APPENDIX H
TRANSPORTATION

This appendix provides an overview of the approach used to assess the potential human health risks from transportation activities. Topics include the scope of the assessment; packaging and transportation regulations; determination of potential transportation routes; analytical methods used for the risk assessment (e.g., computer models); and important assessment assumptions. The results of this assessment are expressed in terms of doses and risks to transportation workers and the exposed population from both incident-free operations and accident conditions. In addition, to aid in understanding and interpreting the results, specific areas of uncertainty are described with an emphasis on how these uncertainties may affect comparisons between alternatives.

H.1 INTRODUCTION

Transportation of any commodity involves a risk to both transportation crewmembers and members of the public. This risk results directly from transportation-related accidents and indirectly from increased levels of pollution from vehicle emissions, regardless of the cargo. Transportation of certain materials, such as hazardous or radioactive waste, can pose an additional risk due to the unique nature of the materials themselves. To permit a complete appraisal of the environmental impacts of the proposed actions and alternatives analyzed in this *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)*, the human health risks associated with the transportation of radioactive materials on public highways and railroads were assessed. The anticipated impacts of each alternative are presented, including projected doses and health effects.

Risk assessment results are presented in this appendix in terms of "per-shipment" risk factors, as well as the total risks under a given alternative. Per-shipment risk factors are used to estimate the risk from a single shipment. The total risks under a given alternative are estimated by multiplying the expected number of shipments by the appropriate per-shipment risk factors.

H.2 ASSESSMENT SCOPE

This section describes the scope of the transportation human health risk assessment, including the alternatives and options, transportation activities, potential radiological and nonradiological impacts, transportation modes, and receptors considered. Several shipping arrangements for various radioactive wastes, involving both onsite and offsite public highways and rail systems, are being considered to cover all of the alternatives evaluated. Additional assessment details are provided in the remaining sections of this appendix.

H.2.1 Transportation-Related Activities

The transportation risk assessment is limited to estimating the human health risks related to transportation under each alternative. The risks to workers and the public during loading, unloading, and handling prior to a shipment under each alternative are provided in the public and occupational health and safety—normal operations and the public and occupational health and safety—facility accidents sections in Chapter 4 and Appendix K of this environmental impact statement (EIS). The impacts of increased transportation levels on local traffic flow or infrastructure under each alternative are addressed in the local transportation subsections in the socioeconomics sections of Chapter 4.

H.2.2 Radiological Impacts

The risk to the affected population is a measure of the radiological risk posed to society as a whole by the alternative being considered. As such, the impact on the affected population is used as the primary means of comparing various alternatives. For each alternative, radiological risks (risks that result from the radioactive nature of the materials) of transportation were assessed for both incident-free (normal) and accident conditions. The radiological risk associated with incident-free transportation conditions would result from the potential exposure of people to external radiation in the vicinity of a shipment. The radiological risk from transportation accidents would come from the potential release and dispersal of radioactive material into the environment during an accident and the subsequent exposure of members of the public.

All radiological impacts are calculated in terms of the committed dose received by the exposed populations and its associated health effects. The calculated radiation dose is the total effective dose equivalent (10 CFR 20), the sum of the effective dose equivalent from external radiation exposure and the 50-year committed effective dose equivalent from internal radiation exposure. Radiation doses are presented in units of roentgen equivalent man (rem) for individuals and person-rem for collective populations. The impacts are further expressed as health risks in terms of latent cancer fatalities (LCFs) in exposed populations using the dose-to-risk conversion factors recommended by the U.S. Department of Energy's (DOE's) Office of National Environmental Policy Act Policy and Compliance, which are based on Interagency Steering Committee on Radiation Safety guidance (DOE 2003).

H.2.3 Nonradiological Impacts

In addition to the radiological risks posed by transportation activities, nonradiological, vehicle-related risks (risks unrelated to radioactive cargo) are assessed for the same transportation routes. Nonradiological transportation risks, which would be incurred for similar shipments of any commodity, are assessed for both incident-free and accident conditions. The nonradiological accident risk refers to the potential occurrence of transportation accidents resulting in fatalities unrelated to the shipment of cargo. Nonradiological risks are presented in terms of estimated fatalities.

Nonradiological risks during incident-free transportation conditions could be caused by potential exposure to increased vehicle exhaust emissions. As explained in Section H.5.2, these emission impacts were not considered.

H.2.4 Transportation Modes

All shipments were assumed to use either dedicated truck or rail transportation modes.

H.2.5 Receptors

Transportation-related risks were calculated and are presented separately for workers and members of the general public. The workers considered were truck and rail crewmembers involved in transportation and inspection of the packages. The general public included all persons who could be exposed to a shipment while it is either moving or stopped during transit. Potential risks were estimated for the affected populations and for a hypothetical maximally exposed individual (MEI). For incident-free operation, the affected population included individuals living within 800 meters (0.5 miles) of each side of the road or rail, and the MEI was a resident living near the highway or railroad who would be exposed to all shipments transported by road or rail. For accident conditions, the affected population included individuals residing within 80 kilometers (50 miles) of the accident, and the MEI was an individual located 100 meters (330 feet) directly downwind from the accident.

H.3 PACKAGING AND TRANSPORTATION REGULATIONS

This section provides a high-level summary of packaging and transportation regulations. The *Code of Federal Regulations* (CFR) details regulations pertaining to the transportation of radioactive materials published by the U.S. Department of Transportation (DOT) (49 CFR 106, 107, and 171–177); U.S. Nuclear Regulatory Commission (NRC) (10 CFR 20, 61, and 71); and U.S. Postal Service (39 CFR 121). Interested readers are encouraged to visit the cited CFR regulations for current specifics or to review DOT's *Radioactive Material Regulations Review* (DOT 2008) for a comprehensive discussion on radioactive material regulations.

H.3.1 Packaging Regulations

The primary regulatory approach to promoting safety from radiological exposure is specification of standards for the packaging of radioactive materials. Packaging represents the primary barrier between the radioactive material being transported and the public, workers, and environment. Transportation packaging for radioactive materials must be designed, constructed, and maintained to contain and shield its contents during normal transport conditions. For highly radioactive material, such as high-level radioactive waste (HLW) or spent nuclear fuel (SNF), packaging must contain and shield its contents in the event of severe accident conditions. The type of packaging used is determined by the total radiological hazard presented by the material to be packaged. Four basic types of packaging are used: Excepted, Industrial, Type A, and Type B.

Excepted packages are limited to transporting materials with extremely low levels of radioactivity. Industrial packages are used to transport materials that, because of their low concentration of radioactive materials, present a limited hazard to the public and the environment. Type A containers and packages are designed to protect and retain their contents under normal transportation conditions and to provide sufficient shielding to limit radiation exposure to handling personnel. Type B containers and packages are used to transport material with the highest radioactivity levels and are designed to protect and retain their contents under transportation accident conditions (for more detail, see the following sections).

Radioactive materials shipped in Type A containers or packages are subject to specific radioactivity limits, identified as A1 and A2 values in DOT requirements (49 CFR 173.435). In addition, external radiation limits must be met (49 CFR 173.441). If the A1 or A2 limits are exceeded and material does not meet the low-specific-activity definition and requirements, the material must be shipped in a Type B container. If the material qualifies as having a low specific activity (number of decays per second per amount of substance), as defined by NRC (10 CFR 71) and DOT (49 CFR 173), it may be shipped in an approved low-specific-activity shipping container that meets the applicable requirements (49 CFR 173.427(b)(4)), such as Industrial or Type A packaging. Type B containers or casks are subject to DOT radiation limits (49 CFR 173.441), but no quantity limits are imposed except in the case of fissile materials and plutonium.

Type A packages are designed to retain their radioactive contents in normal transport. Under normal conditions, a Type A package must withstand the following conditions:

- Operating temperatures ranging from –40 degrees Celsius (°C) to 70 °C (–40 degrees Fahrenheit [°F] to 158 °F)
- A reduction of ambient pressure to 25 kilopascals (3.6 pounds per square inch), such that the containment system will retain its radioactive contents
- Normal vibration experienced during transportation

- Simulated rainfall of 5 centimeters (2 inches) per hour for 1 hour
- Free fall from 0.3 to 1.2 meters (1 to 4 feet), depending on the package weight
- Water immersion-compression tests
- Impact of a 6-kilogram (13.2-pound) steel cylinder with rounded ends dropped from 1 meter (40 inches) onto the most vulnerable surface
- A compressive load of five times the mass of the gross weight of the package for 24 hours, or the equivalent of 13 kilopascals (1.9 pounds per square inch) multiplied by the vertically projected area of the package for 24 hours

Type B packages are designed to retain their radioactive contents under both normal and accident conditions. In addition to the testing for normal transportation conditions outlined above, a Type B package must withstand the following:

- Free drop from 9.1 meters (30 feet) onto an unyielding surface in a way most likely to cause damage
- Free drop from 1 meter (3.3 feet) onto the end of a 15-centimeter-diameter (6-inch-diameter) vertical steel bar
- Exposure to temperatures of 800 °C (1,475 °F) for at least 30 minutes
- Immersion in at least 15 meters (50 feet) of water for 8 hours
- For some packages, immersion in at least 0.9 meters (3 feet) of water for 8 hours in an orientation most likely to result in leakage

Compliance with these requirements is demonstrated by using a combination of simple calculating methods, computer modeling techniques, and scale-model or full-scale testing of packages.

H.3.2 Transportation Regulations

The regulatory standards for packaging and transporting radioactive materials are designed to achieve the following four primary objectives:

- Protect persons and property from radiation emitted from packages during transportation by specific limitations on the allowable radiation levels.
- Contain radioactive material in the package (achieved by packaging design requirements based on performance-oriented packaging integrity tests and environmental criteria).
- Prevent nuclear criticality (an unplanned nuclear chain reaction that may occur as a result of concentrating too much fissile material in one place).
- Provide physical protection against theft and sabotage during transit.

DOT regulates the transportation of hazardous materials for interstate commerce by land, air, and water. DOT specifically regulates the carriers of radioactive materials and the conditions of truck and rail transport, such as routing, handling and storage, and commercial motor vehicle and driver requirements. DOT also regulates the shipping papers, labeling, classification, and marking of radioactive material

packages. Transportation of hazardous materials within Washington State is regulated according to *Washington Administrative Code* Sections 173-303-240 through 173-303-270 and Chapters 246-231 and 446-50.

NRC regulates the packaging and transportation of radioactive material for its licensees, including commercial shippers of radioactive materials. In addition, under an agreement with DOT, NRC sets the standards for packages containing fissile materials and Type B packages.

DOE, through its management directives, orders, and contractual agreements, ensures the protection of public health and safety by imposing standards equivalent to those of DOT and NRC on its transportation activities. In accordance with DOT regulations (49 CFR 173.7(d)), packages made by or under the direction of DOE may be used to transport Class 7 materials (radioactive materials) when the packages have been evaluated, approved, and certified by DOE against packaging standards equivalent to those specified in the NRC regulations (10 CFR 71).

DOT also has requirements that help reduce transportation impacts. Some requirements affect drivers, packaging, labeling, marking, and placarding. Others specify the maximum dose rate from radioactive material shipments to help reduce incident-free transportation doses.

The U.S. Department of Homeland Security (DHS) is responsible for establishing policies for, and coordinating civil emergency management, planning, and interaction with, Federal Executive agencies that have emergency response functions in the event of a transportation incident. Guidelines for response actions have been outlined in the *National Response Framework (NRF)* (FEMA 2008a) in the event a transportation incident involving nuclear material occurs.

DHS would use the Federal Emergency Management Agency, an organization within DHS, to coordinate Federal and state participation in developing emergency response plans and to be responsible for the development and maintenance of the *Nuclear/Radiological Incident Annex (NRIA)* (FEMA 2008b) to the *NRF*. *NRIA* and *NRF* describe the policies, situations, concepts of operations, and responsibilities of the Federal departments and agencies governing the immediate response and short-term recovery activities for incidents involving release of radioactive materials to address the consequences of the event.

The Interstate Commerce Commission is responsible for regulation of the economic aspects of overland shipments of radioactive materials. The Commission issues operating authorities to carriers and monitors and approves freight rates.

H.4 TRANSPORTATION ANALYSIS IMPACT METHODOLOGY

The transportation risk assessment was based on the alternatives described in Chapter 2 of this *TC & WM EIS*. Figure H–1 summarizes the transportation risk assessment methodology. After the EIS alternatives were identified and the requirements of the shipping campaign were understood, data were collected on the material characteristics and accident parameters.

The transportation impacts calculated and analyzed in this *TC & WM EIS* are presented in two parts: impacts of incident-free or routine transportation and impacts of transportation accidents. The impacts of incident-free transportation and transportation accidents are further divided into nonradiological and radiological impacts. Nonradiological impacts of incident-free transportation and transportation accidents could result from vehicular emissions and traffic fatalities, respectively. Radiological impacts of incident-free transportation include impacts on the public and the workers (crew) from radiation emanating from materials within the package. Only under severe accident conditions, which have a low probability of occurrence, could a transportation package of the type used to transport radioactive material be damaged to the point that radioactivity could be released to the environment.

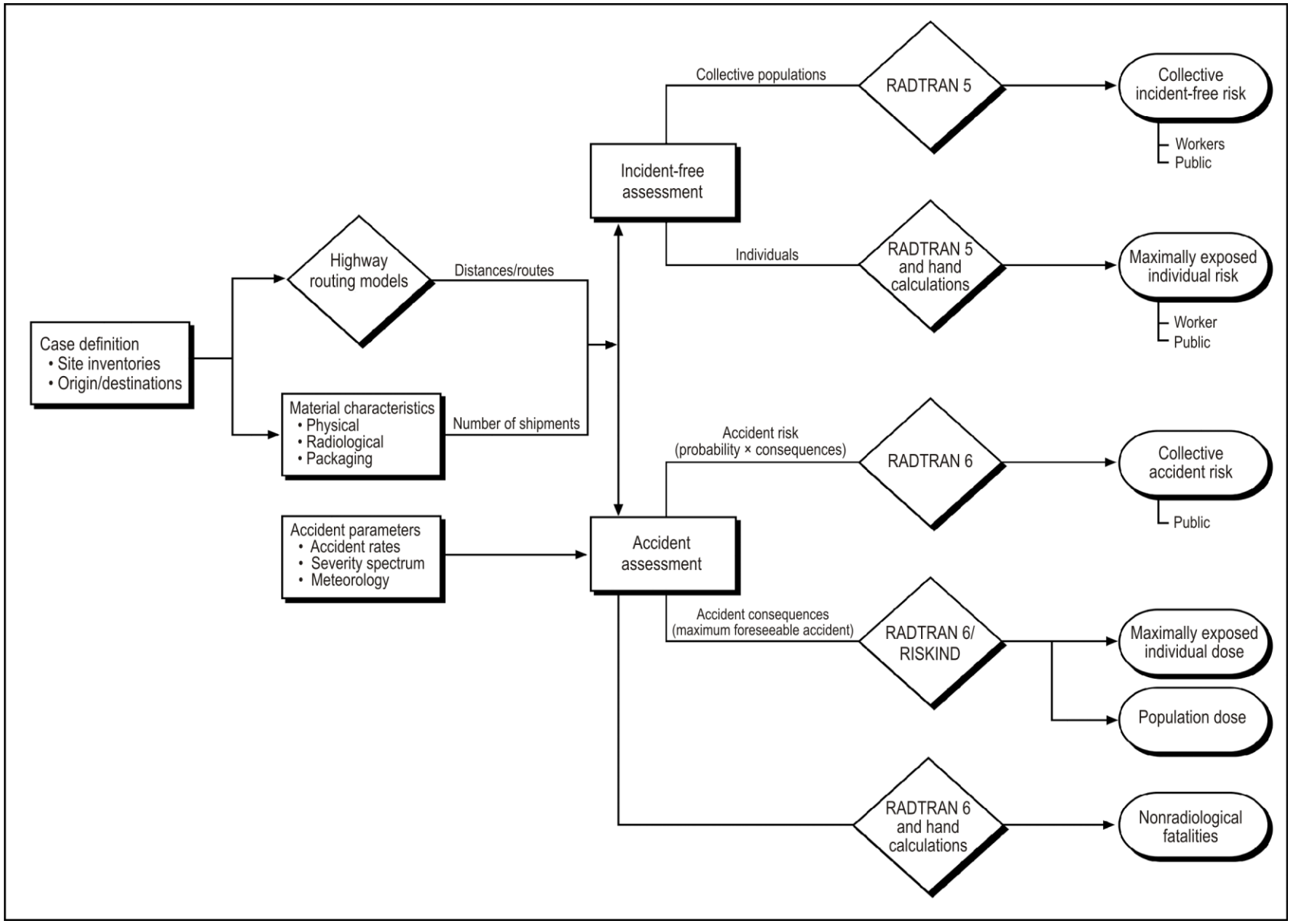

Figure H–1. Transportation Risk Assessment

The impacts of transportation accidents are expressed in terms of probabilistic risk, which is the probability of an accident multiplied by the consequences of that accident and summed over all reasonable accident conditions. Hypothetical transportation accident conditions ranging from low-speed "fender bender" collisions to high-speed collisions with or without fires were analyzed. The frequencies of accidents and consequences were evaluated using a method developed by NRC and originally published in NUREG-0170, *Final Environmental Impact Statement on the Transportation of Radioactive Material by Air and Other Modes (Radioactive Material Transport Study)* (NRC 1977); NUREG/CR-4829, *Shipping Container Response to Severe Highway and Railway Accident Conditions (Modal Study)* (Fischer et al. 1987); and NUREG/CR-6672, *Reexamination of Spent Fuel Shipment Risk Estimates (Reexamination Study)* (Sprung et al. 2000). Radiological accident risk is expressed as additional LCFs. Nonradiological accident risk is expressed as additional traffic fatalities. Incident-free radiological risk is expressed as additional LCFs.

Transportation-related risks were calculated and are presented separately for workers and the general public. The workers considered were truck/rail crewmembers involved in the act of transporting radioactive materials. The general public included all persons who could be exposed to a shipment while it is moving or stopped during transit.

The first step in the ground transportation analysis is to determine the distances and populations along the routes. The TRAGIS [Transportation Routing Analysis Geographic Information System] computer program (Johnson and Michelhaugh 2003) was used to choose representative routes and associated distances and populations. This information, along with the properties of the material being shipped and route-specific accident frequencies, was entered into the RADTRAN computer code, which calculated incident and accident risks on a per-shipment basis. The risks under each alternative were determined by summing the products of per-shipment risks for each waste by the number of shipments.

RADTRAN was developed by Sandia National Laboratories to calculate population risks associated with transportation of radioactive materials by a variety of modes, including truck, rail, air, ship, and barge. The RADTRAN 5 computer code (Neuhauser and Kanipe 2003) was used for incident-free risk assessments to estimate the impacts on populations and MEIs. The RADTRAN 6 computer code (Weiner et al. 2009), an updated version of RADTRAN 5, was used for accident risk assessments to estimate the impacts on populations. Both of these versions of RADTRAN produce the same results for analysis of incident-free transportation. RADTRAN 6 produces accident results different from those of RADTRAN 5, primarily because of the correction of a conservative assumption used in estimating the 50-year dose component from ground shine to an individual residing on the site of a radiological transportation accident (Dennis et al. 2008).

The RADTRAN population risk calculations include both the consequences and probabilities of potential exposure events. The RADTRAN code consequence analyses include cloud shine, ground shine, inhalation, and resuspension exposures. The collective population risk is a measure of the total radiological risk posed to society as a whole by the alternative being considered. As such, the collective population risk was used as the primary means of comparing the various alternatives.

The RISKIND computer code (Yuan et al. 1995) was used to estimate the doses to MEIs and populations from the maximum reasonably foreseeable transportation accident. The RISKIND computer code was developed for DOE's Office of Civilian Radioactive Waste Management to analyze the exposure of individuals during incident-free transportation and provide a detailed assessment of the consequences to individuals and population subgroups from severe transportation accidents under various environmental settings.

The RISKIND calculations were conducted to supplement the collective risk results calculated with RADTRAN 6. Whereas the collective risk results provide a measure of the overall risks under each alternative, the RISKIND calculations are meant to address areas of specific concern to individuals and population subgroups. Essentially, the RISKIND analyses are meant to address "what if" questions such as, "What if I live next to a site access road?" or "What if an accident happens near my town?"

H.4.1 Transportation Routes

To assess incident-free and transportation accident impacts, route characteristics were determined for offsite shipments from the Hanford Site (Hanford) in Richland, Washington, and for offsite shipments from other DOE facilities to Hanford, as well as for onsite shipments between the various waste processing plants and burial locations in the 200-East and 200-West Areas. For offsite transports, highway and rail routes were determined using the TRAGIS computer program (Johnson and Michelhaugh 2003). For almost all transports, direct rail routes between origin and destination were generated by TRAGIS; therefore, limited intermodal transports were needed. Rail transports to the Nevada National Security Site (NNSS), formerly the Nevada Test Site, and Idaho National Laboratory (INL) would require intermodal transfers. As there were only two rail shipments requiring intermodal transfers followed by short (less than 50-kilometer [31-mile]) truck transports, no specific intermodal activities were evaluated.

The TRAGIS computer program is a geographic information system-based transportation analysis computer program used to identify and select highway, rail, and waterway routes for transporting radioactive materials within the United States. Both the road and rail network are 1:100,000-scale databases that were developed from the U.S. Geological Survey digital line graphs and the U.S. Census Bureau Topological Integrated Geographic Encoding and Referencing System. The population densities along each route were derived from 2000 census data. The features in TRAGIS allow users to determine routes for shipment of radioactive materials that conform to specified DOT regulations (49 CFR 397).

H.4.1.1 Offsite Route Characteristics

Route characteristics important to radiological risk assessment include the total shipment distance and the population distribution along the route. The specific route selected determines both the total potentially exposed population and the expected frequency of transportation-related accidents. The population densities along each route were initially derived from 2000 census data (Johnson and Michelhaugh 2003). State-level data from the 2010 census (Census 2010) have been incorporated into this analysis to update population densities along each route. Rural, suburban, and urban areas were characterized according to the following breakdown (Johnson and Michelhaugh 2003):

- Rural population densities range from 0 to 54 persons per square kilometer (0 to 139 persons per square mile).
- Suburban population densities range from 55 to 1,284 persons per square kilometer (140 to 3,326 persons per square mile).
- Urban population densities include all population densities greater than 1,284 persons per square kilometer (3,326 persons per square mile).

The affected population (for route characterization and incident-free dose calculation) includes all persons living within 800 meters (0.5 miles) of each side of the road.

H.4.1.1.1 Tank Closure Alternatives

Except for transuranic (TRU) waste, all radioactive waste generated during tank closure would be disposed of (e.g., immobilized low-activity waste [ILAW]) or stored (e.g., immobilized high-level radioactive waste [IHLW]) on site. The TRU waste would be transported to the Waste Isolation Pilot Project (WIPP). Route characteristics for WIPP transports are summarized in Table H–1.

Table H–1. Tank Closure Alternatives – Offsite Transport Truck and Rail Route Characteristics

From	To	Nominal Distance (kilometers)	Distance Traveled in Zone (kilometers)			Population Density in Zone (number per square kilometer)			Number of Affected Persons
			Rural	Suburban	Urban	Rural	Suburban	Urban	
Truck Routes									
Hanford	WIPP	3,080	2,615	398	67	8.5	396.2	2,673.7	574,069
Rail Routes									
Hanford	WIPP	3,531	3,117	345	69	6.4	475.3	2,616.2	582,081

Note: To convert kilometers to miles, multiply by 0.6214; number per square kilometer to number per square mile, by 2.59.
Key: Hanford=Hanford Site; WIPP=Waste Isolation Pilot Plant.

The truck and rail routes that were analyzed for shipments of radioactive waste materials to WIPP are shown in Figure H–2. The truck transportation routes that were analyzed were similar to those evaluated in the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement (WIPP SEIS-II)* (DOE 1997). The rail route that was analyzed for transport of TRU waste to WIPP is consistent with the assumptions made in the *WIPP SEIS-II*.

H.4.1.1.2 FFTF Decommissioning Alternatives

The main offsite transports used for Fast Flux Test Facility (FFTF) decommissioning could include transportation of remote-handled special components (RH-SCs) and radioactively contaminated bulk sodium to INL for treatment and recovery of sodium. The treated sodium residuals from the RH-SCs and treated bulk sodium would be sent back to Hanford for reuse by the Office of River Protection for the Waste Treatment Plant (WTP) or Hanford tanks corrosion control. The treated RH-SCs could be shipped back to Hanford or sent to NNSS for disposal. Route characteristics for INL and NNSS are summarized in Table H–2.

Table H–2. FFTF Decommissioning Alternatives – Offsite Transport Truck and Rail Route Characteristics

From	To	Nominal Distance (kilometers)	Distance Traveled in Zone (kilometers)			Population Density in Zone (number per square kilometer)			Number of Affected Persons
			Rural	Suburban	Urban	Rural	Suburban	Urban	
Truck Routes									
FFTF	INL	968	813	140	15	11.1	356.4	2,574.4	156,672
INL	NNSS	1,180	935	197	48	10.9	448.4	3,047.5	391,686
Rail Routes									
FFTF	INL	1,062	936	106	20	8.2	468.5	2,612.1	176,103
INL	NNSS	1,460	1,282	143	35	5.4	487.3	2,974.2	287,933

Note: To convert kilometers to miles, multiply by 0.6214; number per square kilometer to number per square mile, by 2.59.
Key: FFTF=Fast Flux Test Facility; INL=Idaho National Laboratory; NNSS=Nevada National Security Site.

The truck and rail routes that were analyzed for shipments of radioactive waste materials are shown in Figure H–3. Rail transports for disposal at NNSS would require intermodal transfers. Because only two shipments were assumed to be disposed of at NNSS, no specific intermodal analysis was performed.

Truck Routes

Rail Routes

Figure H–2. Tank Closure Alternatives – Analyzed Truck and Rail Routes

Truck Routes

Rail Routes

Figure H–3. FFTF Decommissioning Alternatives – Analyzed Truck and Rail Routes

H.4.1.1.3 Waste Management Alternatives

Hanford is one of two regional disposal facilities for DOE's low-level radioactive waste (LLW) and mixed low-level radioactive waste (MLLW), based on the February 2000 Record of Decision regarding the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (65 FR 10061). Accordingly, Hanford is expected to receive both LLW and MLLW from other DOE sites. Route characteristics for offsite radioactive transports from DOE sites to Hanford are summarized in Table H–3.

Table H–3. Waste Management Alternatives – Offsite Transport Truck and Rail Route Characteristics

From	To	Nominal Distance (kilometers)	Distance Traveled in Zone (kilometers)			Population Density in Zone (number per square kilometer)			Number of Affected Persons
			Rural	Suburban	Urban	Rural	Suburban	Urban	
Truck Routes									
ANL-E	Hanford	3,238	2,766	434	38	10.7	326.1	2,446.0	423,057
BNL		4,747	3,576	1,032	139	12.5	338.2	2,593.4	1,207,841
INL/NR		1,023	857	149	17	11.2	363.3	2,573.6	171,637
LANL		2,558	2,138	363	57	9.3	392.1	2,701.3	506,688
ORNL		4,023	3,227	721	75	11.4	340.6	2,458.2	745,403
Paducah		3,541	2,917	558	66	10.3	353.7	2,442.9	619,896
Portsmouth		4,064	3,281	722	61	12.3	319.6	2,410.8	669,991
SRS		4,443	3,410	919	114	11.7	370.1	2,547.8	1,071,377
West Valley		4,225	3,293	856	76	12.2	312.2	2,403.8	782,092
Rail Routes									
ANL-E	Hanford	3,276	2,751	425	100	6.2	391.9	2,693.2	725,011
BNL		4,876	3,693	908	275	8.6	409.7	2,791.4	1,873,074
INL/NR		1,062	936	106	20	8.2	468.5	2,612.1	176,103
LANL[a]		NA	NA	NA	NA	NA	NA	NA	NA
ORNL		4,271	3,420	703	148	8.4	390.4	2,492.3	1,073,276
Paducah		3,723	3,206	450	67	6.2	391.9	2,693.2	725,011
Portsmouth		3,891	3,204	559	128	6.6	387.1	2,384.1	569,254
SRS		4,766	3,699	878	189	8.5	438.7	2,517.6	1,429,311
West Valley		4,169	3,322	680	167	7.8	412.5	2,535.2	1,165,687

[a] No direct rail connection to Los Alamos National Laboratory.

