alternative 2: Disposal Group 3	Alternative 3: Disposal Group 1	Alternative 3: Disposal Group 2	Alternative 3: Disposal Group 3
Public and Occupational Health and Safety – Facility Accidents *(continued)*								
Offsite Population Risk								
Annual number of LCFs[f]	0 (9×10^{-3})	(g)	0 (9×10^{-3})					
Number of LCFs over the life of the project[f]	0 (3×10^{-1})		0 (4×10^{-1})	1	1	0 (4×10^{-1})	1	1
Maximally Exposed Offsite Individual Risk								
Annual increased risk of an LCF	1×10^{-6}	(g)	2×10^{-6}					
Increased risk of an LCF over the life of the project	4×10^{-5}		6×10^{-5}	1×10^{-4}	2×10^{-4}	6×10^{-5}	1×10^{-4}	2×10^{-4}
Noninvolved Worker Risk								
Annual increased risk of an LCF	3×10^{-3}	(g)	3×10^{-3}					
Increased risk of an LCF over the life of the project	9×10^{-2}		1×10^{-1}	3×10^{-1}	5×10^{-1}	1×10^{-1}	3×10^{-1}	5×10^{-1}
Public and Occupational Health and Safety – Transportation								
Traffic accidents[h] (nonradiological fatalities)	0 (0.0064)	2 (1.75)	0 (0.11)	0 (0.38)	0 (0.49)	0 (0.10)	0 (0.38)	0 (0.49)
Offsite Population								
Dose (person-rem)	0.08	350	(i)					
LCFs	5×10^{-5}	2.1×10^{-1}	(i)					
Worker								
Dose (person-rem)	2.6	2,500	(i)					
LCFs	2×10^{-3}	1.5	(i)					
Environmental Justice								
Human health impacts	No disproportionately high and adverse human health impacts on minority or low-income populations due to normal facility operations or postulated facility accidents.							

Table 2–11. Waste Management Alternatives – Summary of Short-Term Environmental Impacts[a] *(continued)*

Parameter/ Resource	Waste Management Alternatives and Disposal Groups							
	Alternative 1: No Action	Alternatives 2 and 3: Treatment and Storage	Alternative 2: Disposal Group 1	Alternative 2: Disposal Group 2	Alternative 2: Disposal Group 3	Alternative 3: Disposal Group 1	Alternative 3: Disposal Group 2	Alternative 3: Disposal Group 3
Waste Management (all values are in cubic meters unless otherwise noted; values rounded to no more than three significant digits)								
LLW	38	1,460	58					
MLLW	N/A	98	N/A					
Hazardous	38	N/A	147	401	401	147	402	402
Industrial Safety								
Worker Population Impact – Total Project								
Total recordable cases (fatalities)	10 (0)	379 (0.05)	199 (0.03)	1,280 (0.17)	2,040 (0.27)	214 (0.03)	1,290 (0.17)	2,050 (0.27)

[a] Total impacts associated with each action alternative would be equal to the sum of the (1) treatment and storage and (2) disposal group values.
[b] Concentrations exceeding applicable standards, discussed in the air quality sections of Chapter 4 of this *TC & WM EIS*, are presented in **bold** text. The Federal standard for $PM_{2.5}$ is 35 micrograms per cubic meter (24-hour average). No specific data for $PM_{2.5}$ were available, but for analysis purposes, concentrations were assumed to be the same as for PM_{10}. Radiological air quality impacts are included separately under the public and occupational health and safety sections.
[c] Disposal group radiological impacts of normal operations are additive to the treatment and storage impacts under Alternatives 2 and 3.
[d] Impacts of the Waste Management No Action Alternative are from existing, permitted facilities and are included in current annual dose estimates.
[e] Regardless of disposal group, emissions from burial ground operations would have a negligible impact on distant receptors.
[f] The number of LCFs in a population is presented as a whole number; where the value is less than 0, the calculated value (dose × 0.0006 LCFs per person-rem) is presented in parentheses.
[g] Treatment and storage accident consequences and risks are encompassed in the values presented for disposal.
[h] Nearest whole integer (calculated value in parentheses).
[i] The impacts of transporting the materials under these disposal groups have already been considered under the Tank Closure and FFTF Decommissioning alternatives.

Note: To convert cubic meters to cubic yards, multiply by 1.308; hectares to acres, by 2.471; liters to gallons, by 0.26417; meters to yards, by 1.0936.

Key: ASIL=acceptable source impact level; FFTF=Fast Flux Test Facility; FTE=full-time equivalent; IDF-East=200-East Area Integrated Disposal Facility; LCF=latent cancer fatality; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; N/A=not applicable; NL=not listed; PM_n=particulate matter with an aerodynamic diameter less than or equal to *n* micrometers; ROI=region of influence; RPPDF=River Protection Project Disposal Facility; *TC & WM EIS=Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*.

Source: Chapter 4 of this *TC & WM EIS*.

2.9 SUMMARY OF LONG-TERM ENVIRONMENTAL IMPACTS

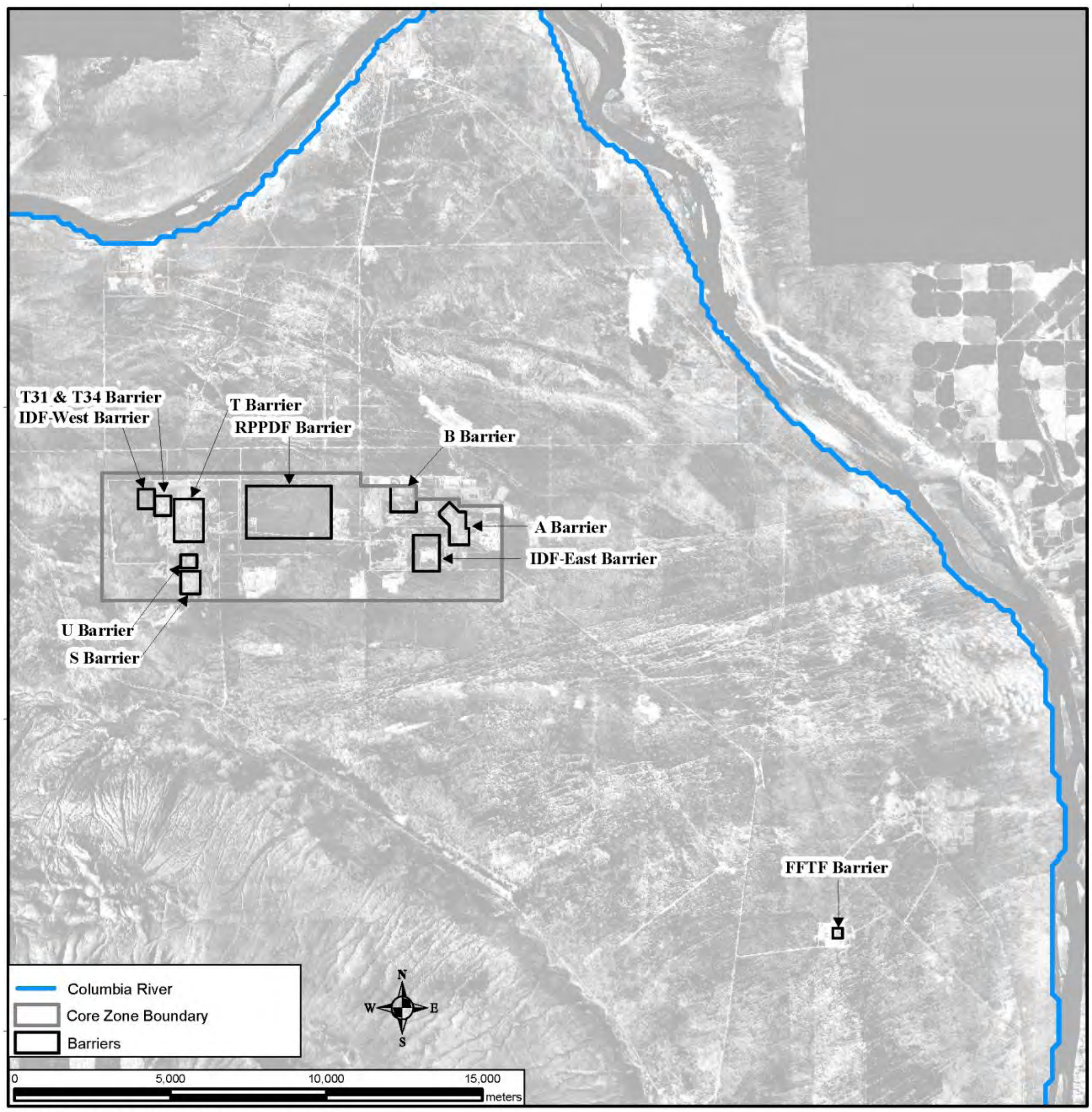
This section provides a summary-level comparison of the potential long-term environmental impacts on water quality, human health, ecological risk, and environmental justice associated with implementing each of the *TC & WM EIS* Tank Closure, FFTF Decommissioning, and Waste Management alternatives. Long-term impacts would occur following the active project phase defined for each alternative and the assumed end of the associated 100-year administrative control, institutional control, or postclosure care period, as appropriate. This comparison of impacts is presented to aid decisionmakers and the public in understanding the potential long-term environmental consequences of proceeding with each of the *TC & WM EIS* alternatives. Note that, for analysis purposes, three disposal groups were identified to support Hanford waste management needs. These groupings (Disposal Groups 1, 2, and 3) were developed to limit the number of analysis iterations; support reader understanding; and encompass the sizing and associated construction, operations, and closure requirements for IDF-East, IDF-West, and the proposed RPPDF that would be necessary to accommodate the various waste volumes considered under each disposal configuration. These disposal groups were further separated into subgroups (see Chapter 5, Section 5.3) reflecting the different types and volumes of waste generated by activities under the 10 Tank Closure action alternatives and 2 FFTF Decommissioning action alternatives to better analyze the long-term impacts associated with disposal of the various waste types and volumes.

Provision of a concise description of human health impacts is facilitated by selection of a single measure of impact and a single type of receptor. Radiological risk is selected as the measure of impact for the summary descriptions because it accounts for nearly the entirety of combined radiological and chemical risk and subsumes the contributions of multiple constituents to overall impacts. The drinking-water well user is selected as the receptor type for the summary descriptions because the drinking water exposure pathway generally contributes the majority of impacts for all receptor types. The impact through this exposure pathway is directly proportional to the concentration of constituents in groundwater; interpretation of results involves consideration of the least number of contributing processes and environmental pathway parameters. The information presented in the following discussion and tables is based on the detailed information presented in Chapter 5 and supporting appendices. Information on the primary radioactive constituent inventory associated with each *TC & WM EIS* alternative is provided in Appendix D.

2.9.1 Tank Closure Alternatives: Long-Term Environmental Impacts

2.9.1.1 Water Quality

This section discusses the long-term impacts on groundwater quality of tank closure sources (i.e., tank farm past leaks, unplanned releases, discharges to cribs and trenches [ditches] closely associated with the tank farms, tank farm residuals, retrieval losses, and ancillary equipment). Long-term impacts on groundwater quality from FFTF decommissioning and waste management sources are discussed in Sections 2.9.2.1 and 2.9.3.1, respectively. Three assessment boundaries were selected for the groundwater analysis based on a combination of regulatory, permit, and land-use requirements. For Tank Closure alternatives, the innermost (i.e., closest to the source) area of analysis comprises the engineered barriers that would be installed above the tank farms (see Figure 2–78). Very little groundwater transport would occur between the time the contaminants encounter the aquifer and the time they pass beneath the outer perimeter of the barriers; in general, the greatest water quality impacts would occur at these innermost assessment boundaries.



Note: To convert meters to feet, multiply by 3.281.
Key: FFTF=Fast Flux Test Facility; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; RPPDF=River Protection Project Disposal Facility; T31 & T34=trenches 31 and 34.

Figure 2–78. Core Zone and Barrier Boundaries

The second area of analysis is established by the location of the Core Zone Boundary. The Core Zone Boundary is approximated by a rectangle encompassing the entire area that would be directly affected by project facilities. The Core Zone Boundary represents the "fence line" of the projected tank closure operational facilities for each of the alternatives. Groundwater beneath the western portions of the northern and southern Core Zone Boundary would be impacted by contaminants released at the S, T, and U Barriers; because the western portion of the aquifer has relatively low groundwater flux (the rate of flow through the unit area), these impacts would be relatively high (although lower than at the barriers themselves). The eastern portion of the Core Zone Boundary is in an area of high groundwater flux, and peak groundwater impacts along the eastern part of the Core Zone Boundary would be correspondingly lower.

The third area of analysis is the Columbia River nearshore (shoreline closest to Hanford). It approximates the location where contaminants in the groundwater system discharge into the surface-water system. Water quality impacts at the Columbia River reflect the superimposition of releases from individual sources.

Groundwater impacts are described in terms of the concentrations of the COPC drivers at the assessment boundaries under the alternatives considered. The COPC drivers are iodine-129, technetium-99, chromium, nitrate, hydrogen-3 (tritium), uranium-238, and total uranium. They fall into three categories, characterized by mobility and decay rate: (1) Iodine-129, technetium-99, chromium, and nitrate are all mobile (i.e., move with groundwater) and long-lived (relative to the 10,000-year period of analysis), or stable. (2) Tritium is also mobile, but short-lived. The half-life of tritium is less than 13 years, and tritium concentrations are strongly attenuated by radioactive decay during travel through the vadose zone and groundwater systems. (3) Uranium-238 and total uranium are long-lived, or stable, but are not as mobile as the other COPC drivers. These constituents move about seven times more slowly than groundwater.

The other COPCs that were analyzed do not significantly contribute to risk or hazard during the period of analysis because of limited inventory, high retardation factors (i.e., retention in the vadose zone), short half-lives (i.e., rapid radioactive decay), or a combination of these factors.

Tables 2–12 through 2–16 present the maximum concentrations of the COPC drivers under each of the Tank Closure alternatives at the tank farm barriers (A and B Barriers in the 200-East Area and S, T, and U Barriers in the 200-West Area); Table 2–17, at the Core Zone Boundary; and Table 2–18, at the Columbia River nearshore. Note that maximum concentrations during the period calendar years (CYs) 2050 through 11,940 are reported in Tables 2–12 through 2–18 and compared to the benchmark concentration. Maximum concentrations during the period CYs 1940 through 2049 are omitted to facilitate comparison of the Tank Closure alternatives. Concentrations prior to CY 2049 reflect past-practice conditions rather than conditions applicable to the alternatives.

The importance of retrieval of tank farm residuals can be seen in the maximum concentrations (and year of peak impact) of iodine-129 at the Core Zone Boundary (see Table 2–17). There is a clear differentiation between Tank Closure Alternative 1 (with no retrieval) and all other Tank Closure alternatives (with retrieval). The peak concentration of iodine-129 at the Core Zone Boundary under Tank Closure Alternative 1 is an order of magnitude greater than under the other Tank Closure alternatives. The years of peak impact for Tank Closure Alternatives 2A through 6C occur between CY 2056 and CY 2092, which is an indication that these peaks are dominated by historical discharges to cribs and trenches (ditches) and past leaks. Retrieval of tank farm residuals lowers the peak impact by an order of magnitude and switches the dominant contributor to impacts from a future source (tank farm residuals) to historical sources (discharges to cribs and trenches [ditches] and past leaks).

Benchmark

"Benchmark" refers to a dose or concentration known or accepted to be associated with a specific level of effect. Thus, Federal drinking water standards (40 CFR Parts 141 and 143) are used as benchmarks against which potential contamination can be compared. Drinking water standards for Washington State are found in *Washington Administrative Code* 246-290. Benchmark standards used in this environmental impact statement represent dose or concentration levels that correspond to known or established human health effects. For groundwater, the benchmark is the maximum contaminant level (MCL) if an MCL is available. For constituents with no available MCL, additional sources for benchmark standards include Washington State guidance and relevant regulatory standards, e.g., Clean Water Act, Safe Drinking Water Act. For example, the benchmark for iodine-129 is 1 picocurie per liter; for technetium-99, it is 900 picocuries per liter. These benchmark standards for groundwater impacts analysis were agreed upon by both the U.S. Department of Energy and the Washington State Department of Ecology as the basis for comparing the alternatives and representing potential groundwater impacts.

Table 2–12. Tank Closure Alternatives – Maximum COPC Concentrations in the Peak Year at the A Barrier

Contaminant	Tank Closure Alternative									
	1	2A	2B, 3A, 3B, 3C, 6C	4	5	6A, Base Case	6A, Option Case	6B, Base Case	6B, Option Case	Benchmark Concentration
Radionuclide (picocuries per liter)										
Hydrogen-3 (tritium)	1,820 (2121)	7 (2058)	7 (2051)			7 (2050)	8 (2050)	7 (2050)	8 (2051)	20,000
Technetium-99	**41,700** (2121)	**964** (2095)	774 (2102)	790 (2100)	**1,110** (4155)	**963** (2103)		875 (2093)		900
Iodine-129	**38.5** (2123)	**1.8** (2105)	**1.5** (2104)	**1.4** (2102)	**1.4** (2107)	**1.9** (2100)		**1.6** (2095)		1
Uranium isotopes (includes uranium-233, -234, -235, -238)	5.1 (11,810)	0.6 (11,860)	0.3 (11,865)	0.2 (11,865)	0.4 (11,832)	0.1 (11,874)	0 N/A	0.1 (11,874)	0 N/A	15
Chemical (micrograms per liter)										
Chromium	**323** (3710)	**108** (2170)	81 (2168)	71 (2168)	79 (2168)	83 (2168)	80 (2164)	77 (2097)	75 (2097)	100
Nitrate	**46,900** (2136)	22,100 (2170)	17,900 (2172)	17,600 (2172)	17,800 (2172)	16,800 (2172)	17,400 (2164)	16,600 (2172)	12,300 (2247)	45,000
Total uranium	6.7 (11,823)	0.7 (11,849)	0.4 (11,826)	0.2 (11,826)	0.5 (11,854)	0 N/A				30

Note: Calendar year of peak concentration shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; N/A=not applicable.

Table 2–13. Tank Closure Alternatives – Maximum COPC Concentrations in the Peak Year at the B Barrier

Contaminant	Tank Closure Alternative									
	1	2A	2B, 3A, 3B, 3C, 6C	4	5	6A, Base Case	6A, Option Case	6B, Base Case	6B, Option Case	Benchmark Concentration
Radionuclide (picocuries per liter)										
Hydrogen-3 (tritium)	349 (2064)	481 (2064)	579 (2052)	578 (2052)	579 (2052)	572 (2052)	455 (2057)	572 (2052)	573 (2051)	20,000
Technetium-99	**26,500** (3957)	**4,000** (2068)	**3,570** (2056)	**3,500** (2056)	**3,880** (3616)	**3,480** (2056)	**3,650** (2066)	**3,480** (2056)	**3,760** (2065)	900
Iodine-129	**58.8** (3577)	**5.8** (2069)	**4.5** (2056)	**4.3** (2056)	**4.4** (2056)	**4.8** (2092)		**4.6** (2092)	**5.0** (2064)	1
Uranium isotopes (includes uranium-233, -234, -235, -238)	**32.1** (11,777)	5.1 (11,789)	3.2 (11,913)	2.6 (11,913)	3.4 (11,938)	0.2 (11,835)	0 N/A	0.2 (11,835)	0 N/A	15
Chemical (micrograms per liter)										
Chromium	**864** (3882)	**228** (2158)	**215** (2050)			**214** (2050)	**208** (2050)	**215** (2050)	**196** (2087)	100
Nitrate	**187,000** (2066)	**192,000** (2068)	**171,000** (2055)				**188,000** (2051)	**171,000** (2055)	**200,000** (2077)	45,000
Total uranium	**41.3** (11,778)	7.4 (11,797)	4.4 (11,827)	3.7 (11,827)	4.6 (11,793)	0.2 (11,754)	0 N/A	0.2 (11,754)	0 N/A	30

Note: Calendar year of peak concentration shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; N/A=not applicable.

Table 2–14. Tank Closure Alternatives – Maximum COPC Concentrations in the Peak Year at the S Barrier

Contaminant	Tank Closure Alternative									
	1	2A	2B, 3A, 3B, 3C, 6C	4	5	6A, Base Case	6A, Option Case	6B, Base Case	6B, Option Case	Benchmark Concentration
Radionuclide (picocuries per liter)										
Hydrogen-3 (tritium)	1,290 (2128)	32 (2050)	32 (2050)	4 (2050)	32 (2050)	31 (2050)		30 (2050)		20,000
Technetium-99	**22,800** (3072)	**1,540** (2051)	**1,510** (2051)	196 (2050)	**3,440** (4314)	**1,480** (2052)		**1,490** (2050)		900
Iodine-129	**29.1** (3136)	**2.8** (2050)		0.4 (2050)	**2.8** (2050)	**2.9** (2050)		**2.9** (2051)		1
Uranium isotopes (includes uranium-233, -234, -235, -238)	4.1 (11,819)	0.3 (11,788)	0.2 (11,928)	0 N/A	0.3 (11,918)	0 N/A				15
Chemical (micrograms per liter)										
Chromium	**541** (3242)	**157** (2050)	**156** (2050)	27 (2059)	**158** (2050)	**156** (2050)		**158** (2051)		100
Nitrate	37,900 (3435)	5,160 (2081)	4,780 (2051)	965 (2070)	10,100 (4088)	4,630 (2051)		4,590 (2051)		45,000
Total uranium	4.6 (11,827)	0.4 (11,706)	0.3 (11,850)	0 N/A	0.3 (11,829)	0 N/A				30

Note: Calendar year of peak concentration shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.
Key: COPC=constituent of potential concern; N/A=not applicable.

Table 2–15. Tank Closure Alternatives – Maximum COPC Concentrations in the Peak Year at the T Barrier

Contaminant	Tank Closure Alternative									
	1	**2A**	**2B, 3A, 3B, 3C, 6C**	**4**	**5**	**6A, Base Case**	**6A, Option Case**	**6B, Base Case**	**6B, Option Case**	**Benchmark Concentration**
Radionuclide (picocuries per liter)										
Hydrogen-3 (tritium)	2,640 (2051)	2,560 (2053)	2,870 (2050)				2,390 (2043)	2,870 (2050)	2,450 (2054)	20,000
Technetium-99	**6,480** (2050)		**6,600** (2051)		**6,630** (2050)	**6,530** (2050)		**6,450** (2051)		900
Iodine-129	**26.1** (4560)	**12.7** (2051)	**12.6** (2050)		**12.8** (2050)	**12.6** (2050)		**12.7** (2050)		1
Uranium isotopes (includes uranium-233, -234, -235, -238)	7.5 (11,799)	3.0 (11,827)	2.0 (11,909)		2.0 (11,895)	1.2 (11,770)	0 N/A	1.2 (11,770)	0 N/A	15
Chemical (micrograms per liter)										
Chromium	**336** (2036)	**341** (2051)	**353** (2045)		**354** (2051)	**354** (2045)	**339** (2050)	**353** (2051)	**337** (2050)	100
Nitrate	**62,000** (2056)	**64,500** (2098)	**62,100** (2053)		**62,000** (2053)		**63,000** (2050)	**61,900** (2053)	**64,000** (2051)	45,000
Total uranium	9.1 (11,840)	1.2 (11,724)	0.7 (11,843)		0.8 (11,810)	0.3 (11,810)	0 N/A	0.3 (11,810)	0 N/A	30

Note: Calendar year of peak concentration shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; N/A=not applicable.

Table 2–16. Tank Closure Alternatives – Maximum COPC Concentrations in the Peak Year at the U Barrier

Contaminant	Tank Closure Alternative									
	1	**2A**	**2B, 3A, 3B, 3C, 6C**	**4**	**5**	**6A, Base Case**	**6A, Option Case**	**6B, Base Case**	**6B, Option Case**	**Benchmark Concentration**
Radionuclide (picocuries per liter)										
Hydrogen-3 (tritium)	14 (2050)	15 (2050)				14 (2050)				20,000
Technetium-99	**9,830** (3985)	508 (2100)	259 (3296)	147 (2058)	**1,420** (3949)	138 (2067)		137 (2067)		900
Iodine-129	**19.6** (4118)	0.9 (2092)	0.3 (3593)	0.2 (2072)	0.5 (4371)	0.2 (2071)		0.2 (2073)		1
Uranium isotopes (includes uranium-233, -234, -235, -238)	5.9 (11,817)	0.2 (11,839)	0.1 (11,910)	0.1 (11,923)	0.3 (11,904)	0 N/A				15
Chemical (micrograms per liter)										
Chromium	**208** (4027)	15 (2092)	6 (2050)		30 (3565)	6 (2050)				100
Nitrate	22,500 (3957)	5,690 (2099)	909 (2071)		3,440 (3568)	413 (2050)		407 (2051)		45,000
Total uranium	7.6 (11,816)	0.3 (11,796)	0.2 (11,830)	0.1 (11,814)	0.4 (11,828)	0 N/A				30

Note: Calendar year of peak concentration shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.
Key: COPC=constituent of potential concern; N/A=not applicable.

Table 2–17. Tank Closure Alternatives – Maximum COPC Concentrations in the Peak Year at the Core Zone Boundary

Contaminant	Tank Closure Alternative									
	1	2A	2B, 3A, 3B, 3C, 6C	4	5	6A, Base Case	6A, Option Case	6B, Base Case	6B, Option Case	Benchmark Concentration
Radionuclide (picocuries per liter)										
Hydrogen-3 (tritium)	639 (2123)	561 (2053)	628 (2051)				660 (2050)	627 (2051)	661 (2050)	20,000
Technetium-99	**26,500** (3957)	**4,000** (2068)	**3,570** (2056)	**3,500** (2056)	**3,880** (3616)	**3,480** (2056)	**3,650** (2066)	**3,480** (2056)	**3,760** (2065)	900
Iodine-129	**58.8** (3577)	**5.8** (2069)	**4.5** (2056)	**4.3** (2056)	**4.4** (2056)	**4.8** (2092)		**4.6** (2092)	**5.0** (2064)	1
Uranium isotopes (includes uranium-233, -234, -235, -238)	**32.1** (11,777)	5.1 (11,789)	3.2 (11,913)	2.6 (11,913)	3.4 (11,938)	0.2 (11,835)	0 N/A	0.2 (11,835)	0 N/A	15
Chemical (micrograms per liter)										
Chromium	**864** (3882)	**228** (2158)	**215** (2050)			**214** (2050)	**208** (2050)	**215** (2050)	**196** (2087)	100
Nitrate	**187,000** (2066)	**192,000** (2068)	**171,000** (2055)				**188,000** (2051)	**171,000** (2055)	**200,000** (2077)	45,000
Total uranium	**41.3** (11,778)	7.4 (11,797)	4.4 (11,827)	3.7 (11,827)	4.6 (11,793)	0.2 (11,754)	0 N/A	0.2 (11,754)	0 N/A	30

Note: Calendar year of peak concentration shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; N/A=not applicable.

Table 2–18. Tank Closure Alternatives – Maximum COPC Concentrations in the Peak Year at the Columbia River Nearshore

Contaminant	Tank Closure Alternative									
	1	2A	2B, 3A, 3B, 3C, 6C	4	5	6A, Base Case	6A, Option Case	6B, Base Case	6B, Option Case	Benchmark Concentration
Radionuclide (picocuries per liter)										
Hydrogen-3 (tritium)	502 (2050)	494 (2050)	477 (2051)				501 (2050)	477 (2051)	490 (2050)	20,000
Technetium-99	**1,700** (2999)	418 (2317)	396 (2254)	392 (2254)	479 (4918)	382 (2251)	396 (2239)	358 (2221)	351 (2275)	900
Iodine-129	**6.8** (4840)	0.8 (2303)	0.7 (2240)	0.7 (2240)	0.8 (2334)	0.7 (2265)		0.7 (2217)		1
Uranium isotopes (includes uranium-233, -234, -235, -238)	0.6 (11,928)	0.3 (11,935)	0.1 (11,937)		0.1 (11,935)		0 N/A	0.1 (11,935)	0 N/A	15
Chemical (micrograms per liter)										
Chromium	84 (4498)	74 (2079)	71 (2076)				64 (2076)	71 (2076)	60 (2074)	100
Nitrate	16,200 (2111)	17,500 (2131)	17,200 (2122)				17,400 (2146)	17,200 (2122)	15,500 (2138)	45,000
Total uranium	0.6 (11,931)	0.2 (11,929)	0.1 (11,937)		0.1 (11,938)	0 N/A				30

Note: Calendar year of peak concentration shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; N/A=not applicable.

The location where the maximum concentrations would occur varies with time, contaminant, and alternative. The benchmark concentration for each contaminant is provided for comparison. The benchmark concentrations include EPA maximum contaminant levels (MCLs) (i.e., primary drinking water standards), EPA interim drinking water standards, DOE-derived concentration guides, and other standards known or accepted to be associated with a specific level of effect. Concentrations that would exceed the benchmark concentrations are indicated in bold text.

Under all Tank Closure alternatives, maximum tritium concentrations are predicted to be more than an order of magnitude beneath the benchmark concentration at the Core Zone Boundary and the Columbia River nearshore. As suggested by the early timing of the peak concentration (ca. 2050–2100), the tritium signature is dominated by past-practice activities and is relatively unaffected by retrieval and closure. Chromium and nitrate show a pattern similar to that of tritium (but at a slightly elevated level), suggesting that the signatures of these chemicals are also driven by past-practice activities. Maximum concentrations of technetium-99 and iodine-129 exceed benchmarks by more than an order of magnitude under Tank Closure Alternative 1 and by a factor of four to five under all other Tank Closure alternatives at the Core Zone Boundary. Except for Tank Closure Alternative 1, there are no post-2049 exceedances at the Columbia River nearshore. These results suggest that retrieval plays a large role in lowering peak concentrations of these radionuclides. Uranium-238 and total uranium maximum concentrations also appear to be reduced by a factor of six to seven when retrieval is included in the Tank Closure alternative.

The magnitude of the impacts can be represented in terms of the total amounts of the COPC drivers released to the vadose zone from all sources related to a particular alternative. Releases of radionuclides are totaled in curies over the 10,000-year period of analysis. The total amounts of iodine-129 and technetium-99 released to the vadose zone under the Tank Closure alternatives are presented in Figures 2–79 and 2–80, respectively. Under the Tank Closure alternatives, the magnitude of the impact is governed by waste inventory (which is the same for all Tank Closure alternatives), retrieval (which is zero percent under Tank Closure Alternative 1; 90 percent under Alternative 5; 99 percent under Alternatives 2A, 2B, 3A, 3B, 3C, and 6C; and 99.9 percent under Alternatives 4, 6A, and 6B), and removal of tanks and soil during closure (which is none under Tank Closure Alternatives 1, 2A, 2B, 3A, 3B, 3C, 5, and 6C; selective clean closure under Alternative 4; and clean closure under Alternatives 6A and 6B). Retrieval of waste from the tank farms is the dominant factor determining the differential magnitudes of impact among the Tank Closure alternatives, followed by removal of contaminated soil during closure activities.

The peak impact can be represented in terms of the peak concentrations of the COPC drivers at the Core Zone under each of the Tank Closure alternatives. The peak concentrations of iodine-129 and technetium-99 at the Core Zone Boundary presented in tabular form above (see Table 2–17) are depicted in Figures 2–81 and 2–82, respectively. For the Tank Closure alternatives, the peak impacts of technetium-99 and iodine-129 are dominated by tank farm residuals and most strongly influenced by retrieval.

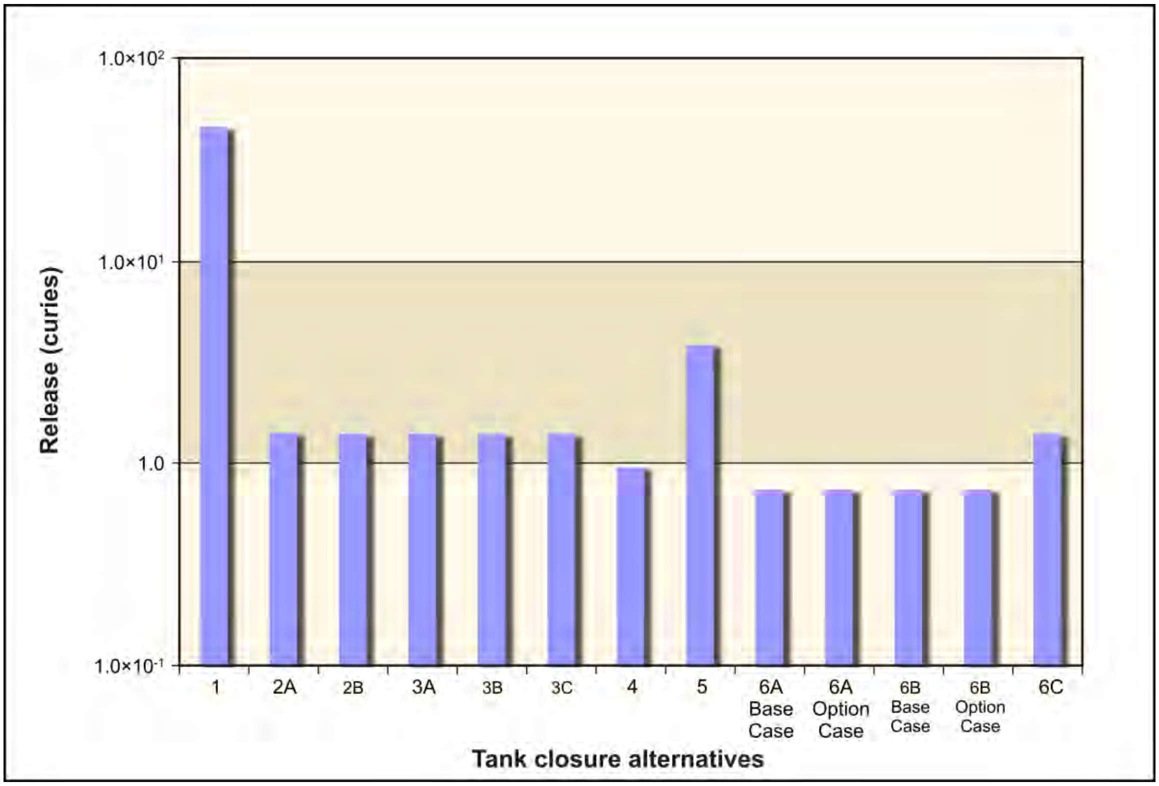


Figure 2–79. Tank Closure Alternatives – Total Iodine-129 Released to the Vadose Zone

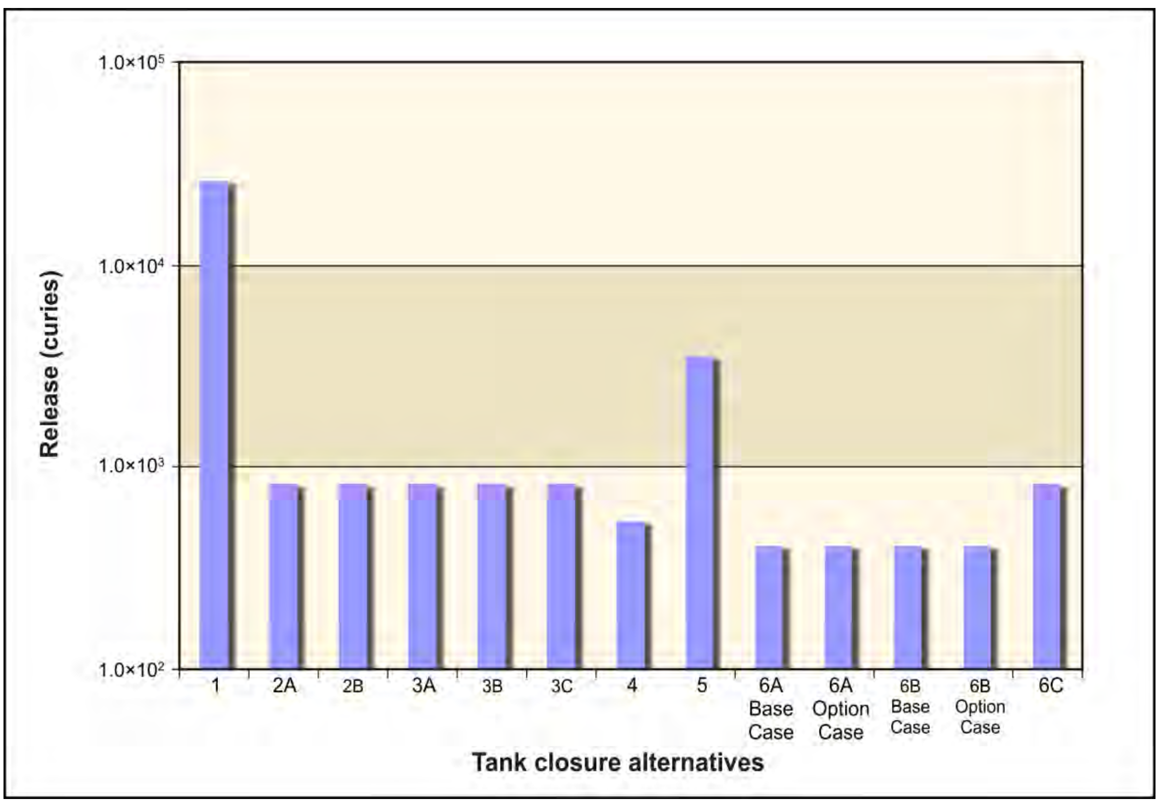


Figure 2–80. Tank Closure Alternatives – Total Technetium-99 Released to the Vadose Zone

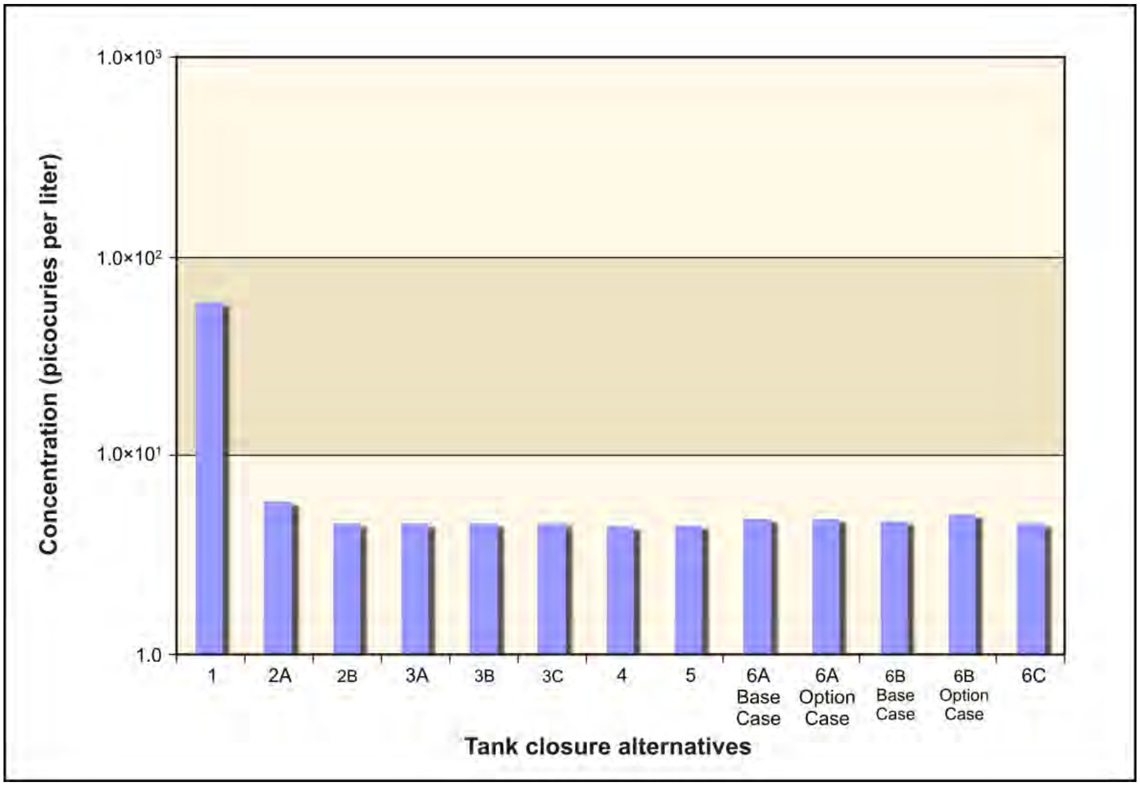


Figure 2–81. Tank Closure Alternatives – Peak Iodine-129 Concentrations at the Core Zone Boundary

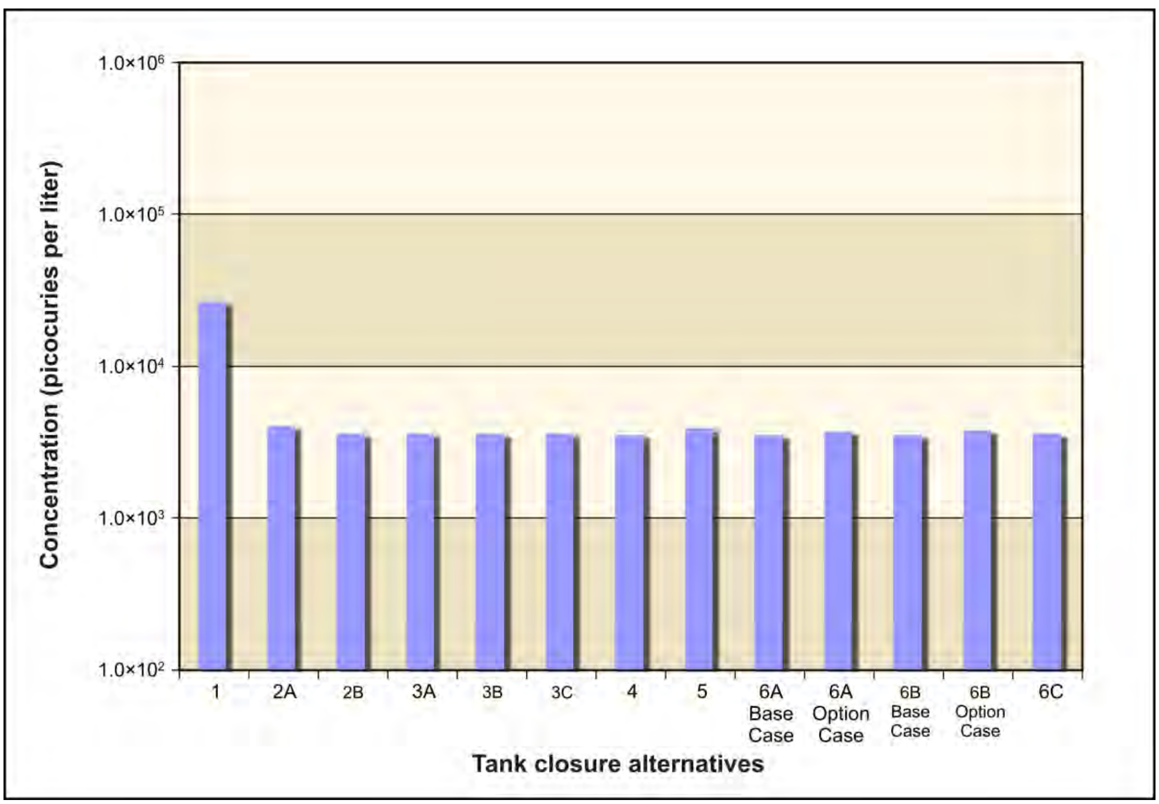


Figure 2–82. Tank Closure Alternatives – Peak Technetium-99 Concentrations at the Core Zone Boundary

2.9.1.2 Human Health

Implementation of activities defined for the Tank Closure alternatives could lead to releases of radioactive and chemical constituents to the environment over long periods of time. Under Tank Closure Alternatives 1 and 2A, these releases would not be controlled by engineered closure of the tanks, but under Tank Closure Alternative 2A, wastes generated by retrieval activities would be stabilized. Under the other Tank Closure alternatives, releases would be controlled by stabilization of the tanks and the wastes generated by retrieval and closure activities. Potential human health impacts due to releases of radioactive constituents are estimated as dose and as lifetime risk of incidence of cancer (i.e., radiological risk). Potential human health effects due to releases of chemical constituents include both carcinogenic effects and other forms of toxicity. Impacts of carcinogenic chemicals are estimated as lifetime risk of incidence of cancer. Noncarcinogenic effects are estimated as a (1) Hazard Quotient, the ratio of the long-term intake of a single chemical to intake that produces no observable effect, and (2) Hazard Index, the sum of the Hazard Quotients of a group of chemicals.

The four measures of human health impacts considered in this EIS analysis—lifetime risks of developing cancer from radioactive and chemical constituents, dose from radionuclides, and Hazard Index from noncarcinogenic chemical constituents—were calculated for each year for 10,000 years for each receptor (described below) at eight locations. The locations are the disposal facility barriers (A, B, S, T, and U), the Core Zone Boundary, Columbia River nearshore, and Columbia River surface water.

Consistent with DOE guidance (DOE Guide 435.1-1 Section IV.P.(2)), the potential consequences of loss of administrative or institutional control are considered by estimation of impacts on onsite receptors. Because DOE does not anticipate loss of control of the site, these onsite receptors are considered hypothetical and are applied to develop estimates for past and future periods of time.

Four types of receptors are considered. The first type, a drinking-water well user, uses groundwater as a source of drinking water. The second type, a resident farmer, uses either groundwater or surface water, but not both, for drinking water consumption and irrigation of crops. Garden size and crop yield are adequate to produce approximately 25 percent of average requirements of crops and animal products. The third type, an American Indian resident farmer, also uses either groundwater or surface water, but not both, for drinking water consumption and irrigation of crops. Garden size and crop yield are adequate to produce the entirety of average requirements of crops and animal products. The fourth type, an American Indian hunter-gatherer, is impacted by both groundwater and surface water because he uses surface water for drinking water consumption and consumes wild plant materials, which use groundwater, and game, which use surface water. A summary of the results for the drinking-water well user at the Core Zone Boundary is provided below. Further discussion of these receptors is provided in Appendix Q, Section Q.2.

This is a large amount of information that must be summarized to allow interpretation of results. The method chosen is to present dose for the year of maximum dose, risk for the year of maximum risk, and Hazard Index for the year of maximum Hazard Index. This choice is based on regulation of radiological impacts expressed as dose and the observation that peak risk and peak noncarcinogenic impacts expressed as a Hazard Index may occur at times other than that of peak dose. The significance of dose impacts is evaluated by comparison against the 100-millirem-per-year all-exposure-modes standard specified for protection of the public and the environment in DOE Order 458.1, *Radiation Protection of the Public and the Environment*. Population doses are compared against a total effective dose equivalent from natural background sources of 311 millirem per year for a member of the population of the United States (NCRP 2009). The significance of noncarcinogenic chemical impacts is evaluated by comparison against a guideline value of unity (1) for Hazard Index. Estimation of a Hazard Index less than unity indicates that observable effects would not occur. Impacts related to tank farm operations, tank waste retrieval, and tank closure would be due to three types of release. The first type is the past practice of directly discharging waste liquid to cribs and trenches (ditches). The second type is past leaks from damaged tanks. The third type results from other tank farm sources, such as leaks during tank waste retrieval and long-term leaching of waste material from tanks and ancillary equipment.

The results of the analysis for each Tank Closure alternative for the drinking-water well user at the Core Zone Boundary are summarized in the sections below. The estimates of impacts presented here are those that derive from Tank Closure alternative sources located at the tank farms. Contributions of Tank Closure alternative sources located at disposal facilities (IDF and RPPDF) to long-term impacts are discussed in Section 2.9.3 (Waste Management Alternatives: Long-Term Environmental Impacts). Impacts that depend upon, or would be affected by, Tank Closure alternative activities would be evident after CY 2050, the approximate time assumed for placement of engineered barriers. However, releases to the vadose zone associated with past practices such as planned discharges to cribs and trenches (ditches) and past leaks from tanks occurring after CY 1940 but before CY 2050 may continue to produce impacts into the future. Because estimates of the time of occurrence of impacts are uncertain and because perspective could be added by knowledge of past impacts, estimates of impacts are provided for time periods beginning in CYs 1940 and 2050. Estimates of peak impacts are provided for the offsite population and for the set of receptors and analysis locations for the time period subsequent to CY 2050. In addition, a time series of estimates of radiological risk for the drinking-water well user at the Core Zone Boundary is presented to provide a view of evolution of impacts over the entire analysis period. Tables 2–19 and 2–20 provide the estimated maximum dose and maximum Hazard Index for the drinking-water well user after CY 2050 by alternative. The estimated radiological impacts on these receptors and locations do not exceed the 100-millirem-per-year standard, but many of the estimated Hazard Indices do exceed the guideline value of unity.

The importance of retrieval of tank farm residuals can be seen in the peak radiation dose (and year of peak dose) to the drinking-water well user at the Core Zone Boundary (see Table 2–19). There is a clear differentiation between Tank Closure Alternative 1 (with no retrieval) and all other Tank Closure alternatives (with retrieval). The peak dose at the Core Zone Boundary under Tank Closure Alternative 1 is almost an order of magnitude greater than under the other Tank Closure alternatives. The years of peak dose for Tank Closure Alternatives 2A through 6C occur between CY 2056 and CY 2069, which is an indication that these peaks are dominated by historical discharges to cribs and trenches (ditches) and past leaks. Retrieval of tank farm residuals lowers the peak dose by an order of magnitude and switches the dominant contributor to dose from a future source (tank farm residuals) to historical sources (discharges to cribs and trenches [ditches] and past leaks).

Table 2–19. Tank Closure Alternatives – Summary of Radiation Dose at Year of Peak Dose for the Drinking-Water Well User

Location	Tank Closure Alternatives (millirem per year)								
	1	2A	2B, 3A, 3B, 3C, 6C	4	5	6A, Base Case	6A, Option Case	6B, Base Case	6B, Option Case
A Barrier	8.37×10^{1} (2121)	2.17 (2095)	1.74 (2102)	1.78 (2100)	2.00 (4155)	2.16 (2103)		1.99 (2093)	
B Barrier	5.88×10^{1} (4313)	8.64 (2069)	7.55 (2056)	7.38 (2056)	7.54 (2056)	7.34 (2056)	7.64 (2066)	7.32 (2056)	7.92 (2065)
S Barrier	4.73×10^{1} (3072)	3.50 (2051)	3.43 (2051)	4.54×10^{-1} (2050)	6.15 (4321)	3.36 (2052)		3.42 (2050)	
T Barrier	1.52×10^{1} (2051)	1.51×10^{1} (2050)	1.55×10^{1} (2050)		1.56×10^{1} (2050)	1.54×10^{1} (2050)	1.53×10^{1} (2050)	1.52×10^{1} (2050)	1.51×10^{1} (2051)
U Barrier	2.23×10^{1} (4002)	1.14 (2100)	5.20×10^{-1} (3296)	3.14×10^{-1} (2058)	2.58 (3949)	2.89×10^{-1} (2067)		2.86×10^{-1} (2067)	
Core Zone Boundary	5.88×10^{1} (4313)	8.64 (2069)	7.58 (2056)	7.41 (2056)	7.57 (2056)	7.37 (2056)	7.64 (2066)	7.35 (2056)	7.92 (2065)
Columbia River nearshore	4.37 (4978)	9.41×10^{-1} (2317)	8.85×10^{-1} (2242)	8.82×10^{-1} (2242)	8.94×10^{-1} (4809)	8.76×10^{-1} (2251)	8.99×10^{-1} (2251)	8.22×10^{-1} (2218)	8.07×10^{-1} (2218)

Note: Calendar year of peak impact shown in parentheses.

Table 2–20. Tank Closure Alternatives – Summary of the Hazard Index at Year of Peak Hazard Index for the Drinking-Water Well User

Location	Tank Closure Alternative								
	1	2A	2B, 3A, 3B, 3C, 6C	4	5	6A, Base Case	6A, Option Case	6B, Base Case	6B, Option Case
A Barrier	3.64 (3710)	1.43 (2170)	1.05 (2168)	9.48×10^{-1} (2168)	1.03 (2168)	1.06 (2168)	1.07 (2164)	9.53×10^{-1} (2168)	8.26×10^{-1} (2097)
B Barrier	9.20 (3696)	5.26 (2068)	4.81 (2050)	4.80 (2050)	4.81 (2050)	4.80 (2050)	5.22 (2051)	4.80 (2050)	5.23 (2083)
S Barrier	5.91 (3242)	1.58 (2050)	1.57 (2051)	2.72×10^{-1} (2059)	1.59 (2050)	1.56 (2050)		1.58 (2051)	
T Barrier	4.28 (2051)	4.32 (2053)	4.47 (2051)		4.48 (2051)	4.48 (2051)	4.35 (2050)	4.47 (2051)	4.31 (2050)
U Barrier	2.33 (4027)	2.44×10^{-1} (2092)	6.73×10^{-2} (2056)		3.42×10^{-1} (3565)	6.09×10^{-2} (2050)		6.18×10^{-2} (2050)	
Core Zone Boundary	9.20 (3696)	5.26 (2068)	4.81 (2050)	4.80 (2050)	4.81 (2050)	4.80 (2050)	5.22 (2051)	4.80 (2050)	5.23 (2083)
Columbia River nearshore	1.01 (4498)	1.01 (2079)	9.71×10^{-1} (2076)				9.12×10^{-1} (2076)	9.72×10^{-1} (2076)	8.30×10^{-1} (2074)

Note: Calendar year of peak impact shown in parentheses.

2.9.1.2.1 Tank Closure Alternative 1

Under Tank Closure Alternative 1, the tank farms would be indefinitely maintained in their current condition; however, for analysis purposes, the tank farms were assumed to fail after an institutional control period of 100 years. At that time, the salt cake in the SSTs was assumed to be available for leaching into the vadose zone, and the liquid contents of the DSTs were assumed to be discharged directly to the vadose zone.

Due to the large magnitude of the liquid release, transport through the vadose zone would be rapid, and the resulting impacts would exceed the dose standard and Hazard Index guideline for the onsite locations before CY 2050. The largest contributors would be the cribs and trenches (ditches), SSTs, and DSTs due to the presence of tritium, technetium-99, iodine-129, uranium-238, chromium, nitrate, and total uranium. After CY 2050, the 100-millirem-per-year standard would not be exceeded at any analysis location. The population dose after CY 2050 was estimated to be 3.12 person-rem for the year of maximum impact, approximately 2×10^{-4} percent of the background dose.

Figure 2–83 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user due to releases from cribs and trenches (ditches), past leaks, and other sources (e.g., tank residuals, ancillary equipment), as well as the total risk from all three sources. The peak radiological risk from the cribs and trenches (ditches) under this alternative occurred around CY 1956 at the Core Zone Boundary and was dominated by tritium, technetium-99, and iodine-129. The peak radiological risk from past leaks for the period beginning in CY 1940 would occur around CY 2100 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129. After CY 2100, peak radiological risk is dominated by the contribution of other tank farm sources, primarily tank residuals. For the period beginning in CY 2050, the peak radiological risk from all three sources combined would occur around CY 4300 and would be dominated by technetium-99 and iodine-129, which move at the same velocity as groundwater.

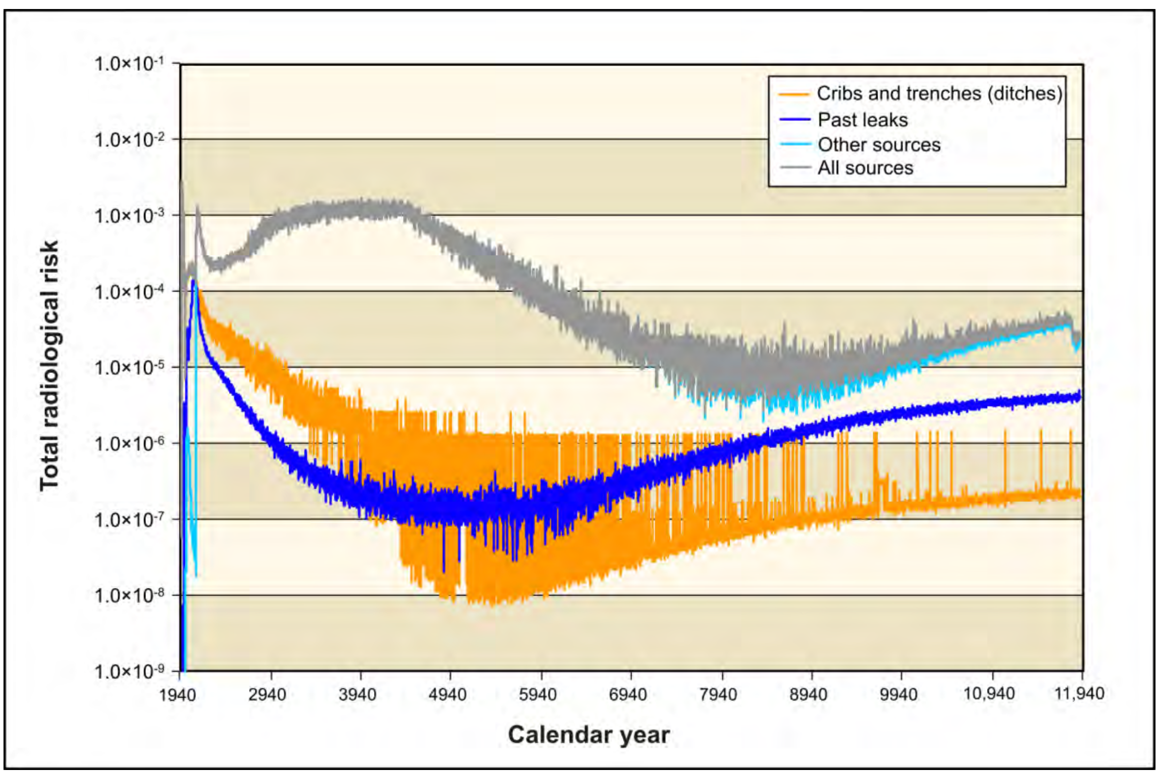


Figure 2–83. Tank Closure Alternative 1 Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.1.2.2 Tank Closure Alternative 2A

Under Tank Closure Alternative 2A, tank waste would be retrieved to a volume corresponding to 99 percent retrieval, but the residual material in the tanks would not be stabilized. After an institutional control period of 100 years, salt cake in the tanks was assumed to be available for dissolution in infiltrating water.

Due to the large magnitude of liquid release at the cribs and trenches (ditches), the dose standard would be exceeded at the Core Zone Boundary before CY 2050. After CY 2050, the dose standard would not be exceeded at the Core Zone Boundary for the drinking-water well user, and most of the dose would be due to the presence of technetium-99 and iodine-129. Both before and after CY 2050, the Hazard Index guideline would be exceeded for the drinking-water well user at the Core Zone Boundary due primarily to releases of chromium and nitrate from the cribs and trenches (ditches) and past leaks. The population dose after CY 2050 was estimated to 0.269 person-rem for the year of maximum impact, approximately 2×10^{-5} percent of the background dose.

Figure 2–84 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user due to releases from cribs and trenches (ditches), past leaks, and other sources (e.g., tank residuals, ancillary equipment), as well as the total risk from all three sources. The peak radiological risk from the cribs and trenches (ditches) under this alternative occurred around CY 1956 at the Core Zone Boundary and was dominated by tritium, technetium-99, and iodine-129. The peak radiological risk from past leaks for the period beginning in CY 1940 would occur around CY 2090 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129. Between CYs 2650 and 5200, peak radiological risk would be due to releases from other tank farm sources, primarily tank residuals. For the period beginning in CY 2050, the peak radiological risk resulting from all three sources combined would occur around CY 2100 and would be dominated by technetium-99, iodine-129, and uranium-238.

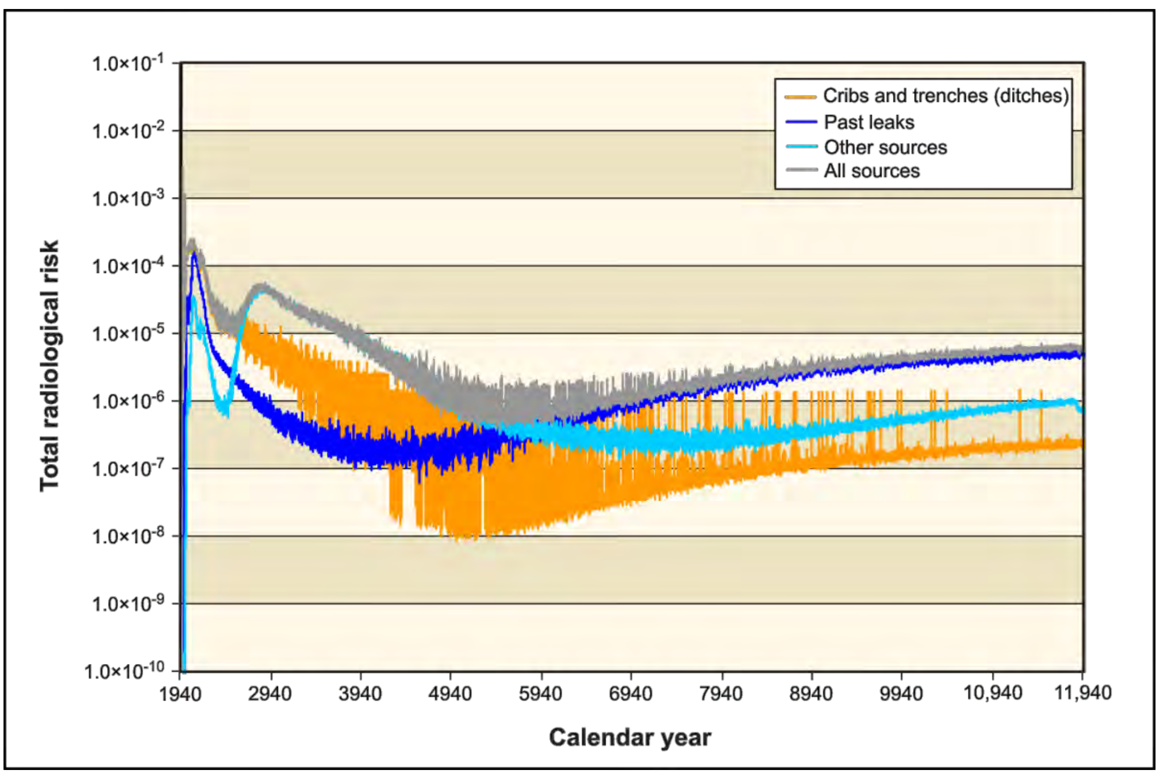


Figure 2–84. Tank Closure Alternative 2A Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.1.2.3 Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C

Activities under Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C would be similar to those under Tank Closure Alternative 2A, except that residual material in the tanks would be stabilized in place. Soil would be removed down to 4.6 meters (15 feet) at the BX and SX tank farms and replaced with clean soils from onsite sources. The tank farms and six sets of adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier.

The risk and hazard drivers would be tritium, technetium-99, iodine-129, uranium-238, chromium, nitrate, and total uranium. The impacts would be slightly less than under Alternative 2A, but the Hazard Index guideline would be exceeded, similar to Alternative 2A. The population dose was estimated to be 0.251 person-rem for the year of maximum impact, approximately 2×10^{-5} percent of the background dose.

Figure 2–85 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user due to releases from cribs and trenches (ditches), past leaks, and other sources (e.g., tank residuals, ancillary equipment), as well as the total risk from all three sources. The peak radiological risk from the cribs and trenches (ditches) under these alternatives occurred around CY 1956 at the Core Zone Boundary and was dominated by tritium, technetium-99, and iodine-129. The peak radiological risk from past leaks for the time period beginning in CY 1940 would occur around CY 2090 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129. Between CYs 2850 and 5000, peak radiological risk would be due to releases from other tank farm sources, primarily tank residuals. For the time period beginning in CY 2050, the peak radiological risk from all three sources combined would occur around CY 2100 and would be dominated by technetium-99 and iodine-129.

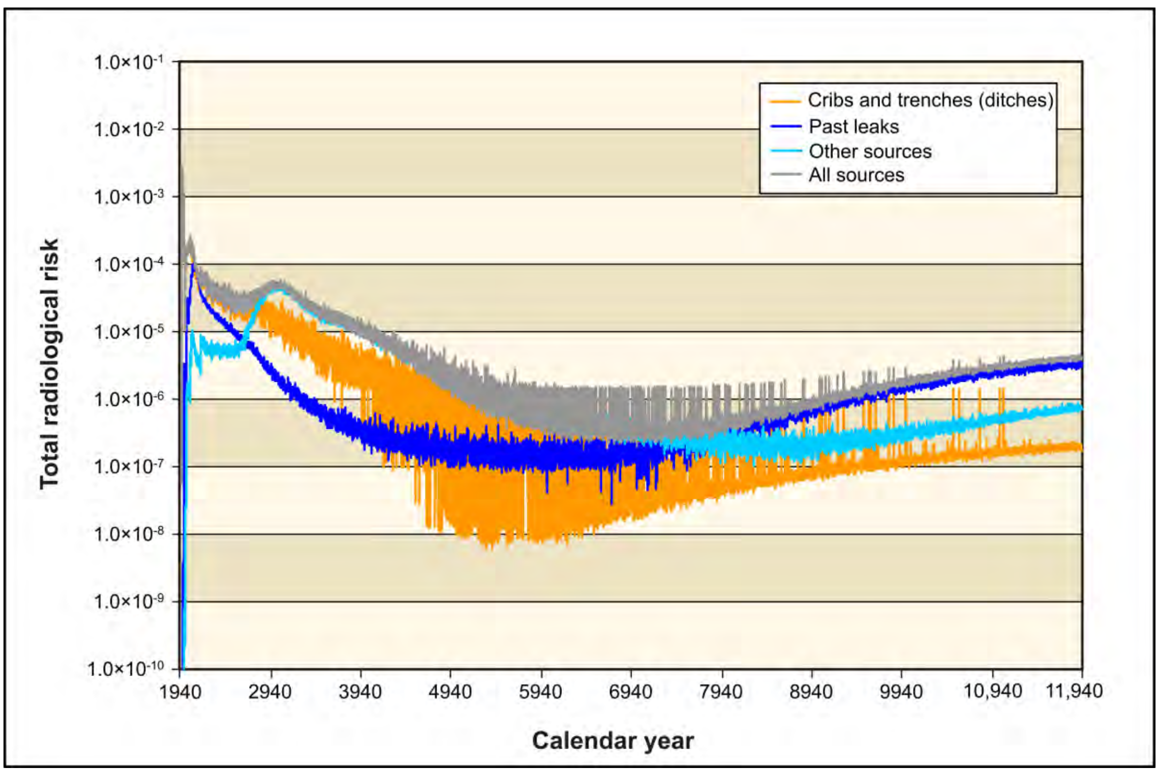


Figure 2–85. Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.1.2.4 Tank Closure Alternative 4

Under Tank Closure Alternative 4, tank waste would be retrieved to a volume corresponding to 99.9 percent retrieval. Except for the BX and SX tank farms, residual material in the tanks would be stabilized in place and the tank farms and adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier. The BX and SX tank farms would be clean-closed by removing the tanks, ancillary equipment, and soils to a depth of 3 meters (10 feet) below the tank base. Where necessary, deep soil excavation would be conducted to remove contamination plumes within the soil column.

Similar to Alternatives 2A, 2B, 3A, 3B, 3C, and 6C, the risk and hazard drivers would be tritium, technetium-99, iodine-129, uranium-238, chromium, nitrate, and total uranium. The Hazard Index guideline would be exceeded at the Core Zone Boundary for the drinking-water well user due primarily to releases from the cribs and trenches (ditches) and past leaks under Tank Closure Alternative 4. Impacts would be slightly less than under Alternatives 2B, 3A, 3B, 3C, and 6C for releases from past leaks as a result of clean closure of the two tank farms located within the B and S Barriers. Impacts at the Core Zone Boundary of cribs and trenches (ditches), past leaks, and other sources (e.g., tank residuals, ancillary equipment) would also be slightly less than under Alternatives 2B, 3A, 3B, 3C, and 6C due to the combined releases. The population dose was estimated to be 0.249 person-rem for the year of maximum impact, approximately 2×10^{-5} percent of the background dose.

Figure 2–86 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user due to releases from cribs and trenches (ditches), past leaks, and other sources (e.g., tank residuals, ancillary equipment), as well as the total risk from all three sources. The peak radiological risk from the cribs and trenches (ditches) under this alternative occurred around CY 1956 at the Core Zone Boundary and was dominated by tritium, technetium-99, and iodine-129. The peak radiological risk from past leaks for the period beginning in 1940 would occur around CY 2070 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129. Between CYs 2900 and 5000, peak radiological risk includes a major contribution from other tank farm sources, primarily tank residuals. For the period beginning in CY 2050, the peak radiological risk from all three sources combined would occur around CY 2060 and would be dominated by technetium-99 and iodine-129.

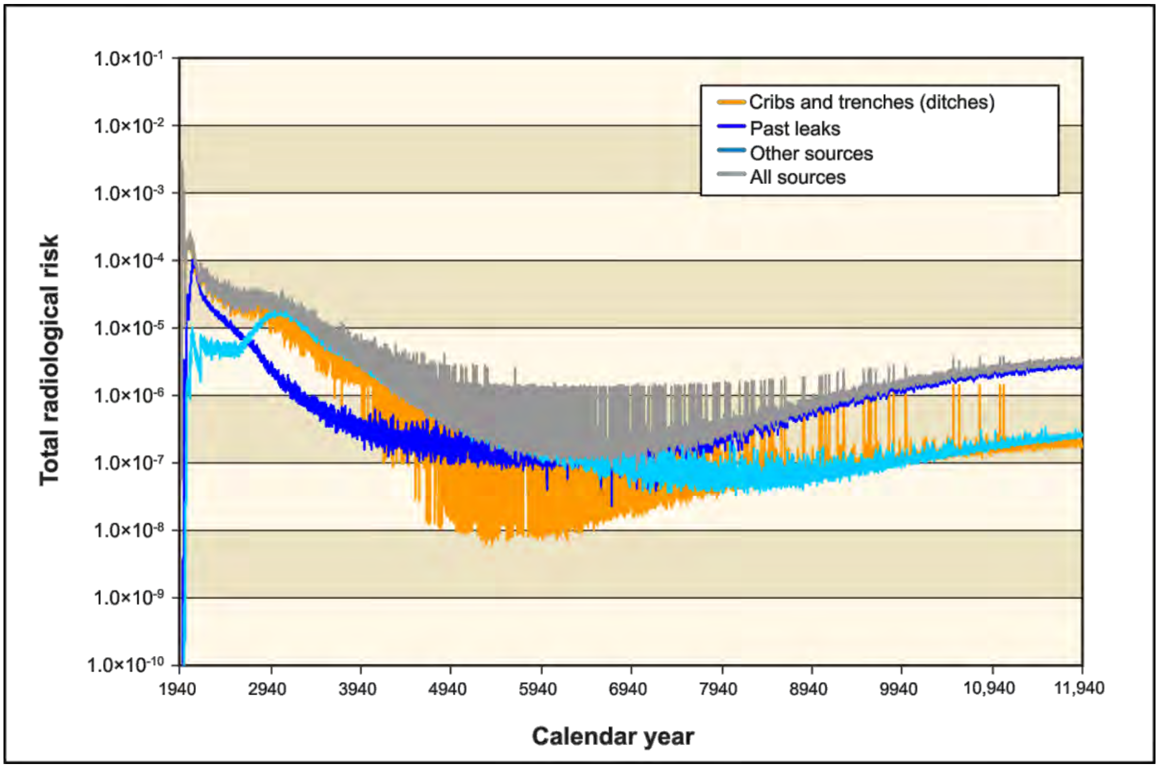


Figure 2–86. Tank Closure Alternative 4 Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.1.2.5 Tank Closure Alternative 5

Under Tank Closure Alternative 5, tank waste would be retrieved to a volume corresponding to 90 percent retrieval, residual material in tanks would be stabilized in place, and the tank farms and adjacent cribs and trenches (ditches) would be covered with a Hanford barrier.

The Hazard Index guideline would be exceeded at the Core Zone Boundary for the drinking-water well user due primarily to releases from the cribs and trenches (ditches) and from past leaks. Impacts at the Core Zone Boundary due to the combined releases from cribs and trenches (ditches), past leaks, and other sources (e.g., tank residuals, ancillary equipment) would occur at a later date than under Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C. This may be due to the Hanford barrier. The population dose was estimated to be 0.424 person-rem for the year of maximum impact, which would represent approximately 3×10^{-5} percent of the background dose.

Figure 2–87 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user due to releases from cribs and trenches (ditches), past leaks, and other sources (e.g., tank residuals, ancillary equipment), as well as the total risk from all three sources. The peak radiological risk from the cribs and trenches (ditches) under this alternative occurred around CY 1956 at the Core Zone Boundary and was dominated by tritium, technetium-99, and iodine-129. The peak radiological risk from past leaks for the time period beginning in 1940 would occur around CY 2090 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129. Between CYs 3000 and 9000, peak radiological risk would be due to releases from other tank farm sources, primarily tank residuals. For the time period beginning in CY 2050, the peak radiological risk from all three sources combined would occur around CY 2060 and would be dominated by technetium-99 and iodine-129.

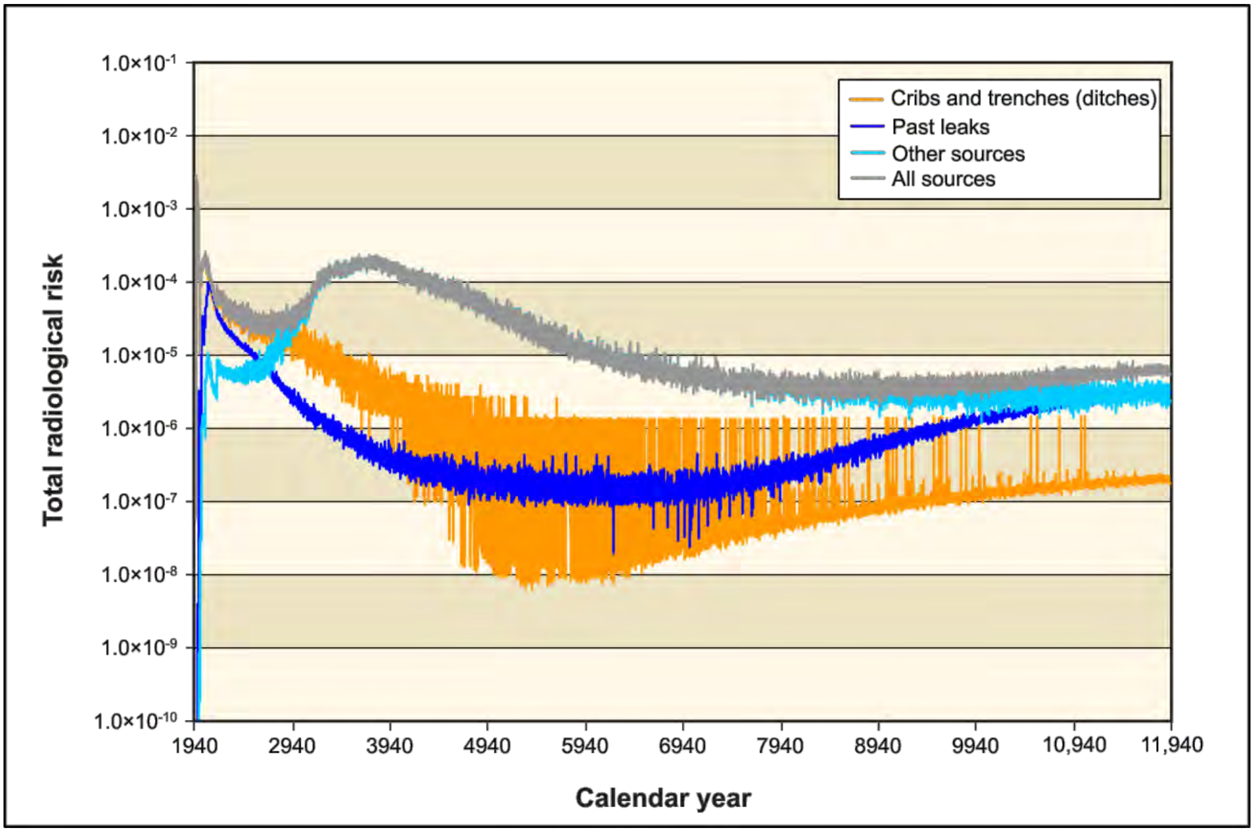


Figure 2–87. Tank Closure Alternative 5 Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.1.2.6 Tank Closure Alternative 6A, Base and Option Cases

Under Tank Closure Alternative 6A, Base and Option Cases, tank waste would be retrieved to a volume corresponding to 99.9 percent retrieval, and all tank farms would be clean-closed by removing the tanks, ancillary equipment, and soils to a depth of 3 meters (10 feet) below the tank base. Where necessary, deep soil excavation would also be conducted to remove contamination plumes within the soil column. This would eliminate the "other sources" of releases that could impact groundwater. Under the Base Case, the adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier; under the Option Case, the adjacent cribs and trenches (ditches) would be clean-closed.

The Hazard Index guideline would be exceeded at the Core Zone Boundary for the drinking-water well user both for releases from the cribs and trenches (ditches) and from past leaks. Impacts at the Core Zone Boundary of the combined releases from cribs and trenches (ditches) and past leaks would be slightly greater than under Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C. However, after CY 2940, the impacts would drop significantly as a result of tank farm removal and clean closure activities. The population doses for the year of maximum impact were estimated to be 0.249 person-rem under the Base Case and 0.260 person-rem under the Option Case, both of which would represent approximately 2×10^{-5} percent of the background dose.

Figures 2–88 and 2–89 depict, for Tank Closure Alternative 6A, Base and Option Cases, respectively, time series showing the lifetime radiological risk of the incidence of cancer at the Core Zone Boundary for the drinking-water well user due to releases from cribs and trenches (ditches), past leaks, and other sources (e.g., tank residuals, ancillary equipment), as well as the total risk from all three sources. The peak radiological risks from the cribs and trenches (ditches) under these cases occurred around CY 1956 at the Core Zone Boundary and were dominated by tritium, technetium-99, and iodine-129. The peak radiological risks from past leaks for the time period beginning in CY 1940 would occur around CY 2090 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129. For these cases, the contribution of other tank farm sources to peak radiological risk is negligible. For the time period beginning in CY 2050, the peak radiological risk from all sources combined would occur around CY 2060 under both the Base and Option Cases and would be dominated by technetium-99 and iodine-129.

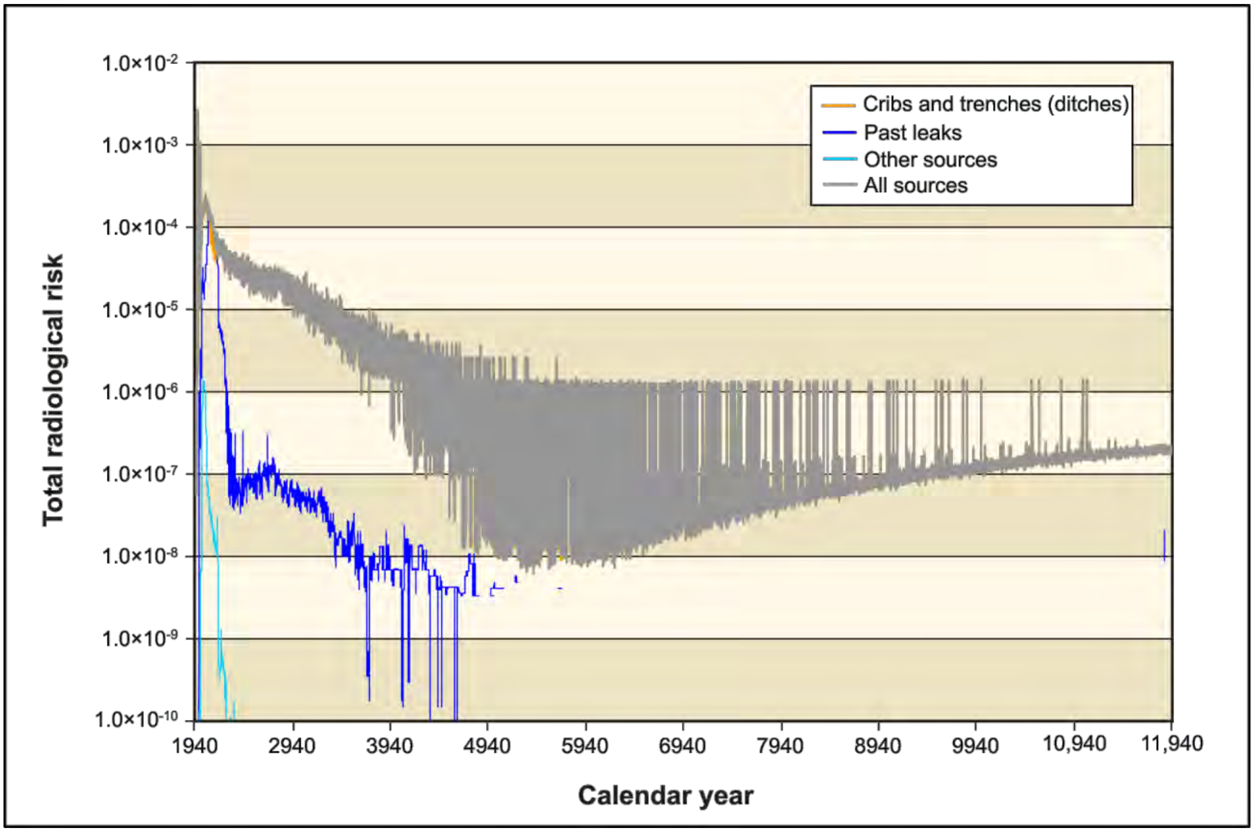


Figure 2–88. Tank Closure Alternative 6A, Base Case, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

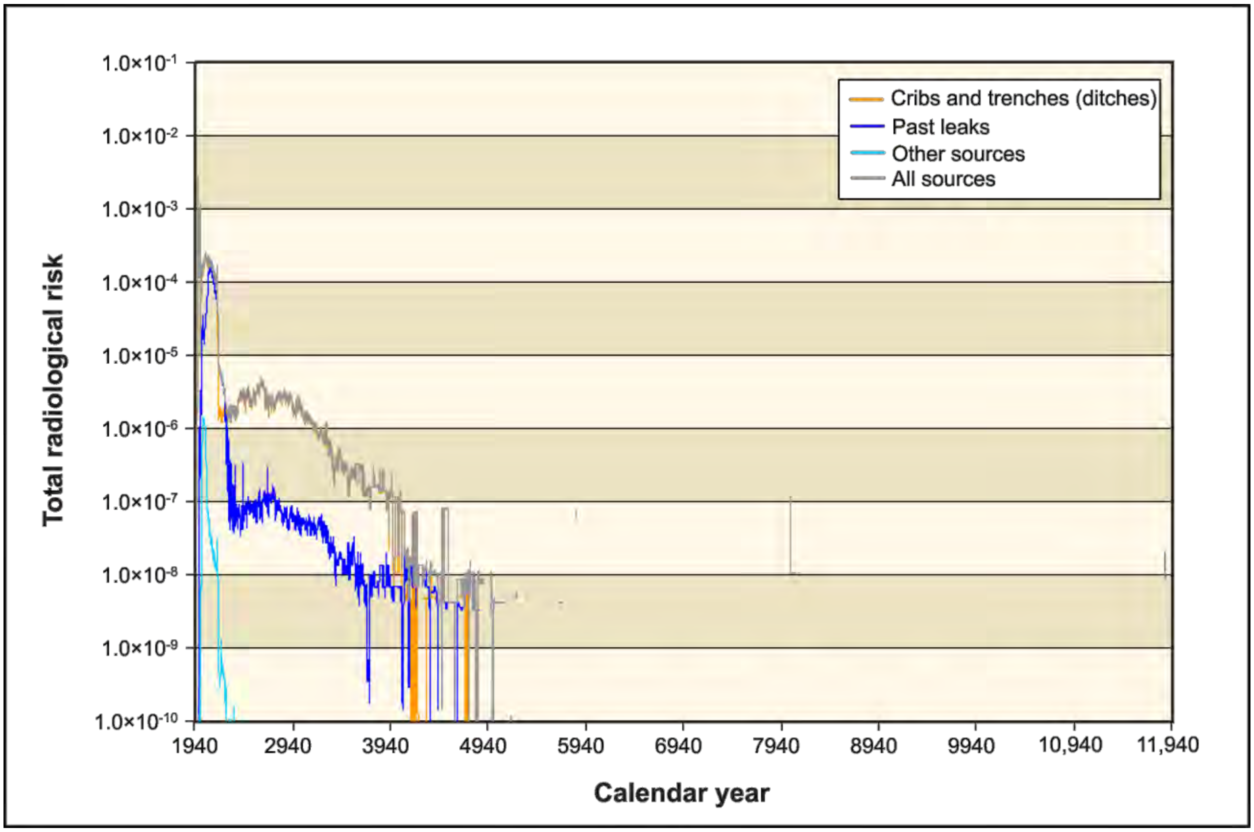


Figure 2–89. Tank Closure Alternative 6A, Option Case, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.1.2.7 Tank Closure Alternative 6B, Base and Option Cases

Tank Closure Alternative 6B, Base and Option Cases, resembles Tank Closure Alternative 6A, Base and Option Cases, except that waste retrieval and processing would proceed at a faster rate and closure would occur at an earlier date. All tank farms would be clean-closed and, under the Base Case, the adjacent cribs and trenches (ditches) would be covered with an engineered modified RCRA Subtitle C barrier; under the Option Case, the adjacent cribs and trenches (ditches) would be clean-closed.

Impacts under Alternative 6B, Base and Option Cases, would be slightly less than those under Alternative 6A. The population dose for the year of maximum impact was estimated to be 0.243 person-rem under the Base Case and 0.244 person-rem under the Option Case, both of which would represent approximately 2×10^{-5} percent of the background dose.

Figures 2–90 and 2–91 depict, for Tank Closure Alternative 6B, Base and Option Cases, respectively, time series showing the lifetime radiological risk of the incidence of cancer at the Core Zone Boundary for the drinking-water well user due to releases from cribs and trenches (ditches), past leaks, and other sources (e.g., tank residuals, ancillary equipment), as well as the total risk from all three sources. The peak radiological risks from the cribs and trenches (ditches) under these cases occurred around CY 1956 at the Core Zone Boundary and were dominated by tritium, technetium-99, and iodine-129. The peak radiological risks from past leaks for the time period beginning in CY 1940 would occur around CY 2090 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129. For the time period beginning in CY 2050, the peak radiological risk from all sources combined would occur around CY 2060 under both the Base and Option Cases and would be dominated by technetium-99 and iodine-129.

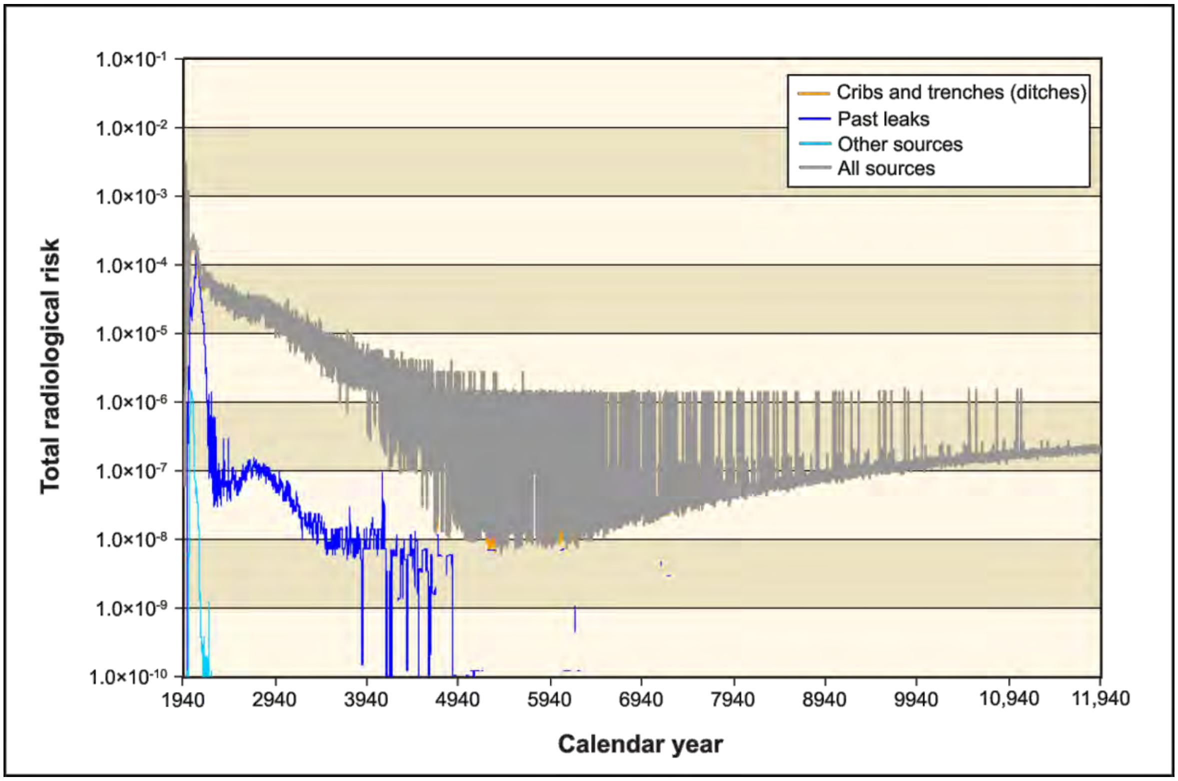


Figure 2–90. Tank Closure Alternative 6B, Base Case, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

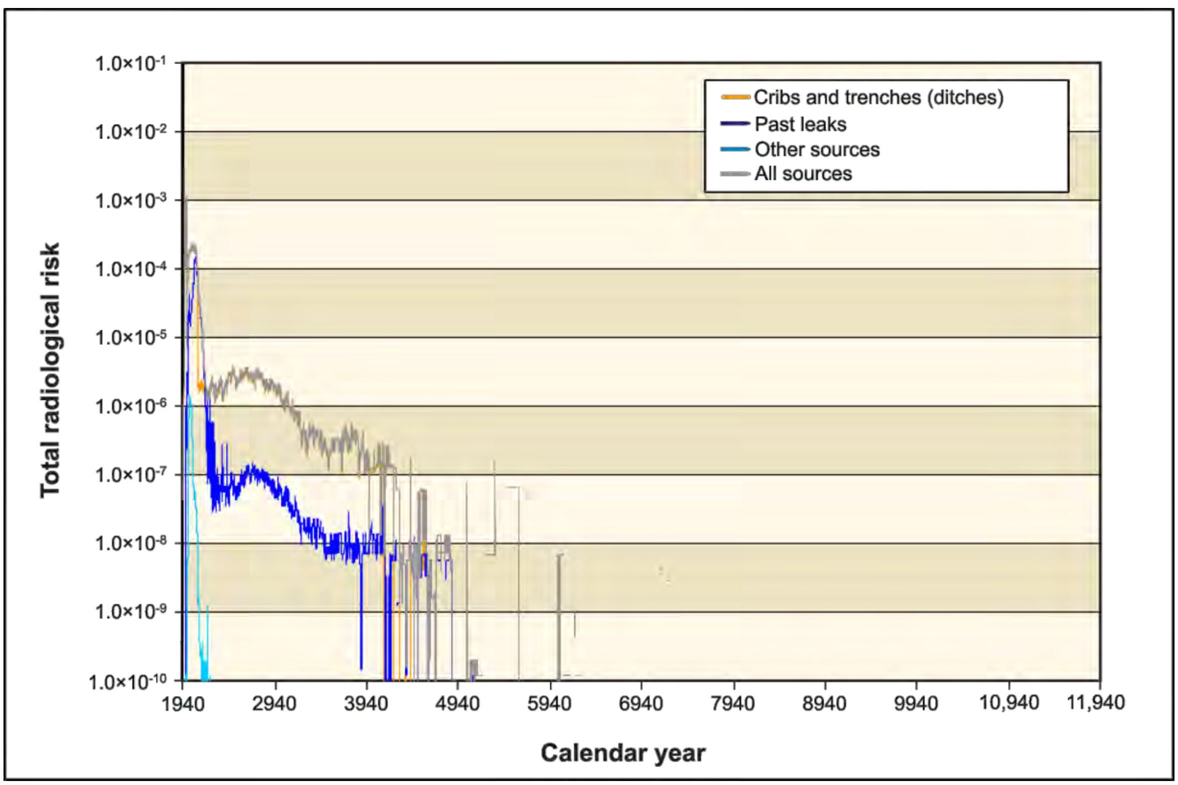


Figure 2–91. Tank Closure Alternative 6B, Option Case, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.1.3 Ecological Risk

Risk indices for ecological receptors exposed to COPCs as a result of air releases and groundwater discharges (see Appendix P) were used in this *TC & WM EIS* to compare Tank Closure alternatives. For ecological receptors, the risk indices are the Hazard Quotient for each chemical COPC and the Hazard Index, which is the sum of Hazard Quotients for all radioactive COPCs. Risk indices less than one indicate little to no likelihood of adverse impact on the receptor. The uncertainties associated with risk indices and the meaning of Hazard Quotients and Hazard Indices for ecological receptors in this *TC & WM EIS* are discussed in Appendix P.

The potential long-term impacts on terrestrial receptors and on aquatic and riparian receptors, as quantified by risk indices for the highest-value COPC for each receptor, are summarized in Tables 2–21 and 2–22, respectively. Long-term impacts would be greatest under Tank Closure Alternatives 3A and 3C for plants, invertebrates, lizards, and birds exposed to mercury at the onsite maximum-exposure location, which, for this *TC & WM EIS*, is the Core Zone Boundary (see Appendix P). Mercury Hazard Quotients range from 0 under the No Action Alternative (Tank Closure Alternative 1), where no mercury is expected to be released to air, to 3.92×10^2 for the side-blotched lizard under Tank Closure Alternatives 3A and 3C. For each of these receptors, risk indices for mercury range from one to two orders of magnitude, with the indices under Tank Closure Alternatives 3A and 3C two to three-and-one-half times larger than under the other Tank Closure action alternatives. Long-term impacts would be greatest under Tank Closure Alternative 6A, Option Case, for mammals exposed to xylene (Great Basin pocket mouse and coyote) and formaldehyde (mule deer) at the onsite maximum-exposure location. For example, xylene Hazard Quotients for mammals range from less than 1 under the No Action Alternative to 2.74×10^2 for the Great Basin pocket mouse under Tank Closure Alternative 6A, Option Case.

Table 2–21. Tank Closure Alternatives – Long-Term Impacts of Contaminant Releases to Air on Terrestrial Receptors at the Onsite Maximum-Impact Location

Alternative	Hazard Quotient of Highest-Value COPC by Receptor								
	Plants	Soil-Dwelling Invertebrates	Side-Blotched Lizard	Great Basin Pocket Mouse	Coyote	Mule Deer	Western Meadow-lark	Mourning Dove	Burrowing Owl
	Mercury	Mercury	Mercury	Xylene	Xylene	Formaldehyde	Mercury	Mercury	Mercury
1	0	0	0	1.16	1.48×10^{-1}	1.63×10^{-1}	0		
2A	6.46	9.02×10^{-1}	1.52×10^{2}	1.21×10^{2}	1.54×10^{1}	1.29×10^{1}	9.12×10^{1}	7.53	6.35
2B	7.05	9.85×10^{-1}	1.66×10^{2}	9.79×10^{1}	1.24×10^{1}	1.24×10^{1}	9.95×10^{1}	8.22	6.92
3A	**1.67×10^{1}**	**2.33**	**3.92×10^{2}**	1.02×10^{2}	1.30×10^{1}	1.24×10^{1}	**2.35×10^{2}**	**1.94×10^{1}**	**1.64×10^{1}**
3B	4.80	6.70×10^{-1}	1.13×10^{2}	1.23×10^{2}	1.57×10^{1}	1.39×10^{1}	6.77×10^{1}	5.59	4.71
3C	**1.67×10^{1}**	**2.33**	**3.92×10^{2}**	1.07×10^{2}	1.35×10^{1}	1.26×10^{1}	**2.35×10^{2}**	**1.94×10^{1}**	**1.64×10^{1}**
4	6.67	9.31×10^{-1}	1.57×10^{2}	9.06×10^{1}	1.15×10^{1}	1.35×10^{1}	9.41×10^{1}	7.77	6.54
5	6.34	8.85×10^{-1}	1.49×10^{2}	1.49×10^{2}	1.90×10^{1}	1.79×10^{1}	8.94×10^{1}	7.38	6.22
6A, Base Case	6.56	9.16×10^{-1}	1.54×10^{2}	2.70×10^{2}	3.43×10^{1}	3.49×10^{1}	9.25×10^{1}	7.64	6.44
6A, Option Case	6.51	9.09×10^{-1}	1.53×10^{2}	**2.74×10^{2}**	**3.48×10^{1}**	**4.26×10^{1}**	9.18×10^{1}	7.58	6.39
6B, Base Case	7.35	1.03	1.73×10^{2}	1.51×10^{2}	1.92×10^{1}	2.32×10^{1}	1.04×10^{2}	8.56	7.21
6B, Option Case	7.30	1.02	1.71×10^{2}	1.56×10^{2}	1.98×10^{1}	3.09×10^{1}	1.03×10^{2}	8.50	7.16
6C	7.30	1.02	1.71×10^{2}	9.70×10^{1}	1.23×10^{1}	1.04×10^{1}	1.03×10^{2}	8.50	7.16

Note: The maximum Hazard Quotient for each receptor is indicated by **bold** text.

Key: COPC=constituent of potential concern.

Table 2–22. Tank Closure Alternatives – Long-Term Impacts of Contaminant Releases to Air on Aquatic and Riparian Receptors at the Columbia River

Alternative	Hazard Quotient of Highest-Value COPC by Receptor					
	Benthic Invertebrate	Aquatic Biota/ Salmonids	Spotted Sandpiper	Raccoon	Least Weasel	Bald Eagle
	Ammonia	Mercury				
1	3.49×10^{-2}	0	0	0	0	0
2A	$\mathbf{6.83\times10^{-2}}$	1.33×10^{-2}	3.90×10^{-1}	3.30×10^{-2}	4.95×10^{-3}	8.44×10^{-3}
2B	1.67×10^{-2}	4.53×10^{-2}	4.25×10^{-1}	3.60×10^{-2}	1.56×10^{-2}	2.73×10^{-2}
3A	1.46×10^{-2}	5.37×10^{-2}	$\mathbf{5.08\times10^{-1}}$	$\mathbf{4.31\times10^{-2}}$	1.85×10^{-2}	3.23×10^{-2}
3B	1.67×10^{-2}	3.06×10^{-2}	2.89×10^{-1}	2.45×10^{-2}	1.05×10^{-2}	1.84×10^{-2}
3C	1.47×10^{-2}	5.37×10^{-2}	$\mathbf{5.08\times10^{-1}}$	$\mathbf{4.31\times10^{-2}}$	1.85×10^{-2}	3.23×10^{-2}
4	1.58×10^{-2}	3.38×10^{-2}	3.66×10^{-1}	3.11×10^{-2}	1.17×10^{-2}	2.04×10^{-2}
5	1.35×10^{-2}	5.07×10^{-2}	3.50×10^{-1}	2.97×10^{-2}	1.73×10^{-2}	3.03×10^{-2}
6A, Base Case	6.67×10^{-2}	6.70×10^{-3}	3.93×10^{-1}	3.33×10^{-2}	2.75×10^{-3}	4.55×10^{-3}
6A, Option Case	6.73×10^{-2}	6.68×10^{-3}	3.92×10^{-1}	3.33×10^{-2}	2.75×10^{-3}	4.54×10^{-3}
6B, Base Case	1.76×10^{-2}	$\mathbf{6.98\times10^{-2}}$	4.40×10^{-1}	3.74×10^{-2}	$\mathbf{2.38\times10^{-2}}$	$\mathbf{4.16\times10^{-2}}$
6B, Option Case	1.82×10^{-2}	$\mathbf{6.98\times10^{-2}}$	4.40×10^{-1}	3.73×10^{-2}	$\mathbf{2.38\times10^{-2}}$	$\mathbf{4.16\times10^{-2}}$
6C	1.66×10^{-2}	$\mathbf{6.98\times10^{-2}}$	4.40×10^{-1}	3.73×10^{-2}	$\mathbf{2.38\times10^{-2}}$	$\mathbf{4.16\times10^{-2}}$

Note: The maximum Hazard Quotient for each receptor is indicated by **bold** text.
Key: COPC=constituent of potential concern.

For each of these receptors, risk indices for xylene range over two orders of magnitude, with the risk index under Tank Closure Alternative 6A, Base and Option Cases, being generally two to three times larger than those under the other Tank Closure action alternatives. Long-term impacts of air releases on aquatic and riparian resources at the Columbia River would not be likely (see Table 2–22). Risk indices would be greatest under Tank Closure Alternative 2A for benthic invertebrates exposed to ammonia; Tank Closure Alternatives 3A and 3C for the spotted sandpiper and raccoon exposed to mercury; and Tank Closure Alternatives 6B, Base and Option Cases, and 6C for the least weasel, bald eagle, and aquatic biota, including salmonids (salmon and related fish), exposed to mercury.

For groundwater discharging to the Columbia River (see Table 2–23), potential long-term impacts on aquatic and riparian receptors would be unlikely for all COPCs and receptors except for chromium and aquatic biota, including salmonids. Risk indices for benthic invertebrates, the raccoon, and birds exposed to chromium would be slightly greater under Tank Closure Alternative 1 than under other Tank Closure alternatives. Risk indices for the muskrat and least weasel exposed to nitrate are essentially equal under all Tank Closure alternatives, but would be slightly greater under Tank Closure Alternatives 2B, 3A, 3B, 3C, 4, 5, 6A (Base Case), 6B (Base Case), and 6C. All nitrate Hazard Quotients were below, or only slightly greater than, the threshold value of 1, indicating no or minimal potential for adverse impacts. For the COPC with the highest risk indices for aquatic biota (chromium), Hazard Quotients range from 43.1 to 44.5 (Tank Closure Alternative 6B, Option Case).