Note: To convert kilometers to miles, multiply by 0.6214; number per square kilometer to number per square mile, by 2.59.

Key: ANL-E=Argonne National Laboratory-East; BNL=Brookhaven National Laboratory; Hanford=Hanford Site; INL/NR=Idaho National Laboratory/Naval Reactor Facility; LANL=Los Alamos National Laboratory; NA=not analyzed; ORNL=Oak Ridge National Laboratory; SRS=Savannah River Site; West Valley=West Valley Demonstration Project.

Truck and rail routes that were analyzed for shipments of radioactive waste materials are shown in Figure H–4.

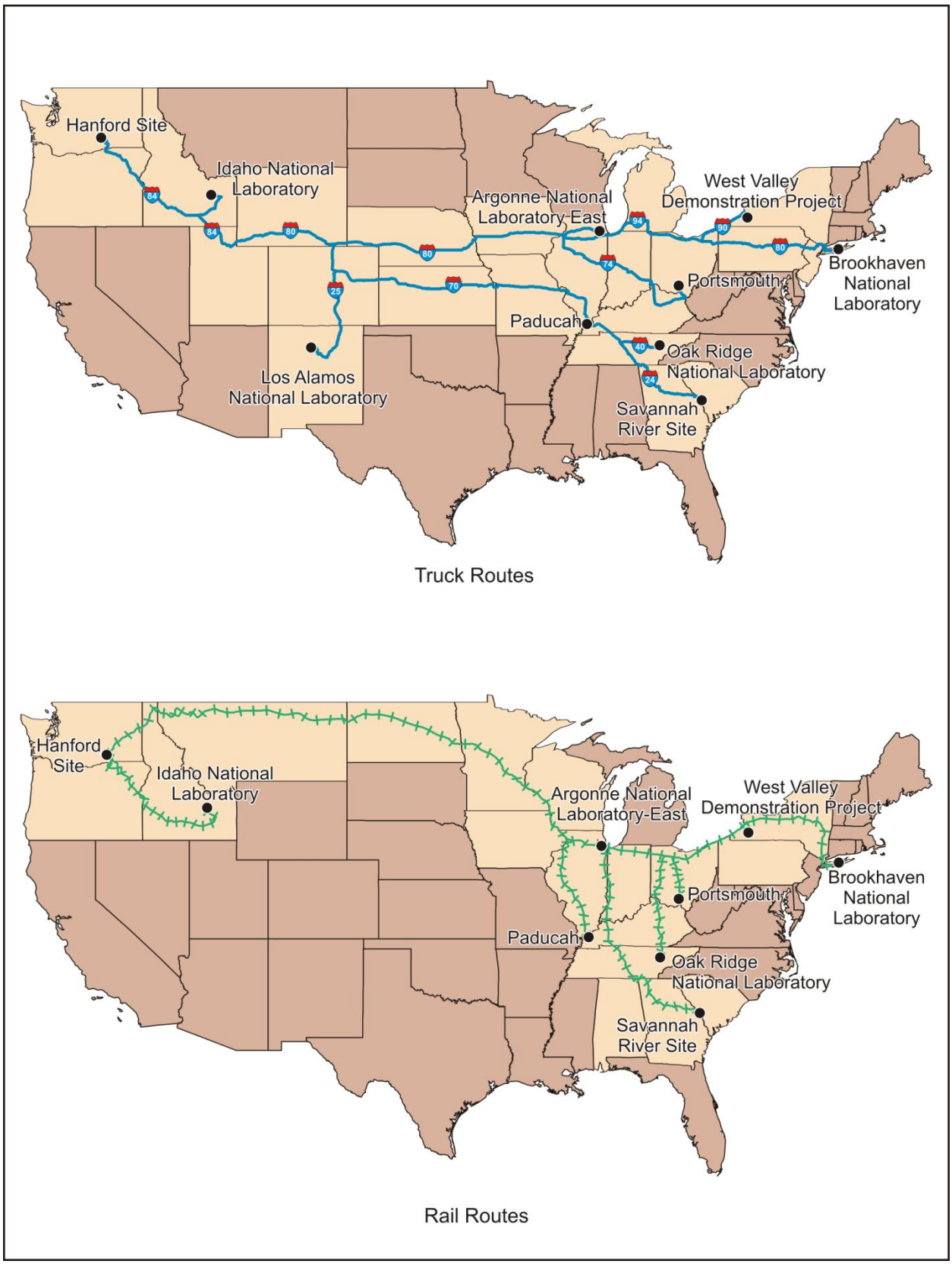

Figure H–4. Waste Management Alternatives – Analyzed Truck and Rail Routes

H.4.1.2 Onsite Route Characteristics

Onsite transport of waste materials would occur within either the 200-East or 200-West Area (under the Tank Closure alternatives), between FFTF and the 200 Areas (under the FFTF Decommissioning alternatives), and between the various facilities and the disposal locations within the 200 Areas (under the Waste Management alternatives). For transports within the 200-East and 200-West Areas (under the Tank Closure and Waste Management alternatives), waste was conservatively assumed to be generated at one area and transported to the other area. The distance traveled between the sites would be about 16 kilometers (10 miles), half of which would occur within the two areas. The population density on the road between the sites is 1 person per 2 square kilometers (4 persons per 3 square miles) (Johnson and Michelhaugh 2003). The population density while the transport is within any one of the areas was assumed to be the same as the population density of the 200-East Area, or 185 persons per square kilometer (479 persons per square mile).[1] This assumption is conservative, as both the road and the site are closed to the public and the individuals working within these areas are considered facility workers who would likely be exposed to more radiation than that emanating from waste packages during transport. For accident conditions, the population density up to an 80-kilometer (50-mile) radius was based on the average population densities for the 200-East and 200-West Areas. The total population within 80 kilometers (50 miles) of these two sites ranges from about 511,000 to 549,000. The 80-kilometer (50-mile) average population density would be about 27 persons per square kilometer (70 persons per square mile). This assumption would result in a conservative population dose because no member of the public resides within the first 10 kilometers (6 miles) of the road.

For transports under the FFTF Decommissioning alternatives, the onsite distance traveled between FFTF and various facilities in the 200 Areas ranges from 24 to 37 kilometers (15 to 23 miles).[2] The population density on the road between the sites is 1 person per 10 square kilometers (2 persons per 20 square miles) (Johnson and Michelhaugh 2003). The population density while the transport is within the 200 Areas was assumed to be the same as the population density of the 200-East Area (185 persons per square kilometer [479 persons per square mile]).

H.4.2 Radioactive Material Shipments

All waste types were assumed to be in certified or certified-equivalent packages[3] and containers and to be transported using exclusive-use vehicles. Legal-weight heavy-haul combination trucks would be used for highway transportation. Type A packages would be transported on common flatbed or covered trailers; Type B packages generally would be shipped on trailers designed specifically for the packaging used. For truck transportation, the maximum payload weight was considered to be about 20,000 kilograms (44,000 pounds), based on the Federal gross vehicle weight limit of 36,288 kilograms (80,000 pounds). However, large numbers of multitrailer combinations (known as longer-combination vehicles), with gross weights exceeding the Federal limit, are currently operating on rural roads and turnpikes in some states (DOT 2000). For evaluation purposes, the load limit for the legal truck was based on the Federal gross vehicle weight.

Rail transport can be done with dedicated and/or general freight trains. For analysis purposes, use of a dedicated train was assumed. The payload weights for railcars range from 45,359 to 68,039 kilograms (100,000 to 150,000 pounds). A median payload weight of 54,431 kilograms (120,000 pounds) was used in this analysis.

---

[1] Based on the number of workers in the 200-East Area as of May 2007.

[2] The path is assumed to follow Route 45 within Hanford toward the 200 Areas.

[3] Packages can be certified by DOE as long as they are evaluated by standards equivalent to NRC regulations (10 CFR 71).

The following types of waste and disposal destinations were evaluated for this *TC & WM EIS*.

Tank Closure

1. IHLW glass would be stored on site until disposition decisions are made and implemented.
2. ILAW glass would be disposed of on site.
3. TRU waste would be disposed of off site (at WIPP).
4. Supplemental technology (bulk vitrification, cast stone, or steam reforming) waste would be disposed of on site.
5. LLW, MLLW, and miscellaneous waste would be disposed of on site.

FFTF Decommissioning

1. Sodium metal would be neutralized (oxidized) either at Hanford or INL. If treatment is carried out at INL, the treated sodium hydroxide would be transported back to Hanford for use at the WTP.
2. RH-SCs and their sodium residuals would be treated either at Hanford or INL. If treatment is carried out at INL, the final waste would either be transported back to Hanford or sent to NNSS for disposal. If treatment occurs at Hanford, the final waste would be disposed of on site.
3. LLW, MLLW, and miscellaneous waste would be disposed of on site.

Waste Management

1. Offsite LLW and MLLW from various DOE sources would be transported for disposal at Hanford.
2. Onsite LLW, MLLW, and miscellaneous waste would be disposed of on site.

The number of shipping containers per shipment was estimated based on the dimensions and weight of the shipping containers, the Transport Index,[4] and the transport vehicle dimensions and weight limits. The number of offsite shipments was estimated based on the following assumptions:

1. For transport of IHLW glass to onsite storage, each truck would transport one IHLW canister in a Type B SNF cask.

2. For transport to WIPP, contact-handled (CH)-TRU waste would be packaged in TRU Waste Package Transporter II (TRUPACT-II) containers, each holding fourteen 208-liter (55-gallon) drums, with three or six TRUPACT-II containers per truck or rail shipment. The remote-handled (RH)-TRU waste would be packaged in a Type B cask (e.g., an RH-72B cask or CNS 10-160B), which can contain three 208-liter (55-gallon) drums, and transported—one cask per truck or two casks per rail car.

3. For transport of sodium metal to INL, sodium metal would be shipped in sodium International Organization for Standardization (ISO) container tanks, each with a volume of about 15.1 cubic meters (4,000 gallons). Each truck would transport one ISO container. Sodium metal stored in a drum overpack would be transported in intermodal containers with 45 drums per truck transport. Two sodium ISO containers or two intermodal containers would be transported per railcar.

4. For transport of RH-SCs, each truck would transport one component in a specially designed Type B cask. Each railcar would transport two RH-SC casks. The same cask would be used to transport the treated RH-SCs back to Hanford, or to send them to NNSS for disposal.

5. For transport of offsite LLW/MLLW to Hanford, each truck would transport eighty 208-liter (55-gallon) drums of CH-waste and between 10 and 14 drums of RH-waste in shielded Type A or Type B truck casks. Each railcar would transport two truck casks, or 160 drums.

The capacities of various onsite shipments per truck transport are as follows:

- One container of bulk vitrification waste on a heavy-haul truck
- Forty 208-liter (55-gallon) drums of LLW/MLLW or CH-TRU waste
- One ILAW glass canister
- Fourteen 208-liter (55-gallon) drums of RH-TRU waste
- One container of cast stone waste or two containers of sulfate grout
- Two shielded boxes or one roll-on/roll-off box of radioactively contaminated soils and/or equipment

[4] The Transport Index is a dimensionless number (rounded up to the next tenth) placed on the label of a package to designate the degree of control to be exercised by the carrier. Its value is equivalent to the maximum radiation level in millirem per hour at 1 meter (3.3 feet) from the package (10 CFR 71.4; 49 CFR 173.403).

Table H–4 summarizes the types of containers and their volumes and the number of containers in a shipment.

Table H–4. Waste Type and Container Characteristics

Waste Type[a]	Container	Volume per Container (cubic meters)	Number of Containers per Transport
IHLW glass	0.6-meter-diameter by 4.5-meter-long cylinder	1.19	1 per truck cask; 5 per rail cask
ILAW glass	1.22-meter-diameter by 2.3-meter-long cylinder	2.31	1 per truck shipment
Bulk vitrification glass	7.3- by 3.1- by 2.4-meter box	54.3	1 per truck shipment
Cast stone waste	2.7- by 2.7- by 1.5-meter box	10	1 per truck shipment
Steam reforming waste	1.5- by 1.5- by 1.5-meter box	2.25	2 per truck shipment
TRU waste[b] (remote-handled)	208-liter drum	0.20	3 per cask: 1 cask per truck shipment; 2 casks per rail shipment[c]
TRU waste[b] (contact-handled)	208-liter drum	0.20	14 per TRUPACT-II: 3 TRUPACT-IIs per truck shipment; 6 TRUPACT-IIs per rail shipment[c]
TRU waste (contact- and remote-handled)	208-liter drum	0.20	40 per truck shipment (contact-handled), 14 per truck shipment in a shielded Type A or Type B cask (remote-handled)
LLW/MLLW[b, d]	208-liter drum	0.20	80, or 10 to 14 in a shielded Type B or Type A cask, respectively, per truck shipment; 160, or 2 casks per rail shipment[c]
Bulk sodium[b]	Sodium ISO container tank	15.1	1 per truck shipment; 2 per rail shipment[c]
Drummed sodium[e]	322-liter drum	0.32	45 per truck shipment; 90 per rail shipment[c]
Sodium hydroxide[f]	Caustic ISO container tank	14.1	1 per truck shipment; 2 per rail shipment[c]
Remote-handled special components[g]	Special cask	NA	1 per truck shipment; 2 per rail shipment[c]
Miscellaneous waste[h]	4.0- by 1.6- by 1.3-meter shielded box to 6.1- by 2.4- by 1.7-meter roll-on/roll-off box	4.6 to 20.0	2 shielded boxes, or 1 roll-on/roll-off box per truck shipment

[a] Transported on site unless specified otherwise.
[b] Transported off site after interim storage on site or brought to Hanford from offsite sources.
[c] Rail transports are for offsite shipments.
[d] Offsite waste transported to Hanford for disposal, including both contact-handled and remote-handled waste. Transport of remote-handled waste would involve use of shielded casks.
[e] This sodium is from the Sodium Reactor Experiment and is stored in 208-liter (55-gallon) drums overpacked in 322-liter (85-gallon) drums.
[f] Sodium hydroxide is a 50-percent caustic solution. Because it has a higher density than that of sodium metal, only about 13.2 cubic meters (3,500 gallons) of sodium hydroxide would be transported per ISO-container tank.
[g] Transport would occur in specially designed Type B casks.
[h] Includes radioactively contaminated equipment and soils that are generated during tank farm dismantling, cleanup, and closure.

Note: To convert cubic meters to cubic feet, multiply by 35.315; cubic meters to gallons, by 264.2; meters to feet, by 3.281; liters to gallons, by 0.26417.

Key: IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; ISO=International Organization for Standardization; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; NA=not available; TRU=transuranic; TRUPACT-II=Transuranic Waste Package Transporter II.

H.5 INCIDENT-FREE TRANSPORTATION RISKS

H.5.1 Radiological Risk

During incident-free transportation of radioactive materials, a radiation dose results from exposure to the external radiation field that surrounds the shipping containers. The population dose is a function of the number of people exposed, their proximity to the containers and length of time of exposure, and the intensity of the radiation field surrounding the containers.

Radiological impacts were determined for crewmembers and the general population during incident-free transportation. For truck shipments, the drivers of the shipment vehicles are the crew. For rail shipments, the crew includes workers in close proximity to the shipping containers during inspection or classification of the railcars. The general population includes persons residing within 800 meters (0.5 miles) of the road or railway (off-link), persons sharing the road or railway (on-link), and persons at stops. Exposures to workers loading and unloading the shipments are not included in this analysis but are included in the occupational estimates for plant workers. Exposures to the inspectors and escorts (persons in a vehicle following or leading the shipment) are evaluated and presented separately.

Collective doses for the crew and general population during incident-free transport were calculated using the RADTRAN 5 computer code (Neuhauser and Kanipe 2003). The radioactive material shipments were assigned an external dose rate based on their radiological characteristics. Offsite transportation of radioactive material in Type B casks has a defined dose limit of 10 millirem per hour at 2 meters (6.6 feet) from the cask (10 CFR 71.47), or about 14 millirem per hour at 1 meter (3.3 feet) from the cask. The RH- and CH-TRU waste package dose rates at 1 meter (3.3 feet) were assigned at 10 millirem per hour and 4 millirem per hour, respectively (DOE 1997). Dose rates for onsite transportation packages could be more than 10 millirem per hour at 2 meters (6.6 feet), provided that the roads are closed to the public. Dose rates at 1 meter (3.3 feet) for the ILAW glass and the cast stone waste, steam reforming waste, and bulk vitrification glass waste containers were estimated based on the cesium-137, cobalt-60, and europium-154 inventory per container. It was assumed that sufficient shielding would be used for each container to meet the Hanford disposal dose rate requirement (surface dose rate less than 200 millirem per hour). Based on the maximum potential inventories of the three isotopes listed above in each container, dose rates of 14, 80, 63, and 60 millirem per hour at 1 meter (3.3 feet) were assessed for the ILAW glass, cast stone waste, steam reforming waste, and bulk vitrification glass, respectively.

Dose rates at 1 meter (3.3 feet) for the sodium and sodium hydroxide tanks were estimated to be about 2 and 1 millirem per hour, respectively. The 1-meter dose rate for the RH-SCs in Type B casks was assumed to be 14 millirem per hour. Dose rates at 1 meter (3.3 feet) for the CH-offsite LLW and MLLW and RH-offsite LLW and MLLW were estimated to be 3 and 6 millirem per hour, respectively. Note that the RH-offsite waste would be transported in shielded Type A or Type B casks, as required.

To calculate the collective dose, a unit risk factor was developed to estimate the impact of transporting one shipment of radioactive material over a unit distance of travel in a given population density zone. Table H–5 provides examples of unit risk factors from transport of a generic radioactive waste package with a Transport Index of 1 (i.e., a dose rate of 1 millirem per hour at 1 meter [3.3 feet] from the surface of the shipping container or the conveyance) by truck and rail. This table provides a perspective to the public on risk values from the movement of radioactive materials in truck and rail packages over 1 kilometer (0.62 miles). The values in Table H–5 reflect the assumptions regarding public shielding afforded by the general housing structure within each population zone that were major contributing factors in calculating the dose, time, and distance to an exposed individual.

Table H–5. Incident-Free Unit Risk Factors for a Dose Rate of 1 Millirem per Hour at 1 Meter (3.3 Feet) from the Shipping Container for Truck and Rail Shipments

Mode	Exposure Group	Unit Risk Factors[a]		
		Rural	Suburban[b]	Urban[b]
Truck	Occupational[c] (person-rem per kilometer)	5.3×10^{-6}	5.9×10^{-6}	5.9×10^{-6}
	General Population			
	Off-link[d] (person-rem per kilometer per person per square kilometer)	2.6×10^{-9}	2.5×10^{-9}	5.2×10^{-11}
	On-link[e] (person-rem per kilometer)	7.2×10^{-7}	1.8×10^{-6}	5.7×10^{-6}
	Stops (person-rem per kilometer per person per square kilometer)	2.3×10^{-10}	2.3×10^{-10}	2.3×10^{-10}
	Escorts[f] (person-rem per kilometer)	2.4×10^{-7}	2.6×10^{-7}	2.6×10^{-7}
Rail	Occupational[g] (person-rem per kilometer)	2.1×10^{-7}	2.1×10^{-7}	2.1×10^{-7}
	General Population			
	Off-link[d] (person-rem per kilometer per person per square kilometer)	3.5×10^{-9}	4.9×10^{-9}	1.7×10^{-10}
	On-link[e] (person-rem per kilometer)	8.2×10^{-9}	1.1×10^{-6}	2.9×10^{-7}
	Stops (person-rem per kilometer per person per square kilometer)	8.1×10^{-10}	8.1×10^{-10}	8.1×10^{-10}
	Escorts[h] (person-rem per kilometer)	1.6×10^{-6}	2.5×10^{-6}	4.2×10^{-6}

[a] The methodology, equations, and data used to develop the unit risk factors are discussed in the *RADTRAN 5 User Guide* (Neuhauser and Kanipe 2003). The risk factors provided here are for truck and rail waste packages (i.e., casks) with the following characteristic lengths and diameters: 5.2 meters (~17.1 feet) in length by 1.0 meter (3.3 feet) in diameter for a truck cask and 5.06 meters (16.6 feet) in length by 2.0 meters (6.6 feet) in diameter for a rail cask. Because the characteristics of transuranic (TRU) waste shipments are different from those used here, the contact-handled TRU waste shipment risk factors would be higher than the values given here by factors of 1.39 and 1.76 for the population dose and crew dose, respectively.

[b] Ten percent of vehicles traveling within these zones encounter rush-hour traffic with a lower speed and a higher traffic density.

[c] The maximum dose in the truck cabin (crew dose) is 2 millirem per hour (10 CFR 71.47) unless the crew includes a trained radiation worker, which would administratively limit the annual dose to 2 rem per year (DOE Standard 1098-2008).

[d] Off-link general population refers to persons within 800 meters (0.5 miles) of the road or railway. The difference in doses between the rural, suburban, and urban populations is due to the assumptions on the shielding factors applicable in various zones.

[e] On-link general population refers to persons sharing the road or railway.

[f] Escorts are two persons in a vehicle that follows or leads the truck by 60 meters (200 feet). The dose to passengers in this vehicle is estimated to be 0.15 millirem per hour for a cask at the regulation dose limit (DOE 2002a).

[g] The nonlinear component of the incident-free rail dose for crewmembers because of railcar inspections and classifications, 0.000233 person-rem per shipment, is not included in the unit risk factors. The *RADTRAN 5 Technical Manual*, Appendix B (Neuhauser, Kanipe, and Weiner 2000), contains an explanation of the rail exposure model.

[h] These escorts (two persons) are at a distance of 30 meters (98 feet) from the end of the shipping cask. The dose to each escort is estimated to be 0.71 millirem per hour for a cask at the regulation dose limit (DOE 2002a).

Note: To convert kilometers to miles, multiply by 0.6214; square kilometers to square miles, by 0.3861.

Unit risk factors were developed using RADTRAN default data for travel on interstate highways and freeways, as required by DOT regulations (49 CFR 171–177) for highway route controlled quantities of radioactive material within rural, suburban, and urban population zones. In addition, the analysis assumed that travel through suburban and urban zones would encounter rush-hour conditions 10 percent of the time, leading to lower average speed and higher traffic density. The unit risk factors were combined with routing information, such as the shipment distances in various population density zones, to determine the risk from a single shipment (shipment risk factor) between a given origin and destination.

The radiological risks from transporting the waste were estimated in terms of the number of LCFs among the crew and the exposed population. A health risk conversion factor of 0.0006 LCFs per person-rem of exposure was used for both the workers and the public (DOE 2003).

H.5.2 Nonradiological Risk

Nonradiological risks (vehicle-related health risks) resulting from incident-free transport may be associated with the generation of air pollutants by transport vehicles during shipment and are independent of the radioactive nature of the shipment. The health endpoint assessed under incident-free transport conditions is the excess latent mortality due to inhalation of vehicle emissions.

Unit risk factors for pollutant inhalation in terms of mortality have been generated (Rao, Wilmot, and Luna 1982). These unit risk factors account for potential fatalities from emissions of particulates and sulfur dioxide, but they are applicable only to the urban population zone, which is a small fraction of the total transport distance. The emergence of considerable data regarding minimum threshold values for health risks from chemical constituents of vehicle exhaust has made linear extrapolation to estimate the risks from lower exposure levels to vehicle emissions untenable. Calculated risks should be compared with a standard or other comparable risks to put the risks in perspective, but this is not possible with emission risks. This calculation has been dropped from RADTRAN in its recent revision (Neuhauser, Kanipe, and Weiner 2000); therefore, no risk factors were assigned to the vehicle emissions analyzed in this *TC & WM EIS*.

H.5.3 Maximally Exposed Individual Exposure Scenarios

The MEI doses for routine offsite transportation were estimated for both transportation workers and members of the general public.

For truck shipments, the following three hypothetical scenarios were evaluated to determine the MEI in the general population (DOE 2002a):

- A person caught in traffic and located 1.2 meters (4 feet) from the surface of the shipping container for 30 minutes
- A resident living 30 meters (98 feet) from the highway used to transport the shipping container
- A service station worker working at a distance of 16 meters (52 feet) from the shipping container for 50 minutes

The hypothetical MEI doses were accumulated over a single year for all transportation shipments. However, for the scenario involving an individual caught in traffic next to a shipping container, the radiological exposures were calculated for only one event because it was considered unlikely that the same individual would be caught in traffic next to all containers for all shipments. For truck shipments, the maximally exposed transportation worker would be the driver, who was assumed to have been trained as a radiation worker and to drive shipments for up to 2,000 hours per year, resulting in an accumulated exposure of 2 rem per year. The maximum exposure rate for a member of a truck crew who is not a radiation worker would be 2 millirem per hour (10 CFR 71.47).

The following three hypothetical scenarios were also evaluated for railcar shipments:

- A rail yard worker working at a distance of 10 meters (33 feet) from the shipping container for 2 hours
- A resident living 30 meters (98 feet) from the rail line where the shipping container is being transported
- A resident living 200 meters (656 feet) from a rail stop during classification and inspection for 20 hours

For rail shipments, the maximally exposed transportation worker would be an individual inspecting the cargo at 1 meter (3.3 feet) from the shipping container for 1 hour.

H.6 TRANSPORTATION ACCIDENT RISKS AND MAXIMUM REASONABLY FORESEEABLE CONSEQUENCES

H.6.1 Methodology

Offsite transportation accident analysis considers the impacts of accidents during transportation of waste by truck or rail. Under accident conditions, impacts on human health and the environment could result from the release and dispersal of radioactive material. Transportation accident impacts were assessed using accident analysis methodology developed by NRC. This section provides an overview of the methodologies; detailed descriptions of various methodologies are found in NUREG-0170, *Radioactive Material Transport Study*; NUREG/CR-4829, *Modal Study*; and NUREG/CR-6672, *Reexamination Study* (NRC 1977; Fischer et al. 1987; Sprung et al. 2000). Accidents that could potentially breach the shipping container were represented by a spectrum of accident severities and radionuclide release conditions. Historically, most transportation accidents involving radioactive materials resulted in little or no release of radioactive material from the shipping container (WNA 2010). Consequently, the analysis of accident risks accounted for a spectrum of accidents ranging from high-probability accidents of low severity to hypothetical high-severity accidents that have a low probability. The accident analysis also calculated the probabilities and consequences of this spectrum of accidents.

Two types of analysis were performed to provide DOE and the public with a reasonable assessment of potential accident impacts of radioactive waste transportation. First, an accident risk assessment was performed to account for the probabilities and consequences of a spectrum of potential accident severities using a methodology developed by NRC (NRC 1977; Fischer et al. 1987; Sprung et al. 2000). For the spectrum of accidents considered in the analysis, accident consequences in terms of the collective "dose risk" to the population within 80 kilometers (50 miles) were determined using the RADTRAN 6 computer program (Weiner et al. 2009). The RADTRAN 6 code sums the product of consequences and probability over all accident severity categories to obtain a probability-weighted risk value referred to in this appendix as the "dose risk," which is expressed in units of person-rem. Second, to represent the maximum reasonably foreseeable impacts on individuals and populations should an accident occur, the maximum radiological consequences were calculated in an urban (or suburban) population zone for an accidental release with a likelihood of occurrence of greater than 1 in 10 million per year using the RISKIND computer program (Yuan et al. 1995).