Long-term modeling predicts peak air concentrations and cumulative soil concentrations of mercury, xylene, and formaldehyde that potentially would cause adverse impacts on some terrestrial ecological receptors at the onsite maximum-exposure location under all Tank Closure alternatives, except the No Action Alternative (Tank Closure Alternative 1). Likewise, maximum groundwater concentrations and nearshore surface-water concentrations of chromium resulting from all Tank Closure alternatives, including the No Action Alternative, could pose a toxicological risk to aquatic biota, including salmonids,

Table 2–23. Tank Closure Alternatives – Long-Term Impacts of Contaminant Releases to Groundwater on Aquatic and Riparian Receptors at the Columbia River

Alternative	Hazard Quotient of Highest-Value COPC by Receptor						
	Benthic Invertebrates	Aquatic Biota/ Salmonids	Spotted Sandpiper	Bald Eagle	Raccoon	Muskrat	Least Weasel
	Chromium[a]					Nitrate	
1	**1.69×10^{-1}**	4.32×10^{1}	**1.15**	**3.71×10^{-2}**	**1.39×10^{-1}**	1.41×10^{-2}	1.36
2A	1.62×10^{-1}	4.31×10^{1}	1.10	3.66×10^{-2}	1.33×10^{-1}	1.38×10^{-2}	1.36
2B, 3A, 3B, 3C, 6C	1.67×10^{-1}	4.31×10^{1}	1.13	3.69×10^{-2}	1.37×10^{-1}	**1.43×10^{-2}**	**1.37**
4	1.67×10^{-1}	4.31×10^{1}	1.13	3.69×10^{-2}	1.37×10^{-1}	**1.43×10^{-2}**	**1.37**
5	1.67×10^{-1}	4.31×10^{1}	1.13	3.69×10^{-2}	1.37×10^{-1}	**1.43×10^{-2}**	**1.37**
6A, Base Case	1.67×10^{-1}	4.31×10^{1}	1.13	3.69×10^{-2}	1.37×10^{-1}	**1.43×10^{-2}**	**1.37**
6A, Option Case	1.45×10^{-1}	4.44×10^{1}	9.84×10^{-1}	3.63×10^{-2}	1.19×10^{-1}	1.37×10^{-2}	**1.37**
6B, Base Case	1.67×10^{-1}	4.31×10^{1}	1.13	3.69×10^{-2}	1.37×10^{-1}	**1.43×10^{-2}**	**1.37**
6B, Option Case	1.41×10^{-1}	**4.45×10^{1}**	9.59×10^{-1}	3.61×10^{-2}	1.16×10^{-1}	1.38×10^{-2}	1.36

[a] For purposes of long-term impacts, it was assumed that this is hexavalent chromium.

Note: The maximum Hazard Quotient for each receptor is indicated by **bold** text.

Key: COPC=constituent of potential concern.

exposed to surface water in the nearshore environment of the Columbia River. Potential long-term impacts of Tank Closure alternatives on ecological resources are discussed in greater detail in Chapter 5, Section 5.1.3, and the uncertainties associated with risk indices calculated using environmental concentrations predicted for air and groundwater releases under the Tank Closure alternatives are discussed in Appendix P.

Predicted maximum nearshore surface-water concentrations of nitrate from releases to groundwater discharging at the Columbia River under Tank Closure alternatives (3.18 milligrams per liter) exceed the 2006 ambient concentrations of dissolved nitrite and nitrate as nitrogen at the Richland Pumphouse immediately downstream of Hanford, which did not exceed 1.0 milligram per liter during 2006 and 2010 (Poston et al. 2007; Poston, Duncan, and Dirkes 2011). With sufficient light and phosphorus, such an increase in dissolved nitrogen could lead to eutrophication of nearshore aquatic habitats in the Columbia River.

2.9.1.4 Environmental Justice

The long-term human health analysis determined that the impacts of tank closure actions would be greatest under Tank Closure Alternative 1. This alternative could result in radiation doses in excess of regulatory limits and chemical exposures with a Hazard Index greater than 1 for receptors located on site at the A, B, S, T, or U Barriers; the Core Zone Boundary; or the Columbia River nearshore. There are no such onsite receptors currently at Hanford. The onsite exposure scenarios do not currently exist and have never existed during Hanford operations. Therefore, the estimated high health risks for past years are hypothetical risks only; no persons were ever exposed at these levels. While it is possible for these receptor scenarios to develop in the future, none are expected within a reasonably foreseeable timeframe because the Core Zone is designated for Industrial-Exclusive land use, the Columbia River nearshore location is designated for Preservation (Hanford Reach National Monument), and the area between them is designated for Conservation (Mining) (DOE 1999). However, exposures of such individuals were evaluated using the exposure scenarios discussed in Section 2.9.1.2. The greatest risk would be to the American Indian resident farmer at the Core Zone Boundary. During the year of peak dose, this receptor would receive a radiation dose of 2.6×10^2 millirem. During the year of peak Hazard Index, this receptor would be exposed to chemicals resulting in a Hazard Index greater than 1. The adverse impacts would also be applicable to non–American Indian receptors at the same locations, but to a lesser extent due primarily to their assumed lower consumption of locally grown food. No adverse impacts were identified for any receptors at offsite locations; therefore, there would be no disproportionately high and adverse impacts on American Indian populations at offsite locations.

2.9.2 FFTF Decommissioning Alternatives: Long-Term Environmental Impacts

2.9.2.1 Water Quality

This section discusses the long-term impacts on groundwater quality from FFTF sources (i.e., any residual contaminants left within the FFTF barrier boundary under each FFTF Decommissioning alternative). Long-term impacts on groundwater quality from sources remaining within the tank farm barrier boundaries and from waste management sources are discussed in Sections 2.9.1.1 and 2.9.3.1, respectively. Three assessment boundaries were selected for the groundwater analysis based on a combination of regulatory, permit, and land-use requirements. For the FFTF Decommissioning alternatives, the FFTF fence line and proposed engineered barrier were selected as the innermost (i.e., closest to the source) assessment boundary. Very little groundwater transport would occur between the time the contaminants encounter the aquifer and the time they pass beneath the outer perimeter of the barrier; in general, this innermost assessment boundary shows the greatest water quality impacts.

The second area of groundwater analysis in this *TC & WM EIS* is established by the location of the Core Zone Boundary (see Figure 2–78). However, because FFTF is outside of and downgradient from the

Core Zone Boundary, the FFTF Decommissioning alternatives would not have an effect on potential impacts at this assessment boundary.

The third area of analysis is the Columbia River nearshore. It approximates the location where contaminants in the groundwater system discharge into the surface-water system. Water-quality impacts at the Columbia River reflect the superimposition of releases from individual sources.

Groundwater impacts are described in terms of the concentrations of the COPC drivers at the assessment boundaries under the alternatives considered. The COPC drivers are tritium, iodine-129, technetium-99, uranium-238, chromium, nitrate, and total uranium. They fall into three categories. Iodine-129, technetium-99, chromium, and nitrate are all mobile (i.e., move with groundwater) and long-lived (relative to the 10,000-year period of analysis), or stable. They are essentially conservative tracers. Tritium is also mobile, but short-lived. The half-life of tritium is less than 13 years, and tritium concentrations are strongly attenuated by radioactive decay during travel through the vadose zone and groundwater systems. Finally, uranium-238 and total uranium are long-lived, or stable, but are not as mobile as the other COPC drivers. These constituents move about seven times more slowly than groundwater. The other COPCs that were analyzed do not significantly contribute to risk or hazard during the period of analysis because of limited inventory, high retardation factors (i.e., retention in the vadose zone), short half-lives (i.e., rapid radioactive decay), or a combination of these factors.

Table 2–24 presents the maximum concentrations of the COPC drivers for each of the FFTF Decommissioning alternatives at the FFTF barrier; Table 2–25, at the Columbia River nearshore. Long-term groundwater impacts under the FFTF Decommissioning alternatives are dominated by technetium-99. Qualitatively, all of the FFTF Decommissioning alternatives are at least a factor of 2 below the benchmark concentration at the Core Zone Boundary, and at least a factor of 30 at the Columbia River nearshore. Quantitatively, there is a difference between FFTF Decommissioning Alternative 3 (which involves complete removal of source materials) and FFTF Decommissioning Alternatives 1 and 2 (which involve no removal or partial removal of source material).

Table 2–24. FFTF Decommissioning Alternatives – Maximum COPC Concentrations in the Peak Year at the FFTF Barrier

<table>
<tr><th rowspan="2">Contaminant</th><th colspan="3">FFTF Decommissioning Alternative</th><th rowspan="2">Benchmark Concentration</th></tr>
<tr><th>1</th><th>2</th><th>3</th></tr>
<tr><td colspan="5">Radionuclide (picocuries per liter)</td></tr>
<tr><td>Hydrogen-3 (tritium)</td><td colspan="3">0
N/A</td><td>20,000</td></tr>
<tr><td>Technetium-99</td><td>411
(2790)</td><td>401
(3137)</td><td>0
N/A</td><td>900</td></tr>
<tr><td>Iodine-129</td><td colspan="3">0
N/A</td><td>1</td></tr>
<tr><td>Uranium isotopes (includes uranium-233, -234, -235, -238)</td><td colspan="3">0
N/A</td><td>15</td></tr>
<tr><td colspan="5">Chemical (micrograms per liter)</td></tr>
<tr><td>Chromium</td><td colspan="3">0
N/A</td><td>100</td></tr>
<tr><td>Nitrate</td><td colspan="3">0
N/A</td><td>45,000</td></tr>
<tr><td>Total uranium</td><td>20
(11,842)</td><td colspan="2">0
N/A</td><td>30</td></tr>
</table>

Note: Calendar year of peak concentration shown in parentheses.

Key: COPC=constituent of potential concern; FFTF=Fast Flux Test Facility; N/A=not applicable.

Table 2–25. FFTF Decommissioning Alternatives – Maximum COPC Concentrations in the Peak Year at the Columbia River Nearshore

Contaminant	FFTF Decommissioning Alternative			Benchmark Concentration
	1	2	3	
Radionuclide (picocuries per liter)				
Hydrogen-3 (tritium)	0 N/A			20,000
Technetium-99	32 (2978)	34 (3307)	0 N/A	900
Iodine-129	0 N/A			1
Uranium isotopes (includes uranium-233, -234, -235, -238)	0 N/A			15
Chemical (micrograms per liter)				
Chromium	0 N/A			100
Nitrate	0 N/A			45,000
Total uranium	0.8 (11,788)	0 N/A		30

Note: Calendar year of peak concentration shown in parentheses.
Key: COPC=constituent of potential concern; FFTF=Fast Flux Test Facility; N/A=not applicable.

The location where the maximum concentrations would occur varies with time, contaminant, and alternative. The benchmark concentration for each contaminant is provided for comparison. The benchmark concentrations include EPA MCLs (i.e., primary drinking water standards), EPA interim drinking water standards, DOE-derived concentration guides, and other standards known or accepted to be associated with a specific level of effect. FFTF Decommissioning alternatives are not expected to result in exceedances of these benchmarks.

The magnitude of the impacts can be represented in terms of the total amounts of the COPC drivers released to the vadose zone from all sources related to a particular alternative. Releases of radionuclides are totaled in curies over the 10,000-year period of analysis.

The total amount of technetium-99 released to the vadose zone under the FFTF Decommissioning alternatives is presented in Figure 2–92 (no iodine-129 inventory is associated with the FFTF Decommissioning alternatives). The magnitude of the impact is governed by the amount of inventory removed, which ranges from essentially none (under FFTF Decommissioning Alternatives 1 and 2) to essentially 100 percent (under FFTF Decommissioning Alternative 3).

The peak impact can be represented in terms of the peak concentration of the COPC drivers at the FFTF barrier for each of the FFTF Decommissioning alternatives. The peak concentrations of technetium-99 at the FFTF barrier, presented in tabular form in Table 2–24, are presented in logarithmic format in Figure 2–93. For the FFTF Decommissioning alternatives, the peak impact is similarly governed by the amount of inventory removed.

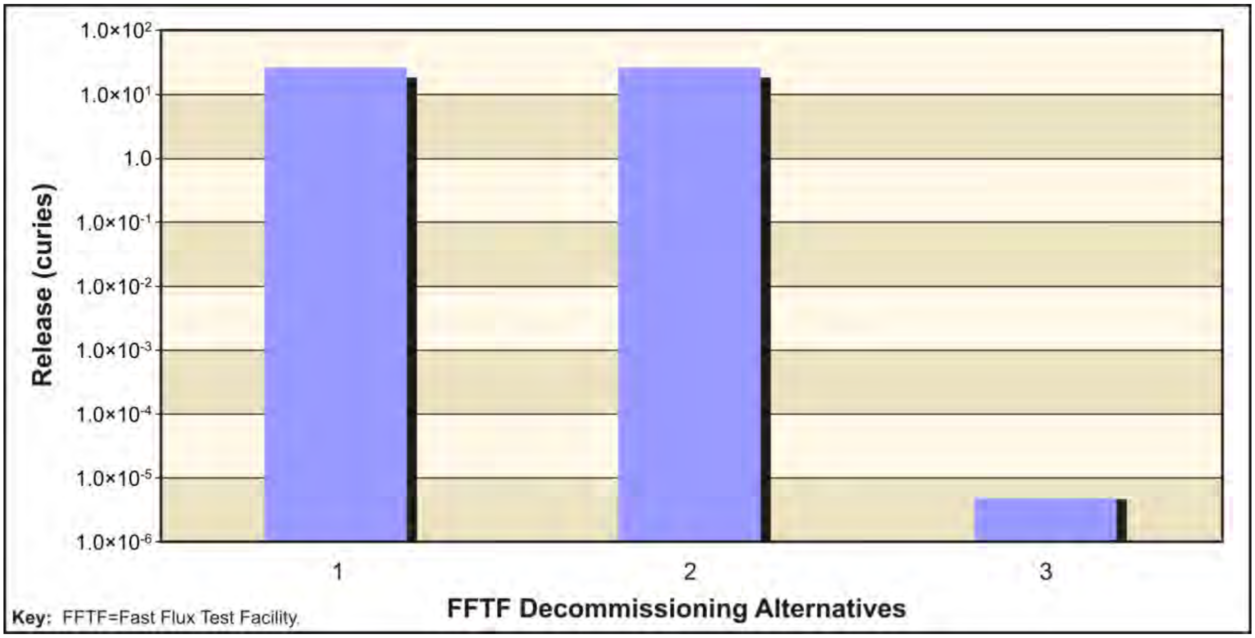


Figure 2–92. FFTF Decommissioning Alternatives – Total Technetium-99 Released to the Vadose Zone

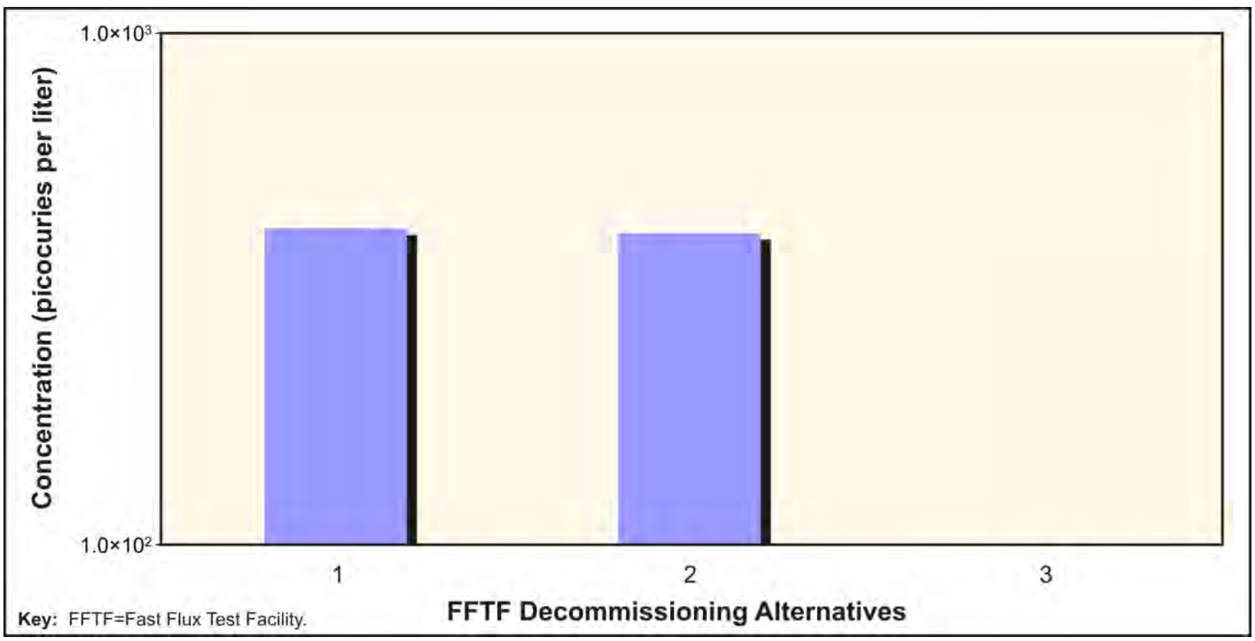


Figure 2–93. FFTF Decommissioning Alternatives – Peak Technetium-99 Concentrations at the FFTF Barrier

2.9.2.2 Human Health

Implementation of activities defined for the FFTF Decommissioning alternatives could lead to releases of radioactive and chemical constituents to the environment over long periods of time. Under FFTF Decommissioning Alternative 1, these releases would not be controlled by final decommissioning activities. Under FFTF Decommissioning Alternative 2, these releases would be controlled by removal of all aboveground structures and minimal removal of below-grade structures, equipment, and materials. An RCRA-compliant barrier would be constructed over the RCB and any other remaining below-grade structures (including the reactor vessel). Under FFTF Decommissioning Alternative 3, these releases would be further controlled by removal of all aboveground structures and contaminated below-grade structures (including the reactor vessel), equipment, and materials.

The four measures of human health impacts considered in this analysis—lifetime risks of developing cancer from radioactive and chemical constituents, dose from radionuclides, and Hazard Index from noncarcinogenic chemical constituents—were calculated for each year for 10,000 years for each receptor at three locations (the FFTF barrier, Columbia River nearshore, and surface water of the Columbia River). This is a large amount of information that must be summarized to allow interpretation of results. The method chosen is to present dose for the year of maximum dose, risk for the year of maximum risk, and Hazard Index for the year of maximum Hazard Index. This choice is based on regulation of radiological impacts expressed as dose and the observation that peak risk and peak noncarcinogenic impacts expressed as a Hazard Index may occur at times other than that of peak dose. The significance of dose impacts is evaluated by comparison against the 100-millirem-per-year all-exposure-modes standard specified for protection of the public and the environment in DOE Order 458.1. Population doses are compared against a total effective dose equivalent from natural background sources of 311 millirem per year for a member of the population of the United States (NCRP 2009). The level of protection provided for the drinking water pathway was evaluated by comparison against the MCLs of EPA's primary drinking water regulations (40 CFR 141) and other benchmarks as presented in Appendix O.

The results of the analysis for the drinking-water well user at the FFTF barrier and Columbia River nearshore for FFTF Decommissioning Alternatives 1, 2, and 3 are summarized in the sections below. Tables 2–26 and 2–27 provide the maximum dose and maximum Hazard Index, respectively, for the drinking-water well user after CY 2050 by alternative. For all receptor types, including the drinking-water well user, neither the radiological dose standard nor Hazard Index guideline would be exceeded due to long-term releases from the FFTF site. Long-term human health impacts under the FFTF Decommissioning alternatives are all at least two orders of magnitude smaller than impacts associated with the Tank Closure alternatives. There is a relatively small difference between FFTF Decommissioning Alternative 3 (which involves complete removal of source materials) and FFTF Decommissioning Alternatives 1 and 2 (which involve no removal or partial removal of source material).

Table 2–26. FFTF Decommissioning Alternatives – Summary of Radiation Dose at Year of Peak Dose for the Drinking-Water Well User

Location	Alternative (millirem per year)		
	1	2	3
FFTF barrier	7.19×10^{-1} (2790)	7.02×10^{-1} (3137)	N/A
Columbia River nearshore	5.57×10^{-2} (2978)	5.86×10^{-2} (3307)	N/A

Note: Calendar year of peak impact shown in parentheses.

Key: FFTF=Fast Flux Test Facility; N/A=not applicable (inventory removal under Alternative 3 reduces estimated dose to low levels, less than approximately 1×10^{-7} millirem per year).

Table 2–27. FFTF Decommissioning Alternatives – Summary of Hazard Index at Year of Peak Hazard Index for the Drinking-Water Well User

Location	Alternative		
	1	2	3
FFTF barrier	1.91×10^{-1} (11,842)	N/A	N/A
Columbia River nearshore	7.99×10^{-3} (11,788)	N/A	N/A

Note: Calendar year of peak impact shown in parentheses.

Key: FFTF=Fast Flux Test Facility; N/A=not applicable (inventory completely removed under Alternative 3).

2.9.2.2.1 FFTF Decommissioning Alternative 1

Under FFTF Decommissioning Alternative 1, only those actions consistent with previous DOE NEPA actions would be completed. Final decommissioning of FFTF would not occur. For analysis purposes, the remaining waste is assumed to become available for release to the environment after an institutional control period of 100 years. The key radioactive constituent contributor to human health risk would be technetium-99. The chemical risk and hazard drivers would be essentially negligible. Neither the dose standard nor the Hazard Index guideline would be exceeded. The population dose was estimated to be 0.012 person-rem for the year of maximum impact, approximately 8×10^{-7} percent of the background dose.

Figure 2–94 depicts a time series showing the lifetime radiological risk of incidence of cancer at the FFTF barrier for the drinking-water well user. The peak radiological risk would occur around CY 2800 at the FFTF barrier and would be dominated by technetium-99, a relatively mobile radionuclide that moves at the same velocity as groundwater.

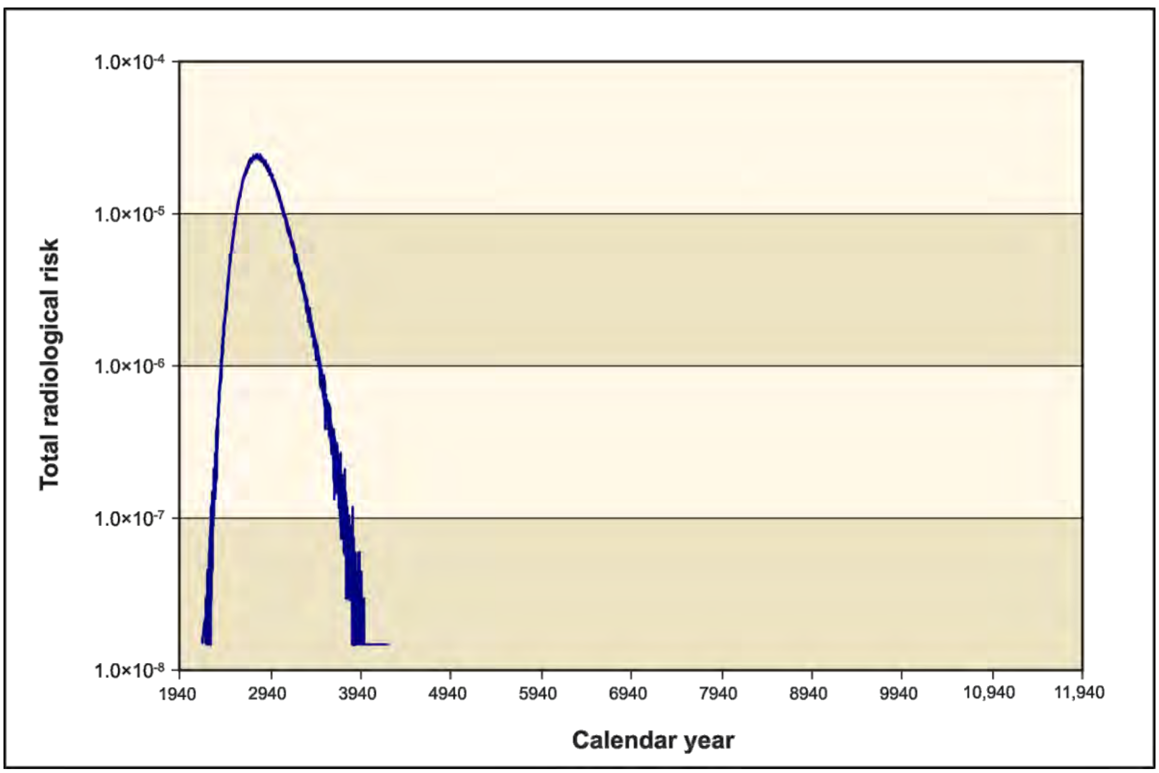


Figure 2–94. FFTF Decommissioning Alternative 1 Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Fast Flux Test Facility Barrier

2.9.2.2.2 FFTF Decommissioning Alternative 2

Under FFTF Decommissioning Alternative 2, all aboveground structures and minimal below-grade structures, equipment, and materials would be removed. An RCRA-compliant barrier would be constructed over the RCB and any other remaining below-grade structures (including the reactor vessel). The key radioactive constituent contributor to human health risk would be technetium-99. The chemical risk and hazard drivers would be essentially negligible. Neither the dose standard nor the Hazard Index guideline would be exceeded. The population dose was estimated to be 0.012 person-rem for the year of maximum impact, representing approximately 7×10^{-7} percent of the background dose.

Figure 2–95 depicts a time series showing the lifetime radiological risk of incidence of cancer at the FFTF barrier for the drinking-water well user. The peak radiological risk would occur around CY 3100 at the FFTF barrier and would be dominated by technetium-99, a relatively mobile radionuclide that moves at the same velocity as groundwater.

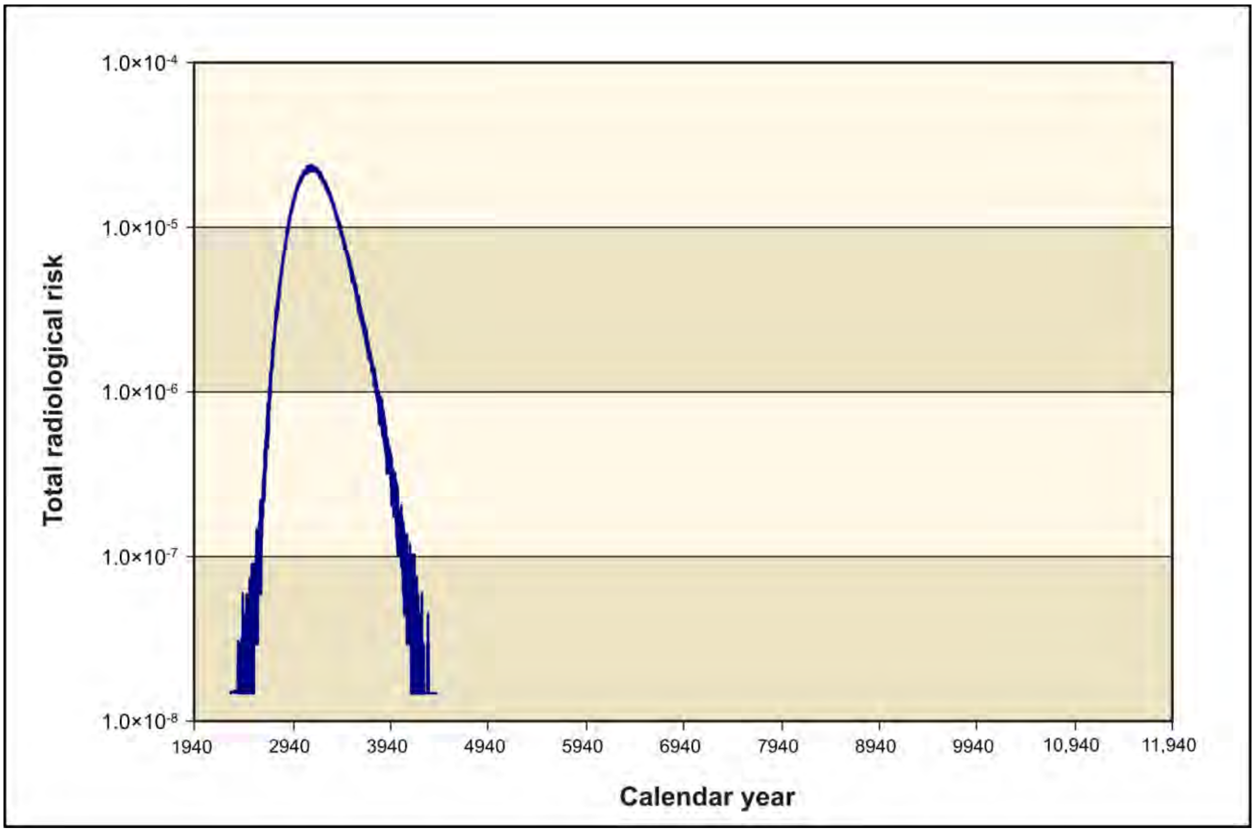


Figure 2–95. FFTF Decommissioning Alternative 2 Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Fast Flux Test Facility Barrier

2.9.2.2.3 FFTF Decommissioning Alternative 3

Under FFTF Decommissioning Alternative 3, aboveground structures, as well as contaminated below-grade structures, equipment, and materials, would be removed. As a result of removal of contaminated material, impacts on groundwater and human health would be reduced to negligible levels.

2.9.2.3 Ecological Risk

Risk indices for ecological receptors exposed to COPCs as a result of air releases and groundwater discharges (see Appendix P) are used in this *TC & WM EIS* to compare the FFTF Decommissioning alternatives. Risk indices less than 1 indicate little to no likelihood of adverse impact on the receptor. The uncertainties associated with risk indices and the meaning of Hazard Quotients and Hazard Indices for ecological receptors in this *TC & WM EIS* are discussed in Appendix P.

The potential long-term impacts of air releases on terrestrial receptors and aquatic and riparian receptors, as quantified by risk indices for the highest-value COPC for each receptor, are shown in Table 2–28. Long-term impacts on all terrestrial, aquatic, and riparian receptors at all locations would be greatest under FFTF Decommissioning Alternative 1. For the COPC with the highest Hazard Quotients (xylene), the potential long-term onsite impacts under the No Action Alternative are more than 275 times greater than the impacts if the Hanford options were selected for processing both RH-SCs and bulk sodium and more than 550 times greater than the Idaho options under FFTF Decommissioning Alternatives 2 and 3. The reduction in impacts would be intermediate between the two options if one of the waste types were processed at Hanford and the other at INL. The smallest difference between FFTF Decommissioning Alternative 1 and the other FFTF Decommissioning alternatives is the sevenfold larger value for aquatic biota, including salmonids, for benzene.

Table 2–28. FFTF Decommissioning Alternatives – Long-Term Impacts of Contaminant Releases to Air on Terrestrial Receptors

FFTF Decommissioning Alternative	Hazard Quotient of Highest-Value COPC by Receptor[a]							
	Onsite Maximum-Exposure Location				Columbia River			
	Plants	Great Basin Pocket Mouse	Coyote	Mule Deer	Benthic Invertebrates	Raccoon	Least Weasel	Aquatic Biota/ Salmonids
	Toluene	Xylene		Formaldehyde	Xylene			Benzene
1	**4.68×10^{1}**	**2.11×10^{3}**	**2.69×10^{2}**	**4.80×10^{1}**	**5.27×10^{-3}**	**3.56×10^{-5}**	**2.06×10^{-4}**	**6.89×10^{-2}**
2 Hanford options	1.64×10^{-1}	7.63	9.69×10^{-1}	6.13×10^{-1}	4.62×10^{-4}	3.13×10^{-6}	1.81×10^{-5}	9.53×10^{-3}
2 Idaho options	7.80×10^{-2}	3.71	4.71×10^{-1}	4.17×10^{-1}	2.59×10^{-4}	1.75×10^{-6}	1.01×10^{-5}	9.33×10^{-3}
3 Hanford options	1.65×10^{-1}	7.68	9.75×10^{-1}	5.85×10^{-1}	4.57×10^{-4}	3.09×10^{-6}	1.79×10^{-5}	8.59×10^{-3}
3 Idaho options	7.95×10^{-2}	3.76	4.77×10^{-1}	3.87×10^{-1}	1.27×10^{-4}	8.59×10^{-7}	4.96×10^{-6}	4.82×10^{-3}

[a] Soil-dwelling invertebrates and the side-blotched lizard, western meadowlark, mourning dove, burrowing owl, spotted sandpiper, and bald eagle had no toxicity reference values or had risk indices equal to zero for chemical COPCs and very small values for radioactive COPCs in these analyses and thus are not shown.

Note: The maximum Hazard Quotient for each receptor is indicated by **bold** text.

Key: COPC=constituent of potential concern; FFTF=Fast Flux Test Facility.

For groundwater discharging to the Columbia River (see Table 2–29), risk indices were small under the FFTF Decommissioning alternatives. All risk indices calculated for COPCs were greatest under FFTF Decommissioning Alternative 1 for all aquatic and riparian receptors except for the Hazard Quotients calculated for technetium-99 for FFTF Decommissioning Alternative 2, which were a fraction larger for benthic invertebrates and the spotted sandpiper, muskrat, and raccoon.

Long-term modeling predicts peak air concentrations and cumulative soil concentrations of benzene, toluene, xylene, and formaldehyde at the onsite maximum-exposure location under FFTF Decommissioning Alternative 1: No Action that are many times greater than those under FFTF Decommissioning Alternatives 2 and 3 and that would potentially cause adverse impacts on terrestrial ecological receptors. Maximum groundwater concentrations and nearshore surface-water and sediment concentrations resulting from all FFTF Decommissioning alternatives would not pose a toxicological risk to aquatic and riparian receptors exposed at the Columbia River. Potential long-term impacts under FFTF Decommissioning alternatives on ecological resources are discussed in greater detail in Chapter 5, Section 5.2.3, and the uncertainties associated with risk indices calculated using environmental concentrations predicted for air and groundwater releases under the FFTF Decommissioning alternatives are discussed in Appendix P.

Table 2–29. FFTF Decommissioning Alternatives – Long-Term Impacts of Contaminant Releases to Groundwater on Aquatic and Riparian Receptors at the Columbia River

FFTF Decommissioning Alternative	Hazard Quotient of Highest-Value COPC by Receptor						
	Benthic Invertebrates	Muskrat	Spotted Sandpiper	Raccoon	Least Weasel	Bald Eagle	Aquatic Biota/ Salmonids
	Technetium-99	Uranium[a]					
1	**2.20×10^{-7}**	**2.73×10^{-5}**	**1.30×10^{-2}**	**2.91×10^{-2}**	**1.28×10^{-3}**	**8.07×10^{-5}**	**5.46×10^{-3}**
2	**2.32×10^{-7}**	0	0	0	0	0	0
3	**8.78×10^{-14}**	0	0	0	0	0	0

[a] Uranium as chemical.

Note: The maximum Hazard Quotient for each receptor is indicated by **bold** text.

Key: COPC=constituent of potential concern; FFTF=Fast Flux Test Facility.

Eutrophication of nearshore surface water as a result of groundwater releases under FFTF Decommissioning alternatives is not expected because nitrate would not occur in groundwater discharging at the Columbia River under these alternatives.

2.9.2.4 Environmental Justice

The long-term human health analysis determined that the impacts of FFTF decommissioning actions would be greatest under FFTF Decommissioning Alternative 1. Under this alternative, none of the hypothetical receptors at any of the assessment boundaries would receive a radiation dose in excess of regulatory limits or a chemical exposure with a Hazard Index greater than 1. The greatest risk would be to the American Indian resident farmer at the FFTF barrier. During the year of peak dose, this receptor would receive a radiation dose of 3.8 millirem compared with the regulatory limit of 100 millirem from all sources. During the year of peak Hazard Index, this receptor would be exposed to chemicals resulting in a Hazard Index less than 1. Therefore, none of the FFTF Decommissioning alternatives would pose a disproportionately high and adverse long-term human health risk to the American Indian population at offsite locations.

2.9.3 Waste Management Alternatives: Long-Term Environmental Impacts

2.9.3.1 Water Quality

This section discusses the long-term impacts on groundwater quality from waste management sources (i.e., contaminants from disposal at trenches 31 and 34, IDF-East, IDF-West, and the proposed RPPDF). Long-term impacts on groundwater quality from sources remaining within the tank farm barrier boundaries and from sources within the FFTF barrier boundary are discussed in Sections 2.9.1.1 and 2.9.2.1, respectively. Three assessment boundaries were selected for the groundwater analysis based on a combination of regulatory, permit, and land-use requirements. For Waste Management alternatives, the innermost (i.e., closest to the source) area of analysis comprises the engineered barriers that would be installed above the IDF, proposed RPPDF, and trenches 31 and 34 in LLBG 218-W-5 (see Figure 2–78). Very little groundwater transport would occur between the time the contaminants encounter the aquifer and the time they pass beneath the outer perimeter of the barriers; in general, the greatest water quality impacts would occur at these innermost assessment boundaries.

The second area of analysis is established by the location of the Core Zone Boundary. The Core Zone Boundary is approximated by a rectangle encompassing the entire area that would be directly affected by candidate facilities. The Core Zone Boundary represents the "fence line" of the projected waste management operational facilities for each of the alternatives. The aquifer beneath the western portion of Core Zone Boundary has relatively low groundwater flux, which results in relatively high peak groundwater impacts. The eastern portion of the Core Zone Boundary is in an area of high groundwater flux, and peak groundwater impacts in the eastern part of the Core Zone Boundary would be correspondingly lower.

The third area of analysis is the Columbia River nearshore. It approximates the location where contaminants in the groundwater system discharge into the surface-water system. Water quality impacts at the Columbia River reflect the superimposition of releases from individual sources.

Groundwater impacts are described in terms of the concentrations of the COPC drivers at the assessment boundaries under the alternative considered. The COPC drivers are tritium, iodine-129, technetium-99, uranium-238, chromium, nitrate, and total uranium. They fall into three categories. Iodine-129, technetium-99, chromium, and nitrate are all mobile (i.e., move with groundwater) and long-lived (relative to the 10,000-year period of analysis), or stable. They are essentially conservative tracers. Tritium is also mobile, but short-lived. The half-life of tritium is less than 13 years, and tritium concentrations are strongly attenuated by radioactive decay during travel through the vadose zone and groundwater systems. Finally, uranium-238 and total uranium are long-lived, or stable, but are not as mobile as the other COPC drivers. These constituents move about seven times more slowly than groundwater. The other COPCs that were analyzed do not significantly contribute to risk or hazard during the period of analysis because of limited inventory, high retardation factors (i.e., retention in the vadose zone), short half-lives (i.e., rapid radioactive decay), or a combination of these factors.

The maximum concentrations of the COPC drivers are reported at the trenches 31 and 34 barrier under Waste Management Alternative 1 (see Table 2–30); at the IDF-East and proposed RPPDF barriers under Waste Management Alternative 2 (see Tables 2–31 and 2–32); and at the IDF-East, IDF-West, and proposed RPPDF barriers under Waste Management Alternative 3 (see Tables 2–33 through 2–35). Tables 2–36 and 2–37 show the maximum concentrations at the Core Zone Boundary under Waste Management Alternatives 2 and 3, respectively. Tables 2–38 and 2–39 show the maximum concentrations under Waste Management Alternatives 2 and 3 at the Columbia River nearshore.

Under Waste Management Alternative 1, no wastes would be disposed of in an IDF or the proposed RPPDF, and the sources of groundwater contamination are trenches 31 and 34. Note that Waste Management Alternative 1 is predicated on, and can be considered only in conjunction with, Tank Closure Alternative 1 and FFTF Decommissioning Alternative 1 (the No Action Alternatives). The maximum concentrations of the COPC drivers are reported at the trenches 31 and 34 barrier under Waste Management Alternative 1 in Table 2–30. All of the projected maximum groundwater concentrations are near (or below) two orders of magnitude lower than benchmark concentrations. Waste Management Alternative 1 impacts at the Core Zone Boundary and the Columbia River nearshore are essentially negligible.

Under Waste Management Alternative 2, wastes would be disposed of in IDF-East and the proposed RPPDF. Under Waste Management Alternative 2, wastes would be disposed of in IDF-East, IDF-West, and the proposed RPPDF. Waste Management Alternatives 2 and 3 are considered in conjunction with one of the Tank Closure action alternatives (i.e., 2A through 6C) and FFTF Decommissioning Alternative 2 or 3. Tables 2–36 and 2–37 show the maximum concentrations at the Core Zone Boundary under Waste Management Alternatives 2 and 3, respectively. Under Waste Management Alternative 2, concentrations of technetium-99 and iodine-129 are within an order of magnitude of benchmark standards for all disposal groups and exceed the benchmark in several cases. Under Waste Management

Alternative 3, concentrations of technetium-99 and iodine-129 exceed benchmark standards for all disposal groups. Because of the higher infiltration rate at IDF-West, dividing the waste load between IDF-East and IDF-West (Waste Management Alternative 3) does not result in lower groundwater impacts at the Core Zone Boundary. Tables 2–38 and 2–39 show the maximum concentrations at the Columbia River nearshore under Waste Management Alternatives 2 and 3, respectively. Groundwater concentration levels are mildly attenuated (relative to concentrations at the Core Zone Boundary), but the results again indicate that disposing of some wastes in IDF-West does not result in lower groundwater impacts.

Table 2–30. Waste Management Alternative 1 Maximum COPC Concentrations in the Peak Year at Trenches 31 and 34

Contaminant	Waste Management Alternative 1	Benchmark Concentration
Radionuclide (picocuries per liter)		
Hydrogen-3 (tritium)	0 N/A	20,000
Technetium-99	7 (3443)	900
Iodine-129	0 N/A	1
Uranium isotopes (includes uranium-233, -234, -235, -238)	0 N/A	15
Chemical (micrograms per liter)		
Chromium	1 (3490)	100
Nitrate	18 (3514)	45,000
Total uranium	0 N/A	30

Note: Calendar year of peak concentration shown in parentheses.
Key: COPC=constituent of potential concern; N/A=not applicable.

Table 2–31. Waste Management Alternative 2 Maximum COPC Concentrations in the Peak Year at the 200-East Area Integrated Disposal Facility

Contaminant	Waste Management Alternative 2												
	Disposal Group 1							Disposal Group 2			Disposal Group 3		Benchmark Concentration
	Subgroup							Subgroup					
	1-A	1-B	1-C	1-D	1-E	1-F	1-G	2-A	2-B, Base Case	2-B, Option Case	Base Case	Option Case	
Radionuclide (picocuries per liter)													
Hydrogen-3 (tritium)	0 N/A												20,000
Technetium-99	**1,290** (7826)	**1,540** (7629)	**2,990** (10,774)	**1,390** (8054)	**3,860** (10,921)	**1,450** (7985)	**1,260** (7826)	**2,310** (7764)	**2,300** (8138)	**2,300** (7672)	**2,440** (7672)	**2,420** (7678)	900
Iodine-129	**2** (7907)							**4** (8097)		**4** (7847)	**4** (8036)		1
Uranium isotopes (includes uranium -233, -234, -235, -238)	0 N/A												15
Chemical (micrograms per liter)													
Chromium	2 (8438)	1 (8691)	**295** (8608)	19 (11,378)	**175** (9008)	**295** (8882)	2 (8555)	2 (8791)	2 (8251)	2 (8501)	2 (8326)	2 (8501)	100
Nitrate	12,100 (7962)	10,300 (8052)	42,600 (8888)	11,500 (8207)	27,200 (8700)	19,400 (8206)	12,100 (7962)	9,300 (7960)	9,590 (7983)	14,600 (7954)	9,590 (7983)	14,600 (7954)	45,000
Total uranium	0 N/A												30

Note: Calendar year of peak concentration shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; N/A=not applicable.

Table 2–32. Waste Management Alternative 2 Maximum COPC Concentrations in the Peak Year at the River Protection Project Disposal Facility

Contaminant	Waste Management Alternative 2												
	Disposal Group 1							Disposal Group 2			Disposal Group 3		Benchmark Concentration
	Subgroup							Subgroup					
	1-A	1-B	1-C	1-D	1-E	1-F	1-G	2-A	2-B, Base Case	2-B, Option Case	Base Case	Option Case	
Radionuclide (picocuries per liter)													
Hydrogen-3 (tritium)	0 N/A					N/A	0 N/A	N/A	0 N/A				20,000
Technetium-99	42 (3818)				107 (3785)	N/A	42 (3818)	N/A	155 (3769)	220 (3812)	147 (3896)	235 (4018)	900
Iodine-129	0.1 (3747)				0.2 (3824)	N/A	0.1 (3747)	N/A	0.3 (3746)	0.4 (3858)	0.3 (4027)	0.4 (3919)	1
Uranium isotopes (includes uranium-233, -234, -235, -238)	0 N/A					N/A	0 N/A	N/A	0 N/A				15
Chemical (micrograms per liter)													
Chromium	2.7 (3740)				6.8 (3666)	N/A	2.7 (3740)	N/A	3.7 (3710)	33.9 (3807)	3.8 (3869)	32.3 (3873)	100
Nitrate	180 (3670)				286 (3728)	N/A	180 (3670)	N/A	277 (3789)	9,860 (3733)	248 (3783)	9,270 (3930)	45,000
Total uranium	0 N/A					N/A	0 N/A	N/A	0 N/A				30

Note: Calendar year of peak concentration shown in parentheses.

Key: COPC=constituent of potential concern; N/A=not applicable.

Table 2–33. Waste Management Alternative 3 Maximum COPC Concentrations in the Peak Year at the 200-East Area Integrated Disposal Facility

Contaminant	Waste Management Alternative 3												Benchmark Concentration
	Disposal Group 1							Disposal Group 2			Disposal Group 3		
	Subgroup							Subgroup					
	1-A	1-B	1-C	1-D	1-E	1-F	1-G	2-A	2-B, Base Case	2-B, Option Case	Base Case	Option Case	
Radionuclide (picocuries per liter)													
Hydrogen-3 (tritium)	0 N/A												20,000
Technetium-99	206 (10,129)	**1,430** (7629)	**2,970** (10,774)	**1,160** (11,434)	**3,840** (10,921)	**1,380** (8878)	208 (11,385)	193 (10,056)	194 (10,188)	196 (9705)	194 (10,188)	196 (9705)	900
Iodine-129	**1.0** (10,177)	**1.1** (9967)	0.4 (9623)	**1.2** (11,054)	0.7 (10,997)	0.8 (9723)	**1.0** (10,177)	0.8 (9950)	0.8 (9907)	0.9 (11,811)	0.8 (9907)	0.9 (11,811)	1
Uranium isotopes (includes uranium-233, -234, -235, -238)	0 N/A												15
Chemical (micrograms per liter)													
Chromium	2 (8438)	1 (8691)	**295** (8608)	19 (11,378)	**175** (9008)	**295** (8882)	2 (8555)	2 (8791)	2 (8251)	2 (8152)	2 (8251)	2 (8501)	100
Nitrate	12,100 (7962)	10,300 (8052)	42,600 (8888)	11,500 (8207)	27,200 (8700)	19,400 (8206)	12,100 (7962)	9,300 (7960)	9,590 (7983)	14,600 (7954)	9,590 (7983)	14,600 (7954)	45,000
Total uranium	0 N/A												30

Note: Calendar year of peak concentration shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; N/A=not applicable.

Table 2–34. Waste Management Alternative 3 Maximum COPC Concentrations in the Peak Year at the 200-West Area Integrated Disposal Facility

Contaminant	Waste Management Alternative 3												Benchmark Concentration
	Disposal Group 1							Disposal Group 2			Disposal Group 3		
	Subgroup							Subgroup					
	1-A	1-B	1-C	1-D	1-E	1-F	1-G	2-A	2-B, Base Case	2-B, Option Case	Base Case	Option Case	
Radionuclide (picocuries per liter)													
Hydrogen-3 (tritium)	0 N/A												20,000
Technetium-99	**13,200** (3818)												900
Iodine-129	**21** (3794)												1
Uranium isotopes (includes uranium-233, -234, -235, -238)	0 N/A												15
Chemical (micrograms per liter)													
Chromium	1 (3813)												100
Nitrate	7 (3927)												45,000
Total uranium	0 N/A												30

Note: Calendar year of peak concentration shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.
Key: COPC=constituent of potential concern; N/A=not applicable.

Table 2–35. Waste Management Alternative 3 Maximum COPC Concentrations in the Peak Year at the River Protection Project Disposal Facility

Contaminant	Waste Management Alternative 3												
	Disposal Group 1							Disposal Group 2			Disposal Group 3		Benchmark Concentration
	Subgroup							Subgroup					
	1-A	1-B	1-C	1-D	1-E	1-F	1-G	2-A	2-B, Base Case	2-B, Option Case	Base Case	Option Case	
Radionuclide (picocuries per liter)													
Hydrogen-3 (tritium)	0 N/A					N/A	0 N/A	N/A	0 N/A				20,000
Technetium-99	42 (3818)				107 (3785)	N/A	42 (3818)	N/A	155 (3769)	220 (3812)	147 (3896)	235 (4018)	900
Iodine-129	0.1 (3747)				0 (3824)	N/A	0.1 (3747)	N/A	0.3 (3746)	0.4 (3858)	0.3 (4027)	0.4 (3919)	1
Uranium isotopes (includes uranium-233, -234, -235, -238)	0 N/A					N/A	0 N/A	N/A	0 N/A				15
Chemical (micrograms per liter)													
Chromium	3 (3740)				7 (3666)	N/A	3 (3740)	N/A	4 (3710)	34 (3807)	4 (3869)	32 (3873)	100
Nitrate	180 (3670)				286 (3728)	N/A	180 (3670)	N/A	277 (3789)	9,860 (3733)	248 (3783)	9,270 (3930)	45,000
Total uranium	0 N/A					N/A	0 N/A	N/A	0 N/A				30

Note: Calendar year of peak concentration shown in parentheses.

Key: COPC=constituent of potential concern; N/A=not applicable.

Table 2–36. Waste Management Alternative 2 Maximum COPC Concentrations in the Peak Year at the Core Zone Boundary

Contaminant	Waste Management Alternative 2												Benchmark Concentration
	Disposal Group 1							Disposal Group 2			Disposal Group 3		
	Subgroup							Subgroup					
	1-A	1-B	1-C	1-D	1-E	1-F	1-G	2-A	2-B, Base Case	2-B, Option Case	Base Case	Option Case	
Radionuclide (picocuries per liter)													
Hydrogen-3 (tritium)	0 N/A												20,000
Technetium-99	497 (7709)	748 (7848)	**1,050** (8334)	610 (8237)	**1,390** (9662)	696 (8302)	497 (7709)	556 (7328)	557 (7328)		577 (7891)	577 (7723)	900
Iodine-129	0.9 (7856)			**1.0** (7856)	0.9 (7856)			0.9 (8116)	0.9 (7972)	0.9 (8060)	**1.0** (7914)		1
Uranium isotopes (includes uranium-233, -234, -235, -238)	0 N/A												15
Chemical (micrograms per liter)													
Chromium	0.7 (3846)		**102** (8680)	6.1 (10,691)	52.5 (8873)	77.9 (9057)	0.7 (3846)	0.7 (8053)	3.4 (3977)	28.6 (3901)	3.3 (3701)	28.4 (3865)	100
Nitrate	3,010 (8248)	2,790 (8095)	16,100 (8973)	3,150 (8121)	8,960 (8189)	6,250 (7810)	3,010 (8248)	2,920 (8291)	3,130 (7860)	7,220 (3814)	3,130 (7860)	7,820 (3782)	45,000
Total uranium	0 N/A												30

Note: Calendar year of peak concentration shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.
Key: COPC=constituent of potential concern; N/A=not applicable.

Table 2–37. Waste Management Alternative 3 Maximum COPC Concentrations in the Peak Year at the Core Zone Boundary

Contaminant	Waste Management Alternative 3												
	Disposal Group 1							Disposal Group 2			Disposal Group 3		
	Subgroup							Subgroup					
	1-A	1-B	1-C	1-D	1-E	1-F	1-G	2-A	2-B, Base Case	2-B, Option Case	Base Case	Option Case	Benchmark Concentration
Radionuclide (picocuries per liter)													
Hydrogen-3 (tritium)	0 N/A												20,000
Technetium-99	**1,370** (3859)												900
Iodine-129	**2** (3937)												1
Uranium isotopes (includes uranium-233, -234, -235, -238)	0 N/A												15
Chemical (micrograms per liter)													
Chromium	0.7 (3846)		**102** (8680)	6.1 (10,691)	52.5 (8873)	78 (9057)	0.7 (3846)	0.7 (8053)	3.4 (3977)	28.6 (3901)	3.3 (3701)	28.4 (3865)	100
Nitrate	3,010 (8248)	2,790 (8095)	16,100 (8973)	3,150 (8121)	8,960 (8189)	6,250 (7810)	3,010 (8248)	2,918 (8123)	3,130 (7860)	7,220 (3814)	3,130 (7860)	7,820 (3782)	45,000
Total uranium	0 N/A												30

Note: Calendar year of peak concentration shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.
Key: COPC=constituent of potential concern; N/A=not applicable.