For accidents in which the waste container or the cask shielding is not damaged, population and individual radiation exposures from the waste package were evaluated for the duration of time needed to recover and restart shipment. It was assumed that it would take 12 hours to recover from an accident. During this period, no individual would remain close to the cask. An individual (first responder) could stay at a location 2 to 10 meters (6.6 to 33 feet) from the package, a position where the dose rate would be

the highest, for 30 minutes in a loss-of-shielding accident and 1 hour for other accidents with no release (DOE 2002a). For accidents leading to loss of cask shielding, a method similar to that provided in NUREG/CR-6672, *Reexamination Study*, was used (DOE 2002a; Sprung et al. 2000). The collective dose over all segments of the transportation routes was evaluated for an affected population located up to a distance of 800 meters (0.5 miles) from the accident location. This dose would be an external dose, approximately inversely proportional to the square of the distance of the affected population from the accident. Any additional dose to those residing beyond 800 meters (0.5 miles) from the accident would be negligible.

H.6.2 Accident Rates

For the calculation of accident risks, vehicle accident and fatality rates were taken from data provided in *State-Level Accident Rates of Surface Freight Transportation: A Reexamination* (Saricks and Tompkins 1999). Accident rates are generically defined as the number of accident involvements (or fatalities) in a given year per unit of travel in that same year. Therefore, the rate is a fractional value, with the accident involvement count as the numerator of the fraction and vehicular activity (total travel distance in truck kilometers) as the denominator. Accident rates are generally determined for a multiyear period. For assessment purposes, the total number of expected accidents or fatalities was calculated by multiplying the total shipment distance for a specific case by the appropriate accident or fatality rate.

For truck transportation, the rates presented here are specifically for heavy-haul combination trucks involved in interstate commerce (Saricks and Tompkins 1999). Heavy-haul combination trucks are rigs composed of a separable tractor unit containing the engine and one to three freight trailers connected to each other. Heavy-haul combination trucks are typically used for radioactive material shipments. The truck accident rates were computed for each state based on statistics compiled by the DOT Federal Highway Administration, Office of Motor Carriers, from 1994 to 1996. A fatality caused by an accident is defined as the death of a member of the public who is killed instantly or dies within 30 days due to injuries sustained in the accident.

For offsite truck transportation, separate accident rates and accident fatality risks were used for rural, suburban, and urban population zones. The values selected are the mean accident and fatality rates under interstate, primary, and total categories for rural, suburban, and urban population zones, respectively (Saricks and Tompkins 1999). The accident rates are 3.15, 3.52, and 3.66 per 10 million truck kilometers, and the fatality rates are 0.88, 1.49, and 2.32 per 100 million truck kilometers for rural, suburban, and urban zones, respectively. For rail transportation, the accident and fatality rates are the mean value rates applicable to all population zones. The rates used in this analysis are 2.74 accidents per 10 million railcar kilometers and 7.82 fatalities per 100 million railcar kilometers (Saricks and Tompkins 1999). The national mean values for truck and rail accident and fatality rates were used because these values are less prone to the uncertainties associated with the state-level data that can be underreported or have a small data set. In addition, the analyzed routes are considered representative and are not necessarily the ones that would be used in the future. Further, the use of national mean values would result in conservative estimates on the number of accidents and fatalities per trip.

For onsite and local/regional transport, Washington State accident and fatality rates were used—1.23 accidents per 10 million truck kilometers and 0.83 fatalities per 100 million truck kilometers (Saricks and Tompkins 1999).

A subsequent review of the truck accidents and fatalities reports by the Federal Carrier Safety Administration indicated that state-level accidents and fatalities were underreported. For the years 1994 through 1996, which were the basis for the analysis in the Saricks and Tompkins (1999) report, the review found that accidents were underreported by about 39 percent and fatalities by about

36 percent (Blower and Matteson 2003). Therefore, truck accident and fatality rates were increased by factors of 1.64 and 1.57, respectively, to account for the underreporting.

H.6.3 Accident Severity Categories and Conditional Probabilities

Accident severity categories for potential radioactive waste transportation accidents are described in NUREG-0170, *Radioactive Material Transport Study* (NRC 1977), which addresses general radioactive waste transportation risks, as well as in NUREG/CR-4829, *Modal Study* (Fischer et al. 1987), and NUREG/CR-6672, *Reexamination Study* (Sprung et al. 2000), both of which address SNF transportation risks (the *Reexamination Study* is a refinement of the *Modal Study*). The method described in NUREG/CR-6672 is applicable to transportation of IHLW glass in a Type B SNF cask. The accident severity categories presented in NUREG-0170 are applicable to onsite waste transport. In addition to these reports, DOE's Richland Operations Office has developed the *Safety Evaluation Report, Hanford Transportation Safety Document*, a site-specific transportation safety document for determining onsite transportation risks (DOE 2002b). This document applied modeling from NUREG/CR-6672 to estimate site-specific severity probabilities.

NUREG-0170, *Radioactive Material Transport Study* (NRC 1977), originally was used to estimate the severity-category conditional probabilities associated with accidents involving transportation of radioactive materials. NUREG/CR-4829, *Modal Study*, and NUREG/CR-6672, *Reexamination Study* (Fischer et al. 1987; Sprung et al. 2000), were initiatives taken by NRC to refine more precisely the analysis presented in NUREG-0170 for SNF shipping casks.

Whereas the analysis in NUREG-0170, *Radioactive Material Transport Study*, was primarily performed using the best engineering judgments and presumptions concerning cask response, later studies relied on sophisticated structural and thermal engineering analysis and a probabilistic assessment of the conditions that could be experienced in severe transportation accidents. These results were based on representative SNF casks that were assumed to be designed, manufactured, operated, and maintained according to national codes and standards. The design parameters of the representative casks were chosen to meet the minimum test criteria specified in NRC regulations (10 CFR 71). NUREG-0170 is believed to provide realistic, yet conservative, results for radionuclide releases under transport accident conditions.

In both NUREG/CR-4829, *Modal Study*, and NUREG/CR-6672, *Reexamination Study*, potential accident damage to a cask is categorized according to the magnitude of the mechanical forces (impact) and thermal forces (fire) to which a cask may be subjected during an accident. Because all accidents can be described in these terms, severity is independent of the specific accident sequence. In other words, any sequence of events that results in an accident in which a cask is subjected to forces within a certain range of values is assigned to the accident severity region associated with that range. The accident severity scheme is designed to take into account all potential foreseeable transportation accidents, including accidents with low probability but high consequences and those with high probability but low consequences.

As discussed earlier, the accident consequence assessment considers only the potential impacts of the most severe transportation accidents. In terms of risk, the severity of an accident must be viewed in terms of potential radiological consequences, which are directly proportional to the fraction of the radioactive material within a cask that is released to the environment during the accident. Although, accident severity regions span the entire range of mechanical and thermal accident loads, they are grouped into accident categories that can be characterized by a single set of release fractions and, therefore, are considered together in the accident consequence assessment. The accident category severity fraction is the sum of all conditional probabilities in that accident category.

For the accident risk assessment, accident "dose risk" was generically defined as the product of the consequences of an accident and the probability of the occurrence of that accident, an approach consistent with the methodology used by the RADTRAN 6 computer code. The RADTRAN 6 code sums the product of consequences and probability over all accident severity categories to obtain a probability-weighted risk value referred to in this appendix as "dose risk," which is expressed in units of person-rem.

H.6.4 Atmospheric Conditions

Because it is impossible to predict the specific location of an offsite transportation accident, generic atmospheric conditions were selected for the risk and consequence assessments. On the basis of observations from National Weather Service surface meteorological stations at over 177 locations in the United States, on an annual average, neutral conditions (Pasquill Stability Classes C and D) occur 58.5 percent of the time, and stable (Pasquill Stability Classes E, F, and G) and unstable (Pasquill Stability Classes A and B) conditions occur 33.5 percent and 8 percent of the time, respectively (DOE 2002a). Neutral weather conditions predominate in each season, but most frequently in winter (nearly 60 percent of the observations).

Neutral weather conditions (Pasquill Stability Class D) compose the most frequently occurring atmospheric stability condition in the United States and are thus most likely to be present in the event of an accident involving a radioactive waste shipment. Neutral weather conditions are typified by moderate windspeeds, vertical mixing within the atmosphere, and good dispersion of atmospheric contaminants. Stable weather conditions are typified by low windspeeds, very little vertical mixing within the atmosphere, and poor dispersion of atmospheric contaminants. The atmospheric condition used in RADTRAN is an average weather condition that corresponds to a stability class spread between Class D (for near distance) and Class E (for farther distance).

The accident consequences for the maximum reasonably foreseeable accident (an accident with a likelihood of occurrence of greater than 1 in 10 million per year) were assessed under both stable (Class F with a windspeed of 1 meter [3.3 feet] per second) and neutral (Class D with a windspeed of 4 meters [13 feet] per second) atmospheric conditions. These calculations estimate the potential doses to an individual and a population within a zone, respectively. The individual dose would represent the MEI in an accident under weather conditions that maximize the dose (stable condition, with minimum diffusion and dilution). The population dose would represent an average weather condition.

H.6.5 Radionuclide Release Characteristics

Radiological consequences were calculated by assigning radionuclide release fractions on the basis of the type of waste, the type of shipping container, and the accident severity category. The release fraction is defined as the fraction of radioactivity in the container that could be released to the atmosphere due to an accident with a given severity. Release fractions vary according to the waste type and the physical or chemical properties of the radioisotopes. Most solid radionuclides are nonvolatile and, therefore, are relatively nondispersible.

Representative release fractions were developed for each waste and container type on the basis of DOE and NRC reports (DOE 2002c; DOE Handbook 3010-94; NRC 1977; Sprung et al. 2000). The severity categories and corresponding release fractions provided in these documents cover a range of accidents from no impact (zero speed) to impacts at a speed in excess of 193 kilometers (120 miles) per hour onto an unyielding surface. Accidents that could occur at Hanford would have lower impacts due to lower local speed limits and site-specific road and surface characteristics.

For the IHLW in a Type B SNF cask, the particulate release fractions for vitrified waste described in the *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (Yucca Mountain EIS)* (DOE 2002a) were used. For the ILAW glass (including bulk vitrification glass and cast stone waste), the particulate release fractions for the severity categories corresponding to the severity accidents listed in NUREG-0170, *Radioactive Material Transport Study*, were used (DOE 2002c; NRC 1977). The aerosolized fractions for these waste types were assumed to be in the respirable range. For waste transported in Type A containers (e.g., a 208-liter [55-gallon] drum), the fractions of radioactive material released from the shipping container were based on recommended values from NUREG-0170 (NRC 1977). The NUREG-0170 values were multiplied by an aerosolized fraction to estimate the amount of material dispersed into the atmosphere. For CH- and RH-TRU waste, the release fractions corresponding to the NUREG-0170 severity categories and adapted in the *WIPP SEIS-II* were used (DOE 1997, 2002c).

For transport of sodium metal and sodium hydroxide solution in ISO container tanks, the severity fractions and associated release fractions were based on accident statistics from the National Highway Traffic Safety Administration (DOT 2002, 2004–2006) and recommended values from NUREG-0170, *Radioactive Material Transport Study* (NRC 1977), and *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities* (DOE Handbook 3010-94). Human health impacts due to toxic chemical exposures from sodium fires are analyzed in Appendix K; two of the analyses involve quantities of sodium similar to those expected to be present in a transportation accident. The potential toxic impacts of a transportation accident that produces a sodium fire are therefore expected to be comparable to those presented in Appendix K.

H.6.6 Acts of Sabotage or Terrorism

In the aftermath of the tragic events of September 11, 2001, DOE is continuing to assess potential measures to minimize the risk or potential consequences of radiological sabotage. While it is not possible to determine terrorists' motives and targets with certainty, DOE considers the threat of terrorist attack to be real and makes all efforts to reduce any vulnerability to this threat. DOE considers, evaluates, and plans for potential terrorist attacks during transportation and storage of radioactive materials. The details of any postulated terrorist attack, as well as DOE's plans for the security of its facilities and its terrorist countermeasures, are classified.

Nevertheless, DOE has evaluated the impacts of acts of sabotage and terrorism for SNF and HLW shipments (DOE 1996, 2002a). The spectrum of acts considered range from direct attack on the cask from afar to hijacking and exploding the shipping cask in an urban area. Both of these actions would result in damaging the cask and its contents and releasing radioactive materials. The fraction of the materials released depends on the nature of the attack (type of explosive or weapons used). The analyses of sabotage events described in the *Yucca Mountain EIS* and its supplement (DOE 2002a, 2008) were considered enveloping analyses for this *TC & WM EIS*. The events were assumed to involve either a truck- or rail-sized cask containing light-water reactor SNF. The consequences of such acts were calculated to result in an MEI dose of 40 to 110 rem (at 140 meters [460 feet]) for events involving a truck- or rail-sized cask, respectively (DOE 2002a). These events would lead to a 2 to 7 percent increase in the risk of fatal latent cancer to an MEI. The 2008 supplemental EIS indicates that the sabotage scenarios analyzed in the *Yucca Mountain EIS* are overstated by a factor between 2.5 and 12 (DOE 2008). The quantity of radioactive materials transported under all *TC & WM EIS* alternatives would be less than those considered in the *Yucca Mountain EIS* (DOE 2002a) and its supplemental EIS (DOE 2008). Therefore, estimates of risks provided in the *Yucca Mountain EIS* envelope the risks from an act of sabotage or terrorism involving radioactive material transported under all alternatives analyzed in this *TC & WM EIS*.

H.7 RISK ANALYSIS RESULTS

Per-shipment risk factors were calculated for collective populations of exposed persons and the crew for all anticipated routes and shipment configurations. Radiological risks are presented in doses per shipment for each unique route, material, and container combination. Per-shipment radiological risk factors for incident-free transportation and accident conditions are presented in Table H–6. For incident-free transportation, both dose and LCF risk factors are provided for the crew and exposed population. The radiological risks would result from potential exposure to external radiation emanating from the packaged waste. The exposed population would include the off-link public (people living along the route), on-link public (pedestrian and car occupants along the route) and the public at rest and fuel stops. For onsite shipments, the populations at rest and fuel stops are set at zero because a truck is not expected to stop during shipments that take less than an hour.

For transportation accidents, both radiological (in terms of potential LCFs among the exposed population) and nonradiological (in terms of number of traffic fatalities) risk factors are given. The LCF represents the number of additional latent fatal cancers among the exposed population. In an accident condition, the population would receive a direct dose if the package is not breached. If the package is breached, the population would receive an additional dose from released radioactive materials. For accidents with no release, the analysis conservatively assumed that it would take about 12 hours to remove the package and/or vehicle from the accident area (DOE 2002a). Accidents leading to loss of cask shielding would only be applicable to those shipments that use lead shielded casks, such as shipments of IHLW glass and RH-waste. Onsite accidents would not lead to loss of shielding due to lower vehicle velocity and accident impacts.

As indicated in Table H–6, all risk factors are less than one, meaning that no LCF or traffic fatalities are expected to occur during each transport. For example, the risk factors for the truck crew and the population from transporting one truck shipment of RH-TRU waste to WIPP are 1.1×10^{-4} and 3.2×10^{-5} LCFs, respectively. These values mean that there is 1 chance in 9,090 that an individual from a truck crew would develop a latent fatal cancer from exposure to radiation during one shipment of RH-TRU waste to WIPP and 1 chance in 31,250 that the exposed population residing along the transport route would experience an additional latent fatal cancer.

Table H–6. Risk Factors per Shipment of Radioactive Waste

Waste Material (mode of transport)	Transport Destination	Incident-Free				Accident	
		Crew Dose (person-rem)	Crew Risk (LCFs)	Population Dose (person-rem)	Population Risk (LCFs)	Rad. Risk (LCFs)	Nonrad. Risk (traffic fatalities)
Tank Closure							
RH-TRU waste (T)[a]	WIPP	1.8×10^{-1}	1.1×10^{-4}	5.4×10^{-2}	3.2×10^{-5}	1.3×10^{-8}	9.6×10^{-5}
CH-TRU waste (T)[a]	WIPP	1.2×10^{-1}	7.0×10^{-5}	4.2×10^{-2}	2.5×10^{-5}	8.9×10^{-10}	9.6×10^{-5}
ILAW glass (T)	Hanford (on site)	2.7×10^{-3}	1.6×10^{-6}	7.5×10^{-4}	4.5×10^{-7}	8.4×10^{-19}	4.4×10^{-7}
Bulk vitrification glass (T)	Hanford (on site)	2.1×10^{-2}	1.3×10^{-5}	2.2×10^{-2}	1.3×10^{-5}	4.5×10^{-16}	4.4×10^{-7}
Cast stone waste (T)	Hanford (on site)	1.6×10^{-2}	9.6×10^{-6}	2.3×10^{-3}	1.4×10^{-6}	1.2×10^{-16}	4.4×10^{-7}
Steam reforming waste (T)	Hanford (on site)	8.8×10^{-3}	5.3×10^{-6}	2.1×10^{-3}	1.3×10^{-6}	3.0×10^{-17}	4.4×10^{-7}
Sulfate grout (T)	Hanford (on site)	6.2×10^{-4}	3.7×10^{-7}	1.4×10^{-4}	8.2×10^{-8}	7.4×10^{-19}	4.4×10^{-7}
IHLW glass (T)[b]	Hanford (on site)	8.8×10^{-4}	5.3×10^{-7}	2.6×10^{-4}	1.6×10^{-7}	7.0×10^{-18}	2.2×10^{-7}
RH-TRU waste (R)[c]	WIPP	1.2×10^{-2}	7.2×10^{-6}	2.7×10^{-2}	1.6×10^{-5}	3.2×10^{-9}	5.5×10^{-4}
CH-TRU waste (R)[c]	WIPP	6.7×10^{-3}	4.0×10^{-6}	2.1×10^{-2}	1.3×10^{-5}	1.8×10^{-10}	5.5×10^{-4}
Miscellaneous waste (T)[d]	Hanford (on site)	2.0×10^{-3}	1.2×10^{-6}	6.7×10^{-5}	4.0×10^{-8}	7.2×10^{-13}	4.4×10^{-7}
RH-TRU waste (T)	Hanford (on site)	4.6×10^{-3}	2.7×10^{-6}	1.6×10^{-4}	9.6×10^{-8}	6.9×10^{-11}	4.4×10^{-7}
CH-TRU waste (T)	Hanford (on site)	1.2×10^{-3}	7.1×10^{-7}	2.1×10^{-4}	1.3×10^{-7}	2.0×10^{-10}	4.4×10^{-7}
Fast Flux Test Facility							
Sodium metal (T)	INL	2.0×10^{-2}	1.2×10^{-5}	5.5×10^{-3}	3.3×10^{-6}	4.9×10^{-12}	3.0×10^{-5}
Sodium metal (R)	INL	1.8×10^{-3}	1.1×10^{-6}	4.2×10^{-3}	2.5×10^{-6}	5.6×10^{-12}	1.7×10^{-4}
Caustic (T)	Hanford	1.0×10^{-2}	6.1×10^{-6}	2.8×10^{-3}	1.7×10^{-6}	1.2×10^{-14}	3.0×10^{-5}
Caustic (R)	Hanford	9.0×10^{-4}	5.4×10^{-7}	2.1×10^{-3}	1.3×10^{-6}	1.3×10^{-14}	1.7×10^{-4}
RH special components (T)	INL	7.8×10^{-2}	4.7×10^{-5}	3.3×10^{-2}	2.0×10^{-5}	5.2×10^{-14}	3.0×10^{-5}
RH special components (R)	INL	6.4×10^{-3}	3.8×10^{-6}	2.1×10^{-2}	1.3×10^{-5}	2.9×10^{-14}	1.7×10^{-4}
Treated special components (T)[e]	NNSS	9.6×10^{-2}	5.8×10^{-5}	4.1×10^{-2}	2.5×10^{-5}	1.6×10^{-13}	3.9×10^{-5}
Treated special components (R)[e]	NNSS	7.5×10^{-3}	4.5×10^{-6}	2.5×10^{-2}	1.5×10^{-5}	5.3×10^{-14}	2.3×10^{-4}
Caustic (T)[f]	Hanford	1.4×10^{-1}	8.5×10^{-5}	3.9×10^{-2}	2.3×10^{-5}	5.2×10^{-10}	3.0×10^{-5}
Sodium metal (T)	Hanford (on site)	1.6×10^{-3}	9.6×10^{-7}	1.7×10^{-4}	1.0×10^{-7}	5.2×10^{-15}	9.6×10^{-7}
Caustic (T)	Hanford (on site)	4.9×10^{-4}	3.0×10^{-7}	4.7×10^{-5}	2.8×10^{-8}	1.5×10^{-17}	6.3×10^{-7}
Special components (T)	Hanford (on site)	6.1×10^{-3}	3.7×10^{-6}	1.0×10^{-3}	6.1×10^{-7}	3.0×10^{-16}	9.6×10^{-7}
Reactor vessel (T)	Hanford (on site)	1.9×10^{-3}	1.2×10^{-6}	1.7×10^{-3}	1.0×10^{-6}	N/A	N/A

Table H–6. Risk Factors per Shipment of Radioactive Waste *(continued)*

Waste Material (mode of transport)	Transport Destination	Incident-Free				Accident	
		Crew Dose (person-rem)	Crew Risk (LCFs)	Population Dose (person-rem)	Population Risk (LCFs)	Rad. Risk (LCFs)	Nonrad. Risk (traffic fatalities)
Waste Management							
LLW (T)[g]	Hanford	2.2×10^{-1}	1.3×10^{-4}	6.6×10^{-2}	4.0×10^{-5}	1.2×10^{-9}	1.6×10^{-4}
LLW (R)[g]	Hanford	8.4×10^{-3}	5.0×10^{-6}	2.3×10^{-2}	1.4×10^{-5}	4.8×10^{-10}	7.6×10^{-4}
MLLW (T)[g]	Hanford	1.6×10^{-1}	9.7×10^{-5}	6.1×10^{-2}	3.7×10^{-5}	2.8×10^{-9}	1.5×10^{-4}
MLLW (R)[g]	Hanford	5.7×10^{-3}	3.4×10^{-6}	2.2×10^{-2}	1.3×10^{-5}	2.6×10^{-9}	7.5×10^{-4}
LLW[h]	Hanford (on site)	1.3×10^{-2}	7.5×10^{-6}	3.1×10^{-4}	1.8×10^{-7}	4.6×10^{-13}	1.4×10^{-6}
MLLW[h]	Hanford (on site)	8.1×10^{-4}	4.9×10^{-7}	1.0×10^{-4}	6.2×10^{-8}	9.6×10^{-12}	1.4×10^{-6}

[a] Truck is the current mode of transporting TRU waste to WIPP.
[b] IHLW transport to an onsite storage location occurs within the 200 Areas.
[c] Rail is the future/reserved mode of transporting TRU waste to WIPP.
[d] Includes radioactively contaminated equipment, dirt, and ancillary equipment placed in shielded boxes during tank closure.
[e] Impacts of transport of treated components to Hanford would be similar to those of transport to INL.
[f] Reflects the transport of caustics generated from treatment of remote-handled special components.
[g] These values reflect the maximum impacts of transport of radioactive waste from offsite sources (i.e., Argonne National Laboratory-East, Brookhaven National Laboratory, INL, Los Alamos National Laboratory, Oak Ridge National Laboratory, Paducah, Portsmouth, Savannah River Site, and West Valley Demonstration Project) to Hanford.
[h] These values reflect maximum impacts of transport of onsite waste.
Note: Radiation dose and risk are rounded to two significant figures.
Key: CH=contact-handled; Hanford=Hanford Site; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; INL=Idaho National Laboratory; LCF=latent cancer fatality; LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste; N/A=not applicable, no accident was considered; Nonrad.=nonradiological; NNSS=Nevada National Security Site; R=rail; Rad.=radiological; RH=remote-handled; T=truck; TRU=transuranic; WIPP=Waste Isolation Pilot Plant.

Both the radiation dose risk factor and nonradiological risk factor for transportation accidents are also presented in Table H–6. The radiological and nonradiological accident risk factors are provided in terms of potential fatalities per shipment. The radiological risks are presented in terms of LCFs. For the population, the radiological risks were calculated by multiplying the accident dose risks by the health risk factor of 0.0006 LCFs per person-rem of exposure. As stated in Section H.6.3, the accident dose is referred to as the "dose risk" because the values incorporate the spectrum of accident severity probabilities and associated consequences (e.g., dose). The radiological accident doses are very low because accident severity probabilities (i.e., the likelihood of accidents leading to confinement breach of a shipping cask and release of its content) are very small and, although persons reside within in an 80-kilometer (50-mile) radius of the road, they are generally quite far from the road. Because RADTRAN uses an assumption of homogeneous population distribution from the road out to 80 kilometers (50 miles), it greatly overestimates the actual doses. The nonradiological risk factors are nonoccupational traffic fatalities resulting from transportation accidents.

H.7.1 Tank Closure Alternatives

Table H–7 provides the estimated number of shipments for various wastes under all Tank Closure alternatives. The numbers of shipments were calculated using the estimated waste volumes and packagings for each waste type given in Appendix D, Section D.1, as well as the waste container and shipment characteristics provided in Table H–2. The offsite shipment values were based on an assumption that RH-TRU waste would be transported by truck. This assumption is consistent with the modes of transportation analyzed for the Preferred Alternative in the *WIPP SEIS-II* (DOE 1997) and selected in the *WIPP SEIS-II* Record of Decision (63 FR 3624).

Table H–7. Tank Closure Alternatives – Estimates of Number of Radioactive Waste Shipments

Alternative	Number of Shipments									
	Offsite Shipments[a]		Onsite Shipments							
	CH-TRU Waste	RH-TRU Waste	IHLW[b]	ILAW Glass	Bulk Vit. Glass	Cast Stone Waste	Steam Reforming Waste	CH-TRU Waste	RH-TRU Waste	Other Wastes[c]
1	0	0	0	0	0	0	0	0	0	0
2A	N/A	N/A	12,300	92,300	N/A	N/A	N/A	N/A	N/A	30
2B	N/A	N/A	12,300	92,300	N/A	N/A	N/A	N/A	N/A	23,600
3A	170	3,400	9,000	28,500	6,000	N/A	N/A	180	730	23,600
3B	170	3,400	9,000	28,500	N/A	23,300	N/A	180	730	23,600
3C	170	3,400	9,000	28,500	N/A	N/A	58,000	180	730	23,600
4	170	3,400	11,100	28,700	2,400	14,400	N/A	180	740	84,600
5	160	3,100	8,100	31,100	2,200	8,100[d]	N/A	160	660	10
6A, Base Case	N/A	N/A	172,000	700	N/A	N/A	N/A	N/A	N/A	250,000
6A, Option Case	N/A	N/A	172,000	18,300	N/A	N/A	N/A	N/A	N/A	684,000
6B, Base Case	N/A	N/A	12,300	93,700	N/A	N/A	N/A	N/A	N/A	250,000
6B, Option Case	N/A	N/A	12,300	111,000	N/A	N/A	N/A	N/A	N/A	684,000
6C	N/A	N/A	12,300	92,300	N/A	N/A	N/A	N/A	N/A	23,600

[a] These are estimates for truck transports. Rail transports would be one-half of the values given.
[b] The IHLW canisters include 340 cesium and strontium high-level radioactive waste canisters.
[c] Other wastes include high-activity waste (equipment and soils), contaminated dirt and grout from the Preprocessing Facility high-level mixed radioactive waste, and end-of-life Waste Treatment Plant low-activity waste melters, as applicable.
[d] This number includes 6,120 containers of sulfate grout, two containers per truck.

Note: The number of shipments is rounded to the nearest ten between 10 and 1,000 shipments; nearest hundred between 1,000 and 100,000 shipments; and nearest thousand for greater than 100,000 shipments.

Key: CH=contact-handled; IHLW=immobilized high-level radioactive waste; ILAW=immobilized low-activity waste; N/A=not applicable (no offsite shipments); RH=remote-handled; TRU=transuranic; Vit.=vitrification.

Source: SAIC 2010a.

Transportation risks were calculated assuming that all shipments would be transported by rail or truck. DOE could decide to use a combination of both truck and rail for transporting materials. Note that the accident and fatality rates are per truck-kilometer or railcar-kilometer, as indicated in Section H.6.2. If DOE decides to ship waste materials using multiple railcars per transport, both accident and fatality rates would increase proportionally. The incident-free population dose would also increase proportionally as the exposure time increases; exposure time would be a function of the rail speed and the length of the waste package in each railcar. Therefore, rail transport per-shipment risk factors would increase proportionally as well. Hence, the risk results presented here are applicable irrespective of future decisions on multiple railcars per transport.

Table H–8 summarizes the risks of transportation under each Tank Closure alternative. These risks were calculated by multiplying the previously given per-shipment factors by the number of shipments over the duration of the program and, for the radiation doses, by the health risk conversion factors. The values presented in Table H–8 show that the total radiological accident risks (the product of the frequency and consequences) are very small under all alternatives. The nonradiological accidents (the potential for fatalities as a direct result of traffic accidents) present the greatest risks. Considering that the transportation activities analyzed under the Tank Closure alternatives would occur from about 20 to over 150 years and the average number of traffic fatalities in the United States is about 34,000 per year (DOT 2011), the traffic fatality risk under all alternatives would be very small.

Table H–8. Tank Closure Alternatives – Risks of Transporting Radioactive Waste

Alt.	Transport	Number of Shipments[a]	Incident-Free				Accident		One-Way Offsite Travel (10^6 km)
			Crew		Population				
			Dose (person-rem)	Risk (LCFs)	Dose (person-rem)	Risk (LCFs)	Rad. Risk (LCFs)	Nonrad. Risk (traffic fatalities)	
2A	Off site[b]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	On site	105,000	260	0.16	73	0.04	1.6×10^{-13}	0.04	N/A
2B	Off site[b]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	On site	128,000	260	0.16	73	0.04	2.1×10^{-9}	0.05	N/A
3A	Off site	3,600	620	0.37	190	0.11	4.3×10^{-5}	0.34	11.0
	On site	68,000	220	0.13	160	0.09	8.8×10^{-8}	0.03	N/A
3B	Off site	3,600	620	0.37	190	0.11	4.3×10^{-5}	0.34	11.0
	On site	85,300	460	0.28	77	0.05	8.8×10^{-8}	0.04	N/A
3C	Off site	3,600	620	0.37	190	0.11	4.3×10^{-5}	0.34	11.0
	On site	120,000	600	0.36	150	0.09	8.8×10^{-8}	0.05	N/A
4	Off site	3,600	630	0.38	190	0.11	4.3×10^{-5}	0.34	11.1
	On site	142,000	460	0.27	110	0.07	1.0×10^{-7}	0.06	N/A
5	Off site	3,200	570	0.34	170	0.10	3.9×10^{-5}	0.31	10.0
	On site	50,300	220	0.13	85	0.05	7.8×10^{-8}	0.02	N/A
6A, Base Case	Off site[b]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	On site	423,000	450	0.27	60	0.04	6.5×10^{-8}	0.15	N/A
6A, Option Case	Off site[b]	N/A	N/A	N/A	N/A	N/A	N/A	0.00	N/A
	On site	874,000	870	0.52	100	0.06	9.4×10^{-8}	0.35	N/A
6B, Base Case	Off site[b]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	On site	356,000	560	0.34	89	0.05	6.5×10^{-8}	0.15	N/A
6B, Option Case	Off site[b]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	On site	808,000	980	0.59	130	0.08	9.4×10^{-8}	0.35	N/A
6C	Off site[b]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	On site	128,000	260	0.16	73	0.04	2.1×10^{-9}	0.05	N/A

[a] Offsite shipments are based on truck transport of transuranic waste (current practice for transport to the Waste Isolation Pilot Plant).
[b] Under this Tank Closure alternative, no transuranic waste would be generated from treatment of tank waste.
Note: Dose and risk results are rounded to two significant figures. To convert kilometers to miles, multiply by 0.6214.
Key: Alt.=Alternative; km=kilometers; LCF=latent cancer fatality; N/A=not applicable; Nonrad.=nonradiological; Rad.=radiological.

The risks to various MEIs under incident-free transportation conditions were estimated for the hypothetical exposure scenarios identified in Section H.5.3. The estimated doses to workers, escorts, and the public are presented in Table H–9. Doses are presented on a per-event basis (person-rem per event), as it is unlikely that the same person would be exposed to multiple events; for those that could have multiple exposures, the cumulative dose could be calculated. The maximum dose to a crewmember was based on the same individual driving every shipment for the duration of the campaign. Note that the potential exists for larger individual exposures if multiple exposure events occur. For example, the dose to a person stuck in traffic next to a shipment of RH-TRU waste for 30 minutes was calculated to be 12 millirem. This scenario was considered a one-time event for that individual. The dose to an escort was estimated per trip to WIPP. Note 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). The exposure to each individual escort would be administratively limited to 2 rem per year (DOE Standard 1098-2008).

Table H–9. Tank Closure Alternatives – Estimated Dose to Maximally Exposed Individuals During Incident-Free Transportation Conditions

Receptor	Dose to Maximally Exposed Individual
Workers	
Crewmember (truck/rail driver)	2 rem per year[a]
Inspector	2.8×10^{-2} rem per event per hour of inspection
Rail yard worker[b]	8×10^{-3} rem per event
Escort (rail transport)[b]	3×10^{-2} rem per trip
Escort (truck transport)	3.8×10^{-3} rem per trip
First responder (accidents with no release)	2.6×10^{-3} rem per event per one-half hour
Public	
Resident (along the rail route)[b]	6.3×10^{-7} rem per event
Resident (along the truck route)	3.0×10^{-7} rem per event
Person in traffic congestion	1.2×10^{-2} rem per event per one-half-hour stop
Resident near the rail yard during classification[b]	8.3×10^{-5} rem per event
Person at a rest stop/gas station	2.5×10^{-4} rem per event per hour of stop
Gas station attendee	2.6×10^{-4} rem per event

[a] Maximum administrative dose limit per year for a trained radiation worker (truck/rail crewmember).
[b] If the offsite transport were to use rail, with escort.

A member of the public residing along the route would likely receive multiple exposures from passing shipments. The cumulative dose to this resident can be calculated, assuming all shipments passed his or her home and the resident would be present for every shipment and would be unshielded at a distance of 30 meters (98 feet) from the route. Therefore, the cumulative dose would depend on the number of truck or rail shipments passing a particular point and would be independent of the actual route being considered. The maximum dose to this resident, if all the materials were shipped via this route, would be about 1 millirem. This dose corresponds to that for the truck shipments under Tank Closure Alternative 4, which would have an estimated 3,600 truck shipments of CH- and RH-TRU waste shipments in about 40 years.

The accident risk assessment and the impacts shown in Table H–8 take into account the entire spectrum of potential accidents, from "fender benders" to extremely severe collisions. To provide additional insight into the severity of accidents in terms of the potential dose to an MEI and the public, an accident consequences assessment was performed for a maximum reasonably foreseeable hypothetical transportation accident with a likelihood of occurrence of greater than 1 in 10 million per year. The results, presented in Table H–8, include all accidents, irrespective of their likelihood.

The maximum reasonably foreseeable offsite transportation accident with the highest consequences is an accident involving a truck shipment of RH-TRU waste. This severe-impact, high-temperature fire accident has a likelihood of occurrence of 4.7×10^{-7} per shipment in the rural area. The per-shipment likelihood of such an accident in suburban and urban areas is 9.4×10^{-9} and 2.8×10^{-10}, respectively. The consequences of such an accident in terms of dose and risk of LCFs to an MEI, an individual standing 100 meters (330 feet) downwind from the accident, and the population residing within 80 kilometers (50 miles) in the rural, suburban, and urban zones are provided in Table H–10.

Table H–10. Tank Closure Alternatives – Estimated Dose to the Population and to Maximally Exposed Individuals During the Most Severe Potential Accident

Material and Accident Location		Population[a]		Maximally Exposed Individual[b]	
		Dose (person-rem)	Risk (LCFs)	Dose (rem)	Risk (LCFs)
Remote-handled transuranic waste	Rural	0.38	2.3×10^{-4}	0.03	1.6×10^{-5}
	Suburban	16	9.7×10^{-3}	0.03	1.6×10^{-5}
	Urban	110	6.6×10^{-2}	0.03	1.6×10^{-5}

[a] Population extends at a uniform density to a radius of 80 kilometers (50 miles). The weather condition was assumed to be Pasquill Stability Class D, with a windspeed of 4 meters per second (9 miles per hour).

[b] The individual is assumed to be 100 meters (330 feet) downwind from the accident and exposed to the entire plume of the radionuclide release from a 2-hour, high-temperature fire. The weather condition was assumed to be Pasquill Stability Class F, with a windspeed of 1 meter per second (2.2 miles per hour).

Note: Dose and risk results are rounded to two significant figures.

Key: LCF=latent cancer fatality.

H.7.2 FFTF Decommissioning Alternatives

Table H–11 provides the estimated number of shipments for various wastes under all FFTF Decommissioning alternatives. The numbers of shipments were calculated using the estimated volumes and packagings for each waste type given in Appendix D, Section D.2, as well as the waste container and shipment characteristics provided in Table H–2. The values presented for offsite shipments in Table H–11 are the estimated numbers of truck shipments for the Idaho options of treating sodium metals and RH-SCs at INL. If these options are selected, the treated sodium, in the form of 50 weight-percent caustic solution, would be transported back to Hanford, and the treated RH-SCs would be shipped to NNSS or transported back to Hanford for disposal.

Table H–11. FFTF Decommissioning Alternatives – Estimates of Number of Radioactive Waste Shipments

Alternative	Number of Shipments							
	Offsite Shipments[a]			Onsite Shipments				
	Sodium Metal	Caustic Solution	RH-SCs	Sodium Metal	Caustic Solution	RH-SCs	Reactor Vessel	Other Wastes[b]
1	0	0	0	0	0	0	0	NA
2	80	190	9	10	190	5	0	6,300
3	80	190	9	10	190	5	1	6,300

[a] These are estimates for truck transports. Rail transports would be one-half of the values given.

[b] Other wastes include components and decommissioning waste transported to an Integrated Disposal Facility and sanitary and hazardous landfills.

Note: The number of shipments is rounded to the nearest ten between 10 and 1,000 shipments and nearest hundred between 1,000 and 100,000 shipments.

Key: NA=not analyzed; RH-SC=remote-handled special component.

Source: SAIC 2010b.

FFTF Decommissioning alternatives consist of three distinct activities: facility disposition, disposition of bulk sodium, and disposition of RH-SCs. Table H–12 summarizes the risks of transportation under each disposition activity. The risks were calculated by multiplying the previously given per-shipment factors by the number of shipments over the duration of the program and, for the radiation doses, by the health risk conversion factors. The values presented in Table H–12 show that the total radiological accident risks (the product of the frequency and consequences) are very small under all disposition activities. In contrast, the nonradiological accidents (the potential for fatalities as a direct result of traffic accidents) present the greatest risks.

Table H–12. FFTF Decommissioning Alternatives – Risks of Transporting Radioactive Waste

Disposition Activity	Location (transport mode)	Number of Shipments	Incident-Free				Accident		One-Way Offsite Travel (10^5 km)
			Crew		Population				
			Dose (person-rem)	Risk (LCFs)	Dose (person-rem)	Risk (LCFs)	Rad. Risk (LCFs)	Nonrad. Risk (traffic fatalities)	
Disposition of bulk sodium	INL (T)	270	3.5	2.1×10^{-3}	0.96	5.7×10^{-4}	3.9×10^{-10}	8.1×10^{-3}	2.6
	INL (R)	140	0.16	9.4×10^{-5}	0.20	1.2×10^{-4}	2.2×10^{-10}	2.2×10^{-2}	1.4
	Hanford (T)	200	0.12	6.9×10^{-5}	0.01	6.7×10^{-6}	7.1×10^{-14}	1.3×10^{-4}	N/A
Disposition of RH-SCs	INL (T)[a]	9	0.84	5.0×10^{-4}	0.33	2.0×10^{-4}	5.3×10^{-10}	3.1×10^{-4}	0.10
	INL (R)[a]	5	0.17	1.0×10^{-4}	0.08	4.8×10^{-5}	5.3×10^{-10}	3.6×10^{-4}	0.06
	Hanford (T)[a]	5	0.03	1.9×10^{-5}	0.005	2.9×10^{-6}	6.8×10^{-13}	4.5×10^{-6}	N/A
Facility disposition	Hanford (T) (Alt. 2)	6,300	(b)	(b)	(b)	(b)	(b)	4.2×10^{-3}	N/A
	Hanford (T) (Alt. 3)	6,300	0.03	2.0×10^{-5}	0.003	1.5×10^{-6}	4.0×10^{-13}	4.2×10^{-3}	N/A

[a] This transport includes one shipment of caustics generated from treatment of sodium metal within the remote-handled special components.
[b] Not analyzed because all waste is sanitary or hazardous (not radioactive).
Note: Dose and risk results are rounded to two significant figures. To convert kilometers to miles, multiply by 0.6214.
Key: Alt.=Alternative; Hanford=Hanford Site; INL=Idaho National Laboratory; km=kilometers; LCF=latent cancer fatality; N/A=not applicable; Nonrad.=nonradiological; R=rail; Rad.=radiological; RH-SC=remote-handled special component; T=truck.

The risks to various MEIs under incident-free transportation conditions were estimated for the hypothetical exposure scenarios identified in Section H.5.3. The estimated doses to workers, escorts, and the public are presented in Table H–13. Doses are presented on a per-event basis (person-rem per event), as it is unlikely that the same person would be exposed to multiple events; for those that could have multiple exposures, the cumulative dose could be calculated. The maximum dose to a crewmember was based on the same individual driving every shipment for the duration of the campaign. Note that the potential exists for larger individual exposures if multiple exposure events occur. For example, the dose to a person stuck in traffic next to a shipment of RH-SCs for 30 minutes was calculated to be 19 millirem. This scenario was considered a one-time event for that individual. The dose to an escort was estimated per trip (either to NNSS or INL). Note 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). The exposure to each individual escort (considered a trained radiation worker) would be administratively limited to 2 rem per year.

Table H–13. FFTF Decommissioning Alternatives – Estimated Dose to Maximally Exposed Individuals During Incident-Free Transportation Conditions

Receptor	Dose to Maximally Exposed Individual
Workers	
Crewmember (truck/rail driver)	2 rem per year[a]
Inspector	4.6×10^{-2} rem per event per hour of inspection
Rail yard worker	7×10^{-4} rem per event
Escort (rail transport)	1.7×10^{-2} rem per trip (Nevada National Security Site[b])
Escort (truck transport)	2.0×10^{-3} rem per trip (Nevada National Security Site[b])
First responder (accidents with no release)[c]	2.6×10^{-3} rem per event per one -half hour
Public	
Resident (along the rail route)	1.2×10^{-6} rem per event
Resident (along the truck route)	5.8×10^{-7} rem per event
Person in traffic congestion	1.9×10^{-2} rem per event per one-half hour stop
Resident near the rail yard during classification	6.4×10^{-6} rem per event
Person at a rest stop/gas station	5.3×10^{-3} rem per event per hour of stop
Gas station attendee	4.9×10^{-4} rem per event

[a] Maximum administrative dose limit per year for a trained radiation worker (truck/rail crewmember).
[b] Formerly the Nevada Test Site.
[c] This dose would result from use of Type B casks for remote-handled special component transport. The external dose was assumed to be similar to that for the immobilized high-level radioactive waste rail cask.
Key: FFTF=Fast Flux Test Facility.

A member of the public residing along the route would likely receive multiple exposures from passing shipments. The cumulative dose to this resident can be calculated, assuming all shipments passed his or her home and the resident would be present for every shipment and would be unshielded at a distance of 30 meters (98 feet) from the route. Therefore, the cumulative dose would depend on the number of truck or rail shipments passing a particular point and would be independent of the actual route being considered. The maximum dose to this resident, if all the materials are shipped via this route, would be less than 0.2 millirem. This dose corresponds to that for the rail shipments under both alternatives if the Idaho options of treating sodium and RH-SCs at INL are selected, which would require an estimated number of about 140 rail shipments over 2 years.

The accident risk assessment and the impacts shown in Table H–12 account for the entire spectrum of potential accidents, from "fender benders" to extremely severe collisions, regardless of their likelihood. To provide additional insight into the severity of accidents in terms of the potential dose to an MEI and the public, an accident consequence assessment was performed for a maximum reasonably foreseeable hypothetical transportation accident with a likelihood of occurrence of greater than 1 in 10 million per year.

The maximum reasonably foreseeable offsite transportation accident with the highest consequences is an accident involving a truck shipment of sodium metal, which would be a severe-impact, high-temperature fire accident. This accident has a likelihood of occurrence of 1.3×10^{-6} per shipment in the rural area. The per-shipment likelihood of such an accident in suburban and urban areas is 2.5×10^{-7} and 2.8×10^{-8}, respectively. The consequences of such an accident in terms of dose and risk of LCFs to an MEI, an individual standing 100 meters (330 feet) downwind from the accident, and the population residing within 80 kilometers (50 miles) of the accident in rural, suburban, and urban zones are provided in Table H–14.

Table H–14. FFTF Decommissioning Alternatives – Estimated Dose to the Population and to Maximally Exposed Individuals During the Most Severe Potential Accident

Material and Accident Location		Population[a]		Maximally Exposed Individual[b]	
		Dose (person-rem)	Risk (LCFs)	Dose (rem)	Risk (LCFs)
Sodium metal	Rural	0.22	1.3×10^{-4}	0.002	9.0×10^{-7}
	Suburban	1.2	7.2×10^{-4}	0.002	9.0×10^{-7}
	Urban	5.6	3.4×10^{-3}	0.002	9.0×10^{-7}

[a] Population extends at a uniform density to a radius of 80 kilometers (50 miles). The weather condition was assumed to be Pasquill Stability Class D, with a windspeed of 4 meters per second (9 miles per hour).

[b] The individual is assumed to be 100 meters (330 feet) downwind from the accident and exposed to the entire plume of the radionuclide release from a 2-hour, high-temperature fire. The weather condition was assumed to be Pasquill Stability Class F, with a windspeed of 1 meter per second (2.2 miles per hour).

Key: FFTF=Fast Flux Test Facility; LCF=latent cancer fatality.

H.7.3 Waste Management Alternatives

Table H–15 provides the estimated number of shipments for various wastes under all Waste Management alternatives. The shipment numbers were calculated using the estimated waste volumes for each waste type given in Appendix D, Section D.3, and the waste container and shipment characteristics provided in Table H–2. The values presented for the offsite waste shipments in Table H–15 were estimated for truck transports. Rail transports were assumed to be one-half of the values given.

Table H–15. Waste Management Alternatives – Estimates of Number of Radioactive Waste Shipments

Alternative	Number of Shipments			
	Offsite Shipments[a]		Onsite Shipments	
	LLW[b]	MLLW[b]	LLW[b]	MLLW[b]
1	0	0	810	200
2	12,800	1,300	810	200
3	12,800	1,300	810	200

[a] These are estimates for truck transports. Rail transports would be one-half of the values given.

[b] These include both contact- and remote-handled wastes.

Note: The number of shipments is rounded to the nearest ten between 10 and 1,000 shipments and nearest hundred between 1,000 and 100,000 shipments.

Key: LLW=low-level radioactive waste; MLLW=mixed low-level radioactive waste.

Source: SAIC 2010c.

Table H–16 shows the risks of transportation under each of the Waste Management alternatives. The risks were calculated by multiplying the previously given per-shipment factors by the number of shipments over the duration of the program and, for radiation doses, by the health risk conversion factors. The values presented in Table H–16 show that the total radiological accident risks (the product of the frequency and consequences) are very small under all alternatives. In contrast, the nonradiological accidents (the potential for fatalities as a direct result of traffic accidents) present the greatest risks.

Table H–16. Waste Management Alternatives – Risks of Transporting Radioactive Waste

Alt.	Transport (Mode)	Number of Shipments	Incident-Free				Accident		One-Way Offsite Travel (10^6 km)
			Crew		Population				
			Dose (person-rem)	Risk (LCFs)	Dose (person-rem)	Risk (LCFs)	Rad. Risk (LCFs)	Nonrad. Risk (traffic fatalities)	
1	Off site	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	On site (T)	1,000	2.6	0.002	0.08	0.00005	7.6×10^{-11}	0.0004	N/A
2	Off site (T)	14,200	2,500	1.5	350	0.21	1.2×10^{-5}	1.7	51.3
	Off site (R)	7,100	49	0.03	140	0.08	1.8×10^{-6}	4.1	26.1
	On site (T)	1,000	4.3	0.003	0.14	0.00008	1.6×10^{-10}	0.0006	N/A
3	Off site (T)	14,200	2,500	1.5	350	0.21	1.2×10^{-5}	1.7	51.3
	Off site (R)	7,100	49	0.03	140	0.08	1.8×10^{-6}	4.1	26.1
	On site (T)	1,000	2.6	0.002	0.08	0.00005	7.6×10^{-11}	0.0004	N/A

Note: To convert kilometers to miles, multiply by 0.6214.

Key: Alt.=Alternative; km=kilometers; LCF=latent cancer fatality; N/A=not applicable (no offsite waste would be accepted at the Hanford Site); Nonrad.=nonradiological; R=rail; Rad.=radiological; T=truck.

The risks to various MEIs under incident-free transportation conditions were estimated for the hypothetical exposure scenarios identified in Section H.5.3. The estimated doses to workers and the public are presented in Table H–17 on a per-event basis (person-rem per event), as it is unlikely that the same person would be exposed to multiple events; for those that could have multiple exposures, the cumulative dose could be calculated. The maximum dose to a crewmember is based on the same individual driving every shipment for the duration of the campaign. Note that the potential exists for larger individual exposures if multiple exposure events occur. For example, the dose to a person stuck in traffic next to a shipment of RH-waste in a Type B cask for 30 minutes was calculated to be 10 millirem. Note 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).

Table H–17. Waste Management Alternatives – Estimated Dose to Maximally Exposed Individuals During Incident-Free Transportation Conditions

Receptor	Dose to Maximally Exposed Individual
Workers	
Crewmember (truck/rail driver)	2 rem per year[a]
Inspector	2.3×10^{-2} rem per event per hour of inspection
Rail yard worker	8×10^{-3} rem per event
First responder (accidents with no release)[b]	1.2×10^{-3} rem per event per one-half hour
Public	
Resident (along the rail route)	6.3×10^{-7} rem per event
Resident (along the truck route)	3.0×10^{-7} rem per event
Person in traffic congestion	9.6×10^{-3} rem per event per one-half hour stop
Resident near the rail yard during classification	8.3×10^{-5} rem per event
Person at a rest stop/gas station	9.7×10^{-5} rem per event per hour of stop
Gas station attendee	7.9×10^{-4} rem per event

[a] Maximum administrative dose limit per year for a trained radiation worker (truck/rail crewmember).

[b] This dose results from using a Type B cask for remote-handled waste.

A member of the public residing along the route would likely receive multiple exposures from passing shipments. The cumulative dose to this resident can be calculated assuming all shipments passed his or her home and the resident would be present for every shipment and would be unshielded at a distance of 30 meters (98 feet) from the route. Therefore, the cumulative dose would depend on the number of truck or rail shipments passing a particular point and would be independent of the actual route being considered. The maximum dose to this resident, if all the materials are shipped via this route, would be less than 5 millirem. This dose corresponds to those for truck shipments under Waste Management Alternatives 2 and 3, which have an estimated number of truck shipments of about 14,200 over 20 years.

The accident risk assessment and the impacts shown in Table H–16 account for the entire spectrum of potential accidents, from "fender benders" to extremely severe collisions. To provide additional insight into the severity of accidents in terms of the potential dose to an MEI and the public, an accident consequence assessment was performed for a maximum reasonably foreseeable hypothetical transportation accident with a likelihood of occurrence of greater than 1 in 10 million per year. The results, presented in Table H–18, include all accidents, irrespective of their likelihood.

Table H–18. Waste Management Alternatives – Estimated Dose to the Population and to Maximally Exposed Individuals During the Most Severe Potential Accident

Material and Accident Location		Population[a]		Maximally Exposed Individual[b]	
		Dose (person-rem)	Risk (LCFs)	Dose (rem)	Risk (LCFs)
Idaho National Laboratory RH-LLW	Rural	1.6	9.7×10^{-4}	0.00031	1.9×10^{-7}
	Suburban	25	1.5×10^{-2}	0.00031	1.9×10^{-7}
	Urban	120	7.3×10^{-2}	0.00031	1.9×10^{-7}

[a] Population extends at a uniform density to a radius of 80 kilometers (50 miles). The weather condition was assumed to be Pasquill Stability Class D, with a windspeed of 4 meters per second (9 miles per hour).

[b] The individual is assumed to be 100 meters (330 feet) downwind from the accident and exposed to the entire plume of the radionuclide release from a 2-hour, high-temperature fire. The weather condition was assumed to be Pasquill Stability Class F, with a windspeed of 1 meter per second (2.2 miles per hour).

Key: LCF=latent cancer fatality; RH-LLW=remote-handled low-level radioactive waste.

The maximum reasonably foreseeable offsite transportation accident with the highest consequences is an accident involving a rail shipment of RH-LLW, which would be a severe-impact, high-temperature fire accident with a likelihood of occurrence of 2.5×10^{-7} per shipment in the rural area. The per-shipment likelihood of such an accident in suburban and urban areas is 2.8×10^{-8} and 5.3×10^{-9}, respectively. The consequences of such an accident in terms of dose and risk of LCFs to an MEI, an individual standing 100 meters (330 feet) downwind from the accident, and the population residing within 80 kilometers (50 miles) in the rural, suburban, and urban zones are provided in Table H–18.

H.8 IMPACT OF CONSTRUCTION AND OPERATIONAL MATERIAL TRANSPORT

This section evaluates the impacts of transporting the materials required to construct new facilities, as well as those required to immobilize, vitrify, or solidify the liquid waste and transport it to storage or burial locations. The construction materials considered are concrete, cement, sand/gravel/dirt, asphalt, steel, and piping. The materials required for waste solidification and transport include glass formers, fly ash, blast furnace slag, canisters, cylinders, and boxes. The impacts were evaluated based on the number of truck shipments required for each of the materials and the distances from their points of origin to Hanford. The origins of these materials are defined as on site, local, and regional, with an average distance of 8, 72, and 256 kilometers (5, 45, and 160 miles) each way, respectively. The truck kilometers for all material shipments under each alternative were calculated by summing the distances for all activities from construction through deactivation and closure (if applicable) under each alternative. The

truck accident and fatality rates were assumed to be those provided earlier for onsite radioactive waste transport. Table H–19 summarizes the impacts in terms of the total number of kilometers, accidents, and fatalities for all alternatives. The results in Table H–19 indicate that, for the Tank Closure alternatives, the potential for traffic fatalities is the largest under Alternative 6A, Option Case, with the potential for nine traffic fatalities, followed by Alternative 3C, with approximately five traffic fatalities. Considering that the duration of Alternatives 6A and 3C would be more than 130 years, the estimated risk is very small.