Table 2–38. Waste Management Alternative 2 Maximum COPC Concentrations in the Peak Year at the Columbia River Nearshore

Contaminant	Waste Management Alternative 2												
	Disposal Group 1							Disposal Group 2			Disposal Group 3		
	Subgroup							Subgroup					
	1-A	1-B	1-C	1-D	1-E	1-F	1-G	2-A	2-B, Base Case	2-B, Option Case	Base Case	Option Case	Benchmark Concentration
Radionuclide (picocuries per liter)													
Hydrogen-3 (tritium)	0 N/A												20,000
Technetium-99	377 (8130)	608 (8014)	**904** (10,429)	486 (8130)	**1,170** (10,639)	559 (8014)	379 (8130)	373 (7754)	377 (7754)	379 (7754)	370 (8233)	373 (8233)	900
Iodine-129	0.7 (8067)	0.6 (7796)	0.6 (7749)	0.7 (7749)	0.6 (7749)	0.6 (8067)	0.7 (8067)	0.6 (8221)	0.6 (7780)	0.6 (7973)	0.6 (7755)		1
Uranium isotopes (includes uranium-233, -234, -235, -238)	0 N/A												15
Chemical (micrograms per liter)													
Chromium	0.4 (8236)	0.3 (4250)	78.5 (8594)	4.7 (11,049)	39.8 (8827)	59.6 (8241)	0.4 (8735)	0.5 (7640)	2.0 (4632)	19.1 (4558)	1.9 (4608)	20.8 (4487)	100
Nitrate	2,030 (7535)	2,210 (7940)	12,240 (8783)	2,400 (7899)	6,820 (9059)	4,140 (7984)	2,030 (7535)	1,860 (8406)	2,140 (7994)	4,340 (4606)	2,140 (7994)	5,190 (4701)	45,000
Total uranium	0 N/A												30

Note: Calendar year of peak concentration shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.
Key: COPC=constituent of potential concern; N/A=not applicable.

Table 2–39. Waste Management Alternative 3 Maximum COPC Concentrations in the Peak Year at the Columbia River Nearshore

Contaminant	Waste Management Alternative 3												
	Disposal Group 1							Disposal Group 2			Disposal Group 3		
	Subgroup							Subgroup					
	1-A	1-B	1-C	1-D	1-E	1-F	1-G	2-A	2-B, Base Case	2-B, Option Case	Base Case	Option Case	Benchmark Concentration
Radionuclide (picocuries per liter)													
Hydrogen-3 (tritium)	0 N/A												20,000
Technetium-99	**1,670** (3920)												900
Iodine-129	**2** (3872)												1
Uranium isotopes (includes uranium-233, -234, -235, -238)	0 N/A												15
Chemical (micrograms per liter)													
Chromium	0.5 (4481)		78.5 (8594)	4.7 (11,049)	39.8 (8827)	59.6 (8241)	0.5 (4481)	0.4 (7640)	2.2 (4632)	19.3 (4558)	2.1 (4608)	20.9 (4487)	100
Nitrate	2,030 (7535)	2,210 (7940)	12,240 (8783)	2,400 (7899)	6,820 (9059)	4,140 (7984)	2,030 (7535)	1,860 (8406)	2,140 (7994)	4,340 (4606)	2,140 (7994)	5,190 (4701)	45,000
Total uranium	0 N/A												30

Note: Calendar year of peak concentration shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; N/A=not applicable.

The location where the maximum concentrations would occur varies with time, contaminant, and alternative. The benchmark concentration for each contaminant is provided for comparison. The benchmark concentrations include EPA MCLs (i.e., primary drinking water standards), EPA interim drinking water standards, DOE-derived concentration guides, and other standards known or accepted to be associated with a specific level of effect. Core Zone Boundary, Columbia River nearshore, proposed RPPDF, and IDF concentrations that would exceed the benchmark concentrations are indicated in bold text. As discussed in Section 2.9, three disposal groups were developed to facilitate analysis of the potential Hanford waste management construction, operations, and closure requirements.

Under Waste Management Alternative 1, there are no exceedances of benchmarks. Under Waste Management Alternative 2, iodine-129 and technetium-99 maximum concentrations at the Core Zone Boundary range from about half of the benchmark to just over the benchmark. Under Waste Management Alternative 3, iodine-129 and technetium-99 maximum concentrations are about twice their benchmarks. The concentration signatures are dominated by contributions from tank farm secondary waste, disposal of offsite waste, and tank farm supplemental-treatment waste forms (in declining order of impact).

The magnitude of the impacts can be represented in terms of the total amounts of the COPC drivers released to the vadose zone from all sources related to a particular alternative. Releases of radionuclides are totaled in curies over the 10,000-year period of analysis. The total amounts of iodine-129 and technetium-99 released to the vadose zone under the Waste Management alternatives are presented in Figures 2–96 and 2–97, respectively. The magnitude of the impact of Waste Management alternatives is governed by inventory and waste form performance. For iodine-129, the magnitude of Waste Management Alternative 2 and 3 impacts is nearly constant under all disposal groups and is driven by the inventory of iodine-129 in offsite waste disposed of in an IDF. For technetium-99, the primary factor is the same as that for iodine-129, followed by differential retention in supplemental-treatment and secondary-waste forms.

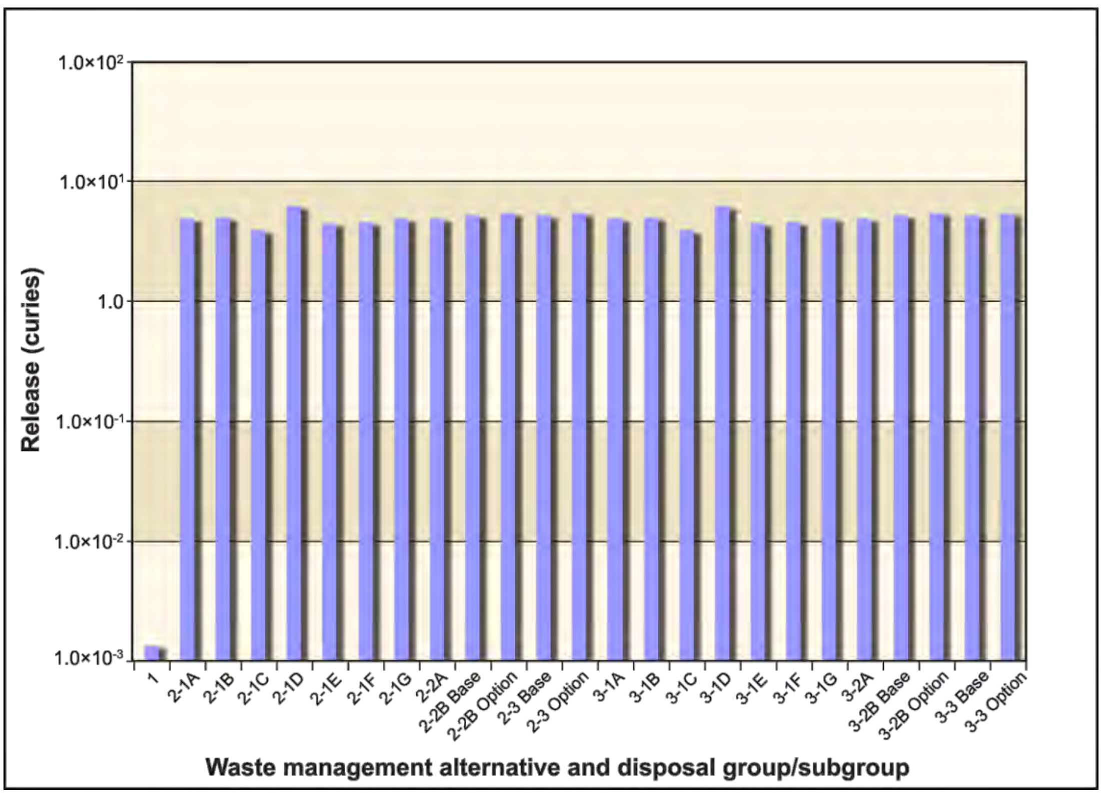


Figure 2–96. Waste Management Alternatives – Total Iodine-129 Released to the Vadose Zone

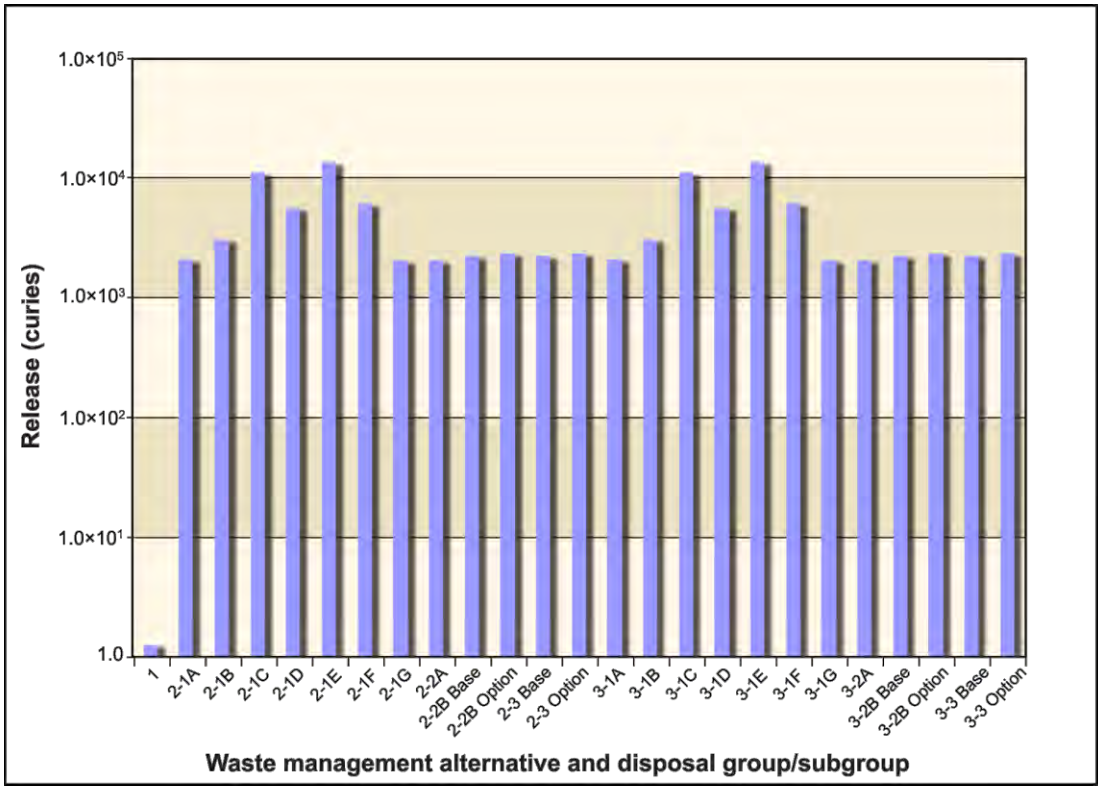


Figure 2–97. Waste Management Alternatives – Total Technetium-99 Released to the Vadose Zone

The peak impact can be represented in terms of the peak concentrations of the COPC drivers at the Core Zone for each of the Waste Management alternatives. The peak concentrations of iodine-129 and technetium-99 at the Core Zone Boundary presented in tabular form above (see Tables 2–36 and 2–37) are depicted in Figures 2–98 and 2–99, respectively. The peak impact of the Waste Management alternatives is governed by inventory (Waste Management Alternative 1 has the lowest inventory and the lowest peak intensity), by location (Waste Management Alternative 2 is located at IDF-East, with a lower infiltration rate and consequently lower rate of movement through the vadose zone than Waste Management Alternative 3, which has waste disposal in both IDF-East and IDF-West), and by rate of release from the waste form (which ranges from highest to lowest, starting with Disposal Group 1, Subgroup 1-D, which is dominated by steam reforming waste; then Subgroup 1-C, which is dominated by cast stone waste; then Subgroups 1-E and 1-F, which have a combination of cast stone waste and bulk vitrification glass; then Subgroup 1-B, which is dominated by bulk vitrification glass; and finally Subgroup 1-A, which is dominated by ILAW glass).

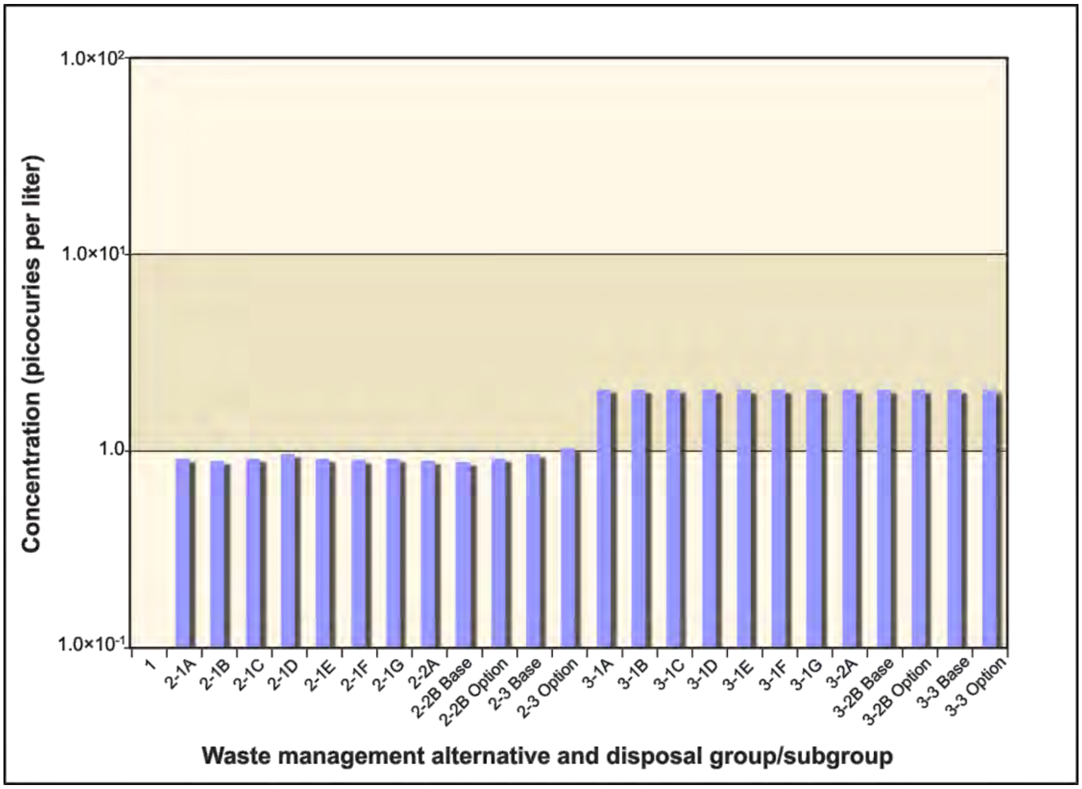


Figure 2–98. Waste Management Alternatives – Peak Iodine-129 Concentrations at the Core Zone Boundary

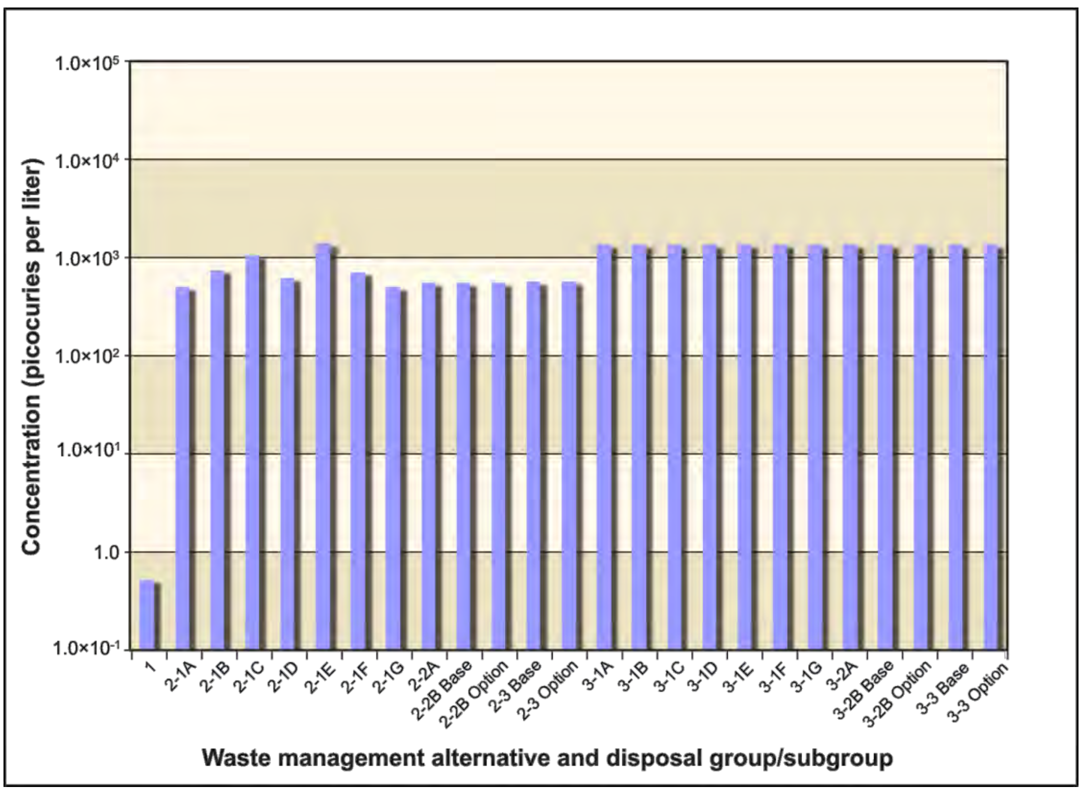


Figure 2–99. Waste Management Alternatives – Peak Technetium-99 Concentrations at the Core Zone Boundary

2.9.3.2 Human Health

Implementation of activities defined for the Waste Management alternatives could lead to releases of radioactive and chemical constituents to the environment over long periods of time. Under Waste Management Alternative 1, these releases would come from LLBG 218-W-5, trenches 31 and 34; under Waste Management Alternative 2, from IDF-East and the proposed RPPDF; and under Waste Management Alternative 3, from IDF-East, IDF-West, and the proposed RPPDF.

The four measures of human health impacts considered in this analysis—lifetime risks of developing cancer from radioactive and chemical constituents, dose from radionuclides, and Hazard Index from noncarcinogenic chemical constituents—were calculated for each year for 10,000 years for each receptor at six locations (IDF-East, IDF-West, the proposed RPPDF, Core Zone Boundary, Columbia River nearshore, and surface water of the Columbia River). This is a large amount of information that must be summarized to allow interpretation of results. The method chosen is to present dose for the year of maximum dose, risk for the year of maximum risk, and Hazard Index for the year of maximum Hazard Index. This choice is based on regulation of radiological impacts expressed as dose and the observation that peak risk and peak noncarcinogenic impacts expressed as a Hazard Index may occur at times other than that of peak dose. The significance of the dose impacts is evaluated by comparison against the 100-millirem-per-year all-exposure-modes standard specified for protection of the public and the environment in DOE Order 458.1. Population doses are compared against a total effective dose equivalent from natural background sources of 311 millirem per year for a member of the population of the United States (NCRP 2009). The level of protection provided for the drinking water pathway was evaluated by comparison against the MCLs of EPA's primary drinking water regulations (40 CFR 141) and other benchmarks, as presented in Appendix O. To reduce their size, the tables in the following sections present only those radionuclides and chemical constituents that resulted in a lifetime risk greater than 1×10^{-10} for all receptors at a given location.

The results of the analysis for the drinking-water well user at the Core Zone Boundary are summarized below. Impacts on other types of receptors vary in proportion to the impacts on the drinking-water well user and do not provide additional information to discriminate among alternatives.

2.9.3.2.1 Waste Management Alternative 1

Under Waste Management Alternative 1, only those wastes currently generated on site at Hanford from non-CERCLA actions would continue to be disposed of in LLBG 218-W-5, trenches 31 and 34. Although the short-term impacts do not address the impacts associated with closure activities for this site, for long-term impacts analysis purposes, it was assumed that these trenches would be closed using an RCRA-compliant barrier consistent with the closure plans for these burial grounds. As a result, the non-CERLCA waste to be disposed of in these trenches from 2008 to 2035 is assumed to become available for release to the environment. The maximum dose and maximum Hazard Index from the groundwater analysis of Waste Management Alternative 1 for the drinking-water well user are summarized in Tables 2–40 and 2–41. The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129. These rather mobile radionuclides move at the same velocity as groundwater. The key chemical constituent contributors would be boron and boron compounds, chromium, fluoride, and nitrate. For radionuclides, the dose standard would not be exceeded at any location. In addition, the Hazard Index would not be exceeded at any location. The population dose for the year of maximum impact was estimated to be 2.23×10^{-4} person-rem, approximately 1×10^{-8} percent of the background dose.

Table 2–40. Waste Management Alternative 1 Summary of Radiation Dose at Year of Peak Dose for the Drinking-Water Well User

Location	Alternative 1 (millirem per year)
LLBG 218-W-5, trenches 31 and 34	1.39×10^{-2} (3434)
Core Zone Boundary	9.90×10^{-4} (3462)
Columbia River nearshore	2.42×10^{-3} (3980)

Note: Calendar year of peak impact shown in parentheses.
Key: LLBG=low-level radioactive waste burial ground.

Table 2–41. Waste Management Alternative 1 Summary of Hazard Index at Year of Peak Hazard Index for the Drinking-Water Well User

Location	Alternative 1
LLBG 218-W-5, trenches 31 and 34	1.00×10^{-2} (3490)
Core Zone Boundary	6.87×10^{-4} (3519)
Columbia River nearshore	1.66×10^{-3} (3993)

Note: Calendar year of peak impact shown in parentheses.
Key: LLBG=low-level radioactive waste burial ground.

Figure 2–100 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user. The peak radiological risk would occur around CY 3460 and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in LLBG 218-W-5, trenches 31 and 34. For all receptor types, including the drinking-water well user, neither the radiological dose standard nor the Hazard Index guideline would be exceeded at the analysis locations due to long-term releases from LLBG 218-W-5 trenches.

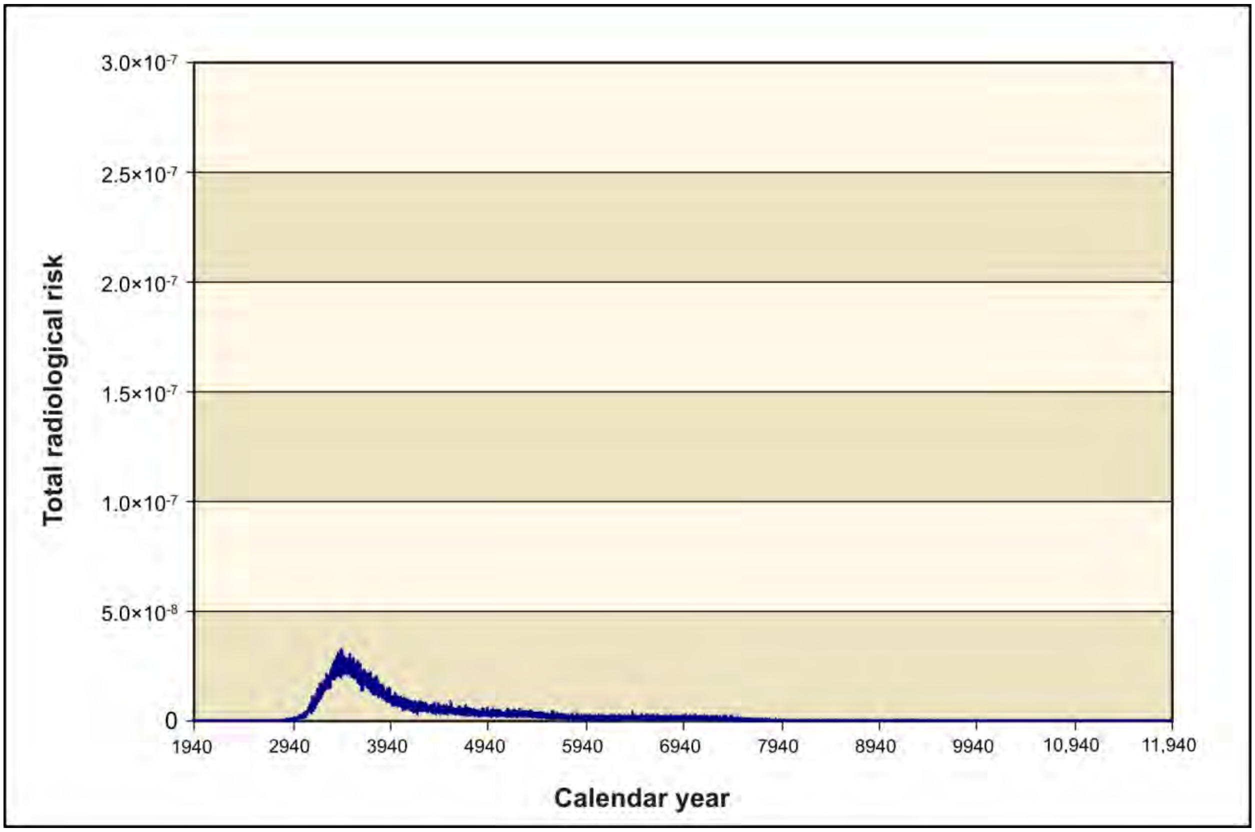


Figure 2–100. Waste Management Alternative 1 Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.2 Waste Management Alternative 2, All Disposal Groups and Subgroups

Under Waste Management Alternative 2, waste from tank treatment operations, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites would be disposed of in IDF-East. Waste from tank farm cleanup activities would be disposed of in the proposed RPPDF. As a result, the waste disposed of in these two facilities is assumed to become available for release to the environment. Because different waste types would result from the Tank Closure action alternatives, three disposal groups were considered to account for the different IDF-East sizes and operational periods. In addition, within these three disposal groups, subgroups were identified to allow consideration of the different waste types resulting from the Tank Closure action alternatives (see Chapter 5, Section 5.3). Potential human health impacts of these subgroups under this alternative are discussed in the following sections. The maximum dose and maximum Hazard Index from the groundwater analysis of Waste Management Alternative 2 for the drinking-water well user are summarized in Tables 2–42 and 2–43. For the drinking-water well user, the radiological dose standard would not be exceeded under any disposal group or subgroup at any analysis location. For the same receptor, the Hazard Index guideline would be exceeded at the IDF-East barrier under Disposal Group 1, Subgroups 1-C (Tank Closure Alternative 3B), 1-E (Tank Closure Alternative 4), and 1-F (Tank Closure Alternative 5), and at the Core Zone Boundary under Disposal Group 1, Subgroup 1-C; it would not, however, be exceeded at other analysis locations under other subgroups of all disposal groups.

Table 2–42. Waste Management Alternative 2, All Disposal Groups and Subgroups, Summary of Radiation Dose at Year of Peak Dose for the Drinking-Water Well User

	Waste Management Alternative 2 (millirem per year)											
	Disposal Group 1							Disposal Group 2			Disposal Group 3	
	Subgroup							Subgroup				
Location	**1-A**	**1-B**	**1-C**	**1-D**	**1-E**	**1-F**	**1-G**	**2-A**	**2-B, Base Case**	**2-B, Option Case**	**Base Case**	**Option Case**
IDF-East	2.70 (7826)	3.06 (8002)	5.31 (10,774)	2.88 (7826)	6.89 (10,921)	3.01 (7826)	2.70 (7826)	5.08 (7644)	5.03 (8117)	5.07 (7644)	5.19 (7678)	5.22 (7832)
RPPDF	8.94×10^{-2} (3818)				2.37×10^{-1} (3785)	N/A	8.94×10^{-2} (3818)	N/A	3.26×10^{-1} (3769)	4.70×10^{-1} (3812)	3.14×10^{-1} (4013)	4.75×10^{-1} (4018)
Core Zone Boundary	1.01 (7439)	1.43 (7848)	1.94 (8334)	1.18 (8237)	2.49 (9662)	1.34 (8302)	1.01 (7439)	1.16 (7328)		1.17 (7328)	1.21 (7891)	1.17 (7723)
Columbia River nearshore	7.56×10^{-1} (7847)	1.17 (8014)	1.60 (10,429)	9.66×10^{-1} (8174)	2.07 (10,639)	1.07 (8014)	7.46×10^{-1} (7847)	7.43×10^{-1} (7754)	7.66×10^{-1} (7754)	7.70×10^{-1} (7754)	7.52×10^{-1} (8233)	7.65×10^{-1} (8233)

Note: Calendar year of peak impact shown in parentheses.

Key: IDF-East=200-East Area Integrated Disposal Facility; N/A=not applicable; RPPDF=River Protection Project Disposal Facility.

Table 2–43. Waste Management Alternative 2, All Disposal Groups and Subgroups, Summary of Hazard Index at Year of Peak Hazard Index for the Drinking-Water Well User

	Waste Management Alternative 2											
	Disposal Group 1							Disposal Group 2			Disposal Group 3	
	Subgroup							Subgroup				
Location	**1-A**	**1-B**	**1-C**	**1-D**	**1-E**	**1-F**	**1-G**	**2-A**	**2-B, Base Case**	**2-B, Option Case**	**Base Case**	**Option Case**
IDF-East	2.29×10^{-1} (7962)	1.89×10^{-1} (8052)	3.40 (8608)	3.05×10^{-1} (8207)	2.08 (9008)	3.03 (8882)	2.29×10^{-1} (7962)	1.77×10^{-1} (7960)	1.82×10^{-1} (7983)	2.78×10^{-1} (7954)	1.82×10^{-1} (7983)	2.78×10^{-1} (7954)
RPPDF	2.84×10^{-2} (3792)				6.92×10^{-2} (3666)	N/A	2.84×10^{-2} (3792)	N/A	3.78×10^{-2} (3710)	4.41×10^{-1} (3680)	3.92×10^{-2} (3929)	4.39×10^{-1} (3916)
Core Zone Boundary	5.76×10^{-2} (8248)	5.16×10^{-2} (8095)	1.11 (8680)	9.26×10^{-2} (8317)	6.26×10^{-1} (8873)	8.21×10^{-1} (8588)	5.78×10^{-2} (8248)	5.65×10^{-2} (8123)	6.05×10^{-2} (7860)	3.56×10^{-1} (3688)	6.05×10^{-2} (7860)	3.75×10^{-1} (3865)
Columbia River nearshore	3.80×10^{-2} (7927)	4.05×10^{-2} (7940)	8.56×10^{-1} (8594)	6.38×10^{-2} (8284)	4.68×10^{-1} (8827)	6.12×10^{-1} (8535)	3.81×10^{-2} (8798)	3.58×10^{-2} (8406)	3.95×10^{-2} (7994)	2.34×10^{-1} (4560)	3.96×10^{-2} (7994)	2.58×10^{-1} (4487)

Note: Calendar year of peak impact shown in parentheses.

Key: IDF-East=200-East Area Integrated Disposal Facility; N/A=not applicable; RPPDF=River Protection Project Disposal Facility.

2.9.3.2.2.1 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A

Disposal Group 1, Subgroup 1-A, addresses the waste resulting from Tank Closure Alternative 2B activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- ILAW glass
- LAW melters
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms to be disposed of in the proposed RPPDF would include those resulting from tank closure cleanup activities under Tank Closure Alternative 2B.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be boron and boron compounds, chromium, fluoride, and nitrate. For the drinking-water well user, neither the radiological dose standard nor the Hazard Index guideline would be exceeded at the analysis locations. The population dose for the year of maximum impact was estimated to be 0.168 person-rem, approximately 1×10^{-5} percent of the background dose.

Figure 2–101 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user. The peak radiological risk would occur around CY 7440 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms to be disposed of in IDF-East.

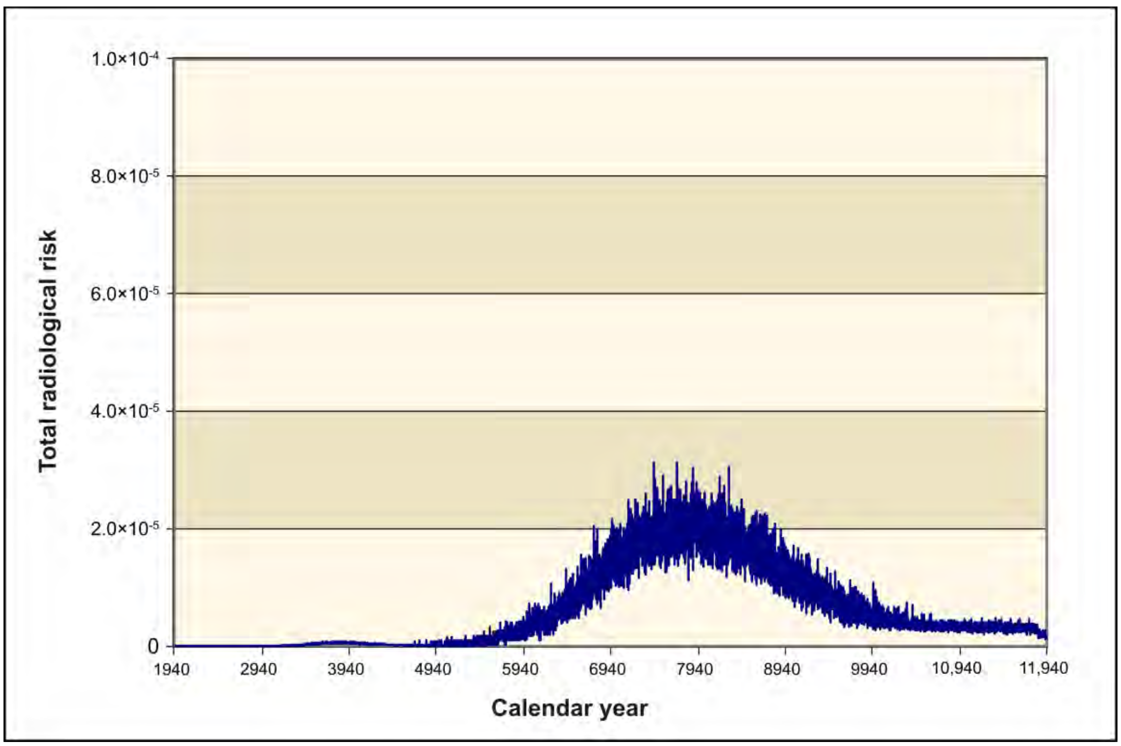


Figure 2–101. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-A, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.2.2 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B

Disposal Group 1, Subgroup 1-B, addresses the waste resulting from Tank Closure Alternative 3A activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms to be disposed of in the proposed RPPDF would include those resulting from tank closure cleanup activities under Tank Closure Alternative 3A.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be boron and boron compounds, chromium, fluoride, and nitrate. For the drinking-water well user, neither the dose standard nor the Hazard Index guideline would be at the analysis locations. The population dose for the year of maximum impact was estimated to be 0.278 person-rem, approximately 2×10^{-5} percent of the background dose.

Figure 2–102 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user. The peak radiological risk would occur around CY 7850 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-East.

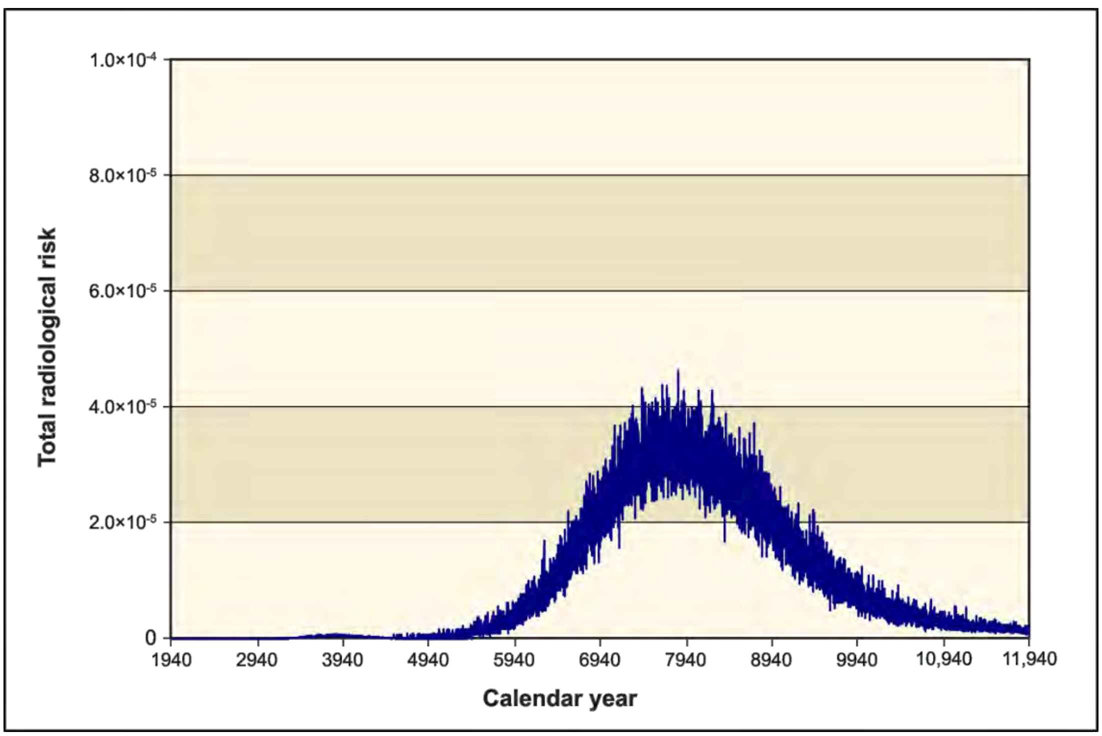


Figure 2–102. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-B, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.2.3 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C

Disposal Group 1, Subgroup 1-C, addresses the waste resulting from Tank Closure Alternative 3B activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- ILAW glass
- LAW melters
- Cast stone waste
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms to be disposed of in the proposed RPPDF would include those resulting from tank closure cleanup activities under Tank Closure Alternative 3B.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be acetonitrile, boron and boron compounds, chromium, fluoride, and nitrate for chemicals. For radionuclides, the dose standard would not be exceeded at any analysis location. However, the Hazard Index guideline would be exceeded at the IDF-East barrier and the Core Zone Boundary for the drinking-water well user due primarily to the presence of chromium. The population dose for the year of maximum impact was estimated to be 0.329 person-rem, approximately 2×10^{-5} percent of the background dose.

Figure 2–103 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user. The peak radiological risk would occur around CY 8330 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-East.

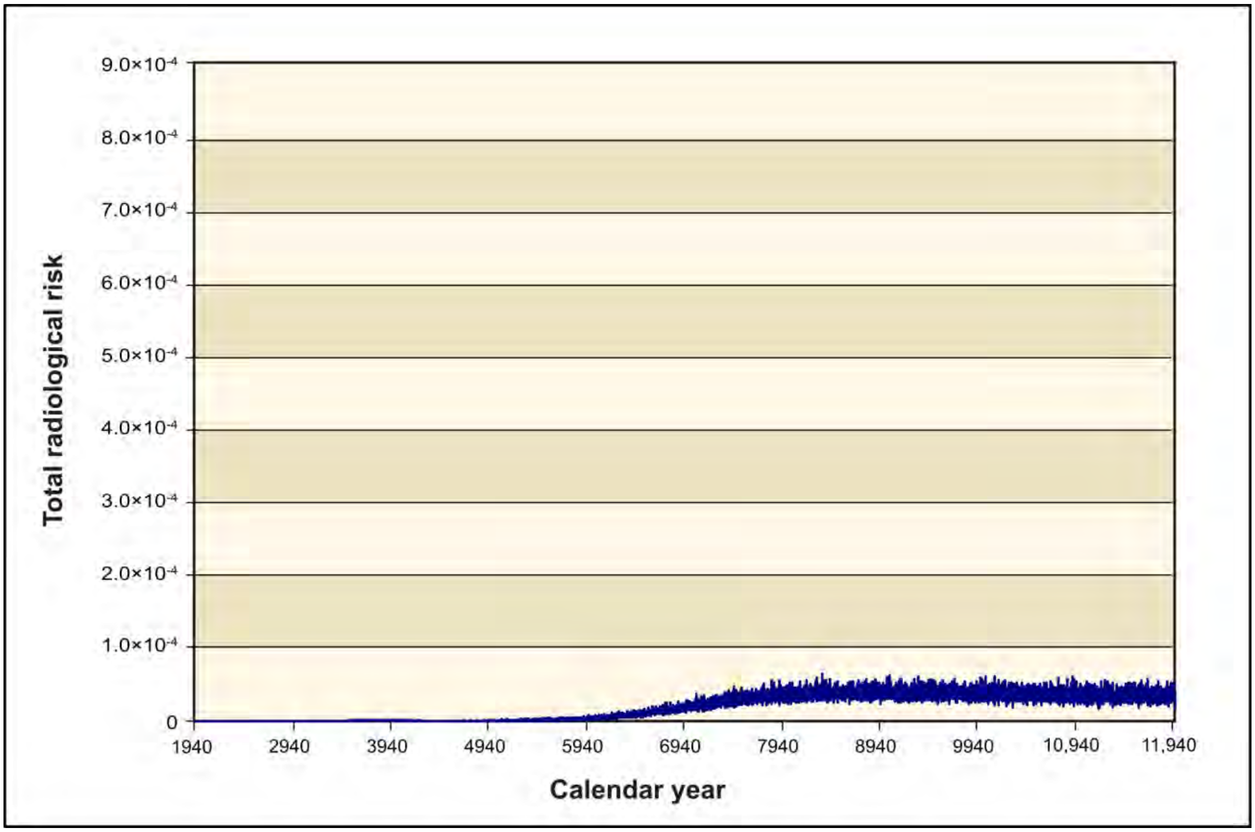


Figure 2–103. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-C, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.2.4 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D

Disposal Group 1, Subgroup 1-D, addresses the waste resulting from Tank Closure Alternative 3C activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- ILAW glass
- LAW melters
- Steam reforming waste
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms to be disposed of in the proposed RPPDF would include those resulting from tank closure cleanup activities under Tank Closure Alternative 3C.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be boron and boron compounds, chromium, fluoride, and nitrate. For the drinking-water well user, neither the radiological dose standard nor the Hazard Index guideline would be exceeded at any analysis location. The population dose for the year of maximum impact was estimated to be 0.211 person-rem, approximately 1×10^{-5} percent of the background dose.

Figure 2–104 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user. The peak radiological risk would occur around CY 8240 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-East.

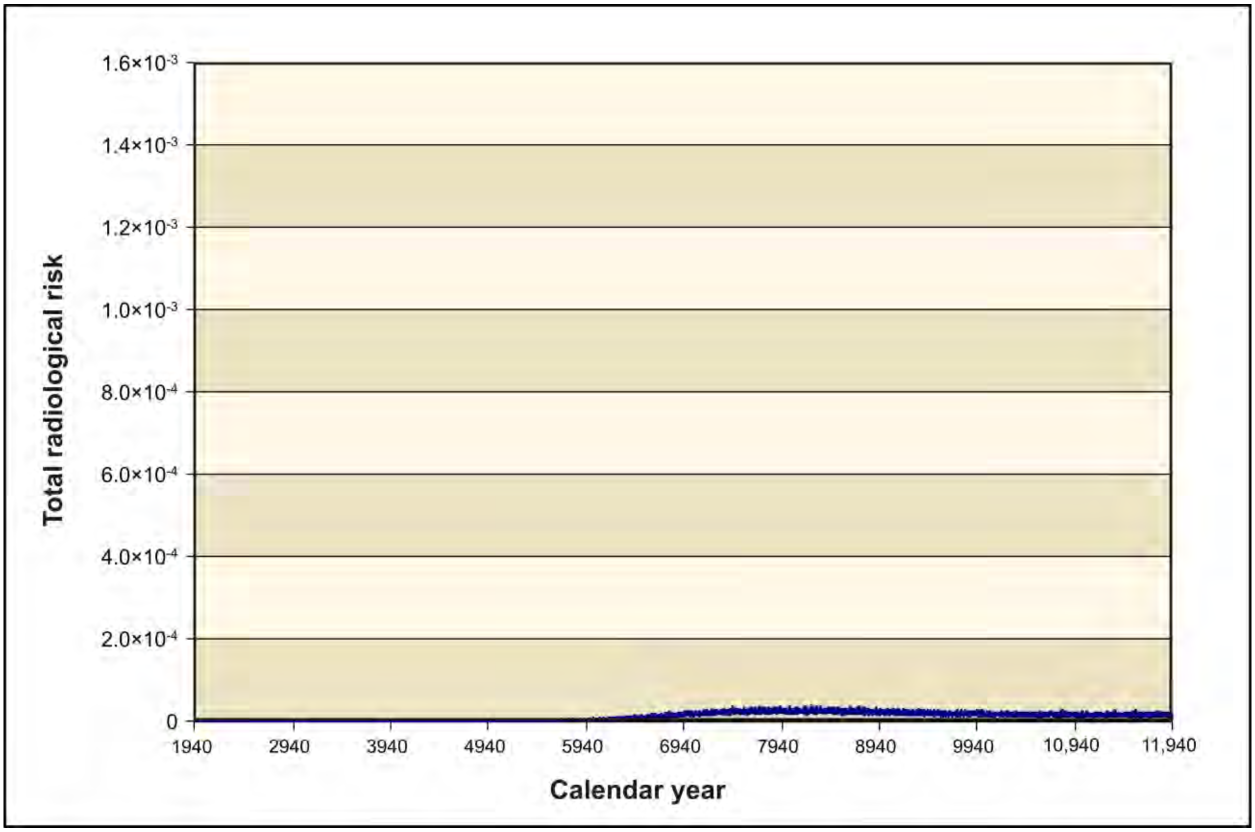


Figure 2–104. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-D, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.2.5 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E

Disposal Group 1, Subgroup 1-E, addresses the waste resulting from Tank Closure Alternative 4 activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Cast stone waste
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms for the proposed RPPDF would include those resulting from tank closure cleanup activities under Tank Closure Alternative 4.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be acetonitrile, boron and boron compounds, chromium, fluoride, and nitrate. For the drinking-water well user, the radiological dose standard would not be exceeded at any analysis location. However, the Hazard Index guideline would be exceeded at the IDF-East barrier for the drinking-water well user due primarily to the presence of chromium. The population dose for the year of maximum impact was estimated to be 0.399 person-rem, approximately 3×10^{-5} percent of the background dose.

Figure 2–105 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user. The peak radiological risk would occur around CY 9660 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-East.

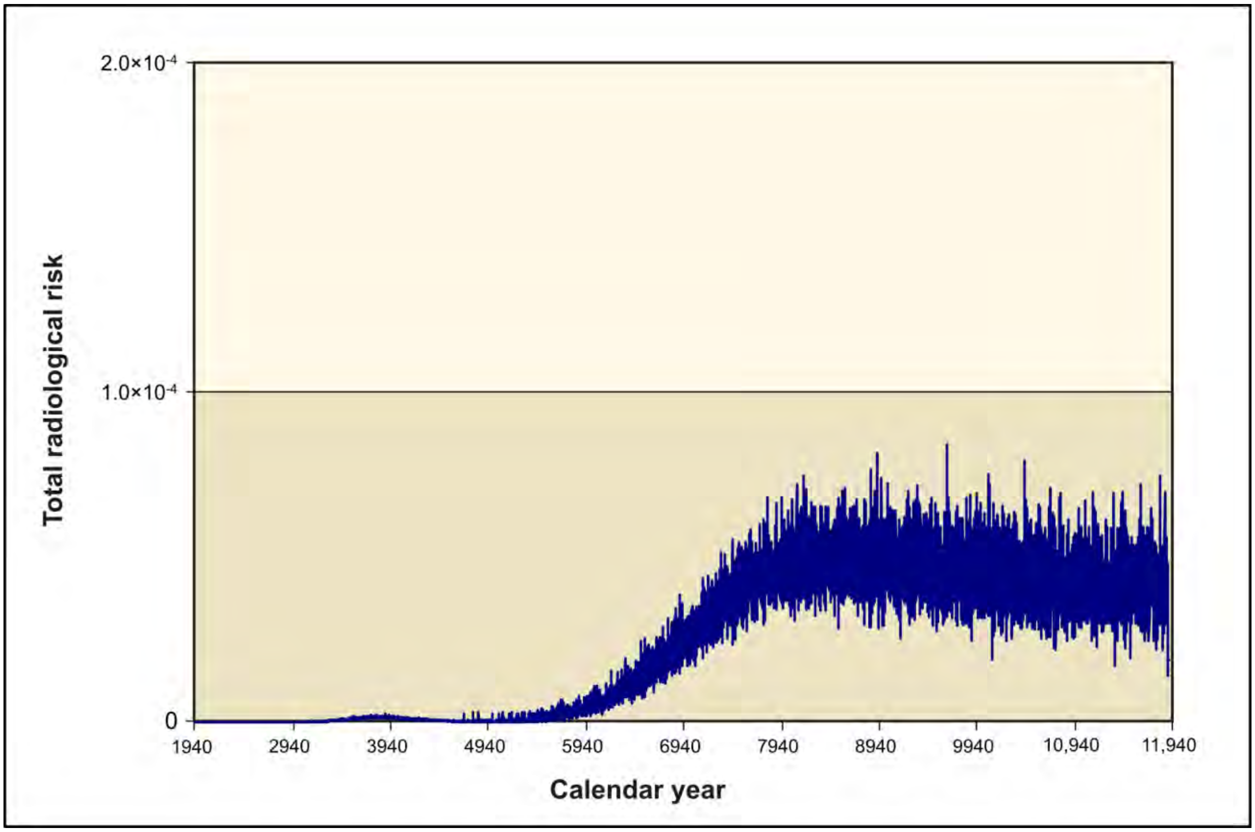


Figure 2–105. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-E, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.2.6 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F

Disposal Group 1, Subgroup 1-F, addresses the waste resulting from Tank Closure Alternative 5 activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Cast stone waste
- Sulfate grout
- Tank closure secondary waste

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

The proposed RPPDF would not be constructed or operated under Tank Closure Alternative 5 because tank closure cleanup activities would not be conducted.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be acetonitrile, boron and boron compounds, chromium, fluoride, and nitrate. For the drinking-water well user, the radiological dose standard would not be exceeded at any analysis location. However, the Hazard Index guideline would be exceeded at the IDF-East barrier for the drinking-water well user due primarily to the presence of chromium. The population dose for the year of maximum impact was estimated to be 0.259 person-rem, approximately 2×10^{-5} percent of the background dose.

Figure 2–106 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user. The peak radiological risk would occur around CY 8300 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-East.