Table H–19. Estimated Impacts of Construction and Operational Material Transport

Alternative	Total Distance Traveled (million kilometers)	Number of Accidents	Number of Fatalities
Tank Closure Alternatives			
1	1.0	0.21	0.01
2A	50	10	0.65
2B	64	13	0.84
3A	91	18	1.2
3B	93	19	1.2
3C	410	82	5.3
4	120	24	1.6
5	88	18	1.2
6A, Base Case	290	60	3.8
6A, Option Case	700	140	9.2
6B, Base Case	140	28	1.8
6B, Option Case	270	55	3.5
6C	71	14	0.92
FFTF Decommissioning Alternatives			
1: No Action	0.03	0.006	0.0004
2: Entombment			
Facility Disposition	1.9	0.38	0.03
Options at Hanford	0.42	0.09	0.006
Disposition of Bulk Sodium	0.04	0.008	0.0005
Disposition of RH-SCs	0.38	0.08	0.005
Options at INL	0.02	0.005	0.0003
Disposition of Bulk Sodium	0.02	0.004	0.0002
Disposition of RH-SCs	0.004	0.0008	0.00005
3: Removal			
Facility Disposition	2.1	0.42	0.03
Options at Hanford	0.35	0.07	0.005
Disposition of Bulk Sodium	0.04	0.008	0.0005
Disposition of RH-SCs	0.31	0.06	0.004
Options at INL	0.02	0.005	0.0003
Disposition of Bulk Sodium	0.02	0.004	0.0002
Disposition of RH-SCs	0.004	0.0008	0.00005

Table H–19. Estimated Impacts of Construction and Operational Material Transport *(continued)*

Alternative	Total Distance Traveled (million kilometers)	Number of Accidents	Number of Fatalities
Waste Management Alternatives			
1: No Action	0.42	0.09	0.006
2: Disposal in IDF, 200-East Area Only	4.2	0.84	0.05
Disposal Group 1	8.2	1.7	0.11
Disposal Group 2	29	5.9	0.38
Disposal Group 3	37	7.5	0.49
3: Disposal in IDF, 200-East and 200-West Areas	4.2	0.84	0.05
Disposal Group 1	7.4	1.5	0.10
Disposal Group 2	29	5.9	0.38
Disposal Group 3	37	7.6	0.49

Note: To convert kilometers to miles, multiply by 0.6214. The baseline includes activities related to facility disposition; the options include treatment of bulk sodium and RH-SCs.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; IDF=Integrated Disposal Facility; INL=Idaho National Laboratory; RH-SC=remote-handled special component.

H.9 CONCLUSIONS

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

H.9.1 Tank Closure Alternatives

Tank closure activities would generate various radioactive waste materials that would require transport for disposition to offsite locations such as New Mexico (WIPP) under Alternatives 3 through 5, as well as to onsite locations within Hanford. In addition, all alternatives would require transport of various nonradioactive materials for construction and operational support. Based on the results presented in the previous sections, the following conclusions were reached (see Tables H–7, H–8, and H–19):

- 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.

- The highest risk to the public would be under Alternative 4, in which about 3,600 truck shipments of TRU waste would be transported to WIPP and 143,000 shipments of various radioactive waste materials would be transported to onsite waste burial and storage locations.

- The lowest risk to the public would be under Alternative 2A, in which only 105,000 shipments of various radioactive wastes would be transported to onsite waste burial and storage locations over a period of 75 years.

- Alternatives 3 through 5 and 6 have risk estimates between those of Alternatives 2A and 4.

- The nonradiological accidents (the potential for fatalities as a direct result of traffic accidents) present the greatest risks. Considering that the transportation activities analyzed would occur over about 20 to 150 years and the average number of traffic fatalities in the United States is about 34,000 per year (DOT 2011), the traffic fatality risks under all alternatives are very small.

H.9.2 FFTF Decommissioning Alternatives

FFTF decommissioning activities would generate various radioactive materials that would require transport to both offsite 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. Based on the results presented in the previous section, the following conclusions were reached (see Tables H–11, H–12, and H–19):

- 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 risk to the public would be under the Idaho options for treatment of bulk sodium and RH-SCs at INL. Alternative 3 adds additional risks for transport of radioactive materials for disposal at an Integrated Disposal Facility and transport of nonradioactive materials for disposal at a sanitary and hazardous landfill.

- The lowest risk to the public would be under the Hanford options for treatment of bulk sodium and RH-SCs at Hanford. Alternative 2 adds some risks for the transport of the nonradioactive materials for disposal at a sanitary and hazardous landfill.

H.9.3 Waste Management Alternatives

The various wastes generated at Hanford from tank closure and FFTF decommissioning activities, along with the waste transported from offsite DOE sources, would be managed and disposed of at an Integrated Disposal Facility. Offsite waste would be accepted at Hanford only under 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. Based on the results presented earlier, the following conclusions were reached (see Tables H–15, H–16, and H–19):

- 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. Note 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 0.0012. Assuming that an individual is exposed to the same annual exposure for 20 years, the cumulative LCF risk would be 0.024.

- The highest risk to the public would occur under Alternative 2 or 3, in which about 14,200 shipments of waste would be transported to Hanford from various DOE facilities.

- The lowest risk to the public would occur under Alternative 1, in which no shipments of waste would be transported to Hanford from various DOE facilities.

H.10 LONG-TERM IMPACTS OF TRANSPORTATION

The cumulative impacts of the transportation of radioactive material, consisting of the impacts of historic shipments of radioactive waste and SNF, reasonably foreseeable actions that include transportation of radioactive material, and general radioactive material transportation that is unrelated to a particular action, are detailed in Appendix T. The collective dose to the general population and workers was the measure used to quantify the cumulative transportation impacts. This measure of impact was chosen because it may be directly related to the LCFs using a cancer risk coefficient. Table H–20 summarizes the total worker and general population collective doses from various transportation activities. The table shows that the impacts of this program are quite small compared with the overall transportation impacts. The total collective worker dose from all types of shipments (historical or related to the alternatives, reasonably foreseeable actions, and general transportation) was estimated to range from 404,000 to 408,000 person-rem (about 240 LCFs) for the period from 1943 through 2073 (131 years). The total general population collective dose was estimated to range from 375,000 to 376,000 person-rem (about 225 LCFs). The majority of the collective doses to workers and the general population would be due to the general transportation of radioactive material and shipments of various SNF and reactor fuel materials under the activities related to the Global Nuclear Energy Partnership (see Appendix T, Table T–4). Examples of general transportation activities include shipments of radiopharmaceuticals to nuclear medicine laboratories and shipments of commercial LLW to commercial disposal facilities. The total number of LCFs estimated to result from radioactive material transportation over the period from 1943 through 2073 is about 470. Over this same period (131 years), approximately 72.4 million people would die from cancer, based on 554,000 cancer fatalities per year (CDC 2007). The transportation-related LCFs would be about 0.0007 percent of the annual number of cancer deaths; therefore, any increase would be indistinguishable from the natural fluctuation in the total annual death rate from cancer.

Table H–20. Cumulative Transportation-Related Collective Radiation Doses and Latent Cancer Fatalities

Category	Worker Dose (person-rem)	General Population Dose (person-rem)
Tank Closure alternatives	260–1,220[a]	60–350[b]
FFTF Decommissioning alternatives	0.18–4.37[a]	0.018–1.30[b]
Waste Management alternatives	52–2,500[a]	140–350[b]
Transportation impacts in this *TC & WM EIS*	312–3,720[a]	200–701[b]
Other Nuclear Material Shipments (Appendix T)		
Historical	292	317
Reasonably foreseeable	29,800	36,900
General transportation (1943–2073)	374,000	338,000
Total—other nuclear materials (up to 2073)[c]	404,000	375,000
Total Collective Dose (up to 2073)[c]	**404,000–408,000**	**375,000–376,000**
Total Latent Cancer Fatalities	**~240**	**~225**

[a] Range of values among the alternatives for the worker dose.
[b] Range of values among the alternatives for the population dose.
[c] The sum values were rounded to three significant figures.
Key: FFTF=Fast Flux Test Facility; *TC & WM EIS=Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*.
Source: Appendix T of this *TC & WM EIS*.

H.11 UNCERTAINTY AND CONSERVATISM IN ESTIMATED IMPACTS

The sequence of analyses performed to generate the estimates of radiological risk for transportation includes (1) determination of the inventory and characteristics, (2) estimation of shipment requirements, (3) determination of route characteristics, (4) calculation of radiation doses to exposed individuals (including estimation of environmental transport and uptake of radionuclides), and (5) estimation of health effects. Uncertainties are associated with each of these steps. Uncertainties exist in the way that the physical systems being analyzed are represented by the computational models; in the data required to exercise the models (due to measurement errors, sampling errors, natural variability, or unknowns caused simply by the future nature of the actions being analyzed); and in the calculations themselves (e.g., approximate algorithms used by the computers).

In principle, one can estimate the uncertainty associated with each input or computational source and predict the resultant uncertainty in each set of calculations. Thus, one can propagate the uncertainties from one set of calculations to the next and estimate the uncertainty in the final, or absolute, result; however, conducting such a full-scale quantitative uncertainty analysis is often impractical and sometimes impossible, especially for actions to be initiated at an unspecified time in the future. Instead, risk analysis is designed to ensure, through uniform and judicious selection of scenarios, models, and input parameters, that relative comparisons of risk between the various alternatives are meaningful. In the transportation risk assessment, this design was accomplished by uniformly applying common input parameters and assumptions to each alternative. Therefore, although considerable uncertainty is inherent in the absolute magnitude of the transportation risk for each alternative, much less uncertainty is associated with the relative differences among the alternatives in a given measure of risk.

In the following sections, areas of uncertainty are discussed for the assessment steps enumerated above. Special emphasis is placed on identifying whether the uncertainties affect relative or absolute measures of risk. The reality and conservatism of the assumptions also are addressed. Where practical, the parameters that most significantly affect the risk assessment results are identified.

H.11.1 Uncertainties in Material Inventory and Characterization

Waste inventories and their physical and radiological characteristics are important input parameters to the transportation risk assessment. The potential number of shipments for all alternatives was based primarily on the projected dimensions of package contents, the strength of the radiation field, and assumptions concerning shipment capacities. The physical and radiological characteristics are important in determining the material released during accidents and the subsequent doses to exposed individuals through multiple environmental exposure pathways.

Uncertainties in the inventory and characterization are reflected in the transportation risk results. If the inventory is overestimated or underestimated, the resulting transportation risk estimates would also be overestimated or underestimated by roughly the same factor. However, the same inventory estimates were used to analyze the transportation impacts of each of the *TC & WM EIS* alternatives. Therefore, for comparison purposes, the observed differences in transportation risks among the alternatives, as given in Tables H–8, H–12, and H–16, represent unbiased, reasonably accurate estimates based on current information in terms of relative risk comparisons.

H.11.2 Uncertainties in Containers, Shipment Capacities, and Number of Shipments

Transportation activities required under each alternative were estimated based in part on assumptions concerning the packaging characteristics and shipment capacities for commercial trucks. Waste shipments would be made in federally and state-certified packages. If a waste type would require a special packaging for offsite transport, the analysis assumed that a specially designed package would be

built and certified before the transportation could occur. Shipment capacities have been defined for assessment purposes based on probable future shipment capacities. In reality, the actual shipment capacities may differ from the predicted capacities such that the projected number of shipments and, consequently, the total transportation risk, would change. However, although the predicted transportation risks would increase or decrease accordingly, the relative differences in risks among the alternatives would remain about the same.

H.11.3 Uncertainties in Route Determination

Routes were determined between all origin and destination sites considered in this *TC & WM EIS*. These routes are consistent with current guidelines, regulations, and practices, but may not be the actual routes that would be used in the future. In reality, the actual routes could differ from the analyzed ones in regard to distances and total populations along the routes. Moreover, because materials could be transported over an extended period starting at some time in the future, the highway infrastructures and demographics along the routes could change. These effects were not accounted for in the transportation assessment; however, potential changes are not expected to significantly affect the relative comparisons of risk between the alternatives considered in this *TC & WM EIS*.

H.11.4 Uncertainties in the Calculation of Radiation Doses

The models used to calculate radiation doses from transportation activities introduce further uncertainty into the risk assessment process. Estimating the accuracy or absolute uncertainty of the risk assessment results is generally difficult. The accuracy of the calculated results is closely related to the limitations of the computational models and the uncertainties in each of the input parameters that the model requires. The single greatest limitation facing users of RADTRAN, or any computer code of this type, is the scarcity of data for certain input parameters. Populations (off-link and on-link) along the routes, shipment surface dose rates, and individuals residing near the roads are the most uncertain data in dose calculations. In preparing these data, one makes assumptions that the off-link population is uniformly distributed; the on-link population is proportional to the traffic density, with an assumed occupancy of two persons per car; the shipment surface dose rate is the maximum allowed dose rate; and the potential exists for an individual to be residing at the edge of the road. It is clear that not all of these assumptions are accurate. For example, the off-link population is mostly heterogeneous, and the on-link traffic density varies widely from road to road within a geographic zone (i.e., urban, suburban, or rural). Finally, added to this complexity are assumptions regarding the expected distances between the public and a shipment at a traffic stop, rest stop, or traffic jam and the afforded shielding.

The uncertainties associated with the computational models were reduced by using state-of-the-art computer codes that have undergone extensive review. Because many uncertainties are recognized but difficult to quantify, assumptions were made at each step of the risk assessment process that were intended to produce conservative results (i.e., to overestimate the calculated dose and radiological risk). Because the parameters and assumptions were applied consistently to all of the alternatives, this model bias is not expected to affect the meaningfulness of the relative comparisons of risk; however, the results may not represent the risks in an absolute sense.

H.12 REFERENCES

Blower, D., and A. Matteson, 2003, *Evaluation of the Motor Carrier Management Information System Crash File, Phase One*, UMTRI-2003-06, University of Michigan Transportation Research Institute, Center for National Truck Statistics, Ann Arbor, Michigan, March.

CDC (Centers for Disease Control and Prevention), 2007, *Total Number of Deaths for 113 Selected Causes, 1999–2004*, National Center for Health Statistics, Hyattsville, Maryland, March 30.

Census (U.S. Census Bureau), 2010, *Resident Population Data, Population Density*, accessed through http://2010.census.gov/2010census/data/apportionment-dens-text.php on December 21.

Dennis, M.L., D.M. Osborn, R.F. Weiner, and T.J. Heames, 2008, *Verification and Validation of RADTRAN 6.0*, SAND2008-4556, Sandia National Laboratories, Albuquerque, New Mexico, May.

DOE (U.S. Department of Energy), 1996, *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel*, DOE/EIS-0218F, Office of Spent Nuclear Fuel Management, Washington, D.C., February.

DOE (U.S. Department of Energy), 1997, *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), 2002a, *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250, Office of Civilian Radioactive Waste Management, Yucca Mountain Site Characterization Office, North Las Vegas, Nevada, February.

DOE (U.S. Department of Energy), 2002b, *Safety Evaluation Report, Hanford Transportation Safety Document*, DOE/RL-2001-0036, Rev. 0, Richland Operations Office, Richland, Washington, February.

DOE (U.S. Department of Energy), 2002c, *A Resource Handbook on DOE Transportation Risk Assessment*, DOE/EM/NTP/HB-01, Office of Environmental Management, National Transportation Program, Albuquerque, New Mexico, July.

DOE (U.S. Department of Energy), 2003, "Recommended Radiation Risk Factors Updated," *National Environmental Policy Act Lessons Learned*, Issue No. 34, First Quarter FY 2003, Office of NEPA Policy and Compliance, Washington, D.C., March 3.

DOE (U.S. Department of Energy), 2008, *Final Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250F-S1, Office of Civilian Radioactive Waste Management, Las Vegas, Nevada, June.

DOT (U.S. Department of Transportation), 2000, *Comprehensive Truck Size and Weight Study – Volume I, Summary Report*, FHWA-PL-00-029, August.

DOT (U.S. Department of Transportation), 2002, *Traffic Safety Facts 2001: A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System*, DOT HS 809 484, National Highway Traffic Safety Administration, National Center for Statistics and Analysis, Washington, D.C., December.

DOT (U.S. Department of Transportation), 2004, *Traffic Safety Facts 2002: A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System*, DOT HS 809 620, National Highway Traffic Safety Administration, National Center for Statistics and Analysis, Washington, D.C., January.

DOT (U.S. Department of Transportation), 2005, *Traffic Safety Facts 2003: A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System*, DOT HS 809 775, National Highway Traffic Safety Administration, National Center for Statistics and Analysis, Washington, D.C., January.

DOT (U.S. Department of Transportation), 2006, *Traffic Safety Facts 2004: A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System*, DOT HS 809 919, National Highway Traffic Safety Administration, National Center for Statistics and Analysis, Washington, D.C., January.

DOT (U.S. Department of Transportation), 2008, *Radioactive Material Regulations Review*, Pipeline and Hazardous Materials Safety Administration, December.

DOT (U.S. Department of Transportation), 2011, *Welcome to the FHWA Safety Program: Reducing Highway Fatalities*, Federal Highway Administration, accessed through http://safety.fhwa.dot.gov/ on July 13.

FEMA (Federal Emergency Management Agency), 2008a, *National Response Framework*, U.S. Department of Homeland Security, accessed through http://www.fema.gov/pdf/emergency/nrf/nrf-core.pdf, January.

FEMA (Federal Emergency Management Agency), 2008b, *Nuclear/Radiological Incident Annex*, U.S. Department of Homeland Security, accessed through http://www.fema.gov/pdf/emergency/nrf/nrf_nuclearradiologicalincidentannex.pdf, June.

Fischer, L.E., C.K. Chou, M.A. Gerhard, C.Y. Kimura, R.W. Martin, R.W. Mensing, M.E. Mount, and M.C. Witte, 1987, *Shipping Container Response to Severe Highway and Railway Accident Conditions*, NUREG/CR-4829, U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, Division of Reactor System Safety, Washington, D.C., February.

Johnson, P.E., and R.D. Michelhaugh, 2003, *Transportation Routing Analysis Geographic Information System (TRAGIS) User's Manual*, ORNL/NTRC-006, Rev. 0, Oak Ridge National Laboratory, Oak Ridge, Tennessee, June.

Neuhauser, K.S., and F.L. Kanipe, 2003, *RADTRAN 5 User Guide*, SAND2003-2354, Sandia National Laboratories, Albuquerque, New Mexico, July.

Neuhauser, K.S., F.L. Kanipe, and R.F. Weiner, 2000, *RADTRAN 5 Technical Manual*, SAND2000-1256, Sandia National Laboratories, Albuquerque, New Mexico, May.

NRC (U.S. Nuclear Regulatory Commission), 1977, *Final Environmental Impact Statement on the Transportation of Radioactive Material by Air and Other Modes*, NUREG-0170, Office of Standards Development, Washington, D.C., December.

Rao, R.K., E.L. Wilmot, and R.E. Luna, 1982, *Non-radiological Impacts of Transporting Radioactive Material*, SAND81-1703, Sandia National Laboratories, Albuquerque, New Mexico, February.

SAIC (Science Applications International Corporation), 2010a, *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.

SAIC (Science Applications International Corporation), 2010b, *Fast Flux Test Facility Alternatives, Scaled Data Sets to Support the "Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington,"* Germantown, Maryland, November 8.

SAIC (Science Applications International Corporation), 2010c, *Waste Management 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.

Saricks, C.L., and M.M. Tompkins, 1999, *State-Level Accident Rates of Surface Freight Transportation: A Reexamination*, ANL/ESD/TM-150, Argonne National Laboratory, Center for Transportation Research, Argonne, Illinois, April.

Sprung, J.L., D.J. Ammerman, N.L. Breivik, R.J. Dukart, F.L. Kanipe, J.A. Koski, G.S. Mills et al., 2000, *Reexamination of Spent Fuel Shipment Risk Estimates*, NUREG/CR-6672, U.S. Nuclear Regulatory Commission, Office of Nuclear Safety and Safeguards, Spent Fuel Project Office, Washington, D.C., March.

Weiner, R.F., M.L. Dennis, D. Hinojosa, T.J. Heames, J.J. Penisten, M.K. Marincel, and D.M. Osborn, 2009, *RadCat 3.0 User Guide*, SAND2009-5129, Sandia National Laboratories, Albuquerque, New Mexico and Livermore, California, May.

WNA (World Nuclear Association), 2010, *Transport of Radioactive Materials*, accessed through http://www.world-nuclear.org/info/inf20.html, November.

Yuan, Y.C., S.Y. Chen, B.M. Biwer, and D.J. LePoire, 1995, *RISKIND – A Computer Program for Calculating Radiological Consequences and Health Risks from Transportation of Spent Nuclear Fuel*, ANL/EAD-1, Argonne National Laboratory, Argonne, Illinois, November.

Code of Federal Regulations

10 CFR 20, U.S. Nuclear Regulatory Commission, "Standards for Protection Against Radiation."

10 CFR 61, U.S. Nuclear Regulatory Commission, "Licensing Requirements for Land Disposal of Radioactive Waste."

10 CFR 71, U.S. Nuclear Regulatory Commission, "Packaging and Transportation of Radioactive Material."

10 CFR 71.4, U.S. Nuclear Regulatory Commission, "Packaging and Transportation of Radioactive Material: Definitions."

10 CFR 71.47, U.S. Nuclear Regulatory Commission, "Packaging and Transportation of Radioactive Material: External Radiation Standards for All Packages."

39 CFR 121, U.S. Postal Service, "Service Standards for Market-Dominant Mail Products."

49 CFR 106, U.S. Department of Transportation, "Rulemaking Procedures."

49 CFR 107, U.S. Department of Transportation, "Hazardous Materials Program Procedures."

49 CFR 171, U.S. Department of Transportation, "General Information, Regulations, and Definitions."

49 CFR 172, U.S. Department of Transportation, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements."

49 CFR 173, U.S. Department of Transportation, "Shippers – General Requirements for Shipments and Packagings."

49 CFR 173.403, U.S. Department of Transportation, "Shippers – General Requirements for Shipments and Packagings: Definitions."

49 CFR 173.427, U.S. Department of Transportation, "Shippers – General Requirements for Shipments and Packagings: Transport Requirements for Low Specific Activity (LSA) Class 7 (Radioactive) Materials and Surface Contaminated Objects (SCO)."

49 CFR 173.435, U.S. Department of Transportation, "Shippers – General Requirements for Shipments and Packagings: Table of A1 and A2 Values for Radionuclides."

49 CFR 173.441, U.S. Department of Transportation, "Shippers – General Requirements for Shipments and Packagings: Radiation Level Limitations and Exclusive Use Provisions."

49 CFR 173.7(d), U.S. Department of Transportation, "Shippers – General Requirements for Shipments and Packagings: Government Operations and Materials."

49 CFR 174, U.S. Department of Transportation, "Carriage by Rail."

49 CFR 175, U.S. Department of Transportation, "Carriage by Aircraft."

49 CFR 176, U.S. Department of Transportation, "Carriage by Vessel."

49 CFR 177, U.S. Department of Transportation, "Carriage by Public Highway."

49 CFR 397, U.S. Department of Transportation, "Transportation of Hazardous Materials; Driving and Parking Rules."

Federal Register

63 FR 3624, U.S. Department of Energy, 1998, "Record of Decision for the Department of Energy's *Waste Isolation Pilot Plant Disposal Phase*; Notice," January 23.

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.

Washington Administrative Code

WAC 173-303, Washington State Department of Ecology, "Dangerous Waste Regulations," Olympia, Washington.

WAC 246-231, Washington State Department of Health, "Packaging and Transportation of Radioactive Material," Olympia, Washington.

WAC 446-50, Washington State Patrol, "Transportation of Hazardous Materials," Olympia, Washington.

U.S. Department of Energy Handbooks and Standards

DOE Standard 1098-2008, *Radiological Control*, Change Notice 1, May 2009.

DOE Handbook 3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Vol. 1, *Analysis of Experimental Data*, Change Notice 1, March 2000.

APPENDIX I
WORKFORCE ESTIMATES

This appendix presents the estimated number of workers required to perform construction, operations, deactivation, closure, and decommissioning tasks under each of the alternatives presented in this *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*.

I.1 INTRODUCTION

Full-time-equivalent (FTE) estimates were based on information provided in data reports prepared to support this environmental impact statement (SAIC 2010a, 2010b, 2010c). The total number of FTEs for each activity was calculated based on the estimated labor hours for onsite radiological, onsite nonradiological, and offsite nonradiological worker categories. For some activities, nonradiological worker FTEs are further subdivided into construction, exempt, and design categories. Construction refers to the labor force used to perform construction activities, including manual and nonmanual personnel. Exempt refers to salaried (exempt from overtime) construction labor force and support personnel. Design refers to architect-engineer workforce personnel. The total number of hours was divided by the number of years for each activity. The hours per year were then divided by an assumed 2,080 hours worked per year (40 hours per week multiplied by 52 weeks) to get the number of FTEs per year. The estimated numbers of FTEs per year for each activity were then combined to get the total for each alternative. The total FTEs by alternative are presented in Table I–1. Because the duration of each activity varies, the sum of the FTEs per year for each activity under an alternative does not necessarily represent the actual number of FTEs required to accomplish the work for that alternative in any given year. That information is provided in Chapter 4, Sections 4.1.9, 4.2.9, 4.3.9, and 4.4.8. However, the numbers of FTEs per year presented in this appendix are useful for comparing the magnitude and complexity of workforce commitments between the alternatives. (Note that the total displayed in many of the tables may not equal the sum of the contributions due to rounding. Values are displayed in three-significant-digit format.)

Table I–1. Total Full-Time Equivalents by Alternative

Alternative	Total Hours	Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents	Offsite Full-Time Equivalents
Tank Closure 1	16,300,000	4,470,000	2,150	1,740	415
Tank Closure 2A	708,000,000	31,000,000	15,000	13,300	1,710
Tank Closure 2B	388,000,000	30,200,000	14,600	12,900	1,670
Tank Closure 3A	349,000,000	31,200,000	15,100	13,400	1,680
Tank Closure 3B	344,000,000	30,700,000	14,800	13,200	1,640
Tank Closure 3C	357,000,000	32,700,000	15,700	14,000	1,810
Tank Closure 4	450,000,000	36,800,000	17,800	15,400	2,350
Tank Closure 5	325,000,000	36,100,000	17,400	15,300	2,090
Tank Closure 6A, Base Case	2,060,000,000	42,900,000	20,700	17,900	2,810
Tank Closure 6A, Option Case	2,130,000,000	49,800,000	24,000	20,400	3,610
Tank Closure 6B, Base Case	515,000,000	39,200,000	19,000	16,500	2,460
Tank Closure 6B, Option Case	572,000,000	46,100,000	22,300	19,000	3,280
Tank Closure 6C	389,000,000	30,200,000	14,600	12,900	1,660
FFTF Decommissioning 1	41,600	416	1	1	0

Table I–1. Total Full-Time Equivalents by Alternative *(continued)*

Alternative	Total Hours	Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents	Offsite Full-Time Equivalents
FFTF Decommissioning 2, Facility Disposition	810,000	235,000	122	112	10
FFTF Decommissioning 2, Disposition of Bulk Sodium					
Hanford Reuse Option	579,000	320,000	158	127	31
Idaho Reuse Option	266,000	163,000	83	76	7
FFTF Decommissioning 2, Disposition of RH-SCs					
Hanford Option	468,000	297,000	144	113	31
Idaho Option	125,000	125,000	61	60	1
FFTF Decommissioning 3, Facility Disposition	951,000	273,000	139	132	7
FFTF Decommissioning 3, Disposition of Bulk Sodium					
Hanford Reuse Option	579,000	320,000	158	127	31
Idaho Reuse Option	266,000	163,000	83	76	7
FFTF Decommissioning 3, Disposition of RH-SCs					
Hanford Option	468,000	297,000	144	113	31
Idaho Option	125,000	125,000	61	60	1
Waste Management 1	1,010,000	262,000	129	110	19
Waste Management 2	37,900,000	2,490,000	1,210	1,100	107
Disposal Group 1	19,900,000	3,710,000	1,790	1,600	184
Disposal Group 2	128,000,000	14,600,000	7,020	6,330	690
Disposal Group 3	204,000,000	14,600,000	7,030	6,340	690
Waste Management 3	37,900,000	2,490,000	1,210	1,100	107
Disposal Group 1	21,400,000	4,240,000	2,050	1,870	185
Disposal Group 2	129,000,000	15,100,000	7,300	6,600	691
Disposal Group 3	205,000,000	15,100,000	7,300	6,610	691

Note: Total may not equal the sum of the contributions due to rounding.
Key: FFTF=Fast Flux Test Facility; RH-SCs=remote-handled special components.

The following sections present the detailed FTE estimates for each of the activities that would be conducted under each alternative.

I.2 ALTERNATIVES

Construction, operations, deactivation, closure, and decommissioning (where appropriate) workforce estimate tables are presented for each of the alternatives in the following sections. In addition, all radiological workers were assumed to work on site.

I.2.1 Tank Closure Alternative 1: No Action

Table I–2. Tank Closure Alternative 1 Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Canister Storage Building (CON_CSB)							
Radiological workers	31,500	2006	2008	3	10,500	6	12
Nonradiological workers							
On site	37,100	2006	2008	3	12,400	6	
Off site	13,700	2006	2008	3	4,570	3	
Other Infrastructure Upgrades (CON_OIU)							
Radiological workers	80,900	2006	2008	3	27,000	13	45
Nonradiological workers							
On site	198,000	2006	2008	3	66,000	32	
Off site	76,900	2006	2008	3	25,600	13	
Tank Upgrades (CON_TU)							
Radiological workers	179,000	2006	2008	3	59,700	29	104
Nonradiological workers							
On site	467,000	2006	2008	3	156,000	75	
Off site	177,000	2006	2008	3	59,000	29	
Waste Treatment Plant (CON_WTP)							
Radiological workers	N/A						904
Nonradiological workers							
On site	5,650,000	2006	2008	3	1,880,000	904	
Off site	1,880,000	2006	2008	3	627,000	302	
Total	**8,790,000**				**2,930,000**	**1,410**	**1,070**

Notes and Assumptions:
Total number of offsite full-time equivalents = 340.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

Table I–3. Tank Closure Alternative 1 Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Routine Operations (OPS_ROUT)							
Radiological workers	780,000	2006	2008	3	260,000	125	650
Nonradiological workers							
On site	3,280,000	2006	2008	3	1,090,000	525	
Off site	465,000	2006	2008	3	155,000	75	
Total	**4,530,000**				**1,510,000**	**725**	**650**

Notes and Assumptions:
Total number of offsite full-time equivalents = 75.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Source: Compiled from SAIC 2010a.

Table I–4. Tank Closure Alternative 1 Deactivation Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Administrative Controls (DEA_ADM)							
Radiological workers	3,000,000	2008	2107	100	30,000	15	15
Nonradiological workers	N/A						
Total	**3,000,000**				**30,000**	**15**	**15**

Notes and Assumptions:
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

I.2.2 Tank Closure Alternative 2A: Existing Waste Treatment Plant Vitrification; No Closure

Table I–5. Tank Closure Alternative 2A Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Canister Storage Building (CON_CSB)							
Radiological workers	116,000	2006	2016	11	10,500	6	12
Nonradiological workers							
On site	136,000	2006	2016	11	12,400	6	
Off site	50,300	2006	2016	11	4,570	3	
Immobilized High-Level Radioactive Waste Shipping/Transfer Facility (CON_STF)							
Radiological workers	N/A						381
Nonradiological workers							
Onsite construction	748,000	2011	2013	3	249,000	120	
Onsite exempt	610,000	2011	2013	3	203,000	98	
Offsite design	1,760,000	2011	2013	3	587,000	283	
Immobilized High-Level Radioactive Waste Interim Storage Modules (CON_ISM)							
Radiological workers	N/A						223
Nonradiological workers							
Onsite construction	3,130,000	2014	2024	11	285,000	138	
Onsite exempt	1,930,000	2014	2024	11	175,000	85	
Offsite design	2,360,000	2014	2024	11	215,000	104	
Other Infrastructure Upgrades (CON_OIU)							
Radiological workers	782,000	2006	2034	29	27,000	13	45
Nonradiological workers							
On site	1,920,000	2006	2034	29	66,200	32	
Off site	743,000	2006	2034	29	25,600	13	
Tank Upgrades (CON_TU)							
Radiological workers	1,200,000	2006	2025	20	60,000	29	104
Nonradiological workers							
On site	3,110,000	2006	2025	20	156,000	75	
Off site	1,180,000	2006	2025	20	59,000	29	

Table I–5. Tank Closure Alternative 2A Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Underground Transfer Lines (CON_UTL)							
Radiological workers	N/A						61
Nonradiological workers							
On site	126,000	2009	2009	1	126,000	61	
Off site	17,400	2009	2009	1	17,400	9	
Waste Treatment Plant (CON_WTP)							
Radiological workers	N/A						904
Nonradiological workers							
On site	22,600,000	2006	2017	12	1,880,000	904	
Off site	7,540,000	2006	2017	12	628,000	302	
Cesium and Strontium Capsule Processing Facility (CON_CSC)							
Radiological workers	N/A						190
Nonradiological workers							
On site	1,580,000	2088	2091	4	395,000	190	
Off site	466,000	2088	2091	4	117,000	57	
Tank Risers (CON_RIS)							
Radiological workers	173,000	2013	2056	44	3,930	2	5
Nonradiological workers							
On site	233,000	2013	2056	44	5,300	3	
Off site	N/A						
Modified Sluicing Retrieval System (CON_MS)							
Radiological workers	4,910,000	2013	2092	80	61,400	30	77
Nonradiological workers							
On site	7,760,000	2013	2092	80	97,000	47	
Off site	2,730,000	2013	2092	80	34,100	17	
Mobile Retrieval System (CON_MRS)							
Radiological workers	8,100,000	2013	2052	40	203,000	98	206
Nonradiological workers							
On site	8,940,000	2013	2052	40	224,000	108	
Off site	4,790,000	2013	2052	40	120,000	58	
Vacuum-Based Retrieval System (CON_VBR)							
Radiological workers	9,690,000	2053	2092	40	242,000	117	242
Nonradiological workers							
On site	10,300,000	2053	2092	40	258,000	125	
Off site	5,900,000	2053	2092	40	148,000	72	
High-Level Radioactive Waste Melter Interim Storage Facilities (CON_PAD)[a]							
Radiological workers	N/A						1
Nonradiological workers							
On site	8,420	2015	2066	6	1,400	1	
Off site	N/A						

Table I–5. Tank Closure Alternative 2A Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Double-Shell Tank Replacements (CON_DST)							
Radiological workers	N/A						144
Nonradiological workers							
On site	12,500,000	2013	2054	42	298,000	144	
Off site	4,510,000	2013	2054	42	107,000	52	
Waste Treatment Plant Replacement (CON_WTPU)							
Radiological workers	N/A						1,360
Nonradiological workers							
On site	33,800,000	2065	2076	12	2,820,000	1,360	
Off site	11,200,000	2065	2076	12	933,000	449	
Underground Transfer Line Replacement (CON_UTLU)							
Radiological workers	N/A						61
Nonradiological workers							
On site	126,000	2044	2044	1	126,000	61	
Off site	17,400	2044	2044	1	17,400	9	
Effluent Treatment Facility Replacement (CON_ETF)							
Radiological workers	N/A						329
Nonradiological workers							
On site	2,050,000	2023	2025	3	683,000	329	
Off site	704,000	2023	2025	3	235,000	113	
Effluent Treatment Facility Replacement (CON_ETFU)							
Radiological workers	N/A						329
Nonradiological workers							
On site	2,050,000	2053	2055	3	683,000	329	
Off site	704,000	2053	2055	3	235,000	113	
242-A Evaporator Replacement (CON_EVA)							
Radiological workers	N/A						102
Nonradiological workers							
On site	635,000	2015	2017	3	212,000	102	
Off site	218,000	2015	2017	3	72,700	35	
242-A Evaporator Replacement (CON_EVAU)[b]							
Radiological workers	N/A						102
Nonradiological workers							
On site	1,270,000	2040	2067	6	212,000	102	
Off site	441,000	2040	2067	6	73,500	36	
Total	**186,000,000**				**13,400,000**	**6,470**	**4,880**

[a] High-Level Radioactive Waste Melter Interim Storage Facilities construction activities would occur over three 2-year periods.
Period 1, 2015–2016
Period 2, 2040–2041
Period 3, 2065–2066

[b] Replacement 242-A Evaporator construction activities would occur over two 3-year periods.
Period 1, 2040–2042
Period 2, 2065–2067

Notes and Assumptions:
Total number of offsite full-time equivalents = 1,590.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
For Waste Treatment Plant operations, no allowance was made for full-time equivalents in ramp-up years.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–6. Tank Closure Alternative 2A Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (OPS_ISF)							
Radiological workers	12,100,000	2018	2093	76	159,000	77	120
Nonradiological workers							
On site	6,750,000	2018	2093	76	88,800	43	
Off site	N/A						
Other Infrastructure Upgrades (OPS_OIU)							
Radiological workers	103,000	2006	2092	87	1,180	1	4
Nonradiological workers							
On site	377,000	2006	2092	87	4,330	3	
Off site	269,000	2006	2092	87	3,090	2	
Routine Operations (OPS_ROUT)							
Radiological workers	22,600,000	2006	2092	87	260,000	125	650
Nonradiological workers							
On site	95,100,000	2006	2092	87	1,090,000	525	
Off site	13,500,000	2006	2092	87	155,000	75	
Retrieval Operations (OPS_RET)							
Radiological workers	29,700	2006	2092	87	341	1	28
Nonradiological workers							
On site	4,830,000	2006	2092	87	55,500	27	
Off site	37,600	2006	2092	87	432	1	
Interim Stabilization/Double-Shell Tanks (OPS_IST)							
Radiological workers	3,190,000	2006	2092	87	36,700	18	44
Nonradiological workers							
On site	4,570,000	2006	2092	87	52,500	26	
Off site	5,050,000	2006	2092	87	58,000	28	
Waste Treatment Plant (OPS_WTP)							
Radiological workers	157,000,000	2018	2092	75	2,090,000	1,010	1,700
Nonradiological workers							
On site	107,000,000	2018	2092	75	1,430,000	688	
Off site	15,800	2018	2092	75	211	1	
Waste Treatment Plant—Cesium and Strontium Capsules (OPS_WTPCSC)							
Radiological workers	2,090,000	2093	2093	1	2,090,000	1,010	1,700
Nonradiological workers							
On site	1,430,000	2093	2093	1	1,430,000	688	
Off site	211	2093	2093	1	211	1	
Cesium and Strontium Capsule Processing Facility (OPS_CSC)							
Radiological workers	103,000	2092	2093	2	51,500	25	25
Nonradiological workers							
On site	N/A						
Off site	N/A						

Table I–6. Tank Closure Alternative 2A Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Modified Sluicing Retrieval System (OPS_MS)							
Radiological workers	7,380,000	2013	2092	80	92,300	45	75
Nonradiological workers							
On site	4,830,000	2013	2092	80	60,400	30	
Off site	N/A						
Mobile Retrieval System (OPS_MRS)							
Radiological workers	5,170,000	2013	2052	40	129,000	63	120
Nonradiological workers							
On site	4,680,000	2013	2052	40	117,000	57	
Off site	N/A						
Vacuum-Based Retrieval System (OPS_VBR)							
Radiological workers	6,630,000	2053	2092	40	166,000	80	153
Nonradiological workers							
On site	6,000,000	2053	2092	40	150,000	73	
Off site	N/A						
High-Level Radioactive Waste Melter Interim Storage Facilities (OPS_PAD)							
Radiological workers	N/A	2018	2192	175	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Effluent Treatment Facility Replacement (OPS_ETF)							
Radiological workers	13,900,000	2006	2095	90	154,000	75	94
Nonradiological workers							
On site	3,480,000	2006	2095	90	38,700	19	
Off site	N/A						
242-A Evaporator Replacement (OPS_EVA)							
Radiological workers	4,300,000	2006	2093	88	48,900	24	32
Nonradiological workers							
On site	1,320,000	2006	2093	88	15,000	8	
Off site	N/A						
Borrow Area C (OPS_CAREA)							
Radiological workers	N/A						43
Nonradiological workers							
On site	8,670,000	2006	2102	97	89,400	43	
Off site	N/A						
Total	**503,000,000**				**10,100,000**	**4,890**	**4,790**

Notes and Assumptions:

Total number of offsite full-time equivalents = 110.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–7. Tank Closure Alternative 2A Deactivation Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (DEA_ISF)							
Radiological workers	N/A						
Nonradiological workers							
On site	160	2094	2094	1	160	1	1
Off site	N/A						
Administrative Controls (DEA_ADM)							
Radiological workers	3,000,000	2094	2193	100	30,000	15	
Nonradiological workers							15
On site	N/A						
Off site	N/A						
Waste Treatment Plant (DEA_WTP)							
Radiological workers	4,190,000	2078	2079	2	2,100,000	1,010	
Nonradiological workers							1,700
On site	2,880,000	2078	2079	2	1,440,000	693	
Off site	N/A	2078	2079	2			
Waste Treatment Plant Upgrades (DEA_WTPU)							
Radiological workers	4,190,000	2094	2095	2	2,100,000	1,010	
Nonradiological workers							1,700
On site	2,880,000	2094	2095	2	1,440,000	693	
Off site	N/A	2094	2095	2	N/A		
Cesium and Strontium Capsule Processing Facility (DEA_CSC)							
Radiological workers	23,900	2094	2094	1	23,900	12	
Nonradiological workers							12
On site	N/A						
Off site	N/A						
Effluent Treatment Facility (Original) (DEA_ETFO)							
Radiological workers	77,300	2026	2026	1	77,300	38	
Nonradiological workers							48
On site	19,300	2026	2026	1	19,300	10	
Off site	N/A						
Effluent Treatment Facility Replacement (DEA_ETF)							
Radiological workers	77,300	2056	2056	1	77,300	38	
Nonradiological workers							48
On site	19,300	2056	2056	1	19,300	10	
Off site	N/A						
Effluent Treatment Facility Replacement (DEA_ETFU)							
Radiological workers	77,300	2096	2096	1	77,300	38	
Nonradiological workers							48
On site	19,300	2096	2096	1	19,300	10	
Off site	N/A						

Table I–7. Tank Closure Alternative 2A Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
242-A Evaporator (Original) (DEA_EVAO)							
Radiological workers	24,400	2018	2018	1	24,400	12	16
Nonradiological workers							
On site	7,480	2018	2018	1	7,480	4	
Off site	N/A						
Modified Sluicing Retrieval System (DEA_MS)							
Radiological workers	372,000	2013	2092	80	4,650	3	3
Nonradiological workers							
On site	N/A						
Off site	N/A						
Mobile Retrieval System (DEA_MRS)							
Radiological workers	680,000	2013	2052	40	17,000	9	9
Nonradiological workers							
On site	N/A						
Off site	N/A						
Vacuum-Based Retrieval System (DEA_VBR)							
Radiological workers	223,000	2053	2092	40	5,580	3	3
Nonradiological workers							
On site	N/A						
Off site	N/A						
242-A Evaporator Replacement (DEA_EVAU)[a]							
Radiological workers	73,300	2043	2094	3	24,400	12	16
Nonradiological workers							
On site	22,400	2043	2094	3	7,470	4	
Off site	N/A						
Total	**18,900,000**				**7,510,000**	**3,630**	**3,620**

[a] Replacement 242-A Evaporator deactivation activities would occur over three 1-year periods.
Period 1, 2043–2043
Period 2, 2068–2068
Period 3, 2094–2094

Notes and Assumptions:
Total number of offsite full-time equivalents = 10.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–8. Tank Closure Alternative 2A Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Decontamination and Decommissioning of 10 Selected Facilities (CLO_D&DTEN)							
Radiological workers	44,400	2018	2028	11	4,040	2	9
Nonradiological workers							
On site	147,000	2018	2028	11	13,400	7	
Off site	79,000	2018	2028	11	7,180	4	
Total	**270,000**				**24,600**	**13**	**9**

Notes and Assumptions:
Total number of offsite full-time equivalents = 4.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Source: Compiled from SAIC 2010a.

I.2.3 Tank Closure Alternative 2B: Expanded WTP Vitrification; Landfill Closure

Table I–9. Tank Closure Alternative 2B Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Canister Storage Building (CON_CSB)							
Radiological workers	116,000	2006	2016	11	10,500	6	12
Nonradiological workers							
On site	136,000	2006	2016	11	12,400	6	
Off site	50,300	2006	2016	11	4,570	3	
Immobilized High-Level Radioactive Waste Shipping/Transfer Facility (CON_STF)							
Radiological workers	N/A						381
Nonradiological workers							
Onsite construction	1,760,000	2011	2013	3	587,000	283	
Onsite exempt	610,000	2011	2013	3	203,000	98	
Offsite design	748,000	2011	2013	3	249,000	120	
Immobilized High-Level Radioactive Waste Interim Storage Modules (CON_ISM)							
Radiological workers	N/A						222
Nonradiological workers							
Onsite construction	3,120,000	2014	2024	11	284,000	137	
Onsite exempt	1,930,000	2014	2024	11	175,000	85	
Offsite design	2,360,000	2014	2024	11	215,000	104	
Other Infrastructure Upgrades (CON_OIU)							
Radiological workers	782,000	2006	2034	29	27,000	13	45
Nonradiological workers							
On site	1,920,000	2006	2034	29	66,200	32	
Off site	743,000	2006	2034	29	25,600	13	

Table I–9. Tank Closure Alternative 2B Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Tank Upgrades (CON_TU)							
Radiological workers	1,200,000	2006	2025	20	60,000	29	104
Nonradiological workers							
On site	3,110,000	2006	2025	20	156,000	75	
Off site	1,180,000	2006	2025	20	59,000	29	
Underground Transfer Lines (CON_UTL)							
Radiological workers	N/A						61
Nonradiological workers							
On site	126,000	2009	2009	1	126,000	61	
Off site	17,400	2009	2009	1	17,400	9	
Waste Treatment Plant (CON_WTP)							
Radiological workers	N/A						1,190
Nonradiological workers							
On site	29,700,000	2006	2017	12	2,480,000	1,190	
Off site	9,930,000	2006	2017	12	828,000	399	
Additional Low-Activity Waste Melters (CON_LAW)							
Radiological workers	N/A						340
Nonradiological workers							
On site	7,060,000	2008	2017	10	706,000	340	
Off site	2,390,000	2008	2017	10	239,000	115	
Cesium and Strontium Capsule Processing Facility (CON_CSC)							
Radiological workers	N/A						190
Nonradiological workers							
On site	1,580,000	2035	2038	4	395,000	190	
Off site	466,000	2035	2038	4	117,000	57	
Waste Receiver Facilities (CON_WRF)							
Radiological workers	N/A						454
Nonradiological workers							
On site	4,720,000	2013	2017	5	944,000	454	
Off site	1,700,000	2013	2017	5	340,000	164	
Tank Risers (CON_RIS)							
Radiological workers	173,000	2013	2016	4	43,300	21	50
Nonradiological workers							
On site	233,000	2013	2016	4	58,300	29	
Off site	N/A						
Modified Sluicing Retrieval System (CON_MS)							
Radiological workers	3,850,000	2013	2043	31	124,000	60	155
Nonradiological workers							
On site	6,080,000	2013	2043	31	196,000	95	
Off site	2,140,000	2013	2043	31	69,000	34	

Table I–9. Tank Closure Alternative 2B Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Mobile Retrieval System (CON_MRS)							
Radiological workers	8,100,000	2013	2028	16	506,000	244	513
Nonradiological workers							
On site	8,940,000	2013	2028	16	559,000	269	
Off site	4,790,000	2013	2028	16	299,000	144	
Vacuum-Based Retrieval System (CON_VBR)							
Radiological workers	11,200,000	2029	2043	15	747,000	360	745
Nonradiological workers							
On site	12,000,000	2029	2043	15	800,000	385	
Off site	6,820,000	2029	2043	15	455,000	219	
High-Level Radioactive Waste Melter Interim Storage Facilities (CON_PAD)[a]							
Radiological workers	N/A						1
Nonradiological workers							
On site	5,620	2015	2030	4	1,410	1	
Off site	N/A						
Effluent Treatment Facility Replacement (CON_ETF)							
Radiological workers	N/A						329
Nonradiological workers							
On site	2,050,000	2023	2025	3	683,000	329	
Off site	704,000	2023	2025	3	235,000	113	
242-A Evaporator Replacement (CON_EVA)							
Radiological workers	N/A						102
Nonradiological workers							
On site	635,000	2015	2017	3	212,000	102	
Off site	218,000	2015	2017	3	72,700	35	
Total	**145,000,000**				**13,400,000**	**6,450**	**4,890**

[a] High-Level Radioactive Waste Melter Interim Storage Facilities construction activities would occur over two 2-year periods.
Period 1, 2015–2016
Period 2, 2029–2030

Notes and Assumptions:
Total number of offsite full-time equivalents = 1,560.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–10. Tank Closure Alternative 2B Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (OPS_ISF)							
Radiological workers	3,650,000	2018	2040	23	159,000	77	120
Nonradiological workers							
On site	2,040,000	2018	2040	23	88,800	43	
Off site	N/A						
Other Infrastructure Upgrades (OPS_OIU)							
Radiological workers	44,900	2006	2043	38	1,180	1	4
Nonradiological workers							
On site	165,000	2006	2043	38	4,340	3	
Off site	117,000	2006	2043	38	3,080	2	
Routine Operations (OPS_ROUT)							
Radiological workers	9,880,000	2006	2043	38	260,000	125	650
Nonradiological workers							
On site	41,500,000	2006	2043	38	1,090,000	525	
Off site	5,890,000	2006	2043	38	155,000	75	
Retrieval Operations (OPS_RET)							
Radiological workers	13,000	2006	2043	38	342	1	28
Nonradiological workers							
On site	2,110,000	2006	2043	38	55,500	27	
Off site	16,400	2006	2043	38	432	1	
Interim Stabilization/Double-Shell Tanks (OPS_IST)							
Radiological workers	1,390,000	2006	2043	38	36,600	18	44
Nonradiological workers							
On site	2,000,000	2006	2043	38	52,600	26	
Off site	2,200,000	2006	2043	38	57,900	28	
Waste Treatment Plant (OPS_WTP)							
Radiological workers	62,800,000	2018	2043	26	2,420,000	1,160	1,940
Nonradiological workers							
On site	42,100,000	2018	2043	26	1,620,000	779	
Off site	8,000	2018	2043	26	308	1	
Waste Treatment Plant—Cesium and Strontium Capsules (OPS_WTPCSC)							
Radiological workers	2,410,000	2040	2040	1	2,410,000	1,160	1,940
Nonradiological workers							
On site	1,620,000	2040	2040	1	1,620,000	779	
Off site	308	2040	2040	1	308	1	
Cesium and Strontium Capsule Processing Facility (OPS_CSC)							
Radiological workers	103,000	2039	2040	2	51,500	25	25
Nonradiological workers							
On site	N/A						
Off site	N/A						

Table I–10. Tank Closure Alternative 2B Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Modified Sluicing Retrieval System (OPS_MS)							
Radiological workers	5,780,000	2013	2043	31	186,000	90	149
Nonradiological workers							
On site	3,780,000	2013	2043	31	122,000	59	
Off site	N/A						
Mobile Retrieval System (OPS_MRS)							
Radiological workers	5,170,000	2013	2028	16	323,000	156	297
Nonradiological workers							
On site	4,680,000	2013	2028	16	293,000	141	
Off site	N/A						
Vacuum-Based Retrieval System (OPS_VBR)							
Radiological workers	7,670,000	2029	2043	15	511,000	246	469
Nonradiological workers							
On site	6,940,000	2029	2043	15	463,000	223	
Off site	N/A						
High-Level Radioactive Waste Melter Interim Storage Facilities (OPS_PAD)							
Radiological workers	N/A	2018	2145	28	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Effluent Treatment Facility Replacement (OPS_ETF)							
Radiological workers	6,180,000	2006	2045	40	155,000	75	94
Nonradiological workers							
On site	1,550,000	2006	2045	40	38,800	19	
Off site	N/A						
242-A Evaporator Replacement (OPS_EVA)							
Radiological workers	1,860,000	2006	2043	38	48,900	24	32
Nonradiological workers							
On site	568,000	2006	2043	38	14,900	8	
Off site	N/A						
Borrow Area C (OPS_CAREA)							
Radiological workers	N/A						43
Nonradiological workers							
On site	4,200,000	2006	2052	47	89,400	43	
Off site	N/A						
Total	**228,000,000**				**12,300,000**	**5,940**	**5,840**

Notes and Assumptions:

Total number of offsite full-time equivalents = 100.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–11. Tank Closure Alternative 2B Deactivation Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (DEA_ISF)							
Radiological workers	N/A						
Nonradiological workers							
On site	160	2041	2041	1	160	1	1
Off site	N/A						
Waste Treatment Plant (DEA_WTP)							
Radiological workers	3,800,000	2044	2045	2	1,900,000	914	
Nonradiological workers							1,530
On site	2,550,000	2044	2045	2	1,280,000	616	
Off site	500	2044	2045	2	250	1	
Modified Sluicing Retrieval System (DEA_MS)							
Radiological workers	291,000	2013	2043	31	9,390	5	
Nonradiological workers							5
On site	N/A						
Off site	N/A						
Mobile Retrieval System (DEA_MRS)							
Radiological workers	680,000	2013	2028	16	42,500	21	
Nonradiological workers							21
On site	N/A						
Off site	N/A						
Vacuum-Based Retrieval System (DEA_VBR)							
Radiological workers	258,000	2029	2043	15	17,200	9	
Nonradiological workers							9
On site	N/A						
Off site	N/A						
Cesium and Strontium Capsule Processing Facility (DEA_CSC)							
Radiological workers	23,900	2041	2041	1	23,900	12	
Nonradiological workers							12
On site	N/A						
Off site	N/A						
Effluent Treatment Facility (Original) (DEA_ETFO)							
Radiological workers	77,300	2026	2026	1	77,300	38	
Nonradiological workers							48
On site	19,300	2026	2026	1	19,300	10	
Off site	N/A						
Effluent Treatment Facility Replacement (DEA_ETF)							
Radiological workers	77,300	2046	2046	1	77,300	38	
Nonradiological workers							48
On site	19,300	2046	2046	1	19,300	10	
Off site (original)	N/A						

Table I–11. Tank Closure Alternative 2B Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
242-A Evaporator (Original) (DEA_EVAO)							
Radiological workers	24,400	2018	2018	1	24,400	12	16
Nonradiological workers							
On site	7,480	2018	2018	1	7,480	4	
Off site	N/A						
242-A Evaporator Replacement (DEA_EVA)							
Radiological workers	24,400	2044	2044	1	24,400	12	16
Nonradiological workers							
On site	7,480	2044	2044	1	7,480	4	
Off site	N/A						
Total	**7,860,000**				**3,530,000**	**1,710**	**1,710**