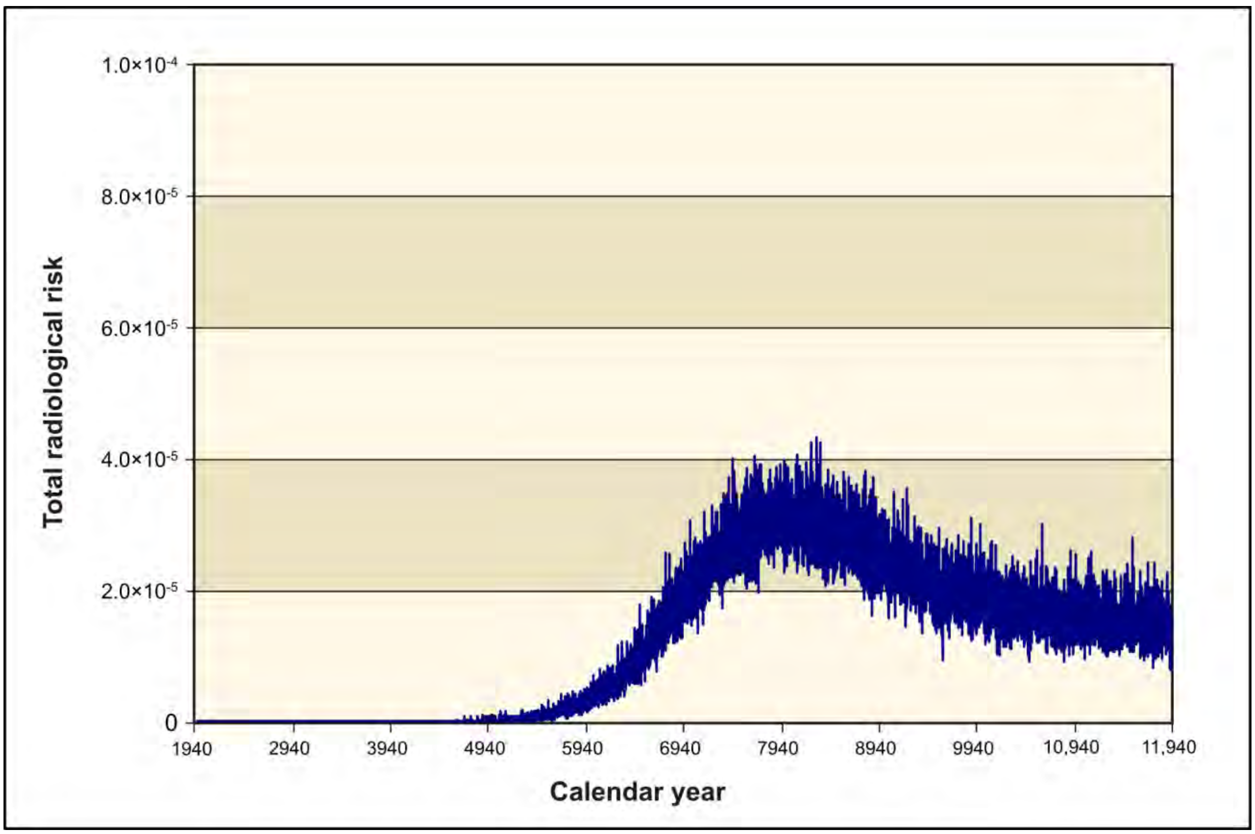


Figure 2–106. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-F, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.2.7 Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G

Disposal Group 1, Subgroup 1-G, addresses the waste resulting from Tank Closure Alternative 6C activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms to be disposed of in the proposed RPPDF would include those resulting from tank closure cleanup activities under Tank Closure Alternative 6C.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be boron and boron compounds, chromium, fluoride, and nitrate. For the drinking-water well user, neither the radiological dose standard nor the Hazard Index guideline would be exceeded at any analysis location. The population dose for the year of maximum impact was estimated to be 0.167 person-rem, approximately 1×10^{-5} percent of the background dose.

Figure 2–107 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user. The peak radiological risk would occur around CY 7440 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-East.

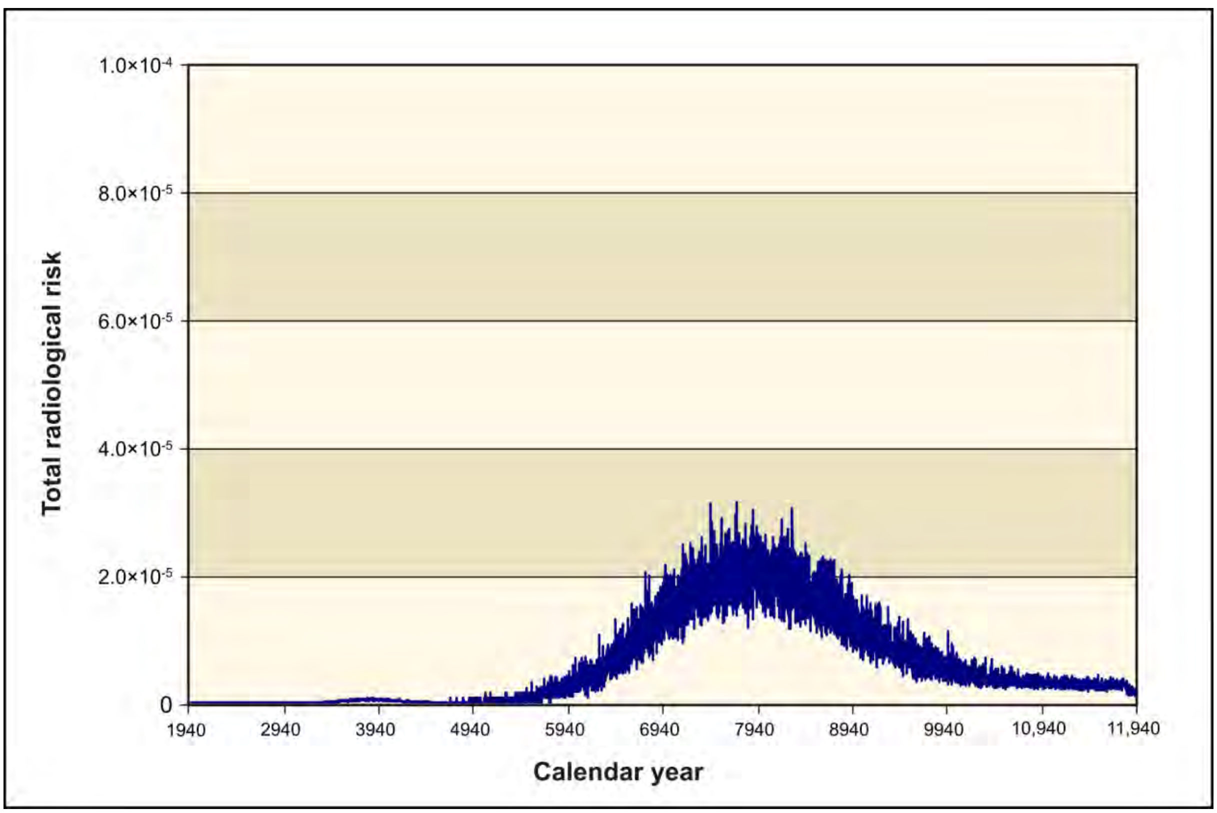


Figure 2–107. Waste Management Alternative 2, Disposal Group 1, Subgroup 1-G, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.2.8 Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A

Disposal Group 2, Subgroup 2-A, addresses the waste resulting from Tank Closure Alternative 2A activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- ILAW glass
- LAW melters
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

The proposed RPPDF would not be constructed or operated under Tank Closure Alternative 2A because tank closure cleanup activities would not be conducted.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be boron and boron compounds, chromium, fluoride, and nitrate. For the drinking-water well user, neither the radiological dose standard nor the Hazard Index would be exceeded at any analysis location. The population dose for the year of maximum impact was estimated to be 0.168 person-rem, approximately 1×10^{-5} percent of the background dose.

Figure 2–108 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user. The peak radiological risk would occur around CY 7330 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-East.

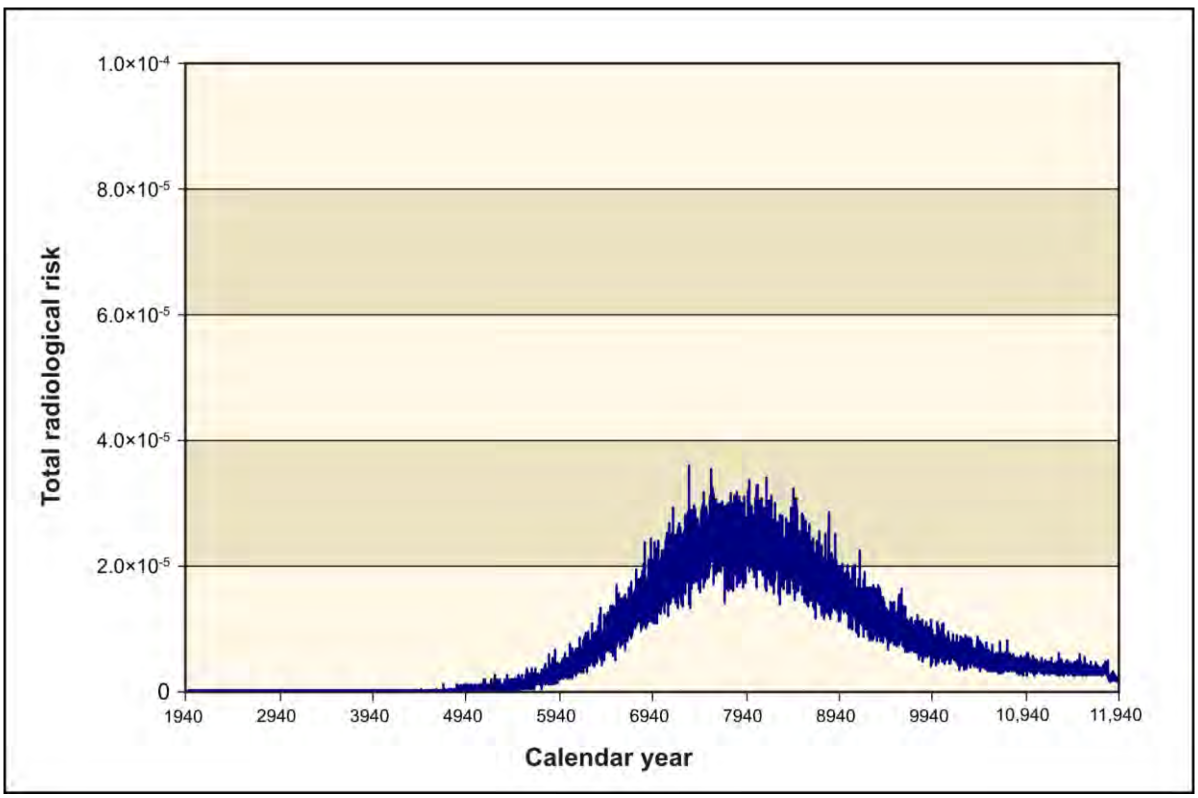


Figure 2–108. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-A, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.2.9 Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B

Disposal Group 2, Subgroup 2-B, addresses the waste resulting from activities under Tank Closure Alternative 6B, Base and Option Cases; onsite non-CERCLA sources; FFTF decommissioning; waste management; and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- PPF glass
- PPF melters
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms to be disposed of in the proposed RPPDF would include those resulting from tank closure cleanup activities under Tank Closure Alternative 6B, Base and Option Cases.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be acetonitrile, boron and boron compounds, chromium, fluoride, nitrate, and total uranium. For the drinking-water well user, neither the radiological dose standard nor the Hazard Index guideline would be exceeded at any analysis location. The population dose for the year of maximum impact was estimated to be 0.165 person-rem under Subgroup 2-B, Base Case, and 0.166 person-rem under Subgroup 2-B, Option Case. Each of these estimates of population dose is approximately 1×10^{-5} percent of the background dose.

Figures 2–109 and 2–110 depict a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user for the Base Case and Option Case, respectively. The early peak in Figures 2–109 and 2–110 is due to releases from the proposed RPPDF, while the later peak is due to releases from IDF-East. Under Subgroup 2-B, both the Base and Option Cases, the peak radiological risk would occur around CY 7330 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-East.

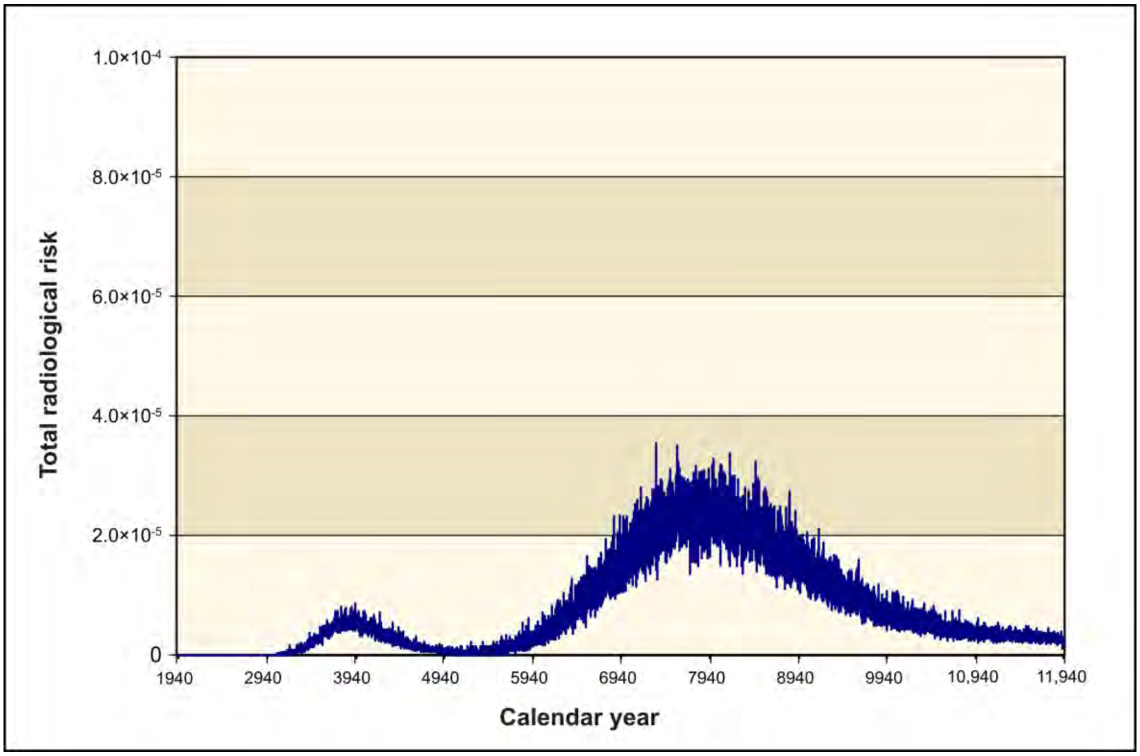


Figure 2–109. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Base Case, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

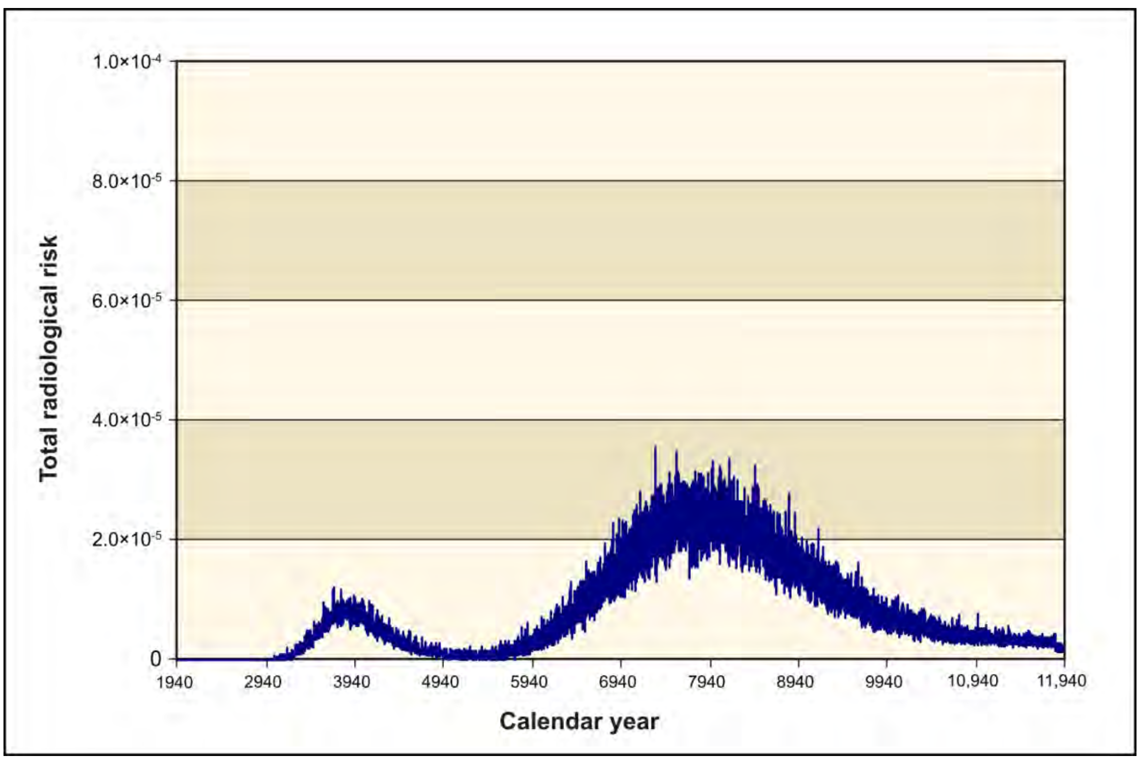


Figure 2–110. Waste Management Alternative 2, Disposal Group 2, Subgroup 2-B, Option Case, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.2.10 Waste Management Alternative 2, Disposal Group 3

Disposal Group 3 addresses the waste resulting from activities under Tank Closure Alternative 6A, Base and Option Cases; onsite non-CERCLA sources; FFTF decommissioning; waste management; and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- PPF glass
- PPF melters
- Tank closure secondary waste
- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms to be disposed of in the proposed RPPDF would include those resulting from tank closure cleanup activities under Tank Closure Alternative 6A, Base and Option Cases.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be acetonitrile, boron and boron compounds, chromium, fluoride, nitrate, and total uranium. For the drinking-water well user under both the Base and Option Cases, neither the radiological dose standard nor the Hazard Index guideline would be exceeded. The population dose for the year of maximum impact was estimated to be 0.171 person-rem under Disposal Group 3, Base Case, and 0.173 person-rem under Disposal Group 3, Option Case. Each of these estimates of population dose is approximately 1×10^{-5} percent of the background dose.

Figures 2–111 and 2–112 depict a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user under the Base Case and Option Case, respectively. The early peak in Figures 2–111 and 2–112 is due to releases from the proposed RPPDF, while the later peak is due to releases from IDF-East. Under the Base Case, the peak radiological risk would occur around CY 7890 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-East. Under the Option Case, the peak radiological risk would occur around CY 7720 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-East.

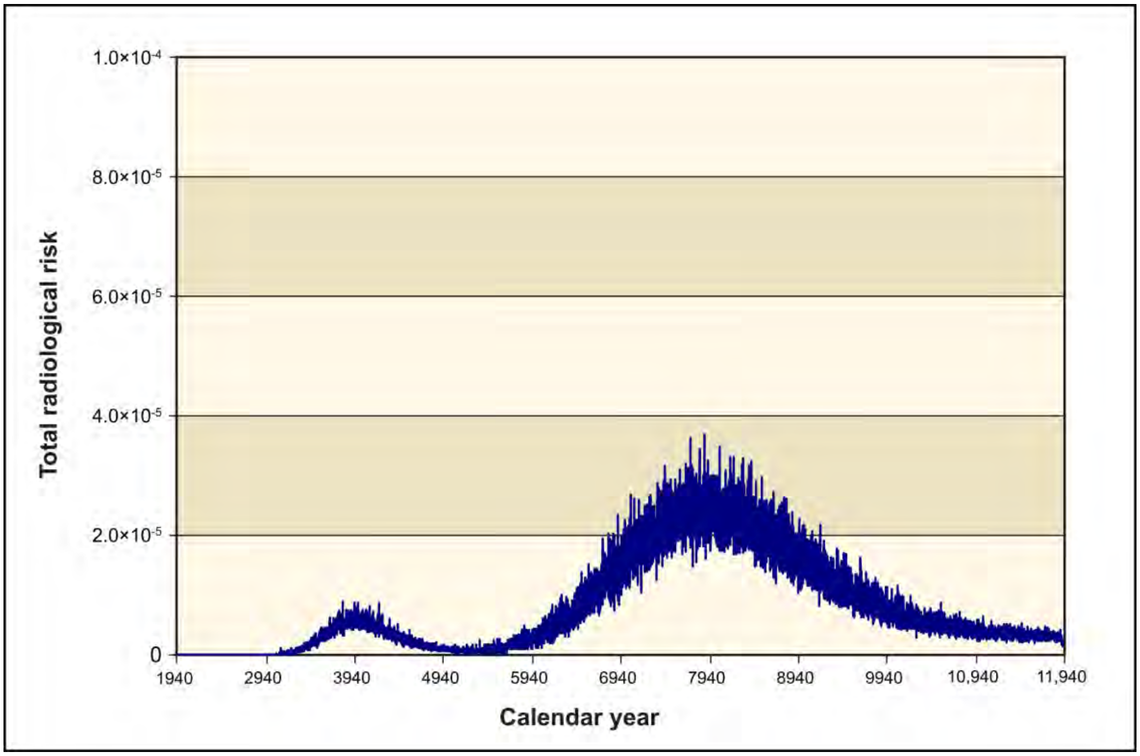


Figure 2–111. Waste Management Alternative 2, Disposal Group 3, Base Case, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

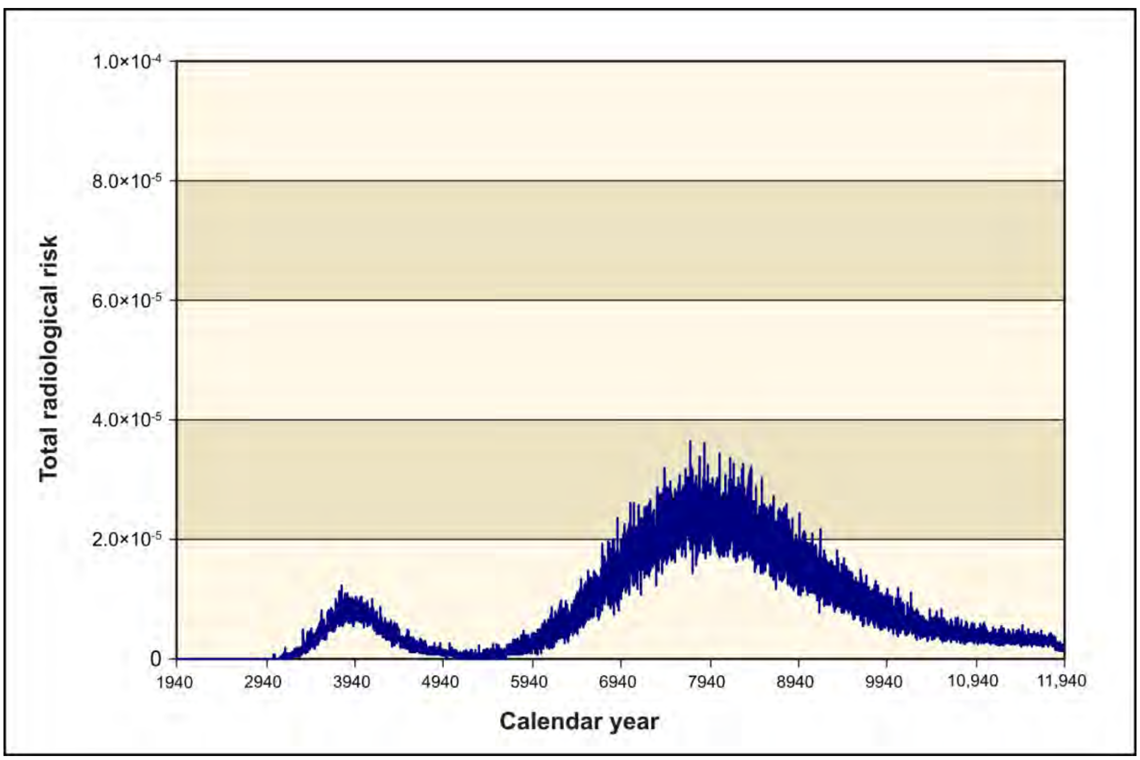


Figure 2–112. Waste Management Alternative 2, Disposal Group 3, Option Case, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.3 Waste Management Alternative 3, All Disposal Groups and Subgroups

Under Waste Management Alternative 3, the waste from tank treatment operations would be disposed of in IDF-East, and waste from onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites would be disposed of in IDF-West. Waste from tank farm cleanup operations would be disposed of in the proposed RPPDF. As a result, the waste disposed of in these three facilities is assumed to become available for release to the environment. Because of the different waste types that would result under the Tank Closure action alternatives, three disposal groups were considered to account for the different IDF-East sizes and operational periods. In addition, within these three disposal groups, subgroups were identified to allow consideration of the different waste types resulting from activities under the Tank Closure alternatives. The potential human health impacts of these subgroups under this alternative are discussed in the following sections. The maximum dose and maximum Hazard Index from the groundwater analysis of Waste Management Alternative 3 for the drinking-water well user are summarized in Tables 2–44 and 2–45. For the drinking-water well user, the radiological dose standard would not be exceeded under any disposal group or subgroup at any analysis location. For the same receptor, the Hazard Index guideline would be exceeded at the IDF-East barrier under Disposal Group 1, Subgroups 1-C (Tank Closure Alternative 3B), 1-E (Tank Closure Alternative 4), and 1-F (Tank Closure Alternative 5), and at the Core Zone Boundary under Disposal Group 1, Subgroup 1-C; it would not, however, be exceeded at other analysis locations under other subgroups of all disposal groups.

Table 2–44. Waste Management Alternative 3 Summary of Radiation Dose at Year of Peak Dose for the Drinking-Water Well User

Location	Waste Management Alternative 3 (millirem per year)											
	Disposal Group 1							Disposal Group 2			Disposal Group 3	
	Subgroup							Subgroup				
	1-A	1-B	1-C	1-D	1-E	1-F	1-G	2-A	2-B, Base Case	2-B, Option Case	Base Case	Option Case
IDF-East	5.64×10^{-1} (9827)	2.59 (7629)	5.27 (10,774)	2.28 (11,434)	6.84 (10,921)	2.53 (8878)	5.50×10^{-1} (11,385)	4.98×10^{-1} (10,979)	5.27×10^{-1} (10,636)	5.08×10^{-1} (9990)	5.27×10^{-1} (10,636)	5.08×10^{-1} (9990)
IDF-West	2.87×10^{-1} (3818)											
RPPDF	8.94×10^{-2} (3818)				2.37×10^{-1} (3785)	N/A	8.94×10^{-2} (3818)	N/A	3.26×10^{-1} (3769)	4.70×10^{-1} (3812)	3.14×10^{-1} (4013)	4.75×10^{-1} (4018)
Core Zone Boundary	2.92 (3859)											
Columbia River nearshore	3.52 (3920)											

Note: Calendar year of peak impact shown in parentheses.

Key: IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; N/A=not applicable; RPPDF=River Protection Project Disposal Facility.

Table 2–45. Waste Management Alternative 3 Summary of Hazard Index at Year of Peak Hazard Index for the Drinking-Water Well User

Location	Waste Management Alternative 3											
	Disposal Group 1							Disposal Group 2			Disposal Group 3	
	Subgroup							Subgroup				
	1-A	1-B	1-C	1-D	1-E	1-F	1-G	2-A	2-B, Base Case	2-B, Option Case	Base Case	Option Case
IDF-East	2.29×10^{-1} (7962)	1.89×10^{-1} (8052)	3.39 (8608)	3.04×10^{-1} (8207)	2.08 (9008)	3.03 (8882)	2.29×10^{-1} (7962)	1.77×10^{-1} (7960)	1.82×10^{-1} (7983)	2.78×10^{-1} (7954)	1.82×10^{-1} (7983)	2.78×10^{-1} (7954)
IDF-West	1.03×10^{-2} (3813)											
RPPDF	2.84×10^{-2} (3792)				6.92×10^{-2} (3666)	N/A	2.84×10^{-2} (3792)	N/A	3.78×10^{-2} (3710)	4.41×10^{-1} (3680)	3.92×10^{-2} (3929)	4.39×10^{-1} (3916)
Core Zone Boundary	5.76×10^{-2} (8248)	5.15×10^{-2} (8095)	1.11 (8680)	9.23×10^{-2} (8317)	6.26×10^{-1} (8873)	8.20×10^{-1} (8588)	5.77×10^{-2} (8248)	5.64×10^{-2} (8123)	6.02×10^{-2} (7860)	3.56×10^{-1} (3688)	6.02×10^{-2} (7860)	3.75×10^{-1} (3865)
Columbia River nearshore	3.77×10^{-2} (7927)	4.04×10^{-2} (7940)	8.56×10^{-1} (8594)	6.35×10^{-2} (8284)	4.68×10^{-1} (8827)	6.11×10^{-1} (8535)	3.78×10^{-2} (7927)	3.57×10^{-2} (8406)	3.95×10^{-2} (7994)	2.36×10^{-1} (4560)	3.95×10^{-2} (7994)	2.60×10^{-1} (4487)

Note: Calendar year of peak impact shown in parentheses.

Key: IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; N/A=not applicable; RPPDF=River Protection Project Disposal Facility.

2.9.3.2.3.1 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A

Disposal Group 1, Subgroup 1-A, addresses the waste resulting from Tank Closure Alternative 2B activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- ILAW glass
- LAW melters
- Tank closure secondary waste

Waste forms to be disposed of in IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms to be disposed of in the proposed RPPDF would include those resulting from tank closure cleanup activities under Tank Closure Alternative 2B.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be boron and boron compounds, chromium, fluoride, and nitrate. For the drinking-water well user, neither the radiological dose standard nor the Hazard Index guideline would be exceeded at any analysis location. The population dose for the year of maximum impact was estimated to be 0.342 person-rem, approximately 2×10^{-5} percent of the background dose.

Figure 2–113 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user. The peak radiological risk would occur around CY 3860 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-West and the proposed RPPDF.

2.9.3.2.3.2 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B

Disposal Group 1, Subgroup 1-B, addresses the waste resulting from Tank Closure Alternative 3A activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Tank closure secondary waste

Waste forms to be disposed of in IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms to be disposed of in the proposed RPPDF would include those resulting from tank closure cleanup activities under Tank Closure Alternative 3A.

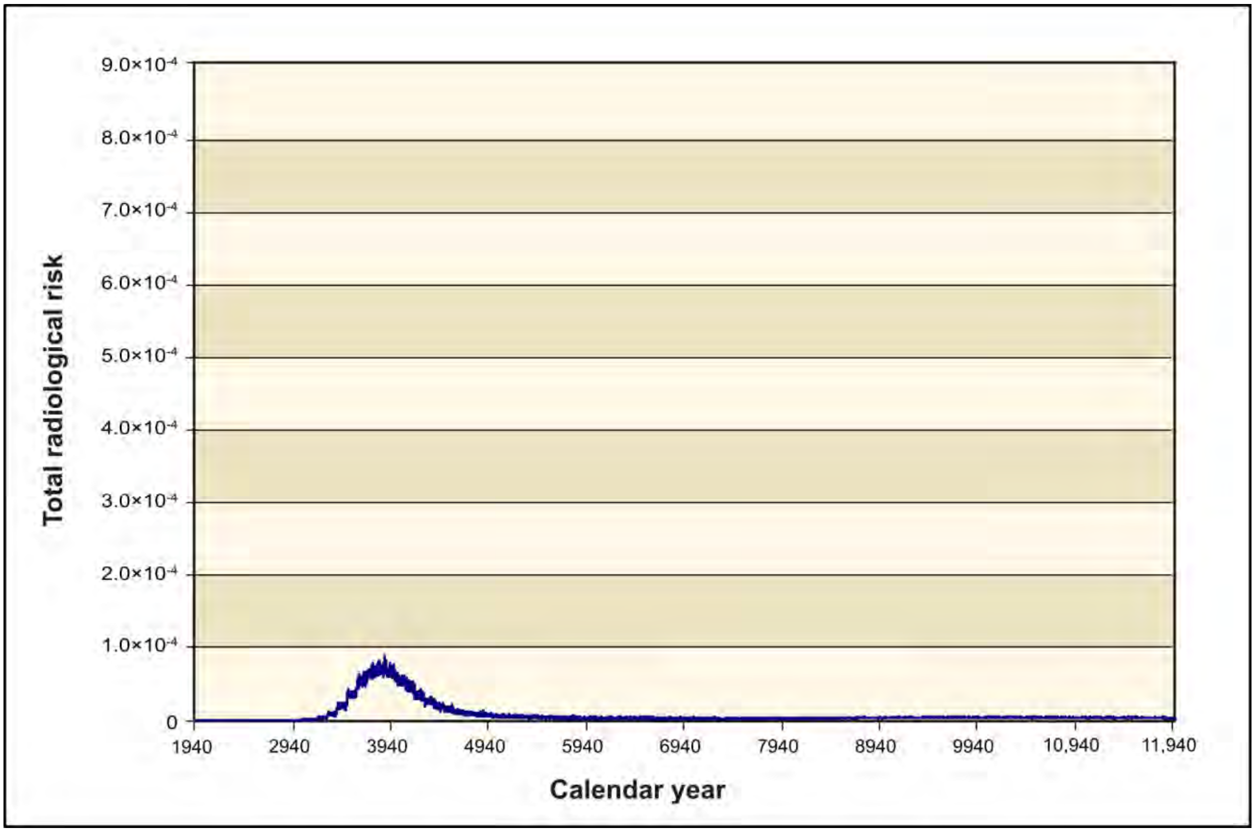


Figure 2–113. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-A, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be boron and boron compounds, chromium, fluoride, and nitrate. For the drinking-water well user, neither the radiological dose standard nor the Hazard Index guideline would be exceeded at any analysis location. The population dose for the year of maximum impact was estimated to be 0.342 person-rem, approximately 2×10^{-5} percent of the background dose.

Figure 2–114 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user. The peak radiological risk would occur around CY 3860 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-West and the proposed RPPDF.

2.9.3.2.3.3 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C

Disposal Group 1, Subgroup 1-C, addresses the waste resulting from Tank Closure Alternative 3B activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- ILAW glass
- LAW melters
- Cast stone waste
- Tank closure secondary waste

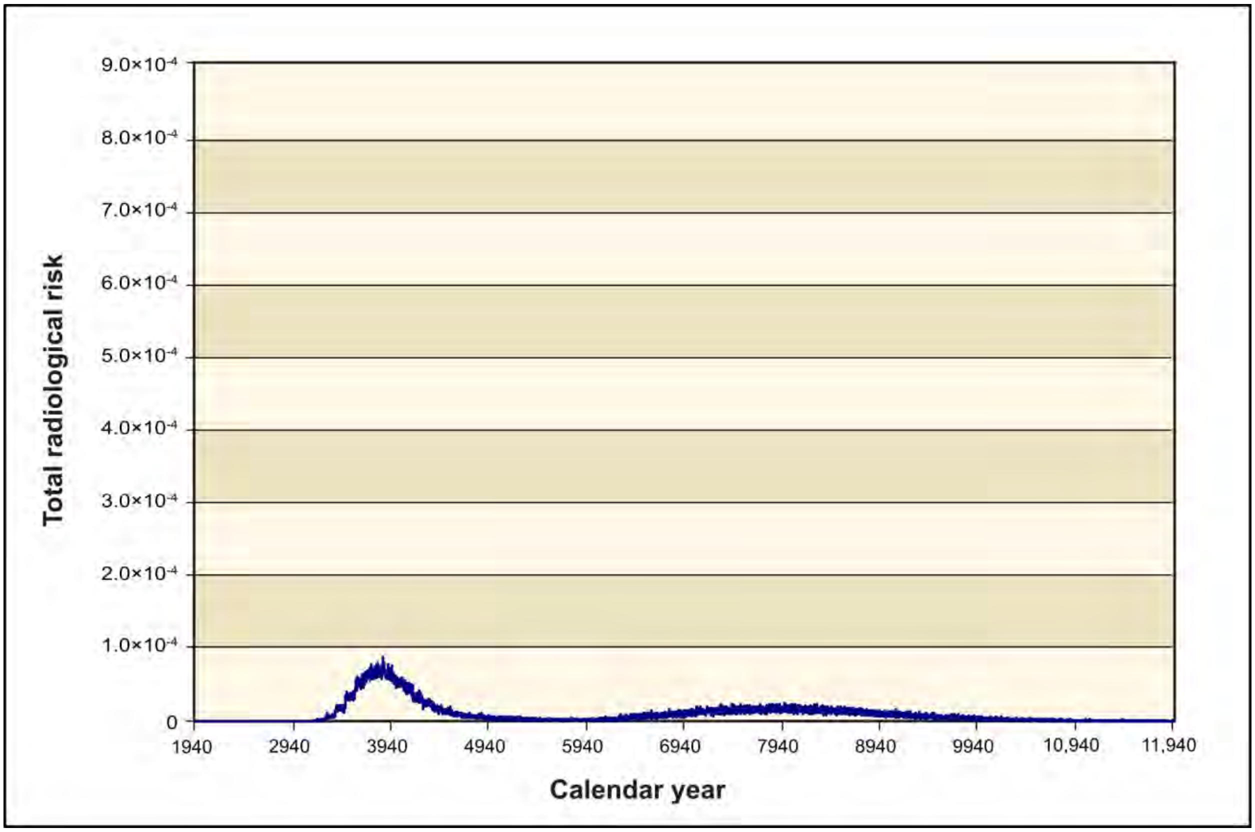


Figure 2–114. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-B, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

Waste forms to be disposed of in IDF-West would include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms to be disposed of in the proposed RPPDF would include those resulting from tank closure cleanup activities under Tank Closure Alternative 3B.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be acetonitrile, boron and boron compounds, chromium, fluoride, and nitrate. For the drinking-water well user, the radiological dose standard would not be exceeded at any analysis location. However, the Hazard Index guideline would be exceeded at the IDF-East barrier and Core Zone Boundary for the drinking-water well user, due primarily to the presence of chromium. The population dose was estimated to be 0.342 person-rem for the year of maximum impact, approximately 2×10^{-5} percent of the background dose.

Figure 2–115 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user. The peak radiological risk would occur around CY 3860 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-West and the proposed RPPDF.

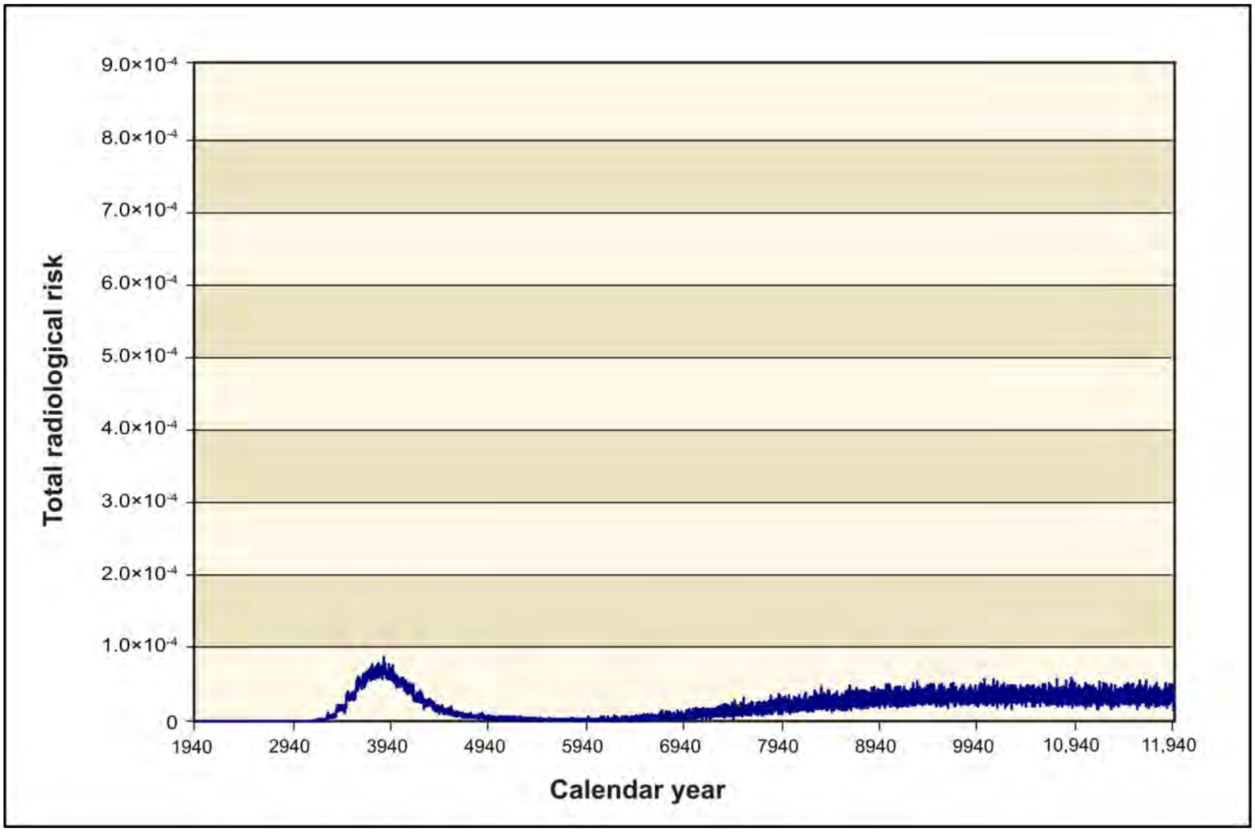


Figure 2–115. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.3.4 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D

Disposal Group 1, Subgroup 1-D, addresses the waste resulting from Tank Closure Alternative 3C activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- ILAW glass
- LAW melters
- Steam reforming waste
- Tank closure secondary waste

Waste forms to be disposed of in IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms to be disposed of in the proposed RPPDF would include those resulting from tank closure cleanup activities under Tank Closure Alternative 3C.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be boron and boron compounds, chromium, fluoride, and nitrate. For the drinking-water well user, neither the radiological dose standard nor the Hazard Index guideline would be exceeded at any analysis location. The population dose for the year of maximum impact was estimated to be 0.342 person-rem, approximately 2×10^{-5} percent of the background dose.

Figure 2–116 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user. The early peak in Figure 2–116 is due to releases from IDF-West, while the later plateau is due to releases from IDF-East. The peak radiological risk would occur around CY 3860 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-West.

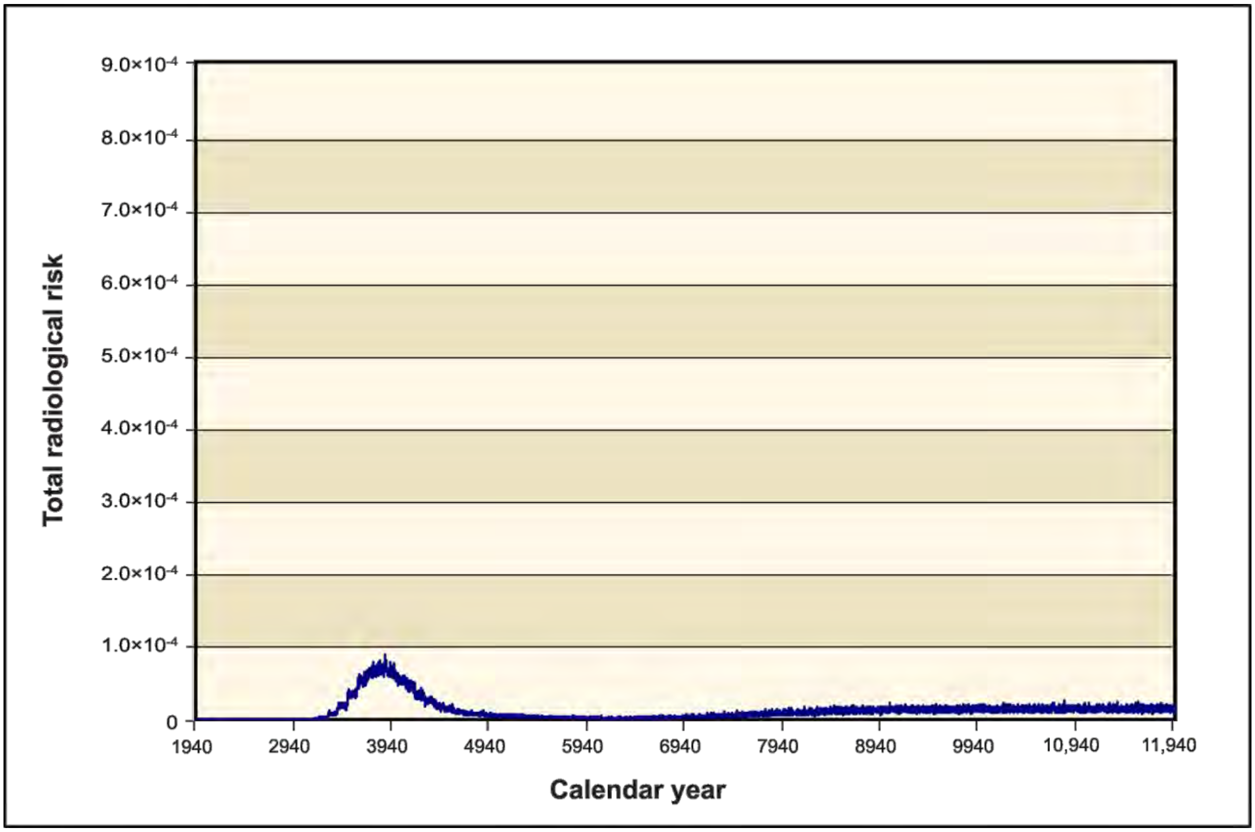


Figure 2–116. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-D, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.3.5 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E

Disposal Group 1, Subgroup 1-E, addresses the waste resulting from Tank Closure Alternative 4 activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Cast stone waste
- Sulfate grout
- Tank closure secondary waste

Waste forms to be disposed of in IDF-West include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms to be disposed of in the proposed RPPDF would include those resulting from tank closure cleanup activities under Tank Closure Alternative 4.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be acetonitrile, boron and boron compounds, chromium, fluoride, and nitrate. For the drinking-water well user, the radiological dose standard would not be exceeded at any analysis location. However, the Hazard Index guideline would be exceeded at the IDF-East barrier for the drinking-water well user due primarily to the presence of chromium. The population dose for the year of maximum impact was estimated to be 0.346 person-rem, approximately 2×10^{-5} percent of the background dose.

Figure 2–117 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user. The early peak in Figure 2–117 is due primarily to releases from IDF-West, while the later plateau is due to releases from IDF-East. The peak radiological risk would occur around CY 3860 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-West and the proposed RPPDF.

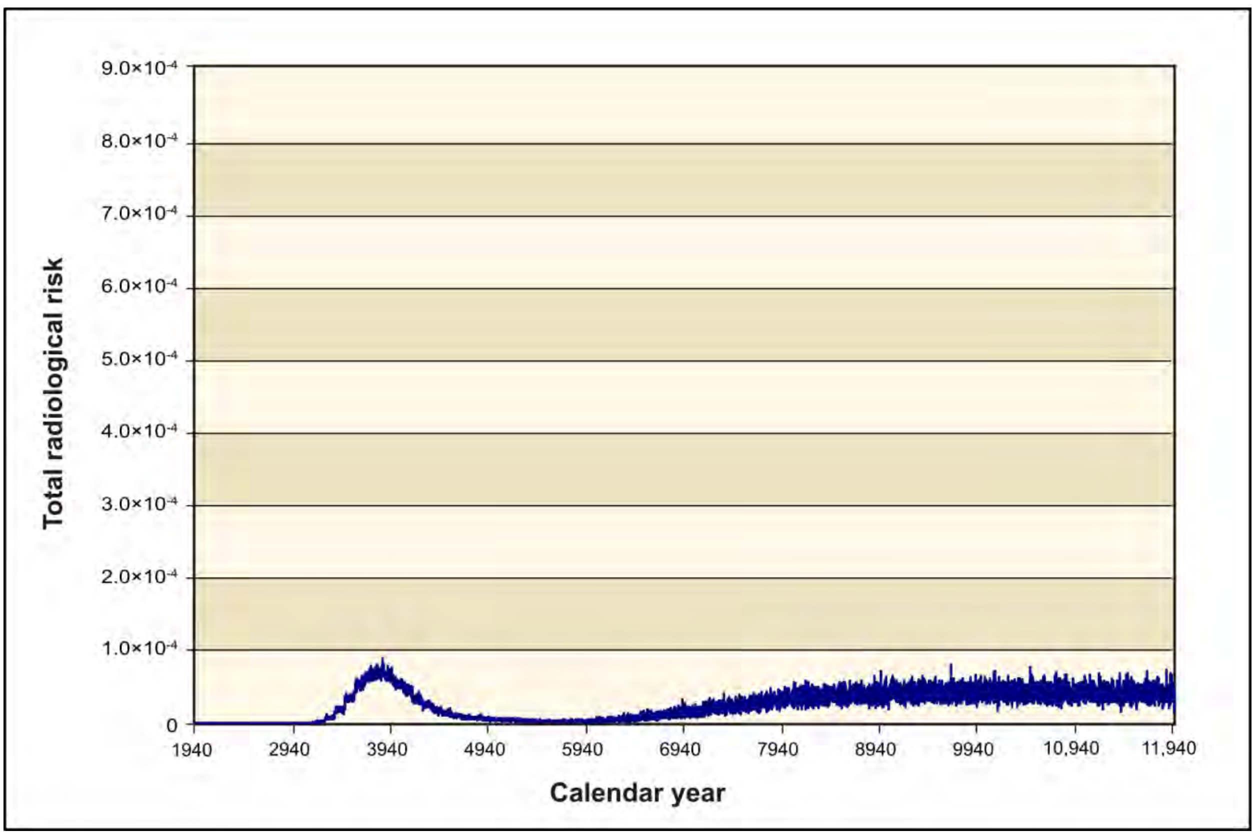


Figure 2–117. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.3.6 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F

Disposal Group 1, Subgroup 1-F, addresses the waste resulting from Tank Closure Alternative 5 activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- ILAW glass
- LAW melters
- Bulk vitrification glass
- Cast stone waste
- Sulfate grout
- Tank closure secondary waste

Waste forms to be disposed of in IDF-West would include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

The proposed RPPDF would not be constructed or operated under Tank Closure Alternative 5 because tank closure cleanup activities would not be conducted.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be acetonitrile, boron and boron compounds, chromium, fluoride, and nitrate. For the drinking-water well user, the radiological dose standard would not be exceeded at any analysis location. However, the Hazard Index guideline would be exceeded at the IDF-East barrier for the drinking-water well user, due primarily to the presence of chromium. The population dose for the year of maximum impact was estimated to be 0.339 person-rem, approximately 2×10^{-5} percent of the background dose.

Figure 2–118 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user. The early peak in Figure 2–118 is due primarily to releases from IDF-West, while the later plateau is due to releases from IDF-East. The peak radiological risk would occur around CY 3860 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-West and the proposed RPPDF.