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

Table I–12. Tank Closure Alternative 2B Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Tank-Filling Grout Facility Construction (CLO_CONGRO)							
Radiological workers	480	2032	2033	2	240	1	5
Nonradiological workers							
On site	13,400	2032	2033	2	6,700	4	
Off site	4,160	2032	2033	2	2,080	1	
Tank-Filling Grout Facility Operations (CLO_OPSGRO)							
Radiological workers	68,000	2034	2043	10	6,800	4	13
Nonradiological workers							
On site	185,000	2034	2043	10	18,500	9	
Off site	130,000	2034	2043	10	13,000	7	
Tank-Filling Grout Facility Deactivation (CLO_DEAGRO)							
Radiological workers	480	2044	2044	1	480	1	4
Nonradiological workers							
On site	4,320	2044	2044	1	4,320	3	
Off site	1,040	2044	2044	1	1,040	1	
Ancillary Equipment Grouting (CLO_ANCFIL)							
Radiological workers	338,000	2013	2037	25	13,500	7	7
Nonradiological workers							
On site	N/A						
Off site	N/A						

Table I–12. Tank Closure Alternative 2B Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Ancillary Equipment Removal (CLO_ANCREM)							
Radiological workers	166,000	2032	2037	6	27,700	14	14
Nonradiological workers							
On site	N/A						
Off site	N/A						
BX and SX Tank Farm Soil Removal (CLO_SOIL)							
Radiological workers	33,000	2032	2037	6	5,500	3	6
Nonradiological workers							
On site	30,000	2032	2037	6	5,000	3	
Off site	N/A						
Containment Structure Construction (CLO_CONCS)							
Radiological workers	2,000	2028	2031	4	500	1	4
Nonradiological workers							
On site	20,000	2028	2031	4	5,000	3	
Off site	N/A						
Containment Structure Deactivation (CLO_DEACS)							
Radiological workers	2,000	2038	2040	3	667	1	5
Nonradiological workers							
On site	20,000	2038	2040	3	6,670	4	
Off site	N/A						
Modified Resource Conservation and Recovery Act Subtitle C Barrier Construction (CLO_RCRA)							
Radiological workers	1,430,000	2039	2045	7	204,000	99	394
Nonradiological workers							
On site	4,290,000	2039	2045	7	613,000	295	
Off site	N/A						
Decontamination and Decommissioning of 10 Selected Facilities (CLO_D&DTEN)							
Radiological workers	44,400	2018	2028	11	4,040	2	9
Nonradiological workers							
On site	147,000	2018	2028	11	13,400	7	
Off site	79,000	2018	2028	11	7,180	4	
Postclosure Care (CLO_POST)							
Radiological workers	N/A						3
Nonradiological workers							
On site	471,000	2046	2145	100	4,710	3	
Off site	N/A						
Total	**7,480,000**				**964,000**	**477**	**464**

Notes and Assumptions:

Total number of offsite full-time equivalents = 13.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

I.2.4 Tank Closure Alternative 3A: Existing WTP Vitrification with Thermal Supplemental Treatment (Bulk Vitrification); Landfill Closure

Table I–13. Tank Closure Alternative 3A Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Canister Storage Building (CON_CSB)							
Radiological workers	116,000	2006	2016	11	10,500	6	12
Nonradiological workers							
On site	136,000	2006	2016	11	12,400	6	
Off site	50,300	2006	2016	11	4,570	3	
Immobilized High-Level Radioactive Waste Shipping/Transfer Facility (CON_STF)							
Radiological workers	N/A						381
Nonradiological workers							
Onsite construction	1,760,000	2011	2013	3	587,000	283	
Onsite exempt	610,000	2011	2013	3	203,000	98	
Offsite design	748,000	2011	2013	3	249,000	120	
Immobilized High-Level Radioactive Waste Interim Storage Modules (CON_ISM)							
Radiological workers	N/A						231
Nonradiological workers							
Onsite construction	1,780,000	2014	2019	6	297,000	143	
Onsite exempt	1,100,000	2014	2019	6	183,000	88	
Offsite design	1,350,000	2014	2019	6	225,000	109	
Other Infrastructure Upgrades (CON_OIU)							
Radiological workers	782,000	2006	2034	29	27,000	13	45
Nonradiological workers							
On site	1,920,000	2006	2034	29	66,200	32	
Off site	743,000	2006	2034	29	25,600	13	
Tank Upgrades (CON_TU)							
Radiological workers	1,200,000	2006	2025	20	60,000	29	104
Nonradiological workers							
On site	3,110,000	2006	2025	20	156,000	75	
Off site	1,180,000	2006	2025	20	59,000	29	
Underground Transfer Lines (CON_UTL)							
Radiological workers	N/A						61
Nonradiological workers							
On site	126,000	2009	2009	1	126,000	61	
Off site	17,400	2009	2009	1	17,400	9	
Waste Treatment Plant (CON_WTP)							
Radiological workers	N/A						904
Nonradiological workers							
On site	22,600,000	2006	2017	12	1,880,000	904	
Off site	7,540,000	2006	2017	12	628,000	302	
Cesium and Strontium Capsule Processing Facility (CON_CSC)							
Radiological workers	N/A						190
Nonradiological workers							
On site	1,580,000	2035	2038	4	395,000	190	
Off site	466,000	2035	2038	4	117,000	57	

Table I–13. Tank Closure Alternative 3A Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Waste Receiver Facilities (CON_WRF)							
Radiological workers	N/A						454
Nonradiological workers							
On site	4,720,000	2013	2017	5	944,000	454	
Off site	1,700,000	2013	2017	5	340,000	164	
Tank Risers (CON_RIS)							
Radiological workers	173,000	2013	2016	4	43,300	21	50
Nonradiological workers							
On site	233,000	2013	2016	4	58,300	29	
Off site	N/A						
Modified Sluicing Retrieval System (CON_MS)							
Radiological workers	3,850,000	2013	2039	27	143,000	69	178
Nonradiological workers							
On site	6,080,000	2013	2039	27	225,000	109	
Off site	2,140,000	2013	2039	27	79,300	39	
Mobile Retrieval System (CON_MRS)							
Radiological workers	8,100,000	2013	2026	14	579,000	279	587
Nonradiological workers							
On site	8,940,000	2013	2026	14	639,000	308	
Off site	4,790,000	2013	2026	14	342,000	165	
Vacuum-Based Retrieval System (CON_VBR)							
Radiological workers	11,200,000	2027	2039	13	862,000	415	859
Nonradiological workers							
On site	12,000,000	2027	2039	13	923,000	444	
Off site	6,820,000	2027	2039	13	525,000	253	
High-Level Radioactive Waste Melter Interim Storage Facilities (CON_PAD)							
Radiological workers	N/A						1
Nonradiological workers							
On site	2,810	2015	2016	2	1,410	1	
Off site	N/A						
Contact-Handled Mixed Transuranic Waste Facilities (CON_CH)							
Radiological workers	N/A						61
Nonradiological workers							
On site	125,000	2008	2008	1	125,000	61	
Off site	42,100	2008	2008	1	42,100	21	
Remote-Handled Mixed Transuranic Waste Facility (CON_RH)							
Radiological workers	N/A						38
Nonradiological workers							
On site	154,000	2013	2014	2	77,000	38	
Off site	51,900	2013	2014	2	26,000	13	
Transuranic Waste Interim Storage Facility (CON_TRU)							
Radiological workers	N/A						4
Nonradiological workers							
On site	16,400	2008	2009	2	8,200	4	
Off site	N/A						

Table I–13. Tank Closure Alternative 3A Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Bulk Vitrification Facility (200-West Area) (CON_BVW)							
Radiological workers	N/A						165
Nonradiological workers							
On site	684,000	2016	2017	2	342,000	165	
Off site	231,000	2016	2017	2	116,000	56	
Solid-Liquid Separations Facility (200-West Area) (CON_SEPW)							
Radiological workers	N/A						38
Nonradiological workers							
On site	156,000	2016	2017	2	78,000	38	
Off site	52,800	2016	2017	2	26,400	13	
Bulk Vitrification Facility (200-East Area) (CON_BVE)							
Radiological workers	N/A						165
Nonradiological workers							
On site	684,000	2016	2017	2	342,000	165	
Off site	231,000	2016	2017	2	116,000	56	
Effluent Treatment Facility Replacement (CON_ETF)							
Radiological workers	N/A						329
Nonradiological workers							
On site	2,050,000	2023	2025	3	683,000	329	
Off site	704,000	2023	2025	3	235,000	113	
242-A Evaporator Replacement (CON_EVA)							
Radiological workers	N/A						102
Nonradiological workers							
On site	635,000	2015	2017	3	212,000	102	
Off site	218,000	2015	2017	3	72,700	35	
Total	**126,000,000**				**13,500,000**	**6,530**	**4,960**

Notes and Assumptions:
Total number of offsite full-time equivalents = 1,570.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

Table I–14. Tank Closure Alternative 3A Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (OPS_ISF)							
Radiological workers	3,650,000	2018	2040	23	159,000	77	120
Nonradiological workers							
On site	2,040,000	2018	2040	23	88,700	43	
Off site	N/A						
Other Infrastructure Upgrades (OPS_OIU)							
Radiological workers	40,200	2006	2039	34	1,180	1	4
Nonradiological workers							
On site	147,000	2006	2039	34	4,320	3	
Off site	105,000	2006	2039	34	3,090	2	

Table I–14. Tank Closure Alternative 3A Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Routine Operations (OPS_ROUT)							
Radiological workers	8,840,000	2006	2039	34	260,000	125	650
Nonradiological workers							
On site	37,200,000	2006	2039	34	1,090,000	525	
Off site	5,270,000	2006	2039	34	155,000	75	
Retrieval Operations (OPS_RET)							
Radiological workers	11,600	2006	2039	34	341	1	28
Nonradiological workers							
On site	1,890,000	2006	2039	34	55,600	27	
Off site	14,700	2006	2039	34	432	1	
Interim Stabilization/Double-Shell Tanks (OPS_IST)							
Radiological workers	1,250,000	2006	2039	34	36,800	18	44
Nonradiological workers							
On site	1,790,000	2006	2039	34	52,600	26	
Off site	1,970,000	2006	2039	34	57,900	28	
Waste Treatment Plant (OPS_WTP)							
Radiological workers	46,100,000	2018	2039	22	2,100,000	1,010	1,700
Nonradiological workers							
On site	31,500,000	2018	2039	22	1,430,000	688	
Off site	4,620	2018	2039	22	210	1	
Waste Treatment Plant—Cesium and Strontium Capsules (OPS_WTPCSC)							
Radiological workers	2,100,000	2040	2040	1	2,100,000	1,010	1,700
Nonradiological workers							
On site	1,430,000	2040	2040	1	1,430,000	688	
Off site	210	2040	2040	1	210	1	
Cesium and Strontium Capsule Processing Facility (OPS_CSC)							
Radiological workers	103,000	2039	2040	2	51,500	25	25
Nonradiological workers							
On site	N/A						
Off site	N/A						
Modified Sluicing Retrieval System (OPS_MS)							
Radiological workers	5,780,000	2013	2039	27	214,000	103	171
Nonradiological workers							
On site	3,780,000	2013	2039	27	140,000	68	
Off site	N/A						
Mobile Retrieval System (OPS_MRS)							
Radiological workers	5,170,000	2013	2026	14	369,000	178	339
Nonradiological workers							
On site	4,680,000	2013	2026	14	334,000	161	
Off site	N/A						
Vacuum-Based Retrieval System (OPS_VBR)							
Radiological workers	7,670,000	2027	2039	13	590,000	284	541
Nonradiological workers							
On site	6,940,000	2027	2039	13	534,000	257	
Off site	N/A						

Table I–14. Tank Closure Alternative 3A Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
High-Level Radioactive Waste Melter Interim Storage Facilities (OPS_PAD)							
Radiological workers	N/A	2018	2141	124			
Nonradiological workers					N/A	0	0
On site	N/A						
Off site	N/A						
Contact-Handled Mixed Transuranic Waste Facilities (OPS_CH)							
Radiological workers	200,000	2009	2010	2	100,000	49	
Nonradiological workers							49
On site	N/A						
Off site	N/A						
Remote-Handled Mixed Transuranic Waste Facility (OPS_RH)							
Radiological workers	1,000,000	2015	2019	5	200,000	97	
Nonradiological workers							97
On site	N/A						
Off site	N/A						
Transuranic Waste Interim Storage Facility (OPS_TRU)							
Radiological workers	N/A	2009	2034	26			
Nonradiological workers					N/A	0	0
On site	N/A						
Off site	N/A						
Bulk Vitrification Facility (200-West Area) (OPS_BVW)							
Radiological workers	3,400,000	2018	2039	22	155,000	75	
Nonradiological workers							94
On site	828,000	2018	2039	22	37,600	19	
Off site	N/A						
Solid-Liquid Separations Facility (200-West Area) (OPS_SEPW)							
Radiological workers	2,800,000	2018	2039	22	127,000	62	
Nonradiological workers							81
On site	850,000	2018	2039	22	38,600	19	
Off site	N/A						
Bulk Vitrification Facility (200-East Area) (OPS_BVE)							
Radiological workers	2,810,000	2018	2039	22	128,000	62	
Nonradiological workers							77
On site	684,000	2018	2039	22	31,100	15	
Off site	N/A						
Effluent Treatment Facility Replacement (OPS_ETF)							
Radiological workers	5,720,000	2006	2042	37	155,000	75	
Nonradiological workers							94
On site	1,430,000	2006	2042	37	38,600	19	
Off site	N/A						
242-A Evaporator Replacement (OPS_EVA)							
Radiological workers	1,710,000	2006	2040	35	48,900	24	
Nonradiological workers							32
On site	523,000	2006	2040	35	14,900	8	
Off site	N/A						

Table I–14. Tank Closure Alternative 3A Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Borrow Area C (OPS_CAREA)							
Radiological workers	N/A						
Nonradiological workers							
On site	4,200,000	2006	2052	47	89,400	43	43
Off site	N/A						
Total	**206,000,000**				**12,400,000**	**5,990**	**5,890**

Notes and Assumptions:
Total number of offsite full-time equivalents = 100.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
For Waste Treatment Plant operations, no allowance was made for full-time equivalents in ramp-up years.
For 200-East and 200-West Area Bulk Vitrification Facility operations, no allowance was made for full-time equivalents in ramp-up years.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

Table I–15. Tank Closure Alternative 3A Deactivation Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (DEA_ISF)							
Radiological workers	N/A						
Nonradiological workers							
On site	160	2041	2041	1	160	1	1
Off site	N/A						
Waste Treatment Plant (DEA_WTP)							
Radiological workers	4,190,000	2041	2042	2	2,100,000	1,010	
Nonradiological workers							
On site	2,880,000	2041	2042	2	1,440,000	693	1,700
Off site	N/A						
Modified Sluicing Retrieval System (DEA_MS)							
Radiological workers	291,000	2013	2039	27	10,800	6	
Nonradiological workers							
On site	N/A						6
Off site	N/A						
Mobile Retrieval System (DEA_MRS)							
Radiological workers	680,000	2013	2026	14	48,600	24	
Nonradiological workers							
On site	N/A						24
Off site	N/A						
Vacuum-Based Retrieval System (DEA_VBR)							
Radiological workers	258,000	2027	2039	13	19,800	10	
Nonradiological workers							
On site	N/A						10
Off site	N/A						

Table I–15. Tank Closure Alternative 3A Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Cesium and Strontium Capsule Processing Facility (DEA_CSC)							
Radiological workers	23,900	2041	2041	1	23,900	12	12
Nonradiological workers							
On site	N/A						
Off site	N/A						
Contact-Handled Mixed Transuranic Waste Facilities (DEA_CH)							
Radiological workers	100,000	2011	2012	2	50,000	25	25
Nonradiological workers							
On site	N/A						
Off site	N/A						
Remote-Handled Mixed Transuranic Waste Facility (DEA_RH)							
Radiological workers	200,000	2020	2021	2	100,000	49	49
Nonradiological workers							
On site	N/A						
Off site	N/A						
Transuranic Waste Interim Storage Facility (DEA_TRU)							
Radiological workers	N/A						1
Nonradiological workers							
On site	80	2035	2035	1	80	1	
Off site	N/A						
Bulk Vitrification Facility (200-West Area) (DEA_BVW)							
Radiological workers	148,000	2040	2041	2	74,000	36	45
Nonradiological workers							
On site	36,000	2040	2041	2	18,000	9	
Off site	N/A						
Solid-Liquid Separations Facility (200-West Area) (DEA_SEPW)							
Radiological workers	122,000	2040	2041	2	61,000	30	39
Nonradiological workers							
On site	37,000	2040	2041	2	18,500	9	
Off site	N/A						
Bulk Vitrification Facility (200-East Area) (DEA_BVE)							
Radiological workers	148,000	2040	2041	2	74,000	36	45
Nonradiological workers							
On site	36,000	2040	2041	2	18,000	9	
Off site	N/A						
Effluent Treatment Facility (Original) (DEA_ETFO)							
Radiological workers	77,300	2026	2026	1	77,300	38	48
Nonradiological workers							
On site	19,300	2026	2026	1	19,300	10	
Off site	N/A						
Effluent Treatment Facility Replacement (DEA_ETF)							
Radiological workers	77,300	2043	2043	1	77,300	38	48
Nonradiological workers							
On site	19,300	2043	2043	1	19,300	10	
Off site	N/A						

Table I–15. Tank Closure Alternative 3A Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
242-A Evaporator (Original) (DEA_EVAO)							
Radiological workers	24,400	2018	2018	1	24,400	12	16
Nonradiological workers							
On site	7,480	2018	2018	1	7,480	4	
Off site	N/A						
242-A Evaporator Replacement (DEA_EVA)							
Radiological workers	24,400	2041	2041	1	24,400	12	16
Nonradiological workers							
On site	7,480	2041	2041	1	7,480	4	
Off site	N/A						
Total	**9,410,000**				**4,310,000**	**2,090**	**2,090**

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

Table I–16. Tank Closure Alternative 3A Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Tank-Filling Grout Facility Construction (CLO_CONGRO)							
Radiological workers	480	2028	2029	2	240	1	5
Nonradiological workers							
On site	13,400	2028	2029	2	6,700	4	
Off site	4,160	2028	2029	2	2,080	1	
Tank-Filling Grout Facility Operations (CLO_OPSGRO)							
Radiological workers	68,000	2030	2039	10	6,800	4	13
Nonradiological workers							
On site	185,000	2030	2039	10	18,500	9	
Off site	130,000	2030	2039	10	13,000	7	
Tank-Filling Grout Facility Deactivation (CLO_DEAGRO)							
Radiological workers	480	2040	2040	1	480	1	4
Nonradiological workers							
On site	4,320	2040	2040	1	4,320	3	
Off site	1,040	2040	2040	1	1,040	1	
Ancillary Equipment Grouting (CLO_ANCFIL)							
Radiological workers	338,000	2012	2032	21	16,100	8	8
Nonradiological workers							
On site	N/A						
Off site	N/A						
Ancillary Equipment Removal (CLO_ANCREM)							
Radiological workers	166,000	2028	2033	6	27,700	14	14
Nonradiological workers							
On site	N/A						
Off site	N/A						

Table I–16. Tank Closure Alternative 3A Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
BX and SX Tank Farm Soil Removal (CLO_SOIL)							
Radiological workers	33,000	2028	2033	6	5,500	3	6
Nonradiological workers							
On site	30,000	2028	2033	6	5,000	3	
Off site	N/A						
Containment Structure Construction (CLO_CONCS)							
Radiological workers	2,000	2024	2027	4	500	1	4
Nonradiological workers							
On site	20,000	2024	2027	4	5,000	3	
Off site	N/A						
Containment Structure Deactivation (CLO_DEACS)							
Radiological workers	2,000	2034	2036	3	667	1	5
Nonradiological workers							
On site	20,000	2034	2036	3	6,670	4	
Off site	N/A						
Modified Resource Conservation and Recovery Act Subtitle C Barrier Construction (CLO_RCRA)							
Radiological workers	1,430,000	2035	2041	7	204,000	99	394
Nonradiological workers							
On site	4,290,000	2035	2041	7	613,000	295	
Off site	N/A						
Decontamination and Decommissioning of 10 Selected Facilities (CLO_D&DTEN)							
Radiological workers	44,400	2018	2028	11	4,040	2	9
Nonradiological workers							
On site	147,000	2018	2028	11	13,400	7	
Off site	79,000	2018	2028	11	7,180	4	
Postclosure Care (CLO_POST)							
Radiological workers	N/A						3
Nonradiological workers							
On site	471,000	2042	2141	100	4,710	3	
Off site	N/A						
Total	**7,480,000**				**967,000**	**478**	**465**

Notes and Assumptions:

Total number of offsite full-time equivalents = 13.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

I.2.5 Tank Closure Alternative 3B: Existing WTP Vitrification with Nonthermal Supplemental Treatment (Cast Stone); Landfill Closure

Table I–17. Tank Closure Alternative 3B Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Canister Storage Building (CON_CSB)							
Radiological workers	116,000	2006	2016	11	10,500	6	12
Nonradiological workers							
On site	136,000	2006	2016	11	12,400	6	
Off site	50,300	2006	2016	11	4,570	3	
Immobilized High-Level Radioactive Waste Shipping/Transfer Facility (CON_STF)							
Radiological workers	N/A						381
Nonradiological workers							
Onsite construction	1,760,000	2011	2013	3	587,000	283	
Onsite exempt	610,000	2011	2013	3	203,000	98	
Offsite design	748,000	2011	2013	3	249,000	120	
Immobilized High-Level Radioactive Waste Interim Storage Modules (CON_ISM)							
Radiological workers	N/A						231
Nonradiological workers							
Onsite construction	1,780,000	2014	2019	6	297,000	143	
Onsite exempt	1,100,000	2014	2019	6	183,000	88	
Offsite design	1,350,000	2014	2019	6	225,000	109	
Other Infrastructure Upgrades (CON_OIU)							
Radiological workers	782,000	2006	2034	29	27,000	13	45
Nonradiological workers							
On site	1,920,000	2006	2034	29	66,200	32	
Off site	743,000	2006	2034	29	25,600	13	
Tank Upgrades (CON_TU)							
Radiological workers	1,200,000	2006	2025	20	60,000	29	104
Nonradiological workers							
On site	3,110,000	2006	2025	20	156,000	75	
Off site	1,180,000	2006	2025	20	59,000	29	
Underground Transfer Lines (CON_UTL)							
Radiological workers	N/A						61
Nonradiological workers							
On site	126,000	2009	2009	1	126,000	61	
Off site	17,400	2009	2009	1	17,400	9	
Waste Treatment Plant (CON_WTP)							
Radiological workers	N/A						904
Nonradiological workers							
On site	22,600,000	2006	2017	12	1,880,000	904	
Off site	7,540,000	2006	2017	12	628,000	302	
Cesium and Strontium Capsule Processing Facility (CON_CSC)							
Radiological workers	N/A						190
Nonradiological workers							
On site	1,580,000	2035	2038	4	395,000	190	
Off site	466,000	2035	2038	4	117,000	57	

Table I–17. Tank Closure Alternative 3B Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Waste Receiver Facilities (CON_WRF)							
Radiological workers	N/A						454
Nonradiological workers							
On site	4,720,000	2013	2017	5	944,000	454	
Off site	1,700,000	2013	2017	5	340,000	164	
Tank Risers (CON_RIS)							
Radiological workers	173,000	2013	2016	4	43,300	21	50
Nonradiological workers							
On site	233,000	2013	2016	4	58,300	29	
Off site	N/A						
Modified Sluicing Retrieval System (CON_MS)							
Radiological workers	3,850,000	2013	2039	27	143,000	69	178
Nonradiological workers							
On site	6,080,000	2013	2039	27	225,000	109	
Off site	2,140,000	2013	2039	27	79,300	39	
Mobile Retrieval System (CON_MRS)							
Radiological workers	8,100,000	2013	2026	14	579,000	279	587
Nonradiological workers							
On site	8,940,000	2013	2026	14	639,000	308	
Off site	4,790,000	2013	2026	14	342,000	165	
Vacuum-Based Retrieval System (CON_VBR)							
Radiological workers	11,200,000	2027	2039	13	862,000	415	859
Nonradiological workers							
On site	12,000,000	2027	2039	13	923,000	444	
Off site	6,820,000	2027	2039	13	525,000	253	
High-Level Radioactive Waste Melter Interim Storage Facilities (CON_PAD)							
Radiological workers	N/A						1
Nonradiological workers							
On site	2,810	2015	2016	2	1,410	1	
Off site	N/A						
Contact-Handled Mixed Transuranic Waste Facilities (CON_CH)							
Radiological workers	N/A						61
Nonradiological workers							
On site	125,000	2008	2008	1	125,000	61	
Off site	42,100	2008	2008	1	42,100	21	
Remote-Handled Mixed Transuranic Waste Facility (CON_RH)							
Radiological workers	N/A						38
Nonradiological workers							
On site	154,000	2013	2014	2	77,000	38	
Off site	51,900	2013	2014	2	26,000	13	
Transuranic Waste Interim Storage Facility (CON_TRU)							
Radiological workers	N/A						4
Nonradiological workers							
On site	16,400	2008	2009	2	8,200	4	
Off site	N/A						

Table I–17. Tank Closure Alternative 3B Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Cast Stone Facility (200-West Area) (CON_CGW)							
Radiological workers	N/A						113
Nonradiological workers							
On site	467,000	2016	2017	2	234,000	113	
Off site	158,000	2016	2017	2	79,000	38	
Solid-Liquid Separations Facility (200-West Area) (CON_SEPW)							
Radiological workers	N/A						38
Nonradiological workers							
On site	156,000	2016	2017	2	78,000	38	
Off site	52,800	2016	2017	2	26,400	13	
Cast Stone Facility (200-East Area) (CON_CGE)							
Radiological workers	N/A						113
Nonradiological workers							
On site	467,000	2016	2017	2	234,000	113	
Off site	158,000	2015	2016	2	79,000	38	
Effluent Treatment Facility Replacement (CON_ETF)							
Radiological workers	N/A						329
Nonradiological workers							
On site	2,050,000	2023	2025	3	683,000	329	
Off site	704,000	2023	2025	3	235,000	113	
242-A Evaporator Replacement (CON_EVA)							
Radiological workers	N/A						102
Nonradiological workers							
On site	635,000	2015	2017	3	212,000	102	
Off site	218,000	2015	2017	3	72,700	35	
Total	**125,000,000**				**13,200,000**	**6,390**	**4,860**

Notes and Assumptions:
Total number of offsite full-time equivalents = 1,530.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

Table I–18. Tank Closure Alternative 3B Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (OPS_ISF)							
Radiological workers	3,660,000	2018	2040	23	159,000	77	120
Nonradiological workers							
On site	2,040,000	2018	2040	23	88,800	43	
Off site	N/A						

Table I–18. Tank Closure Alternative 3B Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Other Infrastructure Upgrades (OPS_OIU)							
Radiological workers	40,200	2006	2039	34	1,180	1	4
Nonradiological workers							
On site	147,000	2006	2039	34	4,330	3	
Off site	105,000	2006	2039	34	3,090	2	
Routine Operations (OPS_ROUT)							
Radiological workers	8,840,000	2006	2039	34	260,000	125	651
Nonradiological workers							
On site	37,200,000	2006	2039	34	1,090,000	526	
Off site	5,270,000	2006	2039	34	155,000	75	
Retrieval Operations (OPS_RET)							
Radiological workers	11,600	2006	2039	34	341	1	28
Nonradiological workers							
On site	1,890,000	2006	2039	34	55,600	27	
Off site	14,700	2006	2039	34	432	1	
Interim Stabilization/Double-Shell Tanks (OPS_IST)							
Radiological workers	1,250,000	2006	2039	34	36,700	18	44
Nonradiological workers							
On site	1,790,000	2006	2039	34	52,500	26	
Off site	1,970,000	2006	2039	34	58,000	28	
Waste Treatment Plant (OPS_WTP)							
Radiological workers	46,100,000	2018	2039	22	2,100,000	1,010	1,700
Nonradiological workers							
On site	31,500,000	2018	2039	22	1,430,000	689	
Off site	4,620	2018	2039	22	210	1	
Waste Treatment Plant—Cesium and Strontium Capsules (OPS_WTPCSC)							
Radiological workers	2,100,000	2040	2040	1	2,100,000	1,010	1,700
Nonradiological workers							
On site	1,430,000	2040	2040	1	1,430,000	689	
Off site	210	2040	2040	1	210	1	
Cesium and Strontium Capsule Processing Facility (OPS_CSC)							
Radiological workers	103,000	2039	2040	2	51,700	25	25
Nonradiological workers							
On site	N/A						
Off site	N/A						
Modified Sluicing Retrieval System (OPS_MS)							
Radiological workers	5,780,000	2013	2039	27	214,000	103	171
Nonradiological workers							
On site	3,780,000	2013	2039	27	140,000	68	
Off site	N/A						
Mobile Retrieval System (OPS_MRS)							
Radiological workers	5,170,000	2013	2026	14	369,000	178	339
Nonradiological workers							
On site	4,680,000	2013	2026	14	334,000	161	
Off site	N/A						

Table I–18. Tank Closure Alternative 3B Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Vacuum-Based Retrieval System (OPS_VBR)							
Radiological workers	7,670,000	2027	2039	13	590,000	284	541
Nonradiological workers							
On site	6,940,000	2027	2039	13	534,000	257	
Off site	N/A						
High-Level Radioactive Waste Melter Interim Storage Facilities (OPS_PAD)							
Radiological workers	N/A	2018	2141	124	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Contact-Handled Mixed Transuranic Waste Facilities (OPS_CH)							
Radiological workers	200,000	2009	2010	2	100,000	49	49
Nonradiological workers							
On site	N/A						
Off site	N/A						
Remote-Handled Mixed Transuranic Waste Facility (OPS_RH)							
Radiological workers	1,000,000	2015	2019	5	200,000	97	97
Nonradiological workers							
On site	N/A						
Off site	N/A						
Transuranic Waste Interim Storage Facility (OPS_TRU)							
Radiological workers	N/A	2009	2034	26	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Cast Stone Facility (200-West Area) (OPS_CGW)							
Radiological workers	1,100,000	2018	2039	22	50,200	25	53
Nonradiological workers							
On site	1,240,000	2018	2039	22	56,500	28	
Off site	N/A						
Solid-Liquid Separations Facility (200-West Area) (OPS_SEPW)							
Radiological workers	2,800,000	2018	2039	22	127,000	62	81
Nonradiological workers							
On site	850,000	2018	2039	22	38,600	19	
Off site	N/A						
Cast Stone Facility (200-East Area) (OPS_CGE)							
Radiological workers	912,000	2018	2039	22	41,500	20	43
Nonradiological workers							
On site	1,030,000	2018	2039	22	46,600	23	
Off site	N/A						
Effluent Treatment Facility Replacement (OPS_ETF)							
Radiological workers	5,720,000	2006	2042	37	155,000	75	94
Nonradiological workers							
On site	1,430,000	2006	2042	37	38,600	19	
Off site	N/A						

Table I–18. Tank Closure Alternative 3B Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
242-A Evaporator Replacement (OPS_EVA)							
Radiological workers	1,710,000	2006	2040	35	48,900	24	32
Nonradiological workers							
On site	523,000	2006	2040	35	15,000	8	
Off site	N/A						
Borrow Area C (OPS_CAREA)							
Radiological workers	N/A						43
Nonradiological workers							
On site	4,200,000	2006	2052	47	89,400	43	
Off site	N/A						
Total	**202,000,000**				**12,300,000**	**5,920**	**5,820**

Notes and Assumptions:

Total number of offsite full-time equivalents = 100.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

For Waste Treatment Plant operations, no allowance was made for full-time equivalents in ramp-up years.