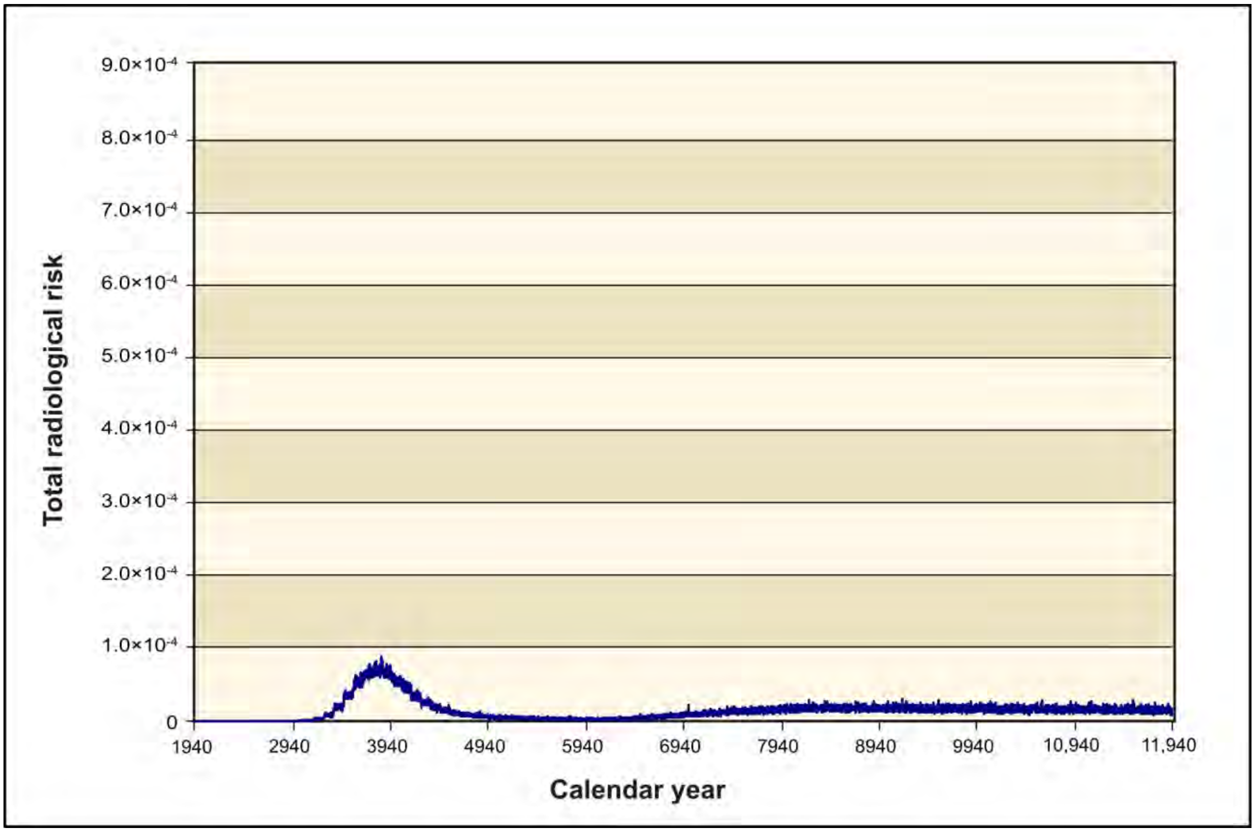


Figure 2–118. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.3.7 Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G

Disposal Group 1, Subgroup 1-G, addresses the waste resulting from Tank Closure Alternative 6C activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Tank closure secondary waste would be the single waste form disposed of in IDF-East.

Waste forms to be disposed of in IDF-West would include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms to be disposed of in the proposed RPPDF would include those resulting from tank closure cleanup activities under Tank Closure Alternative 6C.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be boron and boron compounds, chromium, fluoride, and nitrate. For the drinking-water well user, neither the radiological dose standard nor the Hazard Index guideline would be exceeded at any analysis location. The population dose for the year of maximum impact was estimated to be 0.342 person-rem, approximately 2×10^{-5} percent of the background dose.

Figure 2–119 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user. The peak radiological risk would occur around CY 3860 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-West and the proposed RPPDF.

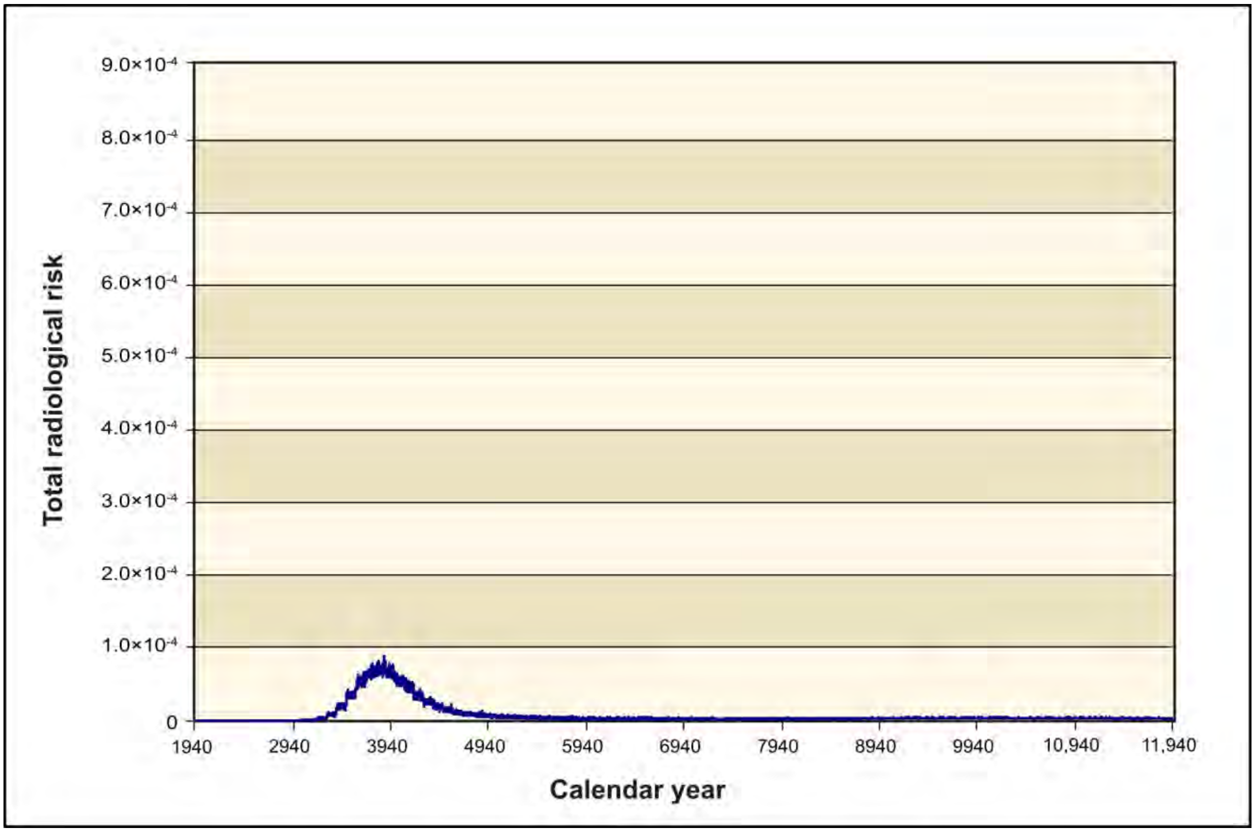


Figure 2–119. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.3.8 Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A

Disposal Group 2, Subgroup 2-A, addresses the waste resulting from Tank Closure Alternative 2A activities, onsite non-CERCLA sources, FFTF decommissioning, waste management, and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- ILAW glass
- LAW melters
- Tank closure secondary waste

Waste forms to be disposed of in IDF-West would include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

The proposed RPPDF would not be constructed or operated under Tank Closure Alternative 2A because tank closure cleanup activities would not be conducted.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be boron and boron compounds, chromium, fluoride, and nitrate. For the drinking-water well user, neither the radiological dose standard nor the Hazard Index guideline would be exceeded at any analysis location. The population dose for the year of maximum impact was estimated to be 0.339 person-rem, approximately 2×10^{-5} percent of the background dose.

Figure 2–120 depicts a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user. The peak radiological risk would occur around CY 3860 at the Core Zone Boundary and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-West and the proposed RPPDF.

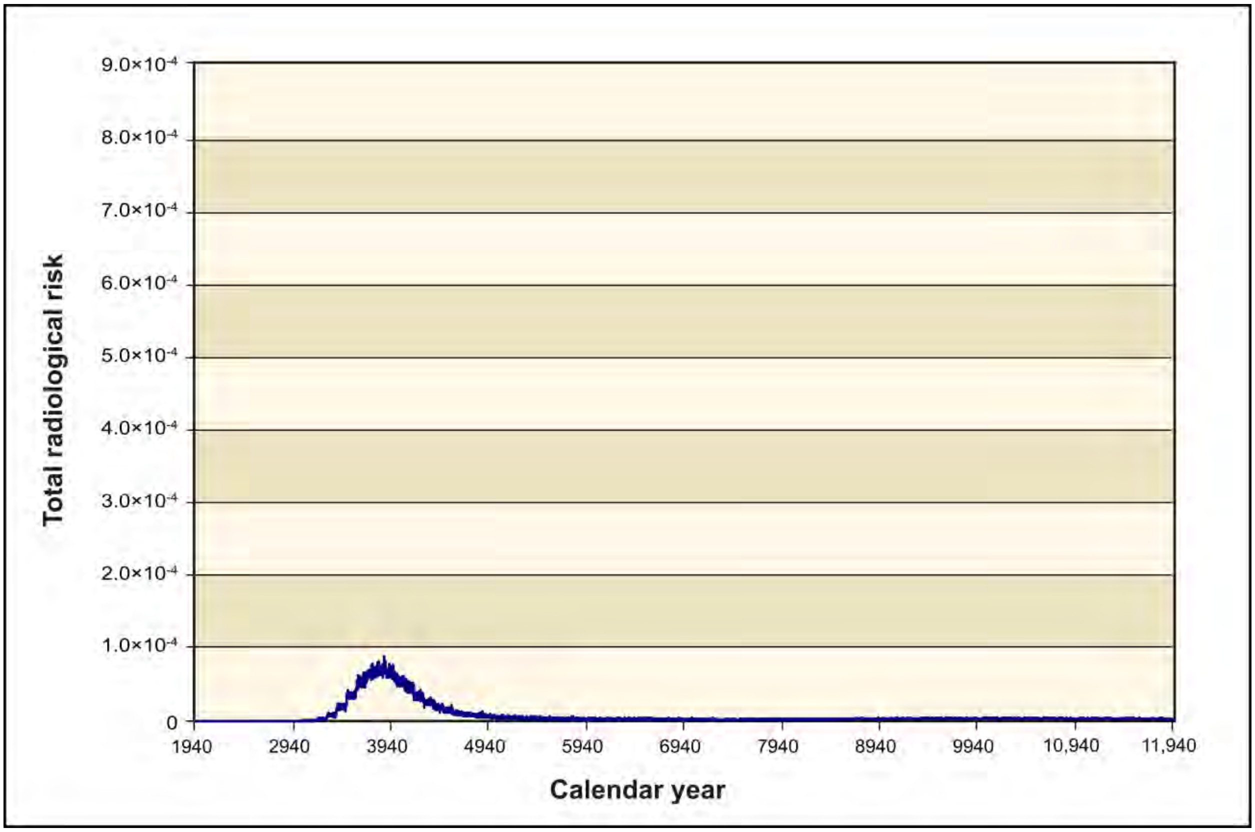


Figure 2–120. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.3.9 Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B

Disposal Group 2, Subgroup 2-B, addresses the waste resulting from activities under Tank Closure Alternative 6B, Base and Option Cases; onsite non-CERCLA sources; FFTF decommissioning; waste management; and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- PPF glass
- PPF melters
- Tank closure secondary waste

Waste forms to be disposed of in IDF-West would include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms to be disposed of in the proposed RPPDF would include those resulting from tank closure cleanup activities under Tank Closure Alternative 6B, Base and Option Cases.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be acetonitrile, boron and boron compounds, chromium, fluoride, and nitrate. For the drinking-water well user under both the Base and Option Cases, neither the radiological dose standard nor the Hazard Index guideline would be exceeded at any analysis location. The population dose for the year of maximum impact was estimated to be 0.377 person-rem under the Base Case and 0.399 person-rem under the Option Case. Each of these estimates of population dose is approximately 2×10^{-5} percent of the background dose.

Figures 2–121 and 2–122 depict a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user under the Base Case and Option Case, respectively. The peak radiological risk would occur around CY 3860 at the Core Zone Boundary under both the Base and Option Cases, and would be dominated by technetium-99 and iodine-129 from the naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-West and the proposed RPPDF.

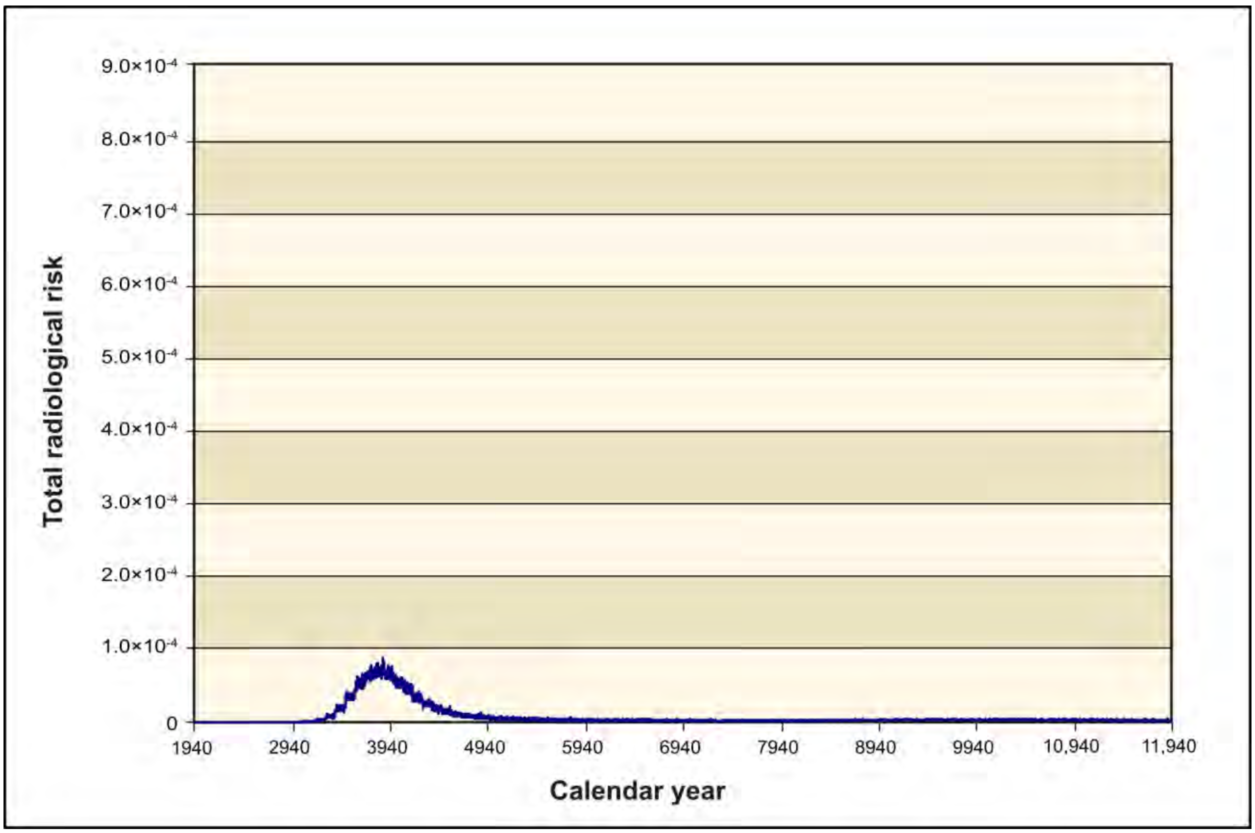


Figure 2–121. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

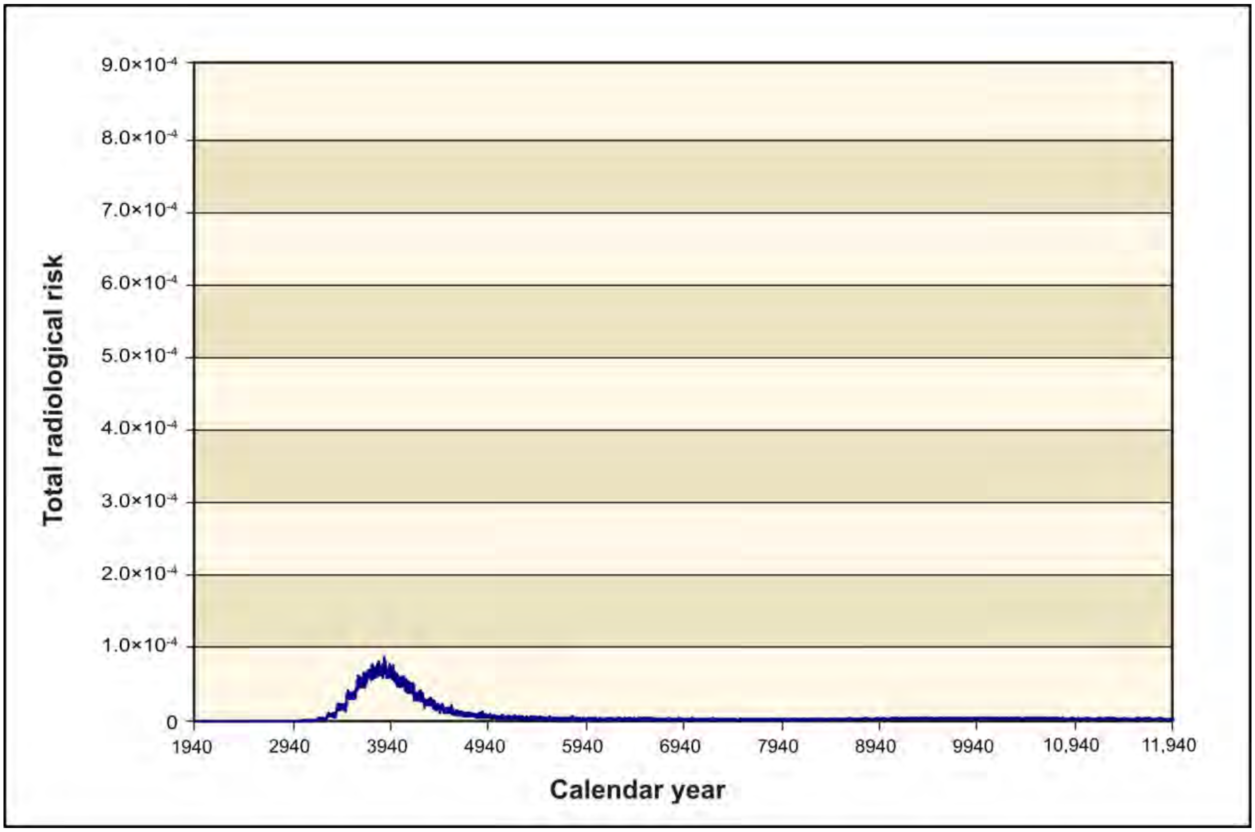


Figure 2–122. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Option Case, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.2.3.10 Waste Management Alternative 3, Disposal Group 3

Disposal Group 3 addresses the waste resulting from activities under Tank Closure Alternative 6A, Base and Option Cases; onsite non-CERCLA sources; FFTF decommissioning; waste management; and other DOE sites. Waste forms to be disposed of in IDF-East would include the following:

- PPF glass
- PPF melters
- Tank closure secondary waste

Waste forms to be disposed of in IDF-West would include the following:

- FFTF decommissioning secondary waste
- Waste management secondary waste
- Offsite waste
- Onsite non-CERCLA waste

Waste forms to be disposed of in the proposed RPPDF would include those resulting from tank closure cleanup activities under Tank Closure Alternative 6A, Base and Option Cases.

The key radioactive constituent contributors to human health risk would be technetium-99 and iodine-129; the key chemical constituent contributors would be acetonitrile, boron and boron compounds, chromium, fluoride, and nitrate. For the drinking-water well user under both the Base and Option Cases, neither the radiological dose standard nor the Hazard Index guideline would be exceeded at any analysis location. The population dose for the year of maximum impact was estimated to be 0.376 person-rem under the Base Case and 0.398 person-rem under the Option Case. Each of these estimates of population dose is approximately 2×10^{-5} percent of the background dose.

Figures 2–123 and 2–124 depict a time series showing the lifetime radiological risk of incidence of cancer at the Core Zone Boundary for the drinking-water well user under the Base Case and Option Case, respectively. The peak radiological risk would occur around CY 3860 at the Core Zone Boundary under both the Base and Option Cases and would be dominated by technetium-99 and iodine-129 from naturally occurring release mechanisms and degradation of waste forms disposed of in IDF-West and the proposed RPPDF.

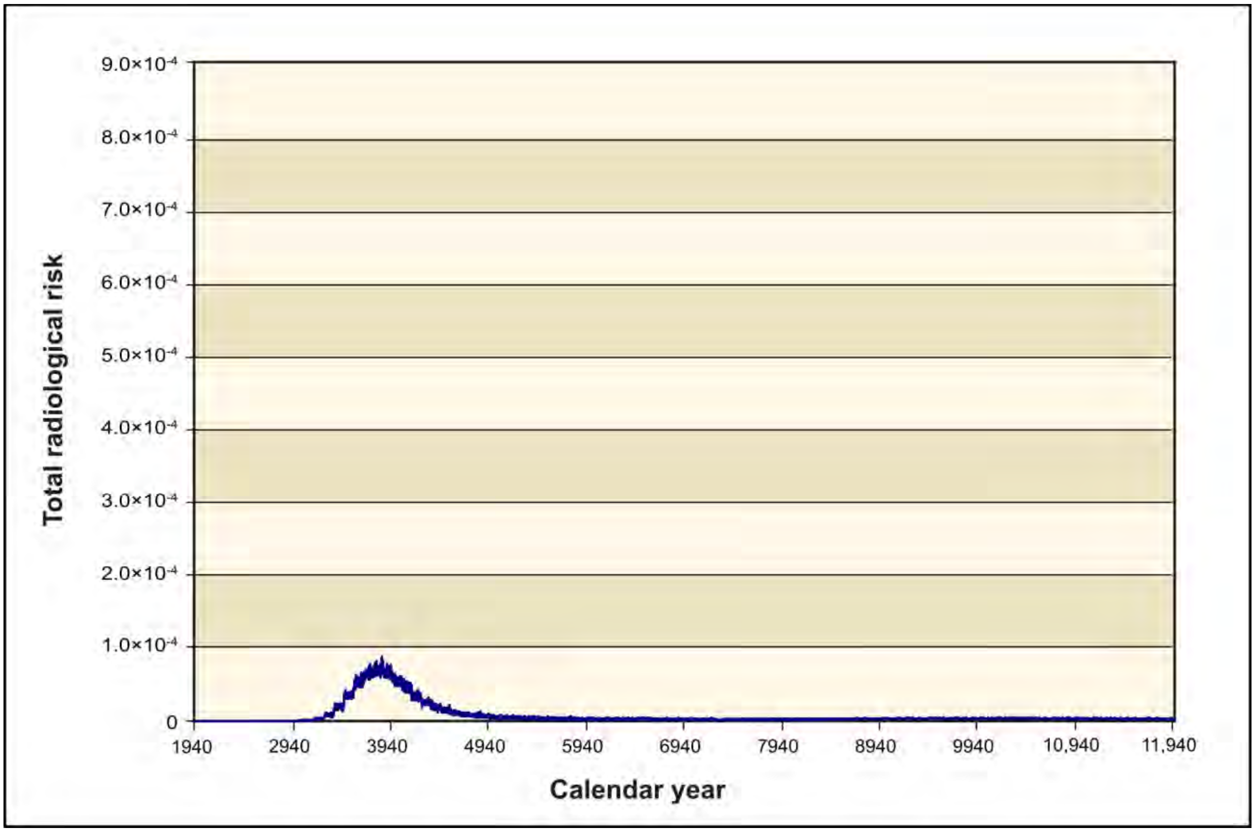


Figure 2–123. Waste Management Alternative 3, Disposal Group 3, Base Case, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

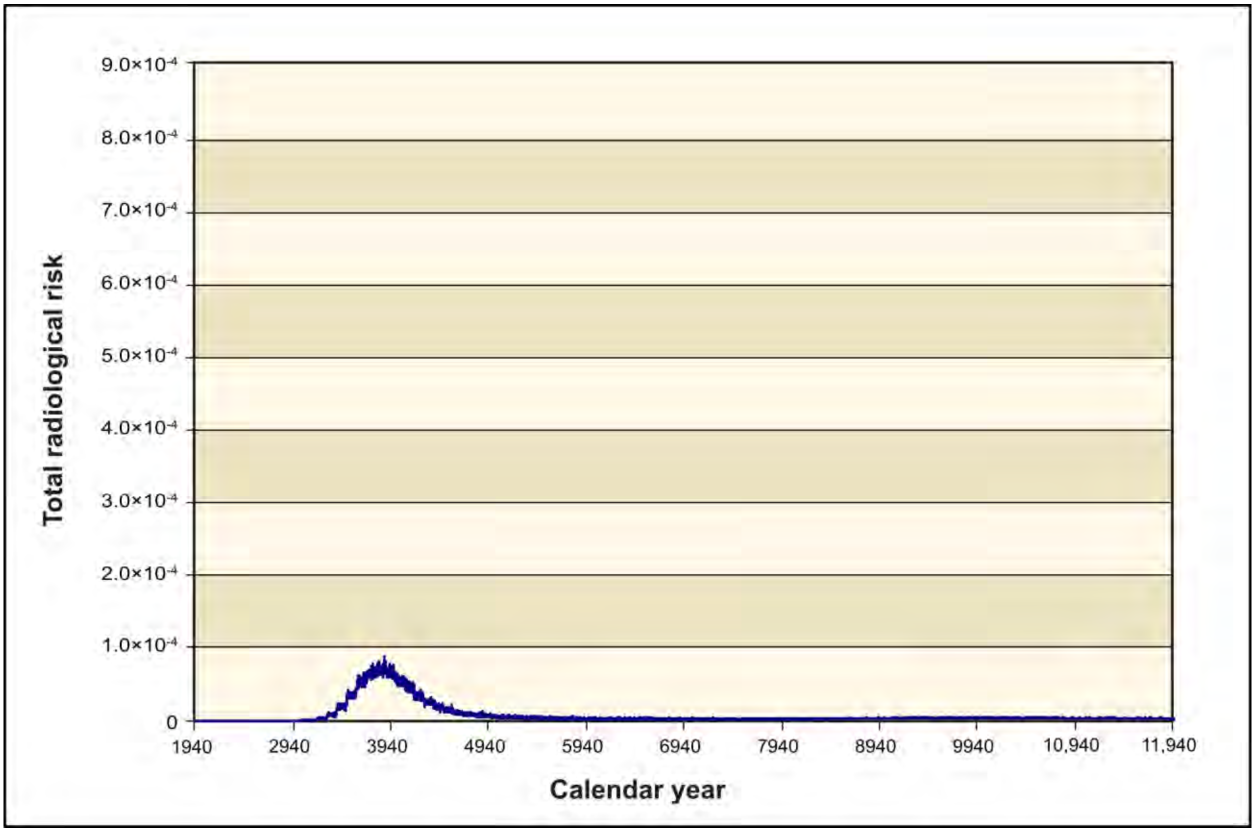


Figure 2–124. Waste Management Alternative 3, Disposal Group 3, Option Case, Summary of Long-Term Human Health Impacts on the Drinking-Water Well User at the Core Zone Boundary

2.9.3.3 Ecological Risk

Risk indices for ecological receptors exposed to COPCs as a result of air releases and groundwater discharge (see Appendix P) were used in this *TC & WM EIS* to compare Waste Management alternatives. Risk indices less than 1 indicate little to no likelihood of adverse impact on the receptor. The uncertainties associated with risk indices and the meaning of Hazard Quotients and Hazard Indices for ecological receptors in this *TC & WM EIS* are discussed in Appendix P.

The potential long-term impacts of air releases on terrestrial receptors and aquatic and riparian receptors, as quantified by risk indices for the highest-value COPC for each receptor, are shown in Table 2–46. Long-term impacts on all terrestrial, aquatic, and riparian receptors would be greatest under Waste Management Alternative 2, Disposal Group 3, for air releases at the onsite maximum-exposure location. In general, for terrestrial receptors exposed to organic chemicals (toluene, xylene, and formaldehyde), risk indices under Waste Management Alternatives 2 and 3, Disposal Group 3, were less than twice as high as those under Disposal Group 2, several times higher than those under Disposal Group 1, and two orders of magnitude higher than those under Waste Management Alternative 1: No Action. The values for xylene in the Great Basin pocket mouse exemplified this pattern. The range of risk indices for aquatic biota, including salmonids, for the COPC with the highest Hazard Quotient (benzene) would not be as great; for each alternative, Disposal Groups 2 and 3 had the same value. The Hazard Quotient under Waste Management Alternative 1: No Action was two orders of magnitude lower. Impacts on benthic invertebrates and the raccoon and least weasel under Waste Management Alternatives 2 and 3 were similar for all disposal groups and two orders of magnitude greater than those under Waste Management Alternative 1.

Table 2–46. Waste Management Alternatives – Long-Term Impacts of Contaminant Releases to Air on Terrestrial Receptors

Waste Management Alternative	Hazard Quotient of Highest-Value COPC by Receptor[a]							
	Onsite Maximum-Exposure Location				Columbia River			
	Plants	Great Basin Pocket Mouse	Coyote	Mule Deer	Aquatic Biota/ Salmonids	Benthic Invertebrates	Raccoon	Least Weasel
	Toluene	Xylene		Formaldehyde	Benzene	Xylene		
1	3.29×10^{-2}	1.65	2.09×10^{-1}	3.71×10^{-1}	6.97×10^{-3}	4.01×10^{-5}	2.71×10^{-7}	1.57×10^{-6}
2, DG 1	1.77	8.70×10^{1}	1.11×10^{1}	1.70×10^{1}	1.24×10^{-1}	4.49×10^{-3}	3.03×10^{-5}	1.75×10^{-4}
2, DG 2	6.98	3.44×10^{2}	4.37×10^{1}	6.70×10^{1}	**4.01×10^{-1}**	**1.45×10^{-2}**	**9.84×10^{-5}**	**5.68×10^{-4}**
2, DG 3	**9.43**	**4.67×10^{2}**	**5.93×10^{1}**	**9.97×10^{1}**	**4.01×10^{-1}**	**1.45×10^{-2}**	**9.84×10^{-5}**	**5.68×10^{-4}**
3, DG 1	1.71	8.36×10^{1}	1.06×10^{1}	1.65×10^{1}	1.20×10^{-1}	4.34×10^{-3}	2.93×10^{-5}	1.69×10^{-4}
3, DG 2	6.92	3.41×10^{2}	4.33×10^{1}	6.64×10^{1}	3.96×10^{-1}	1.44×10^{-2}	9.71×10^{-5}	5.61×10^{-4}
3, DG 3	9.30	4.63×10^{2}	5.88×10^{1}	9.87×10^{1}	3.96×10^{-1}	1.44×10^{-2}	9.71×10^{-5}	5.61×10^{-4}

[a] Soil-dwelling invertebrates and the side-blotched lizard, western meadowlark, mourning dove, burrowing owl, spotted sandpiper, and bald eagle had no toxicity reference values or risk indices were small for COPCs in these analyses and thus are not shown.

Note: The maximum Hazard Quotient for each receptor is indicated by **bold** text.

Key: COPC=constituent of potential concern; DG=Disposal Group.

For groundwater discharging to the Columbia River (see Table 2–47), risk indices were small under the Waste Management alternatives. Only Hazard Quotients for aquatic biota, including salmonids, were a little greater than 1. For all aquatic and riparian receptors, impacts of groundwater releases would be greatest under Waste Management Alternatives 2 and 3, Disposal Group 1, Subgroup 1-C. This pattern was exemplified by the nitrate Hazard Quotients for the muskrat and the chromium Hazard Quotients for the raccoon and aquatic biota, including salmonids. Impacts under the maximum reasonably foreseeable alternatives for all receptors were greater than those under the No Action Alternative.

Long-term modeling predicted peak air concentrations and cumulative soil concentrations of benzene, toluene, xylene, and formaldehyde that potentially would cause adverse impacts on terrestrial mammals (mouse, coyote, and mule deer) and plants at the onsite maximum-exposure location under Waste Management Alternatives 2 and 3. Maximum groundwater concentrations and resulting nearshore surface-water and sediment concentrations under all Waste Management alternatives would be unlikely to pose a toxicological risk to aquatic and riparian receptors exposed at the Columbia River. Potential long-term impacts of Waste Management alternatives on ecological resources are discussed in greater detail in Chapter 5, Section 5.3.3, and the uncertainties associated with risk indices calculated using environmental concentrations predicted for air and groundwater releases under the Waste Management alternatives are discussed in Appendix P.

Eutrophication of nearshore surface water as a result of nitrate in groundwater discharging at the Columbia River under Waste Management alternatives would be unlikely. The predicted maximum nearshore surface-water concentration of nitrate did not exceed 0.13 milligrams per liter, a small fraction of the maximum ambient concentration, 1.0 milligram per liter (Poston et al. 2007; Poston, Duncan, and Dirkes 2011).

Table 2–47. Waste Management Alternatives – Long-Term Impacts of Contaminant Releases to Groundwater on Aquatic and Riparian Receptors at the Columbia River

Waste Management Alternative	Hazard Quotient of Highest-Value COPC by Receptor						
	Benthic Invertebrates	Spotted Sandpiper	Raccoon	Bald Eagle	Aquatic Biota/ Salmonids	Muskrat	Least Weasel
	Chromium[a]					Nitrate	
1	1.15×10^{-4}	7.82×10^{-4}	9.47×10^{-5}	9.34×10^{-6}	3.14×10^{-3}	6.24×10^{-7}	7.73×10^{-6}
2, DG 1, SG 1-A	3.10×10^{-4}	2.10×10^{-3}	2.55×10^{-4}	3.24×10^{-5}	2.05×10^{-2}	4.01×10^{-4}	1.10×10^{-2}
2, DG 1, SG 1-B	2.06×10^{-4}	1.40×10^{-3}	1.69×10^{-4}	2.33×10^{-5}	1.66×10^{-2}	4.35×10^{-4}	1.00×10^{-2}
2, DG 1, SG 1-C	**5.73×10^{-2}**	**3.89×10^{-1}**	**4.71×10^{-2}**	**5.46×10^{-3}**	**2.90**	**2.41×10^{-3}**	**5.66×10^{-2}**
2, DG 1, SG 1-D	3.40×10^{-3}	2.31×10^{-2}	2.79×10^{-3}	3.30×10^{-4}	1.83×10^{-1}	4.74×10^{-4}	1.15×10^{-2}
2, DG 1, SG 1-E	2.91×10^{-2}	1.97×10^{-1}	2.39×10^{-2}	2.87×10^{-3}	1.63	1.34×10^{-3}	3.42×10^{-2}
2, DG 1, SG 1-F	4.35×10^{-2}	2.95×10^{-1}	3.58×10^{-2}	4.35×10^{-3}	2.55	8.16×10^{-4}	2.32×10^{-2}
2, DG 1, SG 1-G	3.03×10^{-4}	2.05×10^{-3}	2.49×10^{-4}	3.21×10^{-5}	2.07×10^{-2}	4.01×10^{-4}	1.10×10^{-2}
2, DG 2, SG 2-A	3.29×10^{-4}	2.23×10^{-3}	2.70×10^{-4}	3.36×10^{-5}	2.04×10^{-2}	3.68×10^{-4}	1.04×10^{-2}
2, DG 2, SG 2-B, Base Case	1.49×10^{-3}	1.01×10^{-2}	1.23×10^{-3}	1.59×10^{-4}	1.03×10^{-1}	4.22×10^{-4}	1.05×10^{-2}
2, DG 2, SG 2-B, Option Case	1.39×10^{-2}	9.45×10^{-2}	1.14×10^{-2}	1.49×10^{-3}	9.72×10^{-1}	8.56×10^{-4}	3.20×10^{-2}
2, DG 3, Base Case	1.39×10^{-3}	9.40×10^{-3}	1.14×10^{-3}	1.52×10^{-4}	1.04×10^{-1}	4.22×10^{-4}	1.05×10^{-2}
2, DG 3, Option Case	1.52×10^{-2}	1.03×10^{-1}	1.25×10^{-2}	1.56×10^{-3}	9.60×10^{-1}	1.02×10^{-3}	3.20×10^{-2}
3, DG 1, SG 1-A	3.48×10^{-4}	2.36×10^{-3}	2.86×10^{-4}	3.61×10^{-5}	2.25×10^{-2}	4.01×10^{-4}	1.10×10^{-2}
3, DG 1, SG 1-B	3.48×10^{-4}	2.36×10^{-3}	2.86×10^{-4}	3.61×10^{-5}	2.25×10^{-2}	4.35×10^{-4}	1.00×10^{-2}
3, DG 1, SG 1-C	**5.73×10^{-2}**	**3.89×10^{-1}**	**4.71×10^{-2}**	5.45×10^{-3}	**2.90**	**2.41×10^{-3}**	**5.66×10^{-2}**
3, DG 1, SG 1-D	3.40×10^{-3}	2.31×10^{-2}	2.79×10^{-3}	3.30×10^{-4}	1.83×10^{-1}	4.74×10^{-4}	1.15×10^{-2}
3, DG 1, SG 1-E	2.91×10^{-2}	1.97×10^{-1}	2.39×10^{-2}	2.86×10^{-3}	1.63	1.34×10^{-3}	3.42×10^{-2}
3, DG 1, SG 1-F	4.35×10^{-2}	2.95×10^{-1}	3.57×10^{-2}	4.35×10^{-3}	2.54	8.16×10^{-4}	2.32×10^{-2}
3, DG 1, SG 1-G	3.48×10^{-4}	2.36×10^{-3}	2.86×10^{-4}	3.61×10^{-5}	2.25×10^{-2}	4.01×10^{-4}	1.10×10^{-2}
3, DG 2, SG 2-A	3.12×10^{-4}	2.11×10^{-3}	2.56×10^{-4}	3.13×10^{-5}	1.85×10^{-2}	3.68×10^{-4}	1.04×10^{-2}
3, DG 2, SG 2-B, Base Case	1.62×10^{-3}	1.10×10^{-2}	1.33×10^{-3}	1.71×10^{-4}	1.09×10^{-1}	4.22×10^{-4}	1.05×10^{-2}
3, DG 2, SG 2-B, Option Case	1.41×10^{-2}	9.54×10^{-2}	1.16×10^{-2}	1.50×10^{-3}	9.77×10^{-1}	8.56×10^{-4}	3.20×10^{-2}
3, DG 3, Base Case	1.51×10^{-3}	1.02×10^{-2}	1.24×10^{-3}	1.64×10^{-4}	1.10×10^{-1}	4.22×10^{-4}	1.05×10^{-2}
3, DG 3, Option Case	1.53×10^{-2}	1.04×10^{-1}	1.26×10^{-2}	1.57×10^{-3}	9.66×10^{-1}	1.02×10^{-3}	3.21×10^{-2}

[a] For purposes of long-term impacts, it was assumed that this is hexavalent chromium.
Note: The maximum Hazard Quotient for each receptor is indicated by **bold** text.
Key: COPC=constituent of potential concern; DG=Disposal Group; SG=Subgroup.

2.9.3.4 Environmental Justice

The long-term human health analysis determined that the impacts of waste management actions would be greatest under Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C. This alternative could result in radiation doses in excess of regulatory limits and chemical exposures with a Hazard Index greater than 1 for receptors on site at the IDF-East barrier, IDF-West barrier, Core Zone Boundary, or Columbia River nearshore. There are no such onsite receptors currently at Hanford. The onsite exposure scenarios do not currently exist and have never existed during Hanford operations. Therefore, the estimated high health risks for past years are hypothetical risks only; no persons were ever exposed at these levels. While it is possible for these receptor scenarios to develop in the future, none are expected within a reasonably foreseeable timeframe because the Core Zone is designated for Industrial-Exclusive land use, the Columbia River nearshore location is designated for Preservation (Hanford Reach National Monument), and the area between them is designated for Conservation (Mining) (DOE 1999). However, exposures to such individuals were evaluated using the exposure scenarios discussed in Section 2.9.1.2.

The greatest risk would be to the American Indian resident farmer at the IDF-West boundary. During the year of peak dose, this receptor would receive a radiation dose of 131 millirem, which is above the 100-millirem-per-year all-exposure-modes standard specified for protection of the public and the environment in DOE Order 458.1. During the year of peak Hazard Index, this receptor would not be exposed to chemicals resulting in a Hazard Index greater than 1; however, the risk from the radiation dose at this location outweighs the nonradiological risk from chemical releases at other reporting locations. The adverse impacts would also be applicable to non–American Indian receptors at the same locations, but to a lesser extent, due primarily to their assumed lower consumption of locally grown food. No adverse impacts were identified for any receptors at offsite locations; therefore, there would be no disproportionately high and adverse impacts on American Indian populations at offsite locations.

2.10 KEY ENVIRONMENTAL FINDINGS

The following sections present an overview of the key findings associated with the Tank Closure, FFTF Decommissioning, and Waste Management alternatives. Both short- and long-term impact analyses are included in this key findings discussion; however, the majority of the findings focus on long-term impacts.

Provision of a concise description of human health impacts is facilitated by selection of a single measure of impact and a single type of receptor. Radiological risk is selected as the measure of impact for the summary descriptions because radiological risk accounts for nearly the entirety of combined radiological and chemical risk and subsumes the contributions of multiple constituents to overall impacts. The drinking-water well user is selected as the receptor type for the summary descriptions because the drinking water exposure pathway generally contributes the majority of impacts for all receptor types; the impact for this exposure pathway is directly proportional to the concentration of constituents in groundwater; and interpretation of results involves consideration of the least number of contributing processes and environmental pathway parameters.

Radiological Risk

In general, a measure of potential harm to populations or individuals due to the presence or occurrence of an environmental or manmade hazard. In terms of human health, risk comprises three components: a sequence of events leading to an adverse impact, the probability of occurrence of that sequence of events, and the severity of the impact. For the release of radionuclides affecting individuals over the long term, the impact is the incidence of cancer; risk is expressed as the probability over a lifetime of developing cancer.

2.10.1 Tank Closure Alternatives

The Tank Closure action alternatives described in this *TC & WM EIS* represent the range of reasonable approaches to storing Hanford tank waste; removing the waste from the tanks to the extent technically and economically feasible; treating the waste through vitrification in the existing WTP, in an expanded WTP, and/or in conjunction with one or more supplemental treatment technologies; packaging the waste for onsite storage or disposal or offsite shipment and disposal; and closing the SST system to permanently reduce the potential risk to human health and the environment. These alternatives were developed in part to allow comparisons of the short-term impacts of the construction, operation, and deactivation of the additional facilities proposed for storage, retrieval, treatment, and disposal of waste from the SST system, and for closure of the SST system. These action alternatives were also developed to allow similar comparisons of the long-term water quality, human health, and ecological risk impacts resulting from completion of these activities. The following is a brief discussion of the key findings for the Tank Closure alternatives.

Tank Farm Waste Retrieval. The Tank Closure alternatives allow the range of retrieval options to be evaluated. Under Tank Closure Alternative 1, the tank waste would not be retrieved. Under Tank Closure Alternative 5, retrieval of 90 percent of the waste would occur. Tank Closure Alternatives 2A, 2B, 3A, 3B, 3C, and 6C would achieve 99 percent retrieval. Tank Closure Alternatives 4, 6A, and 6B would retrieve 99.9 percent of the tank waste.

Continued storage of tank waste with no removal or treatment would have negligible additional short-term impacts but significant long-term impacts. Retrieving the tank waste rather than leaving it in place would reduce long-term impacts on groundwater and human health.

For potential short-term impacts, resource requirements and human health effects associated with tank waste retrieval are similar, and rather small compared with other construction-, operations-, and closure-related impacts under all Tank Closure alternatives.

The influence of degree of retrieval on the magnitude of long-term human health impacts is most clearly discernible through consideration of impacts due to tank farm sources other than past leaks. Potential long-term impacts due to sources in SST and DST farms include losses from residual waste remaining in tanks and ancillary equipment following retrieval, as well as retrieval leaks at SST farms and past unplanned releases at SST farms. Figure 2–125 reflects estimates of lifetime radiological risk for a drinking-water well user at the Core Zone Boundary for these tank farm sources consistent with the following waste retrieval options: Tank Closure Alternative 1 (no retrieval); Tank Closure Alternative 5 (90 percent retrieval); Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C (99 percent retrieval); and Tank Closure Alternative 4 (99.9 percent retrieval). Note: Tank Closure Alternative 2A is not included in Figure 2–125 because tank closure is not included under this alternative. Tank Closure Alternatives 6A and 6B are not included in Figure 2–125 because long-term human health impacts are negligible; three groundwater sources (tank and ancillary equipment residuals and tank retrieval leaks) are completely removed under these alternatives; and impacts of the fourth groundwater source (past unplanned releases at the SST farms) are negligible.

The results show that failure to retrieve waste under Tank Closure Alternative 1 would have the greatest potential impact on human health. This conclusion validates DOE's decision in the *TWRS EIS* ROD (62 FR 8693) to retrieve the tank waste from the SSTs. For Tank Closure alternatives that include retrieval of waste, peak impacts are dominated by tank farm residuals and ancillary equipment, while retrieval leaks and unplanned releases at SST farms are the important contributors to the much lower level of impacts estimated for times prior to CY 4000. Tank Closure Alternative 4 has the lowest estimate of risk due to selective clean closure (complete removal of SST farms BX and SX). Estimates of impacts over longer periods are reduced in approximate proportion to the degree of retrieval, indicating that retrieval has a positive effect of reducing potential human health impacts.

WTP Configuration. Use of the WTP would be required under each of the Tank Closure action alternatives, with the WTP configuration (i.e., number of HLW and LAW melters) varying among these alternatives, as follows:

- Under Tank Closure Alternative 1, construction of the WTP would not be completed and no tank waste would be treated.
- Tank Closure Alternatives 2A, 3A, 3B, 3C, and 4 would use the existing WTP configuration (two HLW melters and two LAW melters).
- Tank Closure Alternatives 2B, 5, 6B, and 6C would use the existing WTP configuration (two HLW melters and two LAW melters) supplemented with expanded LAW treatment capacity (an addition of four LAW melters).
- Tank Closure Alternative 6A would require modification of the WTP to provide HLW vitrification capacity (five HLW melters) only—that is, no LAW vitrification capacity.

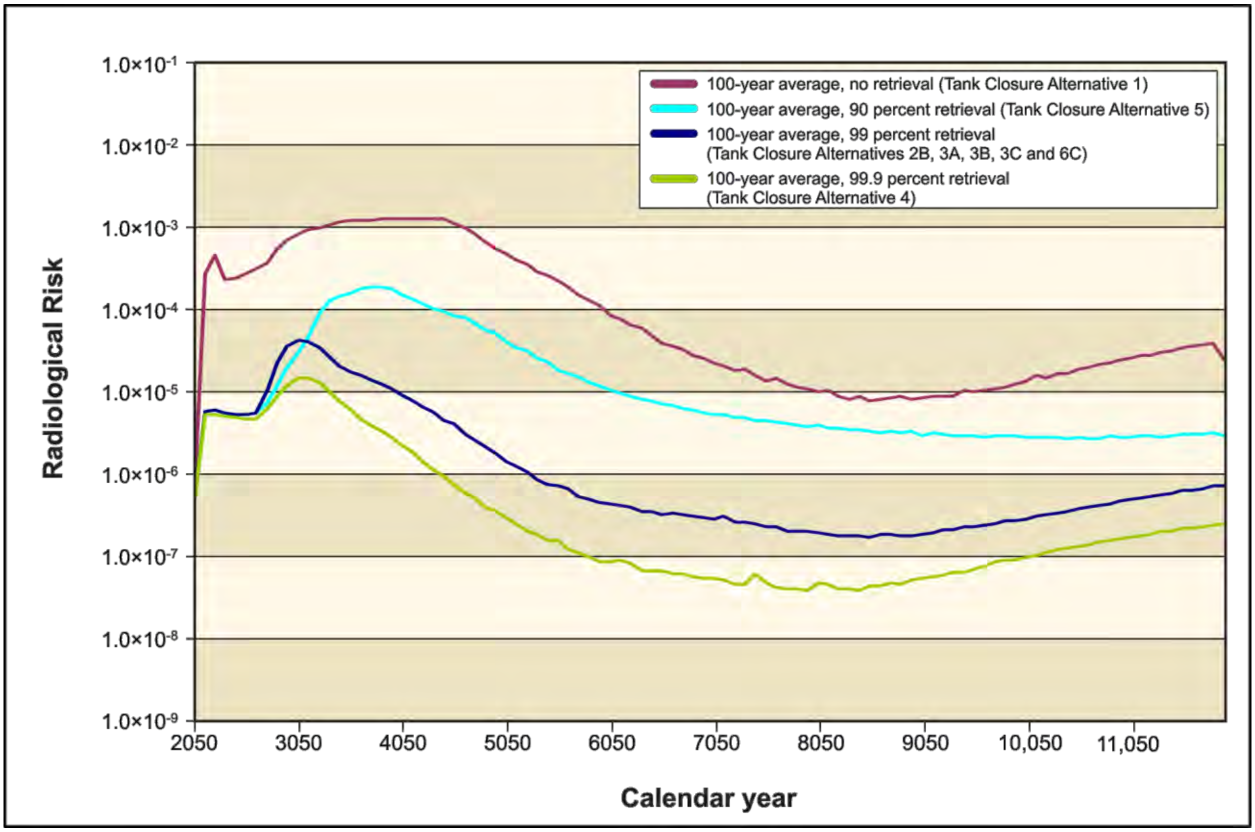


Figure 2–125. Lifetime Radiological Risk for the Drinking-Water Well User at the Core Zone Boundary due to Releases from Tank Farm Sources Other Than Past Leaks

Potential short-term impacts, including resource demands (e.g., land, utilities, geologic resources, workforce), air pollutant emissions, human health impacts, and waste generation, vary roughly in proportion to the magnitude of construction, with total operational impacts generally proportional to the duration of waste treatment. Using the existing WTP treatment configuration would extend treatment time and require replacement DSTs, which would increase short-term impacts. Using the existing WTP configuration supplemented by expanded LAW treatment capacity would reduce the treatment time and result in minor impacts on most resources. Alternative 6A would have the highest demands for, and thus the greatest short-term impacts on, most resources. This is because this alternative would have the highest construction demands coupled with the longest period of WTP operations. It would be necessary to construct replacement WTP facilities twice as the predecessor facilities reached the end of their operational lifetimes. Varying the WTP configuration (i.e., number of HLW and LAW melters) in a given alternative would not change the quantity and performance of waste forms and, therefore, would have minor influence on long-term impacts (except for Alternative 6A, which has no onsite disposal of treated tank waste).

Primary-, Supplemental-, and Secondary-Waste Forms. The Tank Closure alternatives were also developed to evaluate potential impacts of the primary-waste form and a range of thermal and nonthermal supplemental-waste forms. The primary-waste form planned for disposal on site is ILAW glass. The thermal supplemental treatment waste forms are represented in this EIS by bulk vitrification glass and steam reforming waste, and the nonthermal supplemental treatment waste form is represented by cast stone waste. Waste processing using each of the primary or supplemental treatment technologies that generate these waste forms also produces secondary waste, whose impacts are included as part of the evaluation. The Tank Closure alternatives that use these various supplemental treatment technology configurations are as follows:

- Tank Closure Alternative 2B – Thermal (ILAW glass) primary treatment in the 200-East Area
- Tank Closure Alternative 3A – Thermal (ILAW glass) primary treatment in the 200-East Area and thermal (bulk vitrification) supplemental treatment in both the 200-East and 200-West Areas
- Tank Closure Alternative 3B – Thermal (ILAW glass) primary treatment in the 200-East Area and nonthermal (cast stone) supplemental treatment in both the 200-East and 200-West Areas
- Tank Closure Alternative 3C – Thermal (ILAW glass) primary treatment in the 200-East Area and thermal (steam reforming) supplemental treatment in both the 200-East and 200-West Areas

Differences in potential short-term impacts of facility construction and supplemental treatment operations among the Tank Closure alternatives identified above are relatively small for most resource areas. Volumetrically, Tank Closure Alternative 2B would produce no supplemental treatment waste for disposal, while Alternative 3C would produce the highest amount (i.e., approximately 260,000 cubic meters [340,000 cubic yards]). While Tank Closure Alternative 3C would be similar to other supplemental treatment alternatives in its demands for, and thus total short-term construction and operational impacts on, most resources, it would have higher impacts in some resource areas, such as electric power consumption. Tank Closure Alternative 2B would have higher short-term resource impacts on water and fuel (diesel and gasoline) demand than Tank Closure Alternatives 3A, 3B, and 3C.

Estimates of potential long-term human health impacts due to disposal at the IDF-East barrier are presented in Figure 2–126 for the combined effect of primary, supplemental, and secondary wastes under the Waste Management alternatives and disposal groups that include the Tank Closure alternatives described above. The results show that segregation of the maximum amount of waste into the primary-waste form (ILAW glass for Tank Closure Alternative 2B) produces the lowest estimate of risk. Because of the low rate of release from ILAW glass, the major impact of this treatment process is attributable to releases from secondary waste, including the release of iodine-129 captured in the offgas of the melters that is solidified in the ETF-generated secondary waste. A combination of the ILAW glass primary-waste form with the steam reforming supplemental-waste form (Tank Closure Alternative 3C) results in an increase in risk for this alternative relative to Tank Closure Alternative 2B due to the order-of-magnitude increases in release of both technetium-99 and iodine-129 from steam reforming waste compared with ILAW glass. The estimate of risk for steam reforming waste is derived from a solubility-limited release model sensitivity analysis (see Appendix M, Section M.5.5.2, of this EIS) that considered a range of conditions reflecting the early stages of experimental qualification of finely divided steam reforming waste as a waste form for long-term disposal. A combination of the thermal treatment primary-waste form (ILAW glass) with the thermal treatment bulk vitrification glass and secondary waste (Tank Closure Alternative 3A) results in an increase in risk relative to the Tank Closure Alternative 2B primary-waste form (ILAW glass) due to the release from the inventory of technetium-99 deposited in the castable refractory block surrounding the bulk vitrification glass waste form. The treatment process resulting in the nonthermal cast stone waste form (Tank Closure Alternative 3B) produces higher estimates of impact than Alternative 2B due to the remaining inventory of technetium-99 not immobilized into IHLW glass and the relatively poor performance of the current Hanford site-specific grout formulation in retaining this radionuclide.

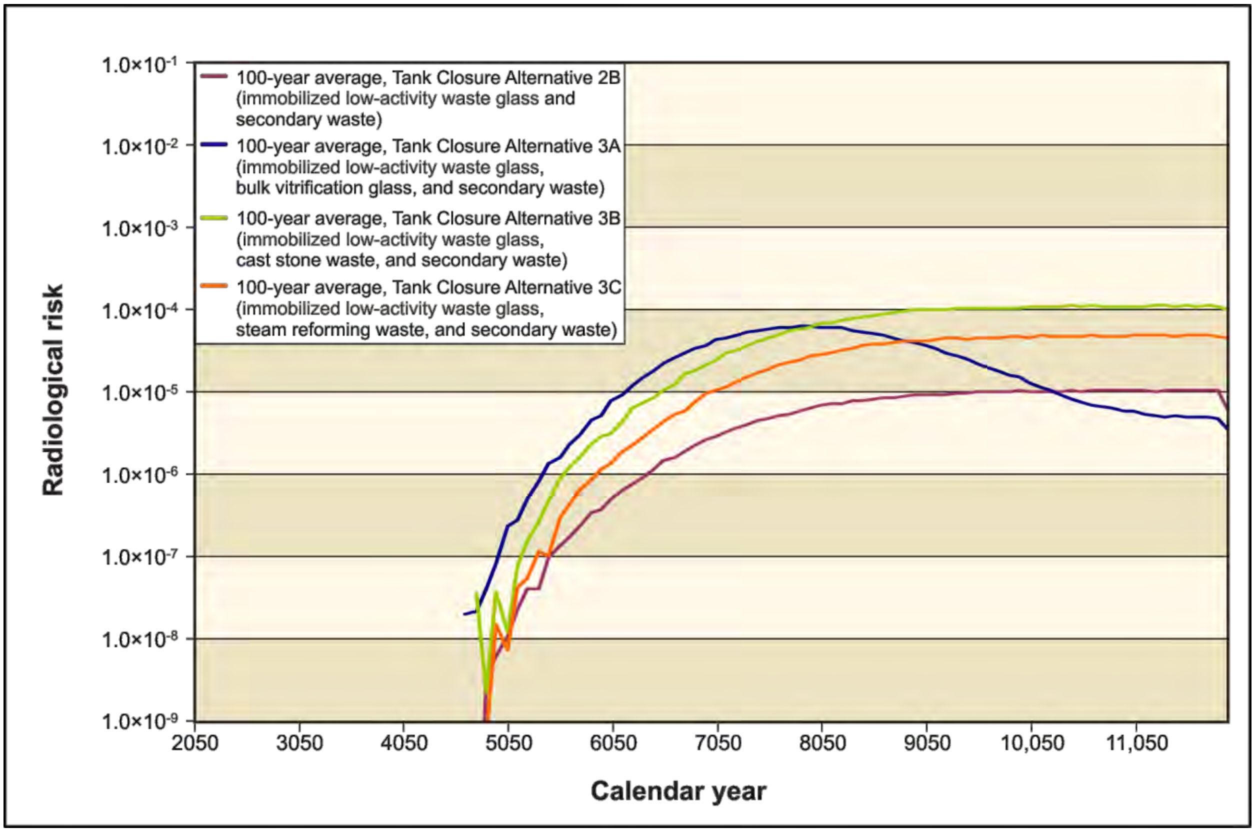


Figure 2–126. Lifetime Radiological Risk for the Drinking-Water Well User at the 200-East Area Integrated Disposal Facility Barrier due to Tank Closure Treatment Process–Generated Waste Forms

The analysis suggests that additional treatment or waste form development may be needed for secondary waste. DOE is currently evaluating potential secondary-waste form research and development activities, which include ceramic and other waste forms. It is anticipated that research and development efforts will continue to address treatment of the liquid secondary waste, as this stream would not be generated until the WTP was operational. Measures could also be pursued involving the increased capture of iodine-129, technetium-99, or other target constituents in ILAW glass. Sensitivity analyses demonstrating the effectiveness of iodine recycling and technetium removal in transferring mobile constituents from grouted secondary-waste forms to the higher-performing ILAW glass primary-waste form are presented in Appendix M, Section M.5.7.

Tank-Derived TRU Waste. Under Tank Closure Alternatives 3A, 3B, 3C, 4, and 5, the waste in some selected tanks would be managed as mixed TRU waste and therefore disposed of at WIPP. These alternatives were developed to determine the environmental impacts related to that approach.

Treating tank-derived TRU waste decreases the WTP and supplemental treatment process timeframes and reduces the volume of waste to be disposed of on site in an IDF, as well as the associated long-term impacts. While treatment of some tank waste as TRU waste increases short-term impacts (e.g., air emissions, worker dose), the total incremental impact over the tank-derived TRU waste treatment period is negligible compared with other waste treatment impacts.

Technetium-99 Removal in the WTP. The Tank Closure action alternatives were also developed to compare WTP pretreatment with and without technetium-99 removal. Tank Closure Alternatives 2B and 3B include technetium-99 removal within the WTP pretreatment process, while Tank Closure Alternatives 2A, 3A, 3C, 4, 5, and 6A through 6C do not.

Tank Closure Alternatives 2B and 3B include technetium-99 removal in the WTP, a pretreatment activity that separates technetium-99 and sends it for immobilization into IHLW glass. By contrast, Tank Closure Alternative 2A assumes no technetium-99 removal in the WTP; therefore, most of the technetium-99 is immobilized in ILAW glass and disposed of on site in an IDF. Comparison of estimates of impacts at the IDF-East barrier under Tank Closure Alternative 2A with those under Tank Closure Alternatives 2B and 3B indicates that ILAW glass with technetium-99 has similar potential impacts, both short- and long-term, to ILAW glass without technetium-99. The analysis further indicates that removal of technetium-99 and its disposal off site as IHLW glass would provide little reduction in the concentrations of technetium-99 compared with disposal as ILAW glass at either the Core Zone Boundary or the Columbia River nearshore. This is because the release rate of technetium-99 from ILAW glass is much lower than that from other sources such as ETF-generated secondary waste and tank closure secondary waste. Thus, technetium-99 removal under Tank Closure Alternative 2B would provide little benefit.

Comparison of estimates of impacts at the IDF-East barrier also indicates that releases of technetium-99 from the cast stone waste form under Tank Closure Alternative 3B increase radiological dose and risk relative to impacts estimated for Tank Closure Alternative 2A. Thus, technetium-99 removal under Tank Closure Alternative 3B would provide substantial benefit.

Sulfate Grout. Under Tank Closure Alternative 5, an additional sulfate removal technology is evaluated after WTP pretreatment to increase the waste loading in ILAW glass, thereby reducing the amount of ILAW glass produced in the WTP and allowing earlier completion of treatment. This alternative was developed to determine the environmental impact of a shorter treatment timeframe. Use of the sulfate removal technology results in a reduced treatment timeframe and reduced ILAW glass volume, with minimal potential short-term impacts, no long-term radiological impacts, and minor long-term chemical impacts. Tank Closure Alternative 5 short-term construction and operational impacts would be very similar to those of other Tank Closure alternatives, although impacts of Sulfate Removal Facility operation would result in higher demands for some resources such as liquid fuels and water.

Closure of the Six Sets of Cribs and Trenches (Ditches). Although the scope of this *TC & WM EIS* does not include decisions to be made for six sets of cribs and trenches (ditches) that are contiguous to the SST farms, they are included in the alternatives analysis because of their close proximity to the SST farms and because it is difficult to distinguish sources of contamination in the vadose zone or groundwater. Tank Closure Alternatives 1 and 2A assume no closure of the SST system, including the cribs and trenches (ditches), while all the remaining Tank Closure alternatives assume landfill closure of the cribs and trenches (ditches) except for Tank Closure Alternatives 6A and 6B, Option Cases. These two alternatives analyze clean closure of the cribs and trenches (ditches).

Overall potential short-term environmental impacts of closure activities would exceed facility construction impacts under most alternatives, especially in terms of air emissions and resource demands. For closure of the cribs and trenches (ditches), there would be some impact tradeoffs between landfill closure of the cribs and trenches (ditches) under the Base Cases and clean closure under the Option Cases. Landfill barrier construction would result in higher peak and total nonradioactive air pollutant emissions than tank farm clean closure would. By contrast, clean closure of the cribs and trenches (ditches) under Tank Closure Alternatives 6A and 6B, Option Cases, would increase the total closure impacts, such as demands for geologic materials, workforce requirements, and secondary-waste generation, to levels measurably higher than those of the Base Cases.

Cribs and trenches (ditches) are major contributors to potential long-term groundwater impacts for all Tank Closure alternatives due to their early discharges in the 1950s and 1960s. As shown in Figure 2–127, estimates of human health impacts (radiological risk to the drinking-water well user) correlate with the closure options under Tank Closure Alternative 1 (no landfill closure of the cribs and trenches [ditches]); Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C (landfill closure of the cribs and trenches [ditches]); and Tank Closure Alternative 6B, Option Case (clean closure of the cribs and trenches [ditches]). For example, Tank Closure Alternative 1 and Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C have similar radiological risk to the drinking-water well user at the Core Zone Boundary throughout the period of analysis because the contaminants have already reached the vadose zone or groundwater and, therefore, there is minimal benefit to the addition of a landfill closure barrier. By contrast, results for Tank Closure Alternative 6B, Option Case, indicate that clean closure of the cribs and trenches (ditches) significantly reduces radiological risk to the drinking-water well user at the Core Zone Boundary after CY 2150. The variability in lifetime radiological risk represented in Figure 2–127 is attributable primarily to the release of multiple constituents at differing times and rates from 33 sources (see Appendix D, Section D.1.5, of this EIS for a list of these sources) comprising these sets of cribs and trenches (ditches).

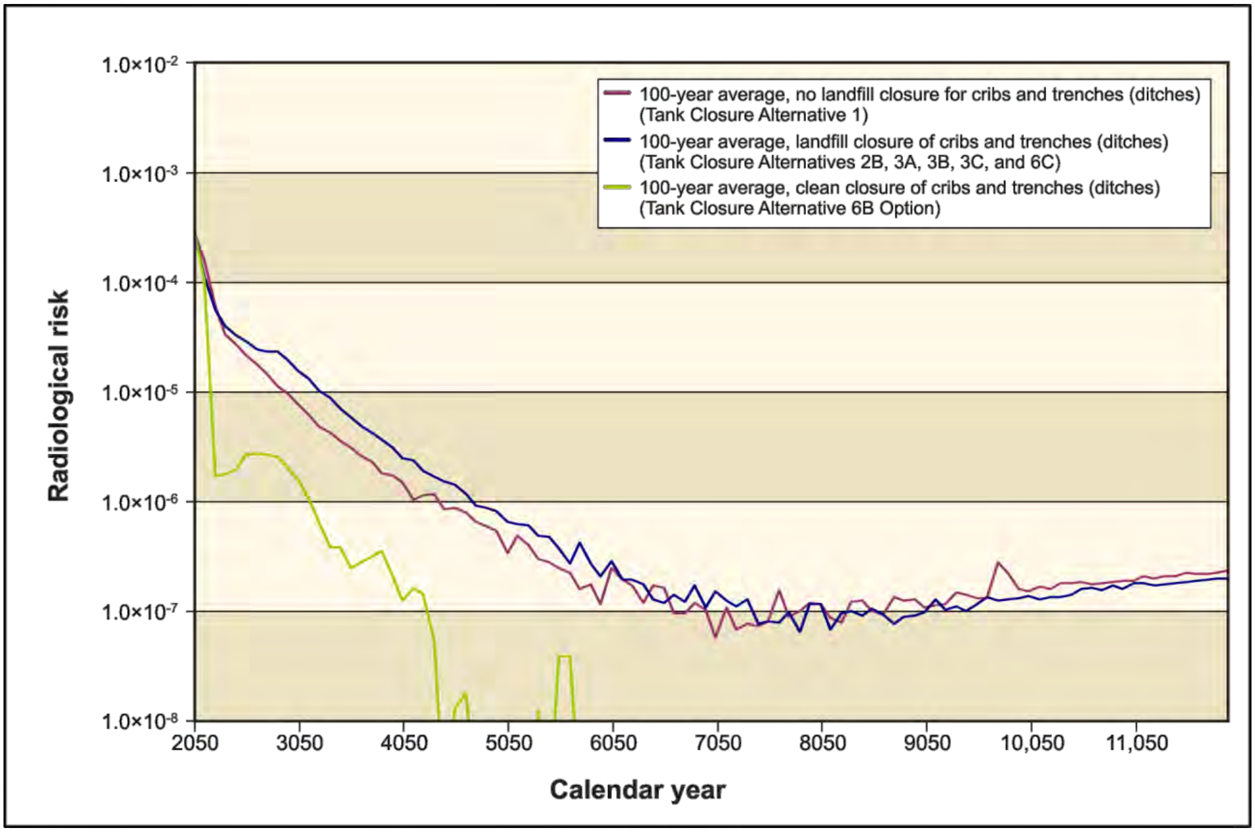


Figure 2–127. Lifetime Radiological Risk for the Drinking-Water Well User at the Core Zone Boundary due to Releases from the Six Sets of Cribs and Trenches (Ditches)

Effect of Closure on SST Past Leaks. Currently, 67 of Hanford's 149 SSTs are listed as "known or suspected" leakers. The Tank Closure alternatives were developed to compare the long-term impacts on groundwater of closing the SST system, including the SST farm past leaks. Tank Closure Alternatives 1 and 2A assume no closure of the SST system, and past leaks would remain. Tank Closure Alternatives 2B, 3A, 3B, 3C, 5, and 6C assume landfill closure of the entire SST system, and past leaks would remain. Tank Closure Alternative 4 assumes selective clean closure/landfill closure, which includes clean closure of the BX and SX SST farms and landfill closure of the remaining SST farms, and past leaks would be removed at the two clean-closed SST farms. The Base and Option Cases of both Tank Closure Alternatives 6A and 6B assume clean closure of the SST farms, and past leaks would be removed at all the SST farms.

Over the short term, past leaks in and around the SST farms could affect clean closure activities. For example, construction dewatering would likely be necessary in some tank farm excavations to allow clean closure to proceed and, depending on the amount of pumping required and the levels of contamination found, may increase worker dose. Also, the water could require special handling and treatment at the ETF prior to release to the environment due to the expected high contamination levels.

Past leaks are major contributors to potential long-term groundwater impacts. Figure 2–128 shows estimates of human health impacts (radiological risk to the drinking-water well user) under Tank Closure Alternative 2A (no landfill closure); Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C (landfill closure); Tank Closure Alternative 4 (selective clean closure/landfill closure); and Tank Closure Alternative 6B, Base Case (clean closure of the SST system). For example, Tank Closure Alternative 2A has the highest radiological risk to the drinking-water well user at the Core Zone Boundary; Tank Closure Alternative 6B, Base Case, the lowest. Estimates of impacts under Tank Closure Alternative 4 do not show a reduction in risk due to selective clean closure of BX and SX tank farm past leaks in comparison with landfill closure. However, selective clean closure or remediation of the deep vadose zone with landfill closure of other SST farms with more-significant past leak radionuclide inventory may result in reducing long-term human health impacts. Risk reduction would be greatest when the remediation of the deep vadose zone occurs in the near term. Remediation of past leaks would be addressed through an RCRA corrective action under the landfill closure plan.

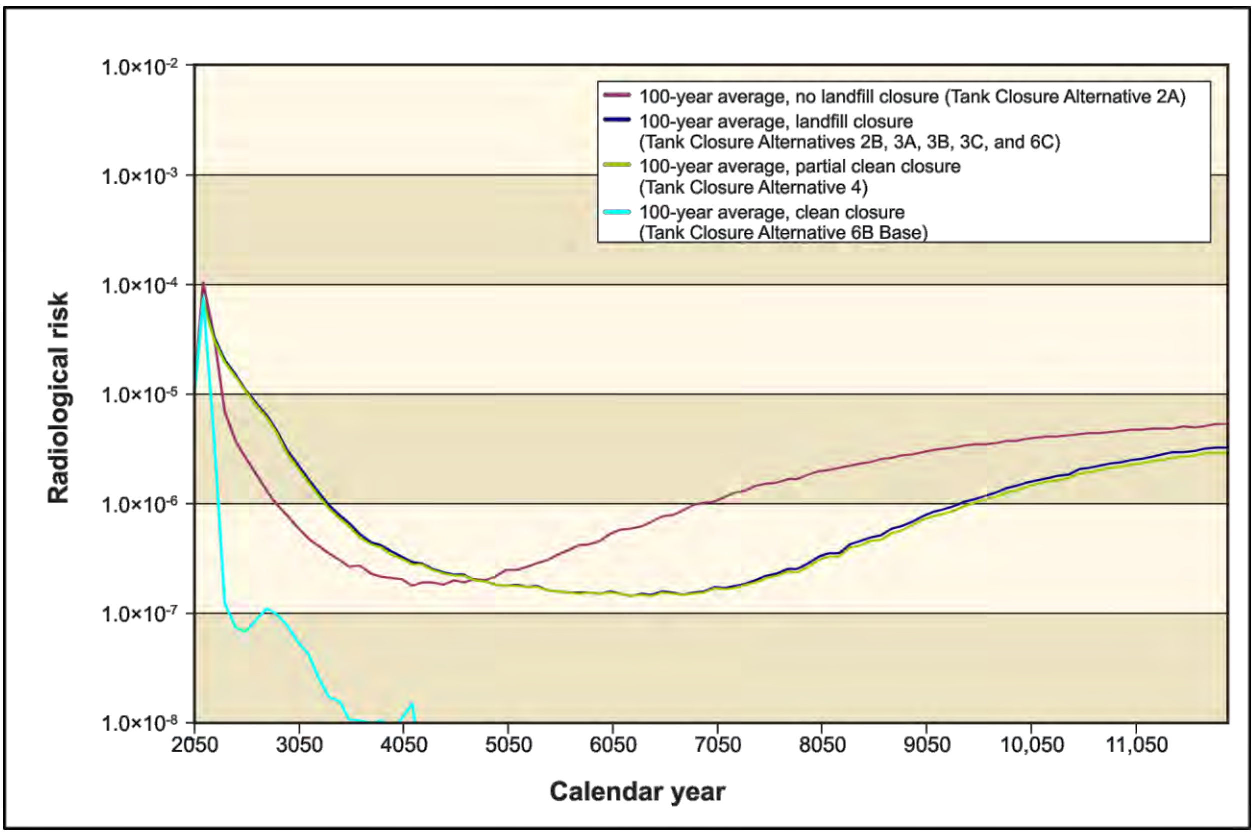


Figure 2–128. Lifetime Radiological Risk for the Drinking-Water Well User at the Core Zone Boundary due to Past Leaks at Single-Shell Tank Farms

Closure of the SST System. The Tank Closure alternatives were also developed to compare the potential long-term impacts on groundwater of closing the SST system. Proposed closure options range from clean closure or selective clean closure/landfill closure to landfill closure with or without any contaminated soil removal. The closure assumptions of the Tank Closure alternatives are summarized below.

- Tank Closure Alternatives 1 and 2A assume no closure of the SST system.
- Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C assume landfill closure using an engineered modified RCRA Subtitle C barrier and removal of 4.6 meters (15 feet) of contaminated soils (which includes ancillary equipment) from two SST farms (BX and SX).
- Tank Closure Alternative 4 assumes selective clean closure of two SST farms (BX and SX) and landfill closure of the remaining SST farms using an engineered modified RCRA Subtitle C barrier.
- Tank Closure Alternative 5 assumes landfill closure of the SST farms using a Hanford barrier without removal of contaminated soils or ancillary equipment.
- Tank Closure Alternatives 6A and 6B assume clean closure of the SST system. The Base Cases would place an engineered modified RCRA Subtitle C barrier over the six sets of cribs and trenches (ditches) in the B and T tank farms, while the Option Cases would include deep soil removal and remediation of these six sets of cribs and trenches (ditches).

As previously mentioned, total short-term and peak short-term environmental impacts of SST farm closure activities would exceed total facility construction impacts under most alternatives, and would substantially add to short-term environmental impacts overall, especially in terms of emissions, worker doses, and resource demands. In terms of land resources, clean closure would allow future use of the tank farm areas, but, unlike all other Tank Closure alternatives, would require significant new, permanent land disturbance for new facilities to treat, store, and dispose of tank waste. In addition, geologic resource requirements (mainly for Borrow Area C material to backfill tank farm excavations) under Alternatives 6A and 6B would be higher than those under the landfill closure alternatives. The peak workforce would increase by as much as 70 percent to support clean closure, as compared with the landfill closure alternatives. Also, the worker population radiation dose would increase by up to a factor of 10 in association with clean closure activities. Landfill closure using the Hanford barrier under Tank Closure Alternative 5 would result in higher peak and total nonradioactive air pollutant emissions than landfill closure employing the engineered modified RCRA Subtitle C barrier, as well as increased demands for utility resources and geologic materials.

Clean closure of the SST system compared with landfill closure would have the following potentially adverse short-term impacts:

- Total land commitments would increase twofold.
- Electricity use would increase by one order of magnitude.
- Geologic resource requirements would increase as much as fivefold.
- Sagebrush habitat affected would increase by as much as two orders of magnitude.
- Radiation worker population dose from normal operations would increase over twofold.
- LLW and MLLW generation volumes would increase threefold.
- Total recordable cases would increase as much as fivefold.[15]

[15] Recordable cases include work-related deaths, as well as work-related illnesses or injuries leading to loss of consciousness, lost work days, or transfer to another job, and/or requiring medical treatment beyond first aid.

These comparisons are representative of Tank Closure Alternative 6A, where utility increases are attributable to the clean closure approach of treating all waste as HLW through the use of HLW melters. This clean closure approach differs under Alternative 6B, where the corresponding comparative increases in potentially adverse short-term impacts are projected to be somewhat less.

One other significant uncertainty of clean closure in terms of technical feasibility and risk is the depth of excavation and soil exhumation that would be required. At a minimum, deep soil removal, including excavation to a depth of about 20 meters (65 feet) below land surface, would be required. This excavation depth should be sufficient to remove soils and sediments contaminated by retrieval-related leaks, as well as contamination from historic waste releases that have accumulated horizontally on compacted strata beneath the waste tanks. For some SST sites, excavation to depths of up to 78 meters (255 feet) below the land surface may be required to remediate contaminant plumes from past-practice discharges that have migrated through the vadose zone soils and sediments and possibly to the water table. Since an effort of this scale in a radioactive environment has never been undertaken in the United States, it is unclear whether this operation could be conducted with adequate considerations for worker safety.

Tank Closure Alternatives 4 and 6 present significant challenges, as mentioned above. The flux reduction evaluation addressed in this EIS examines whether long-term impacts on groundwater could be improved (similar to Alternative 4) by removing contaminants from the soil column at more locations in the Central Plateau as compared to excavation of the BX and SX tank farms and the corresponding contamination down to the groundwater. The sensitivity analysis evaluated what is, in some respects, a hypothetical future site condition, because CERCLA actions are ongoing in the Central Plateau and all seven of the tank farm waste management areas have not been closed. See Chapter 7, Section 7.5, of this EIS for a discussion of sensitivity analyses. Waste Management Area C is the first tank farm to be closed (scheduled for 2019). The sensitivity analysis indicated that more technetium-99, iodine-129, and uranium-238 was removed in the flux reduction 50 percent removal case than under Tank Closure Alternative 4. The 50 percent removal case was applied to 5 ponds, 3 river corridor sites, the BC cribs and trenches (ditches), 3 REDOX [Reduction-Oxidation] waste sites, 4 PUREX waste sites, and 12 tank farms. While the results were interesting and highlighted the influence of these potential activities on high-, medium-, and low-discharge sites, achieving these results is not without its own set of technical challenges. This type of soil removal has the potential to lower waste volumes generated, worker dose, and worker accidents, but it must be balanced with the technical challenges of implementing the concept.

Characterization must be sufficient to potentially treat contamination in the vadose zone and enable decisionmakers to ascertain the (1) extent and depth of the contamination; (2) timeframe in which vadose zone remedies could be effective (e.g., prior to the contaminants reaching the groundwater); (3) available remediation technologies capable of effectively removing specific COPCs; and (4) potential need to develop additional remediation technologies. A potential impact of not treating the vadose zone contamination is that it may reach the unconfined aquifer.

With these technical uncertainties in mind, and as indicated in the Preferred Alternatives discussion in Section 2.12, DOE prefers landfill closure; this could include implementation of corrective/mitigation actions, which may require soil removal or treatment of the vadose zone. It is anticipated that the specific actions to be taken for the tank farms will be identified in the closure plan that will be submitted for each waste management area.

As shown by the radiological risk curves presented in Figure 2–129, the radiological risk peak occurs at approximately CYs 3800 and 3000 under Tank Closure Alternatives 5 and 2B, respectively. The magnitude difference between the two curves is not a result of barrier performance, but of the volume of tank farm residuals (due to different retrieval assumptions). Thus, the Hanford barrier has negligible human health benefits (i.e., radiological risk to the drinking-water well user) at the Core Zone Boundary when measured against the engineered modified RCRA Subtitle C barrier; it would delay release from landfills for only several hundred years.

Figure 2–129, which also includes retrieval leaks and releases from the SST residuals and ancillary equipment for Tank Closure Alternatives 2B (landfill closure) and 4 (selective clean closure/landfill closure), shows that the human health impacts (radiological risk to the drinking-water well user) at the Core Zone Boundary correlate to the closure actions. For example, Tank Closure Alternative 2B has a higher radiological risk than Tank Closure Alternative 4. Note: Tank Closure Alternative 2A is not included in Figure 2–129 because tank closure is not included under this alternative. Tank Closure Alternatives 6A and 6B are not included in Figure 2–129 because long-term human health impacts are negligible; the three groundwater sources (tank retrieval leaks, releases from the tank residuals, and releases from ancillary equipment) are completely removed under this alternative; and impacts of past unplanned releases at the SST farms are negligible. Results presented for closure alternatives in Figures 2–128 (past leaks) and 2–129 (other tank farm sources) indicate that, for the next several hundred years, peak impacts would be due primarily to past leaks, i.e., to contamination already present in the vadose zone. The sensitivity analysis presented in Appendix N, Section N.5, of this EIS indicates that the reduction of solute flux to the water table using advanced technologies, such as dewatering or sequestering, could be useful in mitigation of these impacts. However, the effectiveness of such advanced technologies is uncertain due to insufficient knowledge of the past leaks' magnitude and timing, the current distribution of contamination in the vadose zone, and the limited experience with candidate technologies.

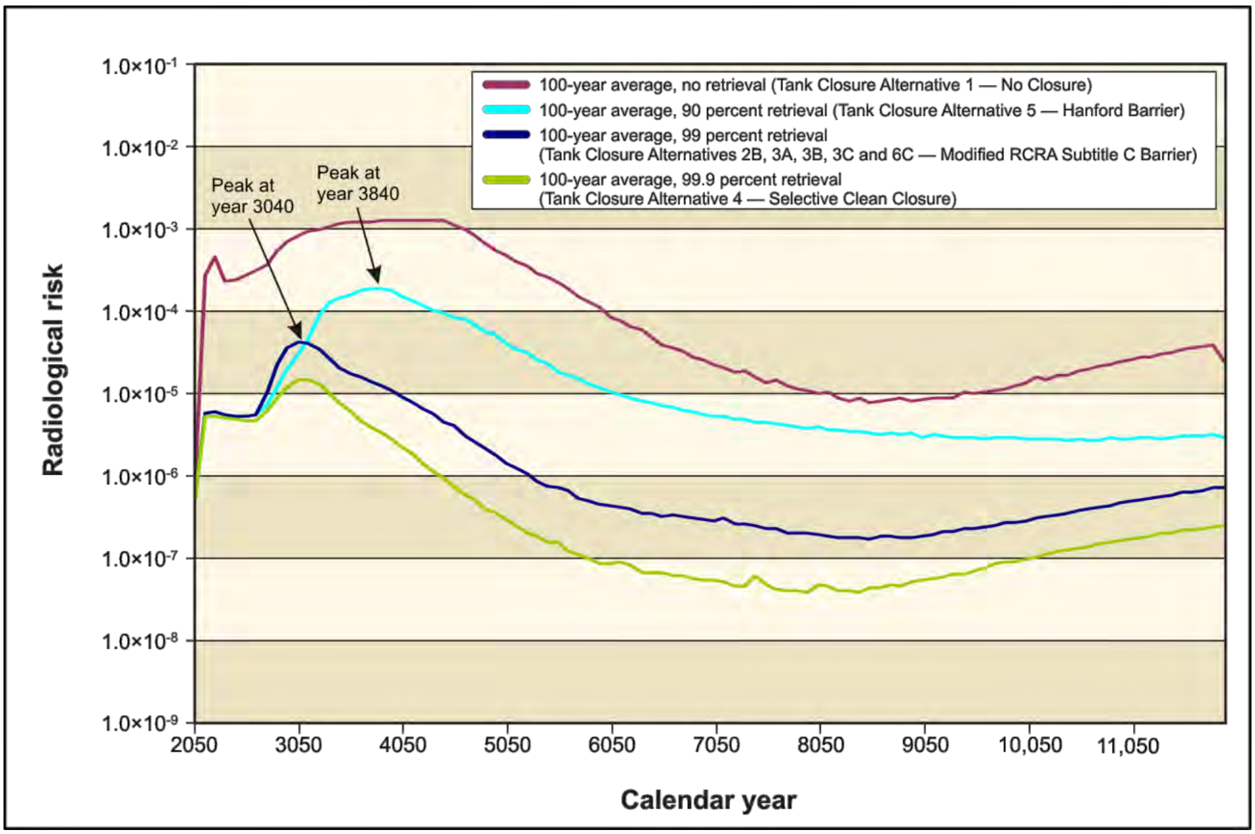


Figure 2–129. Lifetime Radiological Risk for the Drinking-Water Well User at the Core Zone Boundary due to Releases from Tank Farm Residuals and Ancillary Equipment and to Retrieval Leaks

Figures 2–127 and 2–128, which include the releases from the six sets of cribs and trenches (ditches) and the past leaks from the SSTs, respectively, also show that clean closure of the SST farms (Tank Closure Alternative 6B, Base and Option Cases) provides some beneficial long-term impacts on groundwater after CY 2100.

The *TC & WM EIS* analysis further shows that clean closure of the SST farms and contaminated soil (Tank Closure Alternative 6A, Option Case) would not reduce the concentrations of iodine-129 and technetium-99 at the Core Zone Boundary below their respective benchmark concentrations until CY 2100; concentrations will remain within an order of magnitude of the benchmark concentrations (i.e., 1 picocurie per liter and 900 picocuries per liter, respectively) at that location until approximately CY 2600. Thus, there would still be groundwater impacts under the clean closure alternatives due to the early releases from past leaks and intentional releases through the cribs and trenches (ditches).

As a result of the above findings and the excessive cost (see Table 2–52), DOE believes that clean closure may not be a viable alternative. Therefore, DOE prefers landfill closure. Hanford represents somewhat of a unique situation compared with other DOE sites such as West Valley, New York. Some of the tanks at Hanford have leaked and discharged contaminants to the soil column. In addition, there were intentional discharges to the soil column through the six sets of cribs and trenches (ditches) from the 1940s through the 1970s. Hanford also used many different separations processes, which produced a heterogeneous waste. In some cases, select radioactive constituents at Hanford exist in amounts that are orders of magnitude higher than those at other DOE sites. As stated previously, remediation of past leaks would be addressed through an RCRA corrective action under a landfill closure plan.

2.10.2 FFTF Decommissioning Alternatives

The FFTF Decommissioning alternatives were structured to encompass the range of facility disposition options. Under FFTF Decommissioning Alternative 1 (No Action), the facilities would be left in place and stabilized under a blanket of inert gas. By contrast, under FFTF Decommissioning Alternatives 2 (Entombment) and 3 (Removal), radioactive materials would be removed in varying degrees. FFTF Decommissioning Alternative 2 would remove and dispose of a minimal amount of radioactive materials and entomb the rest. All above-grade RCB and adjacent support facilities would be dismantled and either consolidated, entombed in below-grade spaces, or disposed of in an IDF. FFTF Decommissioning Alternative 3 would remove nearly all radioactive materials, including the reactor vessel, internal piping and equipment, and attached depleted-uranium shield, and dispose of these materials on site in an IDF. Though the treatment of the RH-SCs and the disposition of bulk sodium are analyzed in FFTF Decommissioning Alternatives 2 and 3, they are nondiscriminating activities and, therefore, are not included in this discussion on key findings.

As shown in Table 2–10, potential short-term impacts on most resource areas would be similar under FFTF Decommissioning Alternatives 2 and 3, with a few notable exceptions. Emissions of nonradioactive air pollutants, particularly particulate matter, associated with construction of facilities to support decommissioning activities and geologic resource requirements for backfill and site regrading following completion of removal activities would be higher under FFTF Decommissioning Alternative 3. Worker radiation doses and waste generation due to removal activities would also be higher under this alternative.

Because of the relatively small inventory of hazardous constituents at FFTF relative to that of facilities within the Core Zone Boundary and because of the low rate of recharge to groundwater, potential long-term health impacts under all alternatives would be minimal and there would be little difference between the No Action and Entombment Alternatives, except that Entombment would delay any impacts for 500 years. From a facility disposition perspective, other than the need to treat the bulk sodium and RH-SCs so the recovered sodium could be used in the WTP or for Hanford corrosion control, there would be little environmental impact on groundwater under any of the FFTF Decommissioning alternatives. FFTF could remain in surveillance and maintenance status.

2.10.3 Waste Management Alternatives

The Waste Management alternatives described in this *TC & WM EIS* represent the range of reasonable approaches to storing and treating onsite LLW, MLLW, and TRU waste; disposing of onsite and offsite LLW and MLLW (at Hanford) and onsite TRU waste (at WIPP); and closing the disposal facilities to reduce water infiltration and the potential for intrusion. The Waste Management alternatives were developed partly to compare the potential short-term impacts of the expansion of existing facilities and construction of new facilities, as well as the operation and deactivation of facilities used to store, treat, and dispose of waste. They were also developed to compare the potential long-term water quality, human health, and ecological risk impacts resulting from these activities.

Waste disposal would be required under all three Waste Management alternatives. The disposal options for waste and the amount of waste vary among the alternatives. Waste Management Alternative 1 would continue disposal of onsite non-CERCLA, nontank LLW and MLLW in LLBG 218-W-5, trenches 31 and 34. For conservative analysis purposes, both Waste Management Alternatives 2 and 3 would provide for continued operation of these trenches through 2050, though the waste would be disposed of in an IDF once it becomes operational. Waste Management Alternative 2 would provide for completion of IDF-East for the disposal of tank, onsite non-CERCLA, FFTF decommissioning, waste management, and offsite LLW and MLLW. Waste Management Alternative 3 would provide for the disposal of these waste types in two IDFs: IDF-East and IDF-West. Only waste from tank treatment operations would be disposed of in IDF-East. All other wastes would be disposed of in IDF-West. Both Waste Management Alternatives 2 and 3 would include construction and operation of the proposed RPPDF for the disposal of lightly contaminated equipment and soils from closure activities.

For the disposal groups under Waste Management Alternatives 2 and 3, potential demands for, and short-term impacts on, most resources would vary primarily in direct relation to the size (i.e., disposal capacity) and operational lifespan of the disposal facilities. Potential total short-term and peak short-term environmental impacts of disposal activities are projected to be very similar for Waste Management Alternatives 2 and 3. Thus, for short-term impacts, disposal facility configuration and location are not discriminators.

Low-Level Radioactive Waste Burial Ground 218-W-5, Trenches 31 and 34. Under Waste Management Alternative 1 (No Action), the existing LLBG 218-W-5, trenches 31 and 34, would continue to accept onsite non-CERCLA, nontank LLW and MLLW. The analysis indicates that it would be safe to continue to dispose of LLW and MLLW in these trenches. Potential short-term impacts of ongoing disposal operations would be negligible.

Estimates of potential long-term impacts expressed as radiological risk to the drinking-water well user at the Core Zone Boundary due to LLBG 218-W-5, trenches 31 and 34, are presented in Figure 2–130. The estimated radiological risk is low, well below 1×10^{-7}, especially compared to the risks associated with the sources remaining at the SST farms under the Tank Closure alternatives (see Figure 2–125).

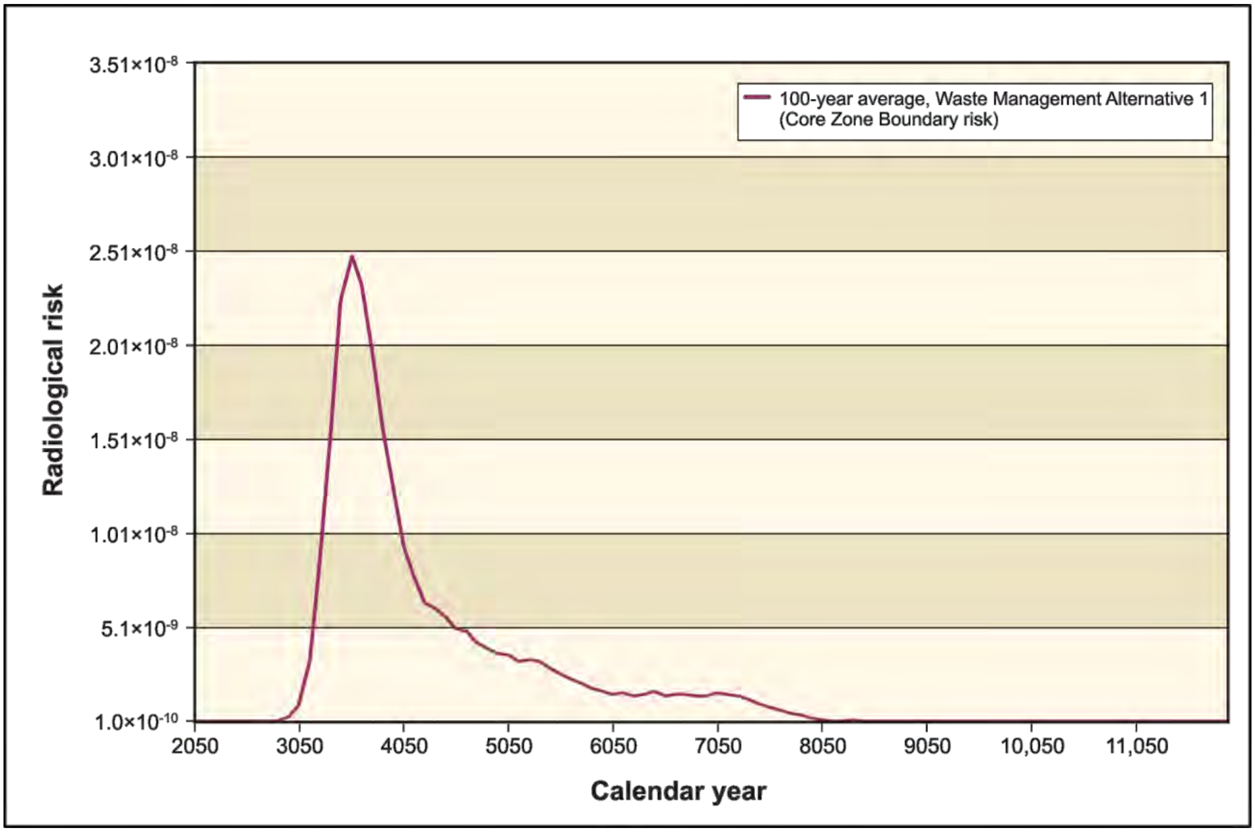


Figure 2–130. Waste Management Alternative 1 (No Action) Lifetime Radiological Risk for the Drinking-Water Well User at the Core Zone Boundary due to Low-Level Radioactive Waste Burial Ground 218-W-5, Trenches 31 and 34

Disposal of Waste in IDF-East and IDF-West. Under Waste Management Alternative 2, tank closure–generated waste (primary, supplemental, and secondary wastes) and non-tank-farm waste (from onsite non-CERCLA sources; FFTF decommissioning; waste management; and other DOE sites, i.e., offsite LLW and MLLW) would be disposed of in IDF-East. Under Waste Management Alternative 3, the tank closure–generated waste would be disposed of in IDF-East; the non-tank-farm waste, in IDF-West. Under both Waste Management alternatives, rubble, soil, and equipment generated by tank farm closure would be disposed of in the RPPDF. Note: Waste Management Alternative 1 does not include the operation of IDF-East or IDF-West. Therefore, it is not relevant to this discussion.

Total short-term impacts of constructing and operating two IDFs under Waste Management Alternative 3 would be substantially the same as those under Waste Management Alternative 2 across nearly all resource areas. This is because no economy of scale is estimated to be achieved by having two IDFs, and short-term impacts would be generally proportional to the total size (i.e., disposal capacity) and operational lifespan of disposal facilities rather than the number or location thereof.

The long-term analysis indicates that IDF-West would not perform as well as IDF-East because of the higher assumed infiltration rate for the 200-West Area location. As indicated in Figure 2–131, long-term human health impacts (radiological risk to the drinking-water well user) at the Core Zone Boundary due to combined releases from the proposed RPPDF and the IDFs would be greater under Waste Management Alternative 3 (IDF-West) than under Waste Management Alternative 2 (IDF-East) prior to CY 6000. For the IDF-East/RPPDF case, the early peak projected around CY 4000 is due to releases from the proposed RPPDF, while the later peak occurring around CY 8000 is due to releases from IDF-East. For the IDF-West/RPPDF case, the peak projected around CY 4000 is due primarily to releases from IDF-West, with secondary contributions due to releases from the proposed RPPDF. Table 2–48 provides the estimated concentration at the year of peak concentration for two of the predominant contaminants, technetium-99 and iodine-129, at the IDF-East and IDF-West barriers due to releases from all sources. To investigate the uncertainty due to variability in infiltration estimates, the performance of the IDF-East and IDF-West locations was investigated for the case of a background infiltration rate of 3.5 millimeters per year at both locations. In addition, to provide a balanced comparison, impacts due solely to releases from the non-tank-farm sources listed above were considered in this sensitivity analysis. Estimates of radiological risk at the IDF-East and IDF-West barrier boundaries are presented in Figure 2–132. The results indicate that, due to differences in facility size and configuration and in local unconfined-aquifer flow conditions, impacts estimated for the IDF-East location are lower than those for the IDF-West location.

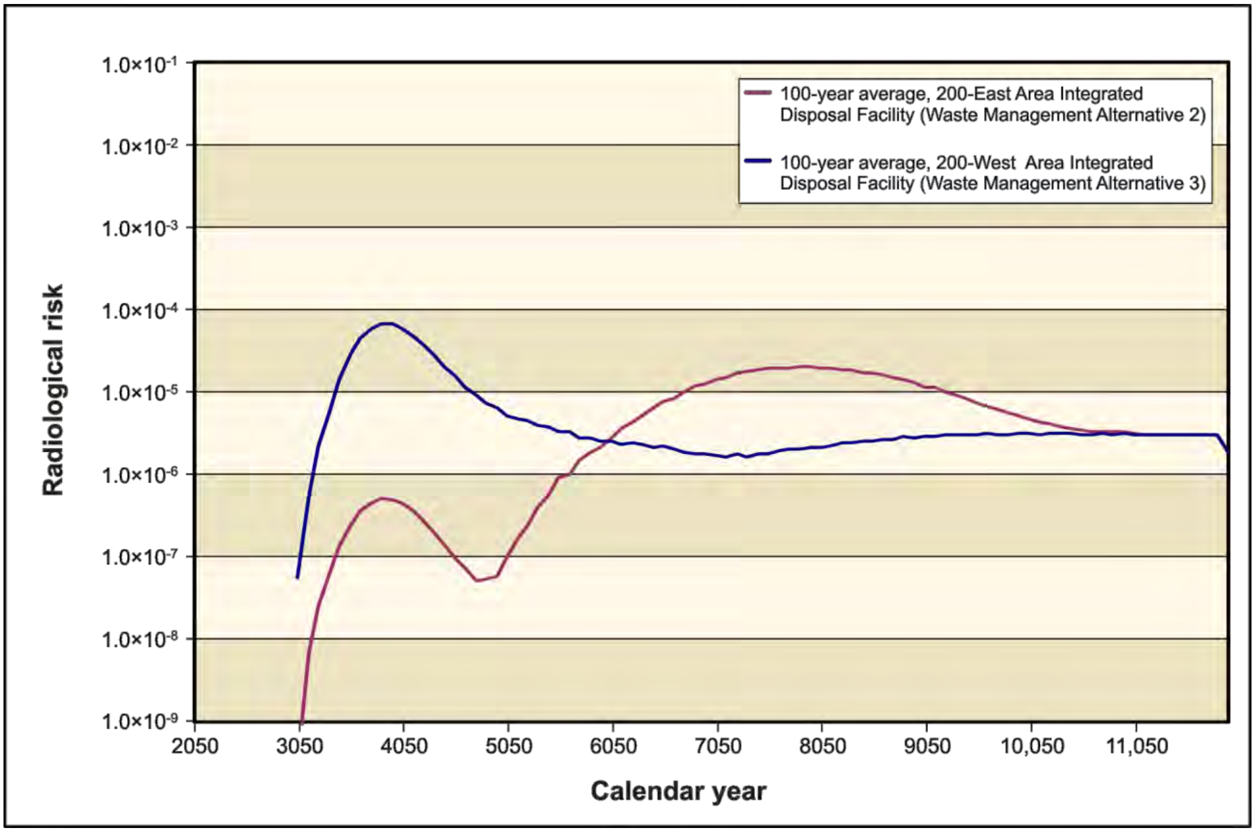


Figure 2–131. Lifetime Radiological Risk for the Drinking-Water Well User at the 200-East and 200-West Area Integrated Disposal Facility Barriers

Table 2–48. Waste Management Alternatives 2 and 3 – Maximum Concentrations of Technetium-99 and Iodine-129 in the Peak Year at the IDF-East and IDF-West Barriers

Contaminant	Concentration (picocuries per liter)		
	IDF-East (Waste Management Alternative 2)	IDF-West (Waste Management Alternative 3)	Benchmark Concentration
Technetium-99	**1,259** (7826)	**13,220** (3818)	900
Iodine-129	**2.1** (7907)	**21** (3794)	1

Note: Corresponding calendar years are shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility.

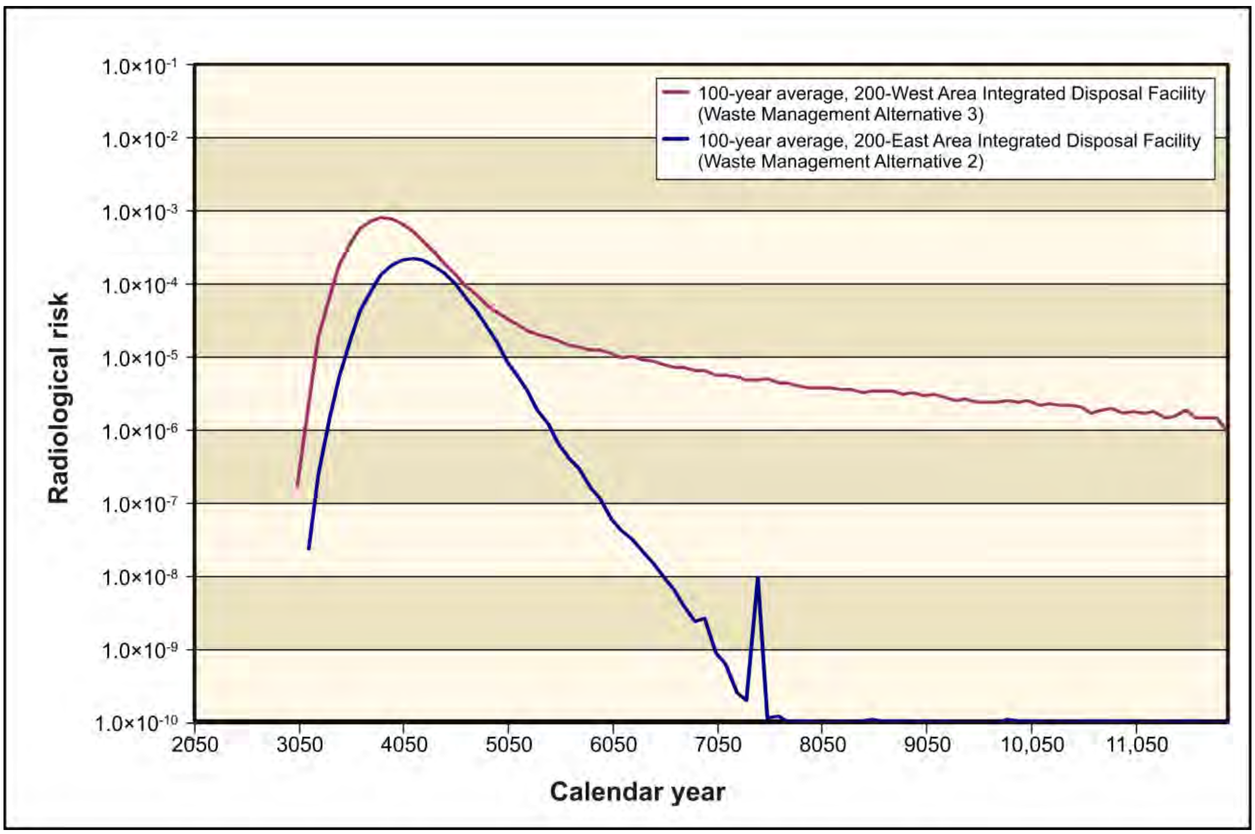


Figure 2–132. Time Series of Radiological Risk for Non-Tank-Farm Sources at 200-East and 200-West Area Integrated Disposal Facility Barriers at an Infiltration Rate of 3.5 Millimeters per Year

Disposal of Offsite Waste. Under Waste Management Alternative 2, waste from other DOE facilities (i.e., offsite waste) would be accepted and disposed of on site in an IDF. The analysis shows that receipt of offsite waste streams that contain specified amounts of certain radionuclides, specifically iodine-129 and technetium-99, could have an adverse impact on the environment. Comparison of human health impact estimates at the IDF-East barrier under Waste Management Alternative 2 for Tank Closure Alternative 2B, with and without offsite waste (see Figure 2–133), illustrates this finding. Estimates of peak radiological risk for Waste Management Alternative 2, including the disposal of offsite waste at IDF-East, are a factor of approximately six higher than those under Waste Management Alternative 2, with offsite waste removed. Table 2–49 provides the estimated concentrations at the year of peak concentration for two of the predominant contaminants, technetium-99 and iodine-129, at the IDF-East barrier. Under both cases (with and without offsite waste), technetium-99 and iodine-129 are major contributors to groundwater impacts and offsite waste is the major contributor of peak concentrations.

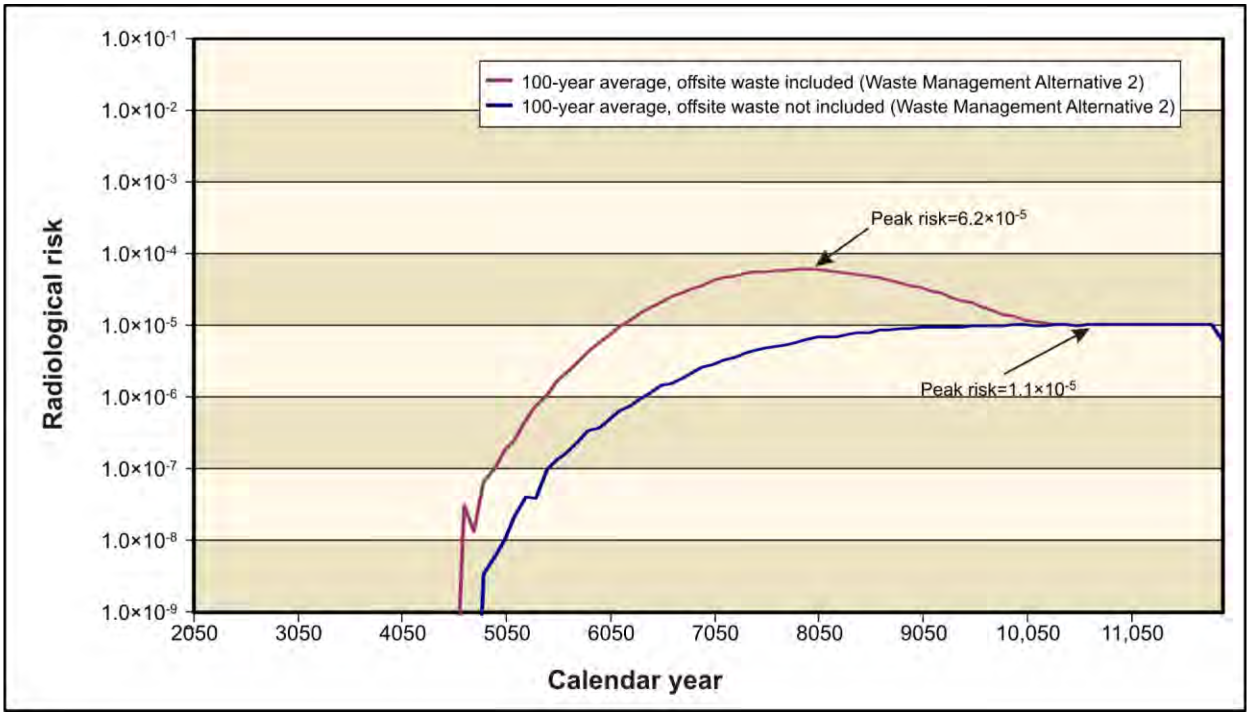


Figure 2–133. Tank Closure Alternative 2B Lifetime Radiological Risk for the Drinking-Water Well User at the 200-East Area Integrated Disposal Facility Barrier

Table 2–49. Waste Management Alternative 2 – Maximum Concentrations of Technetium-99 and Iodine-129 in the Peak Year at the IDF-East Barrier With and Without Offsite Waste

Contaminant	Concentration (picocuries per liter)		
	Waste Management Alternative 2 (offsite waste included)	Waste Management Alternative 2 (offsite waste not included)	Benchmark Concentration
Technetium-99	**1,259** (7826)	206 (10,129)	900
Iodine-129	**2.1** (7907)	**1.0** (10,177)	1

Note: Corresponding calendar years are shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: IDF-East=200-East Area Integrated Disposal Facility.

Disposal of Tank Closure Waste in the Proposed RPPDF. Waste Management Alternatives 2 and 3 would include construction and operation of the proposed RPPDF for the disposal of lightly contaminated equipment and soils from closure activities. As shown in Figure 2–134, the proposed RPPDF is a secondary contributor to human health impacts (radiological risk to the drinking-water well user) at the Core Zone Boundary throughout the period of analysis; the estimated radiological risks are less than 1×10^{-5}. The figure shows higher lifetime radiological risk (approaching 1×10^{-5}) under Tank Closure Alternative 6B, Base Case, which is due to the disposal of large amounts of vadose zone sediments excavated from all SST farms, compared with the estimated risk under Tank Closure Alternative 4, which is due to disposal of vadose zone sediments from only two SST farms (BX and SX).

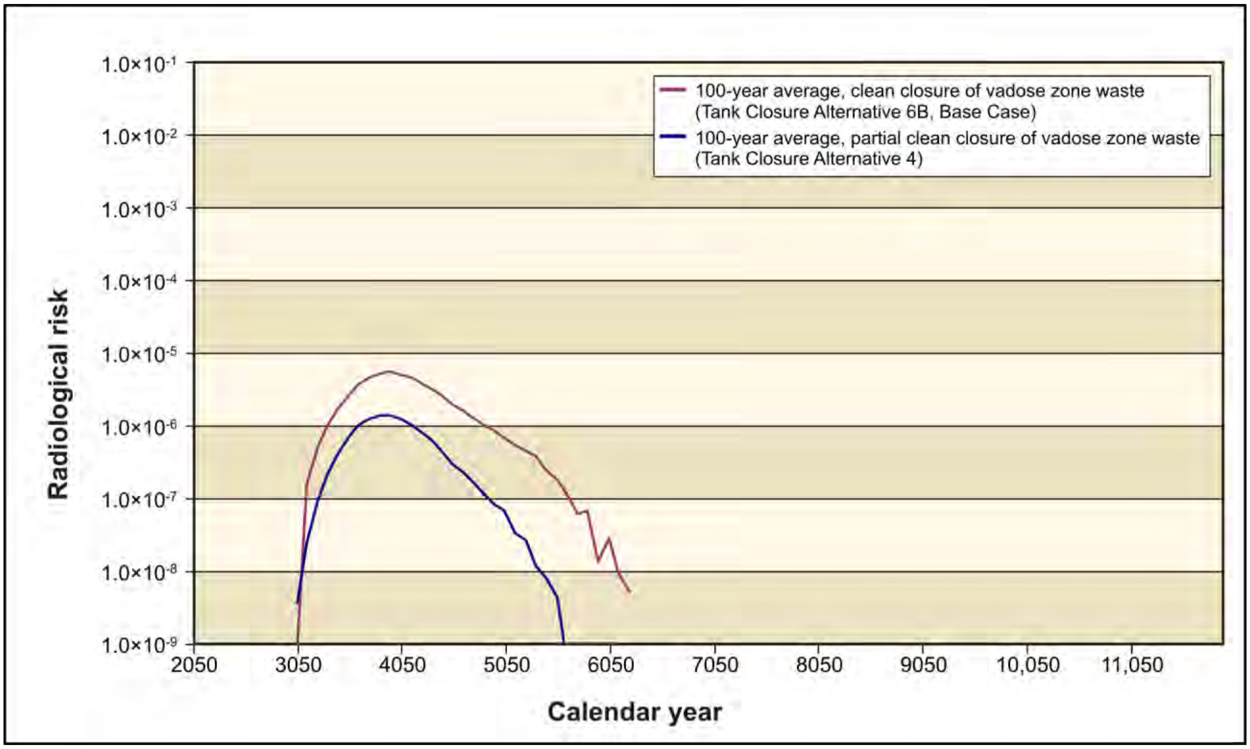


Figure 2–134. Lifetime Radiological Risk for the Drinking-Water Well User at the Core Zone Boundary from River Protection Project Disposal Facility Releases

2.11 COST OF THE ALTERNATIVES

The *Cost Report for "Tank Closure and Waste Management Environmental Impact Statement" Alternatives* was prepared to estimate the consolidated costs for continued operation of existing facilities; construction, operations, and deactivation of new or modified facilities; and associated activities to support the proposed actions (e.g., waste form disposal costs) (DOE 2009b).[16] The costs were calculated using constant 2008 dollars. Because the alternatives cover a broad range of remediation and closure pathways, the estimates developed for the various alternatives span a wide range of potential costs.[17]

Each of the *TC & WM EIS* Tank Closure, FFTF Decommissioning, and Waste Management alternatives is affected by uncertainties that influence confidence in the cost estimate. The following are among the uncertainties common to most of the alternatives (DOE 2009b):

- **Conservative estimates.** NEPA analysis provides an understanding of the potential environmental impacts associated with the proposed actions and the alternatives. Conservative estimates of labor and material requirements, technology performance, and other aspects of the alternatives were adopted. To the extent that conservatism is inherent in components of the alternatives, the cost estimate for the alternatives reflects higher costs than the point estimates developed for allocation of budgets and other planning exercises.

[16] In an EIS, the costs estimated and presented for each alternative are different in nature than the cost estimates used to support the annual DOE budget process (such as the budget estimates for RPP contracts). Budgets to support DOE contracts typically address a near-term timeframe (generally within 5 years) because more-specific information regarding discrete work activities is usually available with a higher degree of certainty.

[17] Because of the wide range of potential costs, the higher Tank Closure alternatives' costs are presented in billions of 2008 dollars, whereas the lower FFTF Decommissioning and Waste Management alternatives' costs are presented in millions of 2008 dollars.

- **Scope definition.** The level of definition associated with the alternatives and/or specific work elements contributes to uncertainty. Cost estimates based on limited definition (planning-level estimates or preconceptual data) are more uncertain than estimates based on detailed design information. Furthermore, there may be greater uncertainty regarding cost estimates for activities involving unspecified radiological and chemical inventories (e.g., resulting from soil remediation) because of the unknown impact the actual inventory may have on remediation costs.
- **Schedule and duration of activities.** Except for the No Action Alternatives, each alternative includes durations for completing the waste retrieval and TSD components of the RPP mission, as well as the deactivation and closure components, which vary among the alternatives. Cost estimates based on projecting current costs (i.e., 2008 dollars) far into the future introduce other significant uncertainties. These uncertainties are driven by economic conditions and labor and material markets; changes in regulatory, technical, and safety requirements; political, scientific, and cultural conditions; and technological advances. All of the alternatives also assume a 100-year period of administrative controls/postclosure care following completion of D&D and/or closure activities. Cost estimates for activities extending into the next century are inherently uncertain and should be interpreted as only rough estimates used to describe the total cost of an alternative and the relative cost differences among the alternatives.
- **Development and use of technologies.** Except for the No Action Alternatives, each alternative involves development and use of unique, specialty technologies to address complex problems. These technologies are in varying stages of completion, ranging from conceptual design to pilot demonstration to full-scale construction. Consequently, in estimating costs, technology performance (e.g., facility throughputs, waste loading, separations efficiencies) was assumed based upon the design criteria. Should these key performance assumptions be found invalid, impacts on the alternative, cost, schedule, and scope would occur.
- **Dependence upon external interfaces.** Many of the alternatives depend on the ability of WIPP and onsite disposal facilities to accept and dispose of waste forms (e.g., CH- and RH-mixed TRU waste). Impacts on various alternatives' cost, schedule, and scope would occur if the adopted assumptions for each of the alternatives proved invalid.
- **Embedded costs.** Efforts were made to remove embedded escalation costs, management reserves, contingency fees, and other fees (e.g., WTP estimate-at-completion values) from the source data when the contributions of these overall cost additions were clearly identified in source documentation.
- **Disposal costs.** Actual disposal costs are not currently available. Only estimated disposal costs based on the assumed waste types, quantities, and radiological content have been published. The estimated disposal costs will continue to vary as disposal facilities near completion, disposal quantities and types are modified, and cost bases are refined.

2.11.1 Tank Closure Alternatives

Cost estimates for each Tank Closure alternative are provided in Tables 2–50 through 2–52. Table 2–50 provides the estimated potential costs of construction, operations, and deactivation for each of the primary components of the proposed actions (storage, retrieval, treatment, disposal, and closure); costs for final-waste-form disposal on or off site are excluded. Table 2–51 provides the costs of final-waste-form disposal, both on and off site, by alternative. These costs represent the post-treatment disposal costs for ILAW, mixed TRU waste, MLLW, LLW, melters taken out of service, and contaminated soils. The costs associated with on- or offsite disposal of HLW shielded boxes are not included in the cost data, nor are the offsite-disposal costs for IHLW. Alternatives that generate higher volumes of IHLW could ultimately have proportionally higher transportation and disposal costs. No credit was taken for cost-reducing actions such as waste volume reduction, alternative waste packaging, or use of alternative disposal sites.

Table 2–50. Tank Closure Alternatives – Summary of Cost Estimates,[a] Excluding Waste Form Disposal Costs (billions of 2008 dollars)

Work Element	Storage	Retrieval	Treatment	Disposal[b]	Closure	Total[c]
Alternative 1: No Action						
Construction	0.02	–	1.9	–	–	2.0
Operations	0.6	–	–	–	–	0.6
Deactivation	0.4	–	–	–	–	0.4
Total[c]	**1.0**	**–**	**1.9**	**–**	**–**	**3.0**
Alternative 2A: Existing WTP Vitrification; No Closure						
Construction	3.5	2.8	14.7	1.2	–	22.1
Operations	16.0	2.1	24.5	1.0	0.7	44.3
Deactivation	0.4	0.1	0.9	<0.01	–	1.4
Total[c]	**19.8**	**5.1**	**40.2**	**2.2**	**0.7**	**67.9**
Alternative 2B: Expanded WTP Vitrification; Landfill Closure						
Construction	1.5	2.6	8.7	1.5	2.3	16.6
Operations	7.1	1.5	11.3	0.7	0.5	21.1
Deactivation	–	0.1	0.6	<0.01	1.8	2.5
Total[c]	**8.6**	**4.2**	**20.6**	**2.1**	**4.6**	**40.1**
Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure						
Construction	1.5	2.6	8.1	1.6	2.3	16.2
Operations	6.4	1.4	11.0	0.7	0.5	19.9
Deactivation	–	0.1	0.5	<0.01	1.8	2.4
Total[c]	**7.9**	**4.2**	**19.6**	**2.3**	**4.6**	**38.5**
Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure						
Construction	1.5	2.6	7.9	1.6	2.3	15.9
Operations	6.4	1.4	11.2	0.7	0.5	20.1
Deactivation	–	0.1	0.5	<0.01	1.8	2.4
Total[c]	**7.9**	**4.2**	**19.6**	**2.3**	**4.6**	**38.4**
Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure						
Construction	1.5	2.6	9.5	1.6	2.3	17.5
Operations	6.4	1.4	11.0	0.7	0.5	19.9
Deactivation	–	0.1	0.5	<0.01	1.8	2.4
Total[c]	**7.9**	**4.2**	**21.0**	**2.3**	**4.6**	**39.8**
Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure						
Construction	1.5	3.6	8.0	1.6	3.0	17.8
Operations	6.9	1.8	11.9	0.7	2.5	23.7
Deactivation	–	0.2	0.5	<0.01	1.4	2.1
Total[c]	**8.4**	**5.6**	**20.4**	**2.3**	**6.9**	**43.6**

Table 2–50. Tank Closure Alternatives – Summary of Cost Estimates[a], Excluding Waste Form Disposal Costs (billions of 2008 dollars) *(continued)*

Work Element	Storage	Retrieval	Treatment	Disposal[b]	Closure	Total[c]
Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure						
Construction	1.8	2.1	8.4	1.3	2.2	15.9
Operations	5.4	1.1	8.7	0.7	0.3	16.3
Deactivation	–	0.1	0.6	<0.01	0.8	1.5
Total[c]	**7.3**	**3.4**	**17.7**	**1.9**	**3.4**	**33.7**
Alternative 6A: All Vitrification/No Separations; Clean Closure[d]						
Construction	8.1 *8.1*	5.1 *5.1*	21.8 *21.8*	69.9 *69.9*	2.6 *3.8*	107.5 *108.7*
Operations	28.7 *28.7*	3.4 *3.4*	48.6 *48.6*	36.2 *36.2*	10.9 *21.0*	127.8 *138.0*
Deactivation	–	0.3 *0.3*	1.4 *1.4*	<0.01 *<0.01*	3.2 *3.6*	4.9 *5.3*
Total[c]	**36.8** ***36.8***	**8.8** ***8.8***	**71.8** ***71.8***	**106.1** ***106.1***	**16.6** ***28.4***	**240.1** ***251.9***
Alternative 6B: All Vitrification with Separations; Clean Closure[d]						
Construction	1.5 *1.5*	3.6 *3.6*	8.8 *8.8*	3.2 *3.2*	2.6 *3.8*	19.7 *20.9*
Operations	7.1 *7.1*	1.8 *1.8*	12.3 *12.3*	0.7 *0.7*	9.3 *19.5*	31.1 *41.3*
Deactivation	–	0.2 *0.2*	0.6 *0.6*	<0.01 *<0.01*	3.2 *3.6*	4.0 *4.4*
Total[c]	**8.6** ***8.6***	**5.6** ***5.6***	**21.7** ***21.7***	**3.8** ***3.8***	**15.1** ***26.9***	**54.8** ***66.6***
Alternative 6C: All Vitrification with Separations; Landfill Closure						
Construction	1.5	2.6	8.7	2.3	2.3	17.3
Operations	7.1	1.5	11.2	0.7	0.5	20.9
Deactivation	–	0.1	0.6	<0.01	1.8	2.5
Total[c]	**8.6**	**4.2**	**20.4**	**2.9**	**4.6**	**40.7**

[a] Estimates are costs to the Hanford Site only.
[b] Includes post-treatment storage. Costs for disposal of the final waste forms (e.g., immobilized low-activity waste and transuranic waste) are presented separately in Table 2–51.
[c] Total may not equal the sum of the contributions due to rounding.
[d] Values presented are for the Base Case. Values for the Option Case (additional clean closure of six adjacent cribs and trenches [ditches]) are presented in *italics*.

Note: Costs associated with the 100-year administrative and/or institutional control periods were assigned in the following manner: Alternatives 1 and 2A under "Storage" and all other alternatives under "Closure."

Key: WTP=Waste Treatment Plant.

Source: DOE 2009b.

Table 2–51. Tank Closure Alternatives – Costs for Final-Waste-Form Disposal (billions of 2008 dollars)[a]

Tank Closure Alternative		Final-Waste-Form Disposal Costs
1	No Action	–
2A	Existing WTP Vitrification; No Closure	0.3
2B	Expanded WTP Vitrification; Landfill Closure	0.8
3A	Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure	1.3
3B	Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure	1.5
3C	Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure	1.5
4	Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure	2.0
5	Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure	0.8
6A	All Vitrification/No Separations; Clean Closure[b]	2.8 *9.2*
6B	All Vitrification with Separations; Clean Closure[b]	2.8 *9.1*
6C	All Vitrification with Separations; Landfill Closure	0.6

[a] Offsite-disposal costs for immobilized high-level radioactive waste are not included.
[b] Values presented are for the Base Case. Values for the Option Case (additional clean closure of six adjacent cribs and trenches [ditches]) are presented in *italics*.

Key: WTP=Waste Treatment Plant.

Source: DOE 2009b.

The highest relative costs would apply to Tank Closure alternatives with more-restrictive scopes (i.e., 99.9 percent retrieval of SST waste and/or clean closure components [Alternatives 4, 6A, and 6B]), extended schedules (Alternatives 2A and 6A), and high waste-form disposal costs (Alternatives 6A and 6B). These higher costs would be driven by required construction of treatment systems; longer relative operating schedules for waste treatment and tank farm facilities; and clean closure of the SST farms (Alternatives 6A and 6B).

DOE would proceed with onsite disposal of some of the final waste forms (e.g., ILAW) only if their disposal complies with applicable laws. Table 2–52 combines the cost data in Tables 2–50 and 2–51 to project a total cost for each Tank Closure alternative.

Table 2–52. Tank Closure Alternatives – Total Cost Projections, Including Waste Disposal Costs (billions of 2008 dollars)[a]

Tank Closure Alternative		Total Cost
1	No Action	3.0
2A	Existing WTP Vitrification; No Closure	68.2
2B	Expanded WTP Vitrification; Landfill Closure	40.9
3A	Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure	39.8
3B	Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure	39.9
3C	Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure	41.3
4	Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure	45.6
5	Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure	34.5
6A	All Vitrification/No Separations; Clean Closure[b]	242.9 *261.1*
6B	All Vitrification with Separations; Clean Closure[b]	57.6 *75.7*
6C	All Vitrification with Separations; Landfill Closure	41.3

[a] Offsite-disposal costs for immobilized high-level radioactive waste are not included.
[b] Values presented are for the Base Case. Values for the Option Case (additional clean closure of six adjacent cribs and trenches [ditches]) are presented in *italics*.

Key: WTP=Waste Treatment Plant.
Source: Tables 2–50 and 2–51.

2.11.2 FFTF Decommissioning Alternatives

Table 2–53 provides summary cost estimates for each of the FFTF Decommissioning alternatives in terms of construction, operations, and deactivation. Table 2–54 presents the separate projected waste disposal costs for each alternative, as well as the projected waste volumes produced under each alternative, as the disposal costs depend on the types and quantities of waste produced. Table 2–55 combines the data in Tables 2–53 and 2–54 to provide the total estimated cost of each FFTF Decommissioning alternative.

Table 2–53. FFTF Decommissioning Alternatives – Summary Cost Estimates, Excluding Waste Form Disposal Costs (millions of 2008 dollars)

Work Element	FFTF Decommissioning Alternatives				
	Alternative 1: No Action[a]	Alternative 2: Entombment		Alternative 3: Removal	
Facility Disposition					
Construction	–	3.9		2.5	
Operations	–	99.1		109.2	
Deactivation	492.5	0.7		0.3	
Subtotal[b, c]	**492.5**	**103.7**		**112.1**	
Work Element		**Hanford Option[d]**	**Idaho Option[e, f]**	**Hanford Option[d]**	**Idaho Option[e, f]**
Disposition of Bulk Sodium	–	**64.3**	**33.9**	**64.3**	**33.9**
Disposition of RH-SCs	–	**121.1**	**121.2**	**121.1**	**121.2**

a The No Action Alternative includes 100 years of surveillance and maintenance activities.
b Costs for disposal of the final waste forms are presented separately in Table 2–54.
c Subtotal may not equal the sum of the contributions due to rounding.
d Hanford Reuse Option for disposition of bulk sodium.
e Idaho Reuse Option for disposition of bulk sodium.
f Cost estimates for the Idaho Option for disposition of RH-SCs conservatively assume construction of a new facility.

Key: FFTF=Fast Flux Test Facility; RH-SC=remote-handled special component.

Source: DOE 2009b.

Table 2–54. FFTF Decommissioning Alternatives – Waste Form Disposal Cost Estimates

Waste Category (cubic meters disposed of)	Alternative 1: No Action[a]	Alternative 2: Entombment[b]	Alternative 3: Removal[b]
Low-level radioactive waste	1,700	140	750
Mixed low-level radioactive waste	60	670	280
Hazardous waste	400	–	60
Nonhazardous waste	–	460	460
Disposal Cost (millions of 2008 dollars)	**2.1**	**0.9**	**1.1**

a Waste volumes of secondary solid waste only.
b Waste volumes are a summation of primary and secondary solid waste and are not expected to differ between the Hanford or Idaho options for disposition of remote-handled special components or bulk sodium.

Note: To convert cubic meters to cubic feet, multiply by 35.315.

Key: FFTF=Fast Flux Test Facility.

Source: DOE 2009b.

Table 2–55. FFTF Decommissioning Alternatives – Total Cost Projections, Including Waste Disposal Costs (millions of 2008 dollars)

FFTF Decommissioning Alternatives		Total Cost
1	**No Action**	494.6
2	**Entombment**	
	Disposition of RH-SCs: Idaho Option Disposition of bulk sodium: Hanford Reuse Option	290.1
	Disposition of RH-SCs: Hanford Option Disposition of bulk sodium: Idaho Reuse Option	259.6
	Disposition of RH-SCs: Hanford Option Disposition of bulk sodium: Hanford Reuse Option	289.9
	Disposition of RH-SCs: Idaho Option Disposition of bulk sodium: Idaho Reuse Option	259.7
3	**Removal**	
	Disposition of RH-SCs: Idaho Option Disposition of bulk sodium: Hanford Reuse Option	298.7
	Disposition of RH-SCs: Hanford Option Disposition of bulk sodium: Idaho Reuse Option	268.1
	Disposition of RH-SCs: Hanford Option Disposition of bulk sodium: Hanford Reuse Option	298.5
	Disposition of RH-SCs: Idaho Option Disposition of bulk sodium: Idaho Reuse Option	268.3

Key: FFTF=Fast Flux Test Facility; RH-SCs=remote-handled special components.
Source: Tables 2–53 and 2–54.

2.11.3 Waste Management Alternatives

Table 2–56 provides the summary cost estimates for each of the Waste Management alternatives in terms of construction, operations, and deactivation of treatment and storage activities, as well as the construction, operations, closure, and transportation activities that would occur in association with each disposal group. Table 2–57 presents the separate costs for disposal of offsite LLW and MLLW; onsite non-CERCLA, nontank waste; and secondary waste from disposal operations. These disposal costs do not differentiate between on- and offsite waste generators and are presented only for Waste Management Alternatives 2 and 3 (no waste would be received for disposal under Waste Management Alternative 1: No Action). Table 2–58 combines the data in Tables 2–56 and 2–57 to provide the total estimated cost of each Waste Management alternative.

Table 2–56. Waste Management Alternatives – Summary Cost Estimates, Excluding Waste Form Disposal Costs (millions of 2008 dollars)

Work Element	Alternative 1: No Action	Alternative 2: Disposal in IDF, 200-East Area Only			Alternative 3: Disposal in IDF, 200-East and 200-West Areas		
Treatment and Storage							
Construction	–	337.9			337.9		
Operations	17.5	2,016.0			2,016.0		
Deactivation	451.3	30.7			30.7		
Subtotal	468.8	2,384.5			2,384.5		
Disposal		**Group 1**	**Group 2**	**Group 3**	**Group 1**	**Group 2**	**Group 3**
Construction	–	118.9	459.3	459.3	118.5	459.7	459.7
Operations	–	649.9	5,268.9	9,465.3	647.0	5,242.0	9,399.8
Closure	–	946.2	1,128.9	1,128.9	1,386.4	1,570.3	1,570.3
Transportation[a]	–	521.5	521.5	521.5	521.5	521.5	521.5
Subtotal	–	2,236.5	7,378.5	11,575.0	2,673.4	7,793.6	11,951.3
Total[b]	**468.8**	**4,621.1**	**9,763.1**	**13,959.5**	**5,057.9**	**10,178.1**	**14,335.9**

[a] Costs associated with transportation of offsite low-level radioactive waste and mixed low-level radioactive waste to the Hanford Site for disposal. The waste quantity, generation location, and transportation distance are the same for each disposal group.

[b] Total may not equal the sum of the contributions due to rounding. Costs for disposal of the final waste forms are presented separately in Table 2–57.

Key: IDF=Integrated Disposal Facility.

Source: DOE 2009b.

Table 2–57. Waste Management Alternatives – Waste Form Disposal Costs

Waste Category (cubic meters disposed of)	Alternative 1: No Action[a]	Alternative 2: Disposal in IDF, 200-East Area Only	Alternative 3: Disposal in IDF, 200-East and 200-West Areas
Offsite LLW and MLLW	–	82,000	82,000
Onsite non-CERCLA, nontank waste	–	5,300	5,300
Secondary waste	–	3,000	3,000
Disposal Cost (millions of 2008 dollars)	–	**96.1**	**96.1**

[a] No waste would be received for disposal under this alternative.

Note: To convert cubic meters to cubic feet, multiply by 35.315.

Key: CERCLA=Comprehensive Environmental Response, Compensation, and Liability Act; IDF=Integrated Disposal Facility; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste.

Source: DOE 2009b.

Table 2–58. Waste Management Alternatives – Total Cost Projections, Including Waste Disposal Costs (millions of 2008 dollars)

Waste Management Alternatives		Total Cost
1	**No Action**	468.8
2	**Disposal in IDF, 200-East Area Only**	
	Disposal Group 1	4,717.2
	Disposal Group 2	9,859.2
	Disposal Group 3	14,055.6
3	**Disposal in IDF, 200-East and 200-West Areas**	
	Disposal Group 1	5,154.0
	Disposal Group 2	10,274.2
	Disposal Group 3	14,432.0

Key: IDF=Integrated Disposal Facility.
Source: Tables 2–56 and 2–57.

2.12 PREFERRED ALTERNATIVES

The preferred alternative is the alternative that the agency believes would fulfill its statutory mission while giving consideration to environmental, economic, technical, and other factors.

This *Final TC & WM EIS* considers three sets of actions: tank closure, FFTF decommissioning, and waste management. The range of reasonable approaches to these three sets of actions is covered by a total of 17 alternatives. DOE has clarified and/or revised its Preferred Alternatives since the *Draft TC & WM EIS* was issued in the three major areas.

2.12.1 Tank Closure

Eleven alternatives for potential tank closure actions are evaluated in this final EIS. These alternatives cover tank waste retrieval and treatment, as well as closure of the SSTs. DOE has identified the following Preferred Alternatives: for retrieval, DOE prefers Tank Closure alternatives that would retrieve at least 99 percent of the tank waste. All Tank Closure alternatives would do this except Alternatives 1 (No Action) and 5. For closure of the SSTs, DOE prefers landfill closure; this could include implementation of corrective/mitigation actions as described in Section 2.10.1, which may require soil removal or treatment of the vadose zone. Decisions on the extent of soil removal or treatment, if needed, will be made on a tank farm or waste management area basis through the RCRA closure permitting process. These landfill closure considerations would apply to Tank Closure Alternatives 2B, 3A, 3B, 3C, 5, and 6C. DOE does not prefer alternatives that include removal of the tanks as evaluated in Tank Closure Alternatives 4, 6A, and 6B. As described in Section 2.10.1, DOE believes that removal of the tank structures is technically infeasible and, due to both the depth of the contamination and the technical issues associated with removal of the tank structures, that it presents significant uncertainty in terms of worker exposure risk and waste generation volume.

DOE does not have a preferred alternative regarding supplemental treatment for LAW; DOE believes it beneficial to study further the potential cost, safety, and environmental performance of supplemental treatment technologies. Nevertheless, DOE is committed to meeting its obligations under the TPA regarding supplemental LAW treatment. When DOE is ready to identify its preferred alternative regarding supplemental treatment for LAW, this action will be subject to NEPA review as appropriate. DOE will provide a notice of its preferred alternative in the *Federal Register* at least 30 days before issuing a ROD. For the actions related to tank waste retrieval, treatment and closure, DOE prefers Tank Closure Alternative 2B, without removing technetium in the Pretreatment Facility.

Although DOE previously expressed its preference that no Hanford tank waste would be shipped to WIPP (74 FR 67189), DOE now prefers to consider the option to retrieve, treat, and package waste that may be properly and legally designated as mixed TRU waste from specific tanks for disposal at WIPP, as analyzed in Tank Closure Alternatives 3A, 3B, 3C, 4, and 5. Initiating retrieval of tank waste identified as mixed TRU waste would be contingent on DOE's obtaining the applicable disposal and other necessary permits and ensuring that the WIPP Waste Acceptance Criteria and all other applicable regulatory requirements have been met. Retrieval of tank waste identified as mixed TRU waste would commence only after DOE had issued a *Federal Register* notice of its preferred alternative and a ROD.

2.12.2 FFTF Decommissioning

There are three FFTF Decommissioning alternatives from which the Preferred Alternative was identified: (1) No Action, (2) Entombment, and (3) Removal. DOE's Preferred Alternative for FFTF Decommissioning is Alternative 2: Entombment, which would remove all above-grade structures, including the reactor building. Below-grade structures, the reactor vessel, piping, and other components would remain in place and be filled with grout to immobilize the remaining radioactive and hazardous constituents. Waste generated from these activities would be disposed of in an IDF, and an engineered modified RCRA Subtitle C barrier would be constructed over the filled area. The RH-SCs would be processed at INL and returned to Hanford. Bulk sodium inventories would be processed at Hanford for use in the WTP.

2.12.3 Waste Management

Three Waste Management alternatives were identified for the proposed actions: (1) Alternative 1: No Action, under which all onsite LLW and MLLW would be treated and disposed of in the existing, lined LLBG 218-W-5 trenches and no offsite waste would be accepted; (2) Alternative 2, which would continue treatment of onsite LLW and MLLW in expanded, existing facilities and dispose of onsite and previously treated, offsite LLW and MLLW in a single IDF (IDF-East); and (3) Alternative 3, which also would continue treatment of onsite LLW and MLLW in expanded, existing facilities, but would dispose of onsite and previously treated, offsite LLW and MLLW in two IDFs (IDF-East and IDF-West). DOE's Preferred Alternative for waste management is Alternative 2, disposal of onsite LLW and MLLW streams in a single IDF (IDF-East). Disposal of SST closure waste that is not highly contaminated, such as rubble, soils, and ancillary equipment, in the proposed RPPDF is also included under this alternative. After completion of disposal activities, IDF-East and the proposed RPPDF would be landfill-closed under an engineered modified RCRA Subtitle C barrier. The final EIS analyses show that, even when mitigation is applied to certain offsite waste streams (e.g., removal of most of the iodine-129), some environmental impacts of small quantities of iodine-129 would still occur and, therefore, limitations on that constituent should apply regardless of the alternative selected.

DOE will continue to defer the importation of offsite waste at Hanford, at least until the WTP is operational, subject to appropriate NEPA review and consistent with its previous Preferred Alternative for waste management (74 FR 67189). The limitations and exemptions defined in DOE's January 6, 2006, Settlement Agreement with the State of Washington (as amended on June 5, 2008) regarding *State of Washington v. Bodman* (Civil No. 2:03-cv-05018-AAM), signed by DOE, Ecology, the Washington State Attorney General's Office, and the U.S. Department of Justice, will remain in place.

2.13 REFERENCES

ANL-W and Fluor Hanford (Argonne National Laboratory-West, Idaho Falls, Idaho, and Fluor Hanford, Inc., Richland, Washington), 2002, *Hanford Site Sodium Disposition Trade-Off Study*, April.

Burke, T.M., 2007, *Hanford Site Sodium Disposition Evaluation Report*, HNF-33211, Rev. 0, Fluor Hanford, Inc., Richland, Washington, May.

CEES (Columbia Energy & Environmental Services, Inc.), 2003, *Feasibility of Tank Closure Environmental Impact Statement Alternatives 3 and 5*, CEES-0064, Rev. 0, Richland, Washington, August 6.

CEES (Columbia Energy & Environmental Services, Inc.), 2006a, *De-encapsulation and Treatment of the Cesium and Strontium Capsules at WTP*, WT-ST-053, Rev. 1, Richland, Washington, September 29.

CEES (Columbia Energy & Environmental Services, Inc.), 2006b, *T-Plant Facility Resource Calculation*, 6734-T-Plant-001, Rev. 1, Richland, Washington, September 29.

CH2M HILL (CH2M HILL Hanford Group, Inc.), 2006, "CH2M HILL Completes State-of-the-Art Landfill at Hanford: State of Washington Issues Permit for Hanford's First RCRA Compliant Landfill," Richland Washington, May 18.

Chapin, D.H., 2007, U.S. Department of Energy, Richland Operations Office, Richland, Washington, personal communication (email) to C.L. Johnson, Science Applications International Corporation, Germantown, Maryland, "DOE-RL/FFTF Project Response to SAIC (Charlotte Johnson) Re: Status of FFTF Deactivation," Attachment, "Status of FFTF Project Deactivation (June 2007)," June 6.

DOE (U.S. Department of Energy), 1995, *Environmental Assessment, Shutdown of the Fast Flux Test Facility, Hanford Site, Richland, Washington*, DOE/EA-0993, Richland Operations Office, Richland, Washington, May.

DOE (U.S. Department of Energy), 1997a, *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*, DOE/EIS-0200-F, Office of Environmental Management, Washington, D.C., May.

DOE (U.S. Department of Energy), 1997b, *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*, DOE/EIS-0026-S-2, Carlsbad Area Office, Carlsbad, New Mexico, September.

DOE (U.S. Department of Energy), 1997c, *Hanford Facility Dangerous Waste Permit Application, Low-Level Burial Grounds*, DOE/RL-88-20, Rev. 1, Richland Operations Office, Richland, Washington, July.

DOE (U.S. Department of Energy), 1999, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, DOE/EIS-0222-F, Richland Operations Office, Richland, Washington, September.

DOE (U.S. Department of Energy), 2000, *Final Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility*, DOE/EIS-0310, Office of Nuclear Energy, Science and Technology, Washington, D.C., December.

DOE (U.S. Department of Energy), 2001, *Hanford Site Biological Resources Management Plan*, DOE/RL 96-32, Rev. 0, Richland Operations Office, Richland, Washington, August.

DOE (U.S. Department of Energy), 2003a, *Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, WA: Tank System Closure and Facility D&D Data Package*, DOE/ORP-2003-05, Rev. 0, Office of River Protection, Richland, Washington, April 17.

DOE (U.S. Department of Energy), 2003b, *Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, WA: Waste Retrieval and Storage Data Package*, DOE/ORP-2003-06, Rev. 0, Office of River Protection, Richland, Washington, April 17.

DOE (U.S. Department of Energy), 2003c, *Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, WA: No Action Baseline Tank Farm Operations and Waste Treatment Data Package*, DOE/ORP-2003-08, Rev. 0, Office of River Protection, Richland, Washington, April 17.

DOE (U.S. Department of Energy), 2003d, *Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, WA: Inventory and Source Term Data Package,* DOE/ORP-2003-02, Rev. 0, Office of River Protection, Richland, Washington, April 17.

DOE (U.S. Department of Energy), 2003e, *Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, WA: Waste Treatment and Supplemental Technology Data Package*, DOE/ORP-2003-07, Rev. 0, Office of River Protection, Richland, Washington, April 17.

DOE (U.S. Department of Energy), 2003f, *Tank Removal and Deep Soil Excavation*, Rev. 0, Office of River Protection, Richland, Washington, May 15.

DOE (U.S. Department of Energy), 2004a, *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements*, 2nd ed., Office of Environment, Safety and Health, Office of NEPA Policy and Compliance, Washington, D.C., December.

DOE (U.S. Department of Energy), 2004b, *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington*, DOE/EIS-0286F, Richland Operations Office, Richland, Washington, January.

DOE (U.S. Department of Energy), 2006a, *Environmental Assessment, Sodium Residuals Reaction/Removal and Other Deactivation Work Activities, Fast Flux Test Facility (FFTF) Project, Hanford Site, Richland, Washington*, DOE/EA-1547F, Richland Operations Office, Richland, Washington, March.

DOE (U.S. Department of Energy), 2006b, *Finding of No Significant Impact, "Environmental Assessment, Sodium Residuals Reaction/Removal and Other Deactivation Work Activities, Fast Flux Test Facility (FFTF) Project, Hanford Site, Richland, Washington,"* Richland Operations Office, Richland, Washington, March 31.

DOE (U.S. Department of Energy), 2007, *Civilian Radioactive Waste Management System Waste Acceptance System Requirements Document*, DOE/RW-0351, Rev. 5, Office of Civilian Radioactive Waste Management, North Las Vegas, Nevada, May 31.

DOE (U.S. Department of Energy), 2008, *Supplement Analysis, Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, DOE/EIS-0222-SA-01, Richland Operations Office, Richland, Washington, June.

DOE (U.S. Department of Energy), 2009a, *Final Environmental Assessment for the Remote-Handled Waste Disposition Project,* DOE/EA-01386, Idaho Operations Office, Idaho Falls, Idaho, February.

DOE (U.S. Department of Energy), 2009b, *Cost Report for "Tank Closure and Waste Management Environmental Impact Statement" Alternatives*, DOE/ORP-2003-14, Rev. 6, Vol. 1 and 2, Office of River Protection, Richland, Washington, July.

DOE and Ecology (U.S. Department of Energy, Richland Operations Office, Richland, Washington, and Washington State Department of Ecology, Olympia, Washington), 1996, *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement*, DOE/EIS-0189, August.

DOE and Ecology (U.S. Department of Energy and Washington State Department of Ecology), 2006, Memorandum of Understanding Between the United States Department of Energy and the Washington State Department of Ecology for Development of the *Hanford Site Tank Closure and Waste Management EIS ("TC & WM EIS*"), January 6.

Ecology, EPA, and DOE (Washington State Department of Ecology, Olympia, Washington; U.S. Environmental Protection Agency, Washington, D.C.; and U.S. Department of Energy, Richland, Washington), 1989, Hanford Federal Facility Agreement and Consent Order, 89-10, as amended, accessed through http://www.hanford.gov/tpa/tpahome.htm, May 15.

Ecology, EPA, and DOE (Washington State Department of Ecology, Olympia, Washington; U.S. Environmental Protection Agency, Washington, D.C.; and U.S. Department of Energy, Richland, Washington), 2002, Reestablish Milestones and Target Dates for the Shutdown (Transition; Pursuant to Tri-Party Agreement Section 8) of the Fast Flux Test Facility (FFTF) (M-81-00 Series and M-20-29A), Hanford Federal Facility Agreement and Consent Order Change Control Form M-81-02-01, July 31.

Fluor Hanford (Fluor Hanford, Inc.), 2005a, *Technical Information Document for the Fast Flux Test Facility Closure Project Environmental Impact Statement*, FFTF-18346, Rev. 1, Richland, Washington, April.

Fluor Hanford (Fluor Hanford, Inc.), 2005b, *Hanford Site Solid Waste Acceptance Criteria*, HNF-EP-0063, Rev. 12, Richland, Washington, July 6.

Hanlon, B.M., 2003, *Waste Tank Summary Report for Month Ending August 31, 2003*, HNF-EP-0182, Rev. 185, CH2M HILL Hanford Group, Inc., Richland, Washington, October.

Hebdon, J., 2001, U.S. Department of Energy, Richland Operations Office, Richland, Washington, personal communication (letter) to M.A. Wilson, State of Washington, Department of Ecology, Kennewick, Washington, "Response to the Washington State Department of Ecology (Ecology) Inspection of the Inactive Miscellaneous Underground Storage Tanks (IMUST)," July 25.

Hedges, J.A., 2008, Washington State Department of Ecology, Richland, Washington, personal communication (letter) to S.J. Olinger, U.S. Department of Energy, Office of River Protection, Richland, Washington, D.A. Brockman, U.S. Department of Energy, Richland Operations Office, Richland, Washington, and W.S. Elkins, Bechtel National, Inc., Richland, Washington, "Draft Waste Treatment and Immobilization Plant (WTP) Dangerous Waste Permit," October 15.

Jeppson, D.W., ed., 1973, *Technical Manual, Waste Encapsulation and Storage Facility*, SD-RE-TM-002, Rev. 0, Atlantic Richfield Hanford Company, Richland, Washington, April.

Naiknimbalkar, A.N., 2006, *Waste Tank Summary Report for Month Ending June 30, 2006*, HNF-EP-0182, Rev. 219, CH2M HILL Hanford Group, Inc., Richland, Washington, August.

NCRP (National Council on Radiation Protection and Measurements), 2009, *Ionizing Radiation Exposure of the Population of the United States*, NCRP Report No. 160, Bethesda, Maryland, March 3.

Poston, T.M., J.P. Duncan, and R.L. Dirkes, eds., 2011, *Hanford Site Environmental Report for Calendar Year 2010 (Including Some Early 2011 Information)*, PNNL-20548, Pacific Northwest National Laboratory, Richland, Washington, September.

Poston, T.M., R.W. Hanf, J.P. Duncan, and R.L. Dirkes, eds., 2007, *Hanford Site Environmental Report for Calendar Year 2006 (Including Some Early 2007 Information)*, PNNL-16623, Pacific Northwest National Laboratory, Richland, Washington, September.

SAIC (Science Applications International Corporation), 2010, *Tank Closure Alternatives, Scaled Data Sets to Support the "Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington,"* Germantown, Maryland, June 3, August 26, and December 10.

Wade, K., W. Hewitt, L. Holton, K. Gerdes, K. Juroff, J. Loving, and D. Wodrich, 2007, *Hanford River Protection Project Low Activity Waste Treatment: A Business Case Evaluation*, DOE/ORP-2007-03, Rev. 0a Draft, Office of Environmental Management and Office of River Protection, December.

Waite, J.L., 1991, *Tank Wastes Discharged Directly to the Soil at the Hanford Site*, WHC-MR-0227, Westinghouse Hanford Company, Richland, Washington, April.

Weidert, J.R., 2003, *Waste Management Project (WMP) Master Documented Safety Analysis (MDSA) for the Solid Waste Operations Complex (SWOC)*, HNF-14741, Rev. 1, Fluor Hanford, Inc., Richland, Washington, July.

Code of Federal Regulations

10 CFR 61, U.S. Nuclear Regulatory Commission, "Licensing Requirements for Land Disposal of Radioactive Waste."

10 CFR 61.40–44, U.S. Nuclear Regulatory Commission, "Licensing Requirements for Land Disposal of Radioactive Waste," Subpart C, "Performance Objectives."

10 CFR 61.55, U.S. Nuclear Regulatory Commission, "Licensing Requirements for Land Disposal of Radioactive Waste: Waste Classification."

10 CFR 1022, U.S. Department of Energy, "Compliance with Floodplain and Wetland Environmental Review Requirements."

40 CFR 51, U.S. Environmental Protection Agency, "Requirements for Preparation, Adoption, and Submittal of Implementation Plans," Subpart W, "Determining Conformity of General Federal Actions to State or Federal Implementation Plans."

40 CFR 61, U.S. Environmental Protection Agency, "National Emission Standards for Hazardous Air Pollutants," Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities."

40 CFR 81.313, U.S. Environmental Protection Agency, "Designation of Areas for Air Quality Planning Purposes," Subpart C, Section 107, "Attainment Status Designations: Idaho."

40 CFR 81.348, U.S. Environmental Protection Agency, "Designation of Areas for Air Quality Planning Purposes," Subpart C, Section 107, "Attainment Status Designations: Washington."

40 CFR 141, U.S. Environmental Protection Agency, "National Primary Drinking Water Regulations."

40 CFR 143, U.S. Environmental Protection Agency, "National Secondary Drinking Water Regulations."

40 CFR 191, U.S. Environmental Protection Agency, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes."

40 CFR 261.20–24, U.S. Environmental Protection Agency, "Identification and Listing of Hazardous Waste," Subpart C, "Characteristics of Hazardous Waste."

40 CFR 261.31–33, U.S. Environmental Protection Agency, "Identification and Listing of Hazardous Waste: Hazardous Wastes from Non-specific Sources; Hazardous Wastes from Specific Sources; Discarded Commercial Chemical Products, Off-Specification Species, Container Residues, and Spill Residues Thereof."

40 CFR 1502.14(d), Council on Environmental Quality, "Environmental Impact Statement: Alternatives Including the Proposed Action."

Executive Orders

Executive Order 11988, *Floodplain Management*, May 24, 1977.

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, February 11, 1994.

Federal Register

62 FR 8693, U.S. Department of Energy, 1997, "Record of Decision for the Tank Waste Remediation System, Hanford Site, Richland, WA," February 26.

64 FR 61615, U.S. Department of Energy, 1999, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)," November 12.

65 FR 10061, U.S. Department of Energy, 2000, "Record of Decision for the Department of Energy's Waste Management Program: Treatment and Disposal of Low-Level Waste and Mixed Low-Level Waste; Amendment of the Record of Decision for the Nevada Test Site," February 25.

68 FR 1052, U.S. Department of Energy, 2003, "Notice of Intent to Prepare an Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, WA," January 8.

69 FR 39449, U.S. Department of Energy, 2004, "Record of Decision for the Solid Waste Program, Hanford Site, Richland, WA: Storage and Treatment of Low-Level Waste and Mixed Low-Level Waste; Disposal of Low-Level Waste and Mixed Low-Level Waste, and Storage, Processing, and Certification of Transuranic Waste for Shipment to the Waste Isolation Pilot Plant," June 30.

73 FR 55824, U.S. Department of Energy, 2008, "Amended Record of Decision for the *Hanford Comprehensive Land-Use Plan Environmental Impact Statement*," September 26.

74 FR 67189, U.S. Department of Energy, 2009, "Notice of Modifications to the Preferred Alternatives for Tank Waste Treatment and Disposal of Off Site Waste in the *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, WA,*" December 18.

United States Code

40 U.S.C. 7401 et seq., Clean Air Act of 1970.

42 U.S.C. 2011 et seq., Atomic Energy Act of 1954.

42 U.S.C. 6901 et seq., Resource Conservation and Recovery Act of 1976.

U.S. Public Law

P.L. 102-579, Waste Isolation Pilot Plant Land Withdrawal Act.

Washington Administrative Code

WAC 173-303, Washington State Department of Ecology, "Dangerous Waste Regulations," Olympia, Washington.

WAC 173-460, Washington State Department of Ecology, "Controls for New Sources of Toxic Air Pollutants," Olympia, Washington.

WAC 246-290, Washington State Department of Health, "Group A Public Water Supplies," Olympia, Washington.

U.S. Department of Energy Guides, Manuals, Orders, and Standards

DOE Order 430.1B, *Real Property Asset Management*, Change 2, April 25, 2011.

DOE Order 435.1, *Radioactive Waste Management*, Change 1, August 28, 2001.

DOE Manual 435.1-1, *Radioactive Waste Management Manual*, Change 2, June 8, 2011.

DOE Guide 435.1-1, *Implementation Guide for Use with DOE M 435.1-1*, July 9, 1999.

DOE Order 458.1, *Radiation Protection of the Public and the Environment*, Change 2, June 6, 2011.

DOE Standard 1098-2008, *Radiological Control*, Change Notice 1, May 2009.