For 200-East and 200-West Area Bulk Vitrification Facility operations, no allowance was made for full-time equivalents in ramp-up years.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–19. Tank Closure Alternative 3B Deactivation Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (DEA_ISF)							
Radiological workers	N/A						1
Nonradiological workers							
On site	160	2041	2041	1	160	1	
Off site	N/A						
Waste Treatment Plant (DEA_WTP)							
Radiological workers	4,190,000	2041	2042	2	2,100,000	1,010	1,700
Nonradiological workers							
On site	2,880,000	2041	2042	2	1,440,000	693	
Off site	N/A						
Cesium and Strontium Capsule Processing Facility (DEA_CSC)							
Radiological workers	23,900	2041	2041	1	23,900	12	12
Nonradiological workers							
On site	N/A						
Off site	N/A						
Modified Sluicing Retrieval System (DEA_MS)							
Radiological workers	291,000	2013	2039	27	10,800	6	6
Nonradiological workers							
On site	N/A						
Off site	N/A						

Table I–19. Tank Closure Alternative 3B Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Mobile Retrieval System (DEA_MRS)							
Radiological workers	680,000	2013	2026	14	48,600	24	24
Nonradiological workers							
On site	N/A						
Off site	N/A						
Vacuum-Based Retrieval System (DEA_VBR)							
Radiological workers	258,000	2027	2039	13	19,800	10	10
Nonradiological workers							
On site	N/A						
Off site	N/A						
Contact-Handled Mixed Transuranic Waste Facilities (DEA_CH)							
Radiological workers	100,000	2011	2012	2	50,000	25	25
Nonradiological workers							
On site	N/A						
Off site	N/A						
Remote-Handled Mixed Transuranic Waste Facility (DEA_RH)							
Radiological workers	200,000	2020	2021	2	100,000	49	49
Nonradiological workers							
On site	N/A						
Off site	N/A						
Transuranic Waste Interim Storage Facility (DEA_TRU)							
Radiological workers	N/A						1
Nonradiological workers							
On site	80	2035	2035	1	80	1	
Off site	N/A						
Cast Stone Facility (200-West Area) (DEA_CGW)							
Radiological workers	48,000	2040	2041	2	24,000	12	25
Nonradiological workers							
On site	54,000	2040	2041	2	27,000	13	
Off site	N/A						
Solid-Liquid Separations Facility (200-West Area) (DEA_SEPW)							
Radiological workers	122,000	2040	2041	2	61,000	30	39
Nonradiological workers							
On site	37,000	2040	2041	2	18,500	9	
Off site	N/A						
Cast Stone Facility (200-East Area) (DEA_CGE)							
Radiological workers	48,000	2040	2041	2	24,000	12	25
Nonradiological workers							
On site	54,000	2040	2041	2	27,000	13	
Off site	N/A						
Effluent Treatment Facility (Original) (DEA_ETFO)							
Radiological workers	77,300	2026	2026	1	77,300	38	48
Nonradiological workers							
On site	19,300	2026	2026	1	19,300	10	
Off site	N/A						

Table I–19. Tank Closure Alternative 3B Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Effluent Treatment Facility Replacement (DEA_ETF)							
Radiological workers	77,300	2043	2043	1	77,300	38	48
Nonradiological workers							
On site	19,300	2043	2043	1	19,300	10	
Off site	N/A						
242-A Evaporator (Original) (DEA_EVAO)							
Radiological workers	24,400	2018	2018	1	24,400	12	16
Nonradiological workers							
On site	7,480	2018	2018	1	7,480	4	
Off site	N/A						
242-A Evaporator Replacement (DEA_EVA)							
Radiological workers	24,400	2041	2041	1	24,400	12	16
Nonradiological workers							
On site	7,480	2041	2041	1	7,480	4	
Off site	N/A						
Total	**9,240,000**				**4,230,000**	**2,050**	**2,050**

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

Table I–20. Tank Closure Alternative 3B Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Tank-Filling Grout Facility Construction (CLO_CONGRO)							
Radiological workers	480	2028	2029	2	240	1	5
Nonradiological workers							
On site	13,400	2028	2029	2	6,700	4	
Off site	4,160	2028	2029	2	2,080	1	
Tank-Filling Grout Facility Operations (CLO_OPSGRO)							
Radiological workers	68,000	2030	2039	10	6,800	4	13
Nonradiological workers							
On site	185,000	2030	2039	10	18,500	9	
Off site	130,000	2030	2039	10	13,000	7	
Tank-Filling Grout Facility Deactivation (CLO_DEAGRO)							
Radiological workers	480	2040	2040	1	480	1	4
Nonradiological workers							
On site	4,320	2040	2040	1	4,320	3	
Off site	1,040	2040	2040	1	1,040	1	
Ancillary Equipment Grouting (CLO_ANCFIL)							
Radiological workers	338,000	2012	2032	21	16,100	8	8
Nonradiological workers							
On site	N/A						
Off site	N/A						

Table I–20. Tank Closure Alternative 3B Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Ancillary Equipment Removal (CLO_ANCREM)							
Radiological workers	166,000	2028	2033	6	27,700	14	14
Nonradiological workers							
On site	N/A						
Off site	N/A						
BX and SX Tank Farm Soil Removal (CLO_SOIL)							
Radiological workers	33,000	2028	2033	6	5,500	3	6
Nonradiological workers							
On site	30,000	2028	2033	6	5,000	3	
Off site	N/A						
Containment Structure Construction (CLO_CONCS)							
Radiological workers	2,000	2024	2027	4	500	1	4
Nonradiological workers							
On site	20,000	2024	2027	4	5,000	3	
Off site	N/A						
Containment Structure Deactivation (CLO_DEACS)							
Radiological workers	2,000	2034	2036	3	667	1	5
Nonradiological workers							
On site	20,000	2034	2036	3	6,670	4	
Off site	N/A						
Modified Resource Conservation and Recovery Act Subtitle C Barrier Construction (CLO_RCRA)							
Radiological workers	1,430,000	2035	2041	7	204,000	99	394
Nonradiological workers							
On site	4,290,000	2035	2041	7	613,000	295	
Off site	N/A						
Decontamination and Decommissioning of 10 Selected Facilities (CLO_D&DTEN)							
Radiological workers	44,400	2018	2028	11	4,040	2	9
Nonradiological workers							
On site	147,000	2018	2028	11	13,400	7	
Off site	79,000	2018	2028	11	7,180	4	
Postclosure Care (CLO_POST)							
Radiological workers	N/A						3
Nonradiological workers							
On site	471,000	2042	2141	100	4,710	3	
Off site	N/A						
Total	**7,480,000**				**967,000**	**478**	**465**

Notes and Assumptions:

Total number of offsite full-time equivalents = 13.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

I.2.6 Tank Closure Alternative 3C: Existing WTP Vitrification with Thermal Supplemental Treatment (Steam Reforming); Landfill Closure

Table I–21. Tank Closure Alternative 3C Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Canister Storage Building (CON_CSB)							
Radiological workers	116,000	2006	2016	11	10,500	6	12
Nonradiological workers							
On site	136,000	2006	2016	11	12,400	6	
Off site	50,300	2006	2016	11	4,570	3	
Immobilized High-Level Radioactive Waste Shipping/Transfer Facility (CON_STF)							
Radiological workers	N/A						380
Nonradiological workers							
Onsite construction	1,760,000	2011	2013	3	587,000	282	
Onsite exempt	610,000	2011	2013	3	203,000	98	
Offsite design	748,000	2011	2013	3	249,000	120	
Immobilized High-Level Radioactive Waste Interim Storage Modules (CON_ISM)							
Radiological workers	N/A						232
Nonradiological workers							
Onsite construction	1,780,000	2014	2019	6	297,000	143	
Onsite exempt	1,100,000	2014	2019	6	183,000	89	
Offsite design	1,350,000	2014	2019	6	225,000	109	
Other Infrastructure Upgrades (CON_OIU)							
Radiological workers	782,000	2006	2034	29	27,000	13	45
Nonradiological workers							
On site	1,920,000	2006	2034	29	66,200	32	
Off site	743,000	2006	2034	29	25,600	13	
Tank Upgrades (CON_TU)							
Radiological workers	1,200,000	2006	2025	20	60,000	29	104
Nonradiological workers							
On site	3,110,000	2006	2025	20	156,000	75	
Off site	1,180,000	2006	2025	20	59,000	29	
Underground Transfer Lines (CON_UTL)							
Radiological workers	N/A						61
Nonradiological workers							
On site	126,000	2009	2009	1	126,000	61	
Off site	17,400	2009	2009	1	17,400	9	
Waste Treatment Plant (CON_WTP)							
Radiological workers	N/A						906
Nonradiological workers							
On site	22,600,000	2006	2017	12	1,880,000	906	
Off site	7,540,000	2006	2017	12	628,000	302	
Cesium and Strontium Capsule Processing Facility (CON_CSC)							
Radiological workers	N/A						190
Nonradiological workers							
On site	1,580,000	2035	2038	4	395,000	190	
Off site	466,000	2035	2038	4	117,000	56	

Table I–21. Tank Closure Alternative 3C Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Waste Receiver Facilities (CON_WRF)							
Radiological workers	N/A						454
Nonradiological workers							
On site	4,720,000	2013	2017	5	944,000	454	
Off site	1,700,000	2013	2017	5	340,000	164	
Tank Risers (CON_RIS)							
Radiological workers	173,000	2013	2016	4	43,300	21	50
Nonradiological workers							
On site	233,000	2013	2016	4	58,300	29	
Off site	N/A						
Modified Sluicing Retrieval System (CON_MS)							
Radiological workers	3,850,000	2013	2039	27	143,000	69	178
Nonradiological workers							
On site	6,080,000	2013	2039	27	225,000	109	
Off site	2,140,000	2013	2039	27	79,300	39	
Mobile Retrieval System (CON_MRS)							
Radiological workers	8,100,000	2013	2026	14	579,000	279	587
Nonradiological workers							
On site	8,940,000	2013	2026	14	639,000	308	
Off site	4,790,000	2013	2026	14	342,000	165	
Vacuum-Based Retrieval System (CON_VBR)							
Radiological workers	11,200,000	2027	2039	13	862,000	415	858
Nonradiological workers							
On site	12,000,000	2027	2039	13	923,000	443	
Off site	6,820,000	2027	2039	13	525,000	253	
High-Level Radioactive Waste Melter Interim Storage Facilities (CON_PAD)							
Radiological workers	N/A						1
Nonradiological workers							
On site	2,810	2015	2016	2	1,410	1	
Off site	N/A						
Contact-Handled Mixed Transuranic Waste Facilities (CON_CH)							
Radiological workers	N/A						60
Nonradiological workers							
On site	125,000	2008	2008	1	125,000	60	
Off site	42,100	2008	2008	1	42,100	21	
Remote-Handled Mixed Transuranic Waste Facility (CON_RH)							
Radiological workers	N/A						37
Nonradiological workers							
On site	154,000	2013	2014	2	77,000	37	
Off site	51,900	2013	2014	2	26,000	13	
Transuranic Waste Interim Storage Facility (CON_TRU)							
Radiological workers	N/A						4
Nonradiological workers							
On site	16,400	2008	2009	2	8,200	4	
Off site	N/A						

Table I–21. Tank Closure Alternative 3C Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Steam Reforming Facility (200-West Area) (CON_SRW)							
Radiological workers	N/A						284
Nonradiological workers							
On site	1,180,000	2016	2017	2	590,000	284	
Off site	398,000	2016	2017	2	199,000	96	
Solid-Liquid Separations Facility (200-West Area) (CON_SEPW)							
Radiological workers	N/A						38
Nonradiological workers							
On site	156,000	2016	2017	2	78,000	38	
Off site	52,800	2016	2017	2	26,400	13	
Steam Reforming Facility (200-East Area) (CON_SRE)							
Radiological workers	N/A						430
Nonradiological workers							
On site	1,790,000	2016	2017	2	895,000	430	
Off site	603,000	2016	2017	2	302,000	145	
Effluent Treatment Facility Replacement (CON_ETF)							
Radiological workers	N/A						329
Nonradiological workers							
On site	2,050,000	2023	2025	3	683,000	329	
Off site	704,000	2023	2025	3	235,000	113	
242-A Evaporator Replacement (CON_EVA)							
Radiological workers	N/A						102
Nonradiological workers							
On site	635,000	2015	2017	3	212,000	102	
Off site	218,000	2015	2017	3	72,700	35	
Total	**128,000,000**				**14,600,000**	**7,040**	**5,340**

Notes and Assumptions:
Total number of offsite full-time equivalents = 1,700.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

Table I–22. Tank Closure Alternative 3C Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (OPS_ISF)							
Radiological workers	3,650,000	2018	2040	23	159,000	77	120
Nonradiological workers							
On site	2,040,000	2018	2040	23	88,700	43	
Off site	N/A						
Other Infrastructure Upgrades (OPS_OIU)							
Radiological workers	40,200	2006	2039	34	1,180	1	4
Nonradiological workers							
On site	147,000	2006	2039	34	4,320	3	
Off site	105,000	2006	2039	34	3,090	2	

Table I–22. Tank Closure Alternative 3C Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Routine Operations (OPS_ROUT)							
Radiological workers	8,840,000	2006	2039	34	260,000	125	651
Nonradiological workers							
On site	37,200,000	2006	2039	34	1,090,000	526	
Off site	5,270,000	2006	2039	34	155,000	75	
Retrieval Operations (OPS_RET)							
Radiological workers	11,600	2006	2039	34	341	1	28
Nonradiological workers							
On site	1,890,000	2006	2039	34	55,600	27	
Off site	14,700	2006	2039	34	432	1	
Interim Stabilization/Double-Shell Tanks (OPS_IST)							
Radiological workers	1,250,000	2006	2039	34	36,800	18	44
Nonradiological workers							
On site	1,790,000	2006	2039	34	52,600	26	
Off site	1,970,000	2006	2039	34	57,900	28	
Waste Treatment Plant (OPS_WTP)							
Radiological workers	46,100,000	2018	2039	22	2,100,000	1,010	1,700
Nonradiological workers							
On site	31,500,000	2018	2039	22	1,430,000	689	
Off site	4,620	2018	2039	22	210	1	
Waste Treatment Plant—Cesium and Strontium Capsules (OPS_WTPCSC)							
Radiological workers	2,100,000	2040	2040	1	2,100,000	1,010	1,700
Nonradiological workers							
On site	1,430,000	2040	2040	1	1,430,000	689	
Off site	210	2040	2040	1	210	1	
Cesium and Strontium Capsule Processing Facility (OPS_CSC)							
Radiological workers	103,000	2039	2040	2	51,500	25	25
Nonradiological workers							
On site	N/A						
Off site	N/A						
Modified Sluicing Retrieval System (OPS_MS)							
Radiological workers	5,780,000	2013	2039	27	214,000	103	171
Nonradiological workers							
On site	3,780,000	2013	2039	27	140,000	68	
Off site	N/A						
Mobile Retrieval System (OPS_MRS)							
Radiological workers	5,170,000	2013	2026	14	369,000	178	339
Nonradiological workers							
On site	4,680,000	2013	2026	14	334,000	161	
Off site	N/A						
Vacuum-Based Retrieval System (OPS_VBR)							
Radiological workers	7,670,000	2027	2039	13	590,000	284	541
Nonradiological workers							
On site	6,940,000	2027	2039	13	534,000	257	
Off site	N/A						

Table I–22. Tank Closure Alternative 3C Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
High-Level Radioactive Waste Melter Interim Storage Facilities (OPS_PAD)							
Radiological workers	N/A	2018	2141	124	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Contact-Handled Mixed Transuranic Waste Facilities (OPS_CH)							
Radiological workers	200,000	2009	2010	2	100,000	49	49
Nonradiological workers							
On site	N/A						
Off site	N/A						
Remote-Handled Mixed Transuranic Waste Facility (OPS_RH)							
Radiological workers	1,000,000	2015	2019	5	200,000	97	97
Nonradiological workers							
On site	N/A						
Off site	N/A						
Transuranic Waste Interim Storage Facility (OPS_TRU)							
Radiological workers	N/A	2009	2034	26	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Steam Reforming Facility (200-West Area) (OPS_SRW)							
Radiological workers	3,840,000	2018	2039	22	175,000	84	112
Nonradiological workers							
On site	1,280,000	2018	2039	22	58,200	28	
Off site	N/A						
Solid-Liquid Separations Facility (200-West Area) (OPS_SEPW)							
Radiological workers	2,800,000	2018	2039	22	127,000	62	81
Nonradiological workers							
On site	850,000	2018	2039	22	38,600	19	
Off site	N/A						
Steam Reforming Facility (200-East Area) (OPS_SRE)							
Radiological workers	6,390,000	2018	2039	22	290,000	140	187
Nonradiological workers							
On site	2,130,000	2018	2039	22	96,800	47	
Off site	N/A						
Effluent Treatment Facility Replacement (OPS_ETF)							
Radiological workers	5,720,000	2006	2042	37	155,000	75	94
Nonradiological workers							
On site	1,430,000	2006	2042	37	38,600	19	
Off site	N/A						
242-A Evaporator Replacement (OPS_EVA)							
Radiological workers	1,710,000	2006	2040	35	48,900	24	32
Nonradiological workers							
On site	523,000	2006	2040	35	14,900	8	
Off site	N/A						

Table I–22. Tank Closure Alternative 3C Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Borrow Area C (OPS_CAREA)							
Radiological workers	N/A						
Nonradiological workers							
On site	4,200,000	2006	2052	47	89,400	43	43
Off site	N/A						
Total	**212,000,000**				**12,700,000**	**6,120**	**6,020**

Notes and Assumptions:

Total number of offsite full-time equivalents = 100.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

For Waste Treatment Plant operations, no allowance was made for full-time equivalents in ramp-up years.

For 200-East and 200-West Area Bulk Vitrification Facility operations, no allowance was made for full-time equivalents in ramp-up years.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–23. Tank Closure Alternative 3C Deactivation Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (DEA_ISF)							
Radiological workers	N/A						
Nonradiological workers							
On site	160	2041	2041	1	160	1	1
Off site	N/A						
Waste Treatment Plant (DEA_WTP)							
Radiological workers	4,190,000	2041	2042	2	2,100,000	1,010	
Nonradiological workers							
On site	2,880,000	2041	2042	2	1,440,000	692	1,700
Off site	N/A						
Cesium and Strontium Capsule Processing Facility (DEA_CSC)							
Radiological workers	23,900	2041	2041	1	23,900	12	
Nonradiological workers							
On site	N/A						12
Off site	N/A						
Modified Sluicing Retrieval System (DEA_MS)							
Radiological workers	291,000	2013	2039	27	10,800	6	
Nonradiological workers							
On site	N/A						6
Off site	N/A						
Mobile Retrieval System (DEA_MRS)							
Radiological workers	680,000	2013	2026	14	48,600	24	
Nonradiological workers							
On site	N/A						24
Off site	N/A						

Table I–23. Tank Closure Alternative 3C Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Vacuum-Based Retrieval System (DEA_VBR)							
Radiological workers	258,000	2027	2039	13	19,800	10	10
Nonradiological workers							
On site	N/A						
Off site	N/A						
Contact-Handled Mixed Transuranic Waste Facilities (DEA_CH)							
Radiological workers	100,000	2011	2012	2	50,000	25	25
Nonradiological workers							
On site	N/A						
Off site	N/A						
Remote-Handled Mixed Transuranic Waste Facility (DEA_RH)							
Radiological workers	200,000	2020	2021	2	100,000	49	49
Nonradiological workers							
On site	N/A						
Off site	N/A						
Transuranic Waste Interim Storage Facility (DEA_TRU)							
Radiological workers	N/A						1
Nonradiological workers							
On site	80	2035	2035	1	80	1	
Off site	N/A						
Steam Reforming Facility (200-West Area) (DEA_SRW)							
Radiological workers	168,000	2040	2041	2	84,000	41	55
Nonradiological workers							
On site	56,000	2040	2041	2	28,000	14	
Off site	N/A						
Solid-Liquid Separations Facility (200-West Area) (DEA_SEPW)							
Radiological workers	122,000	2040	2041	2	61,000	30	39
Nonradiological workers							
On site	37,000	2040	2041	2	18,500	9	
Off site	N/A						
Steam Reforming Facility (200-East Area) (DEA_SRE)							
Radiological workers	336,000	2040	2041	2	168,000	81	108
Nonradiological workers							
On site	112,000	2040	2041	2	56,000	27	
Off site	N/A						
Effluent Treatment Facility (Original) (DEA_ETFO)							
Radiological workers	77,300	2026	2026	1	77,300	38	48
Nonradiological workers							
On site	19,300	2026	2026	1	19,300	10	
Off site	N/A						
Effluent Treatment Facility Replacement (DEA_ETF)							
Radiological workers	77,300	2043	2043	1	77,300	38	48
Nonradiological workers							
On site	19,300	2043	2043	1	19,300	10	
Off site	N/A						

Table I–23. Tank Closure Alternative 3C Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
242-A Evaporator (Original) (DEA_EVAO)							
Radiological workers	24,400	2018	2018	1	24,400	12	16
Nonradiological workers							
On site	7,480	2018	2018	1	7,480	4	
Off site	N/A						
242-A Evaporator Replacement (DEA_EVA)							
Radiological workers	24,400	2041	2041	1	24,400	12	16
Nonradiological workers							
On site	7,480	2041	2041	1	7,480	4	
Off site	N/A						
Total	**9,710,000**				**4,470,000**	**2,160**	**2,160**

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

Table I–24. Tank Closure Alternative 3C Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Tank-Filling Grout Facility Construction (CLO_CONGRO)							
Radiological workers	480	2028	2029	2	240	1	5
Nonradiological workers							
On site	13,400	2028	2029	2	6,700	4	
Off site	4,160	2028	2029	2	2,080	1	
Tank-Filling Grout Facility Operations (CLO_OPSGRO)							
Radiological workers	68,000	2030	2039	10	6,800	4	13
Nonradiological workers							
On site	185,000	2030	2039	10	18,500	9	
Off site	130,000	2030	2039	10	13,000	7	
Tank-Filling Grout Facility Deactivation (CLO_DEAGRO)							
Radiological workers	480	2040	2040	1	480	1	4
Nonradiological workers							
On site	4,320	2040	2040	1	4,320	3	
Off site	1,040	2040	2040	1	1,040	1	
Ancillary Equipment Grouting (CLO_ANCFIL)							
Radiological workers	338,000	2012	2032	21	16,100	8	8
Nonradiological workers							
On site	N/A						
Off site	N/A						
Ancillary Equipment Removal (CLO_ANCREM)							
Radiological workers	166,000	2028	2033	6	27,700	14	14
Nonradiological workers							
On site	N/A						
Off site	N/A						

Table I–24. Tank Closure Alternative 3C Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
BX and SX Tank Farm Soil Removal (CLO_SOIL)							
Radiological workers	33,000	2028	2033	6	5,500	3	6
Nonradiological workers							
On site	30,000	2028	2033	6	5,000	3	
Off site	N/A						
Containment Structure Construction (CLO_CONCS)							
Radiological workers	2,000	2024	2027	4	500	1	4
Nonradiological workers							
On site	20,000	2024	2027	4	5,000	3	
Off site	N/A						
Containment Structure Deactivation (CLO_DEACS)							
Radiological workers	2,000	2034	2036	3	667	1	5
Nonradiological workers							
On site	20,000	2034	2036	3	6,670	4	
Off site	N/A						
Modified Resource Conservation and Recovery Act Subtitle C Barrier Construction (CLO_RCRA)							
Radiological workers	1,430,000	2035	2041	7	204,000	99	394
Nonradiological workers							
On site	4,290,000	2035	2041	7	613,000	295	
Off site	N/A						
Decontamination and Decommissioning of 10 Selected Facilities (CLO_D&DTEN)							
Radiological workers	44,400	2018	2028	11	4,040	2	9
Nonradiological workers							
On site	147,000	2018	2028	11	13,400	7	
Off site	79,000	2018	2028	11	7,180	4	
Postclosure Care (CLO_POST)							
Radiological workers	N/A						3
Nonradiological workers							
On site	471,000	2042	2141	100	4,710	3	
Off site	N/A						
Total	**7,480,000**				**967,000**	**478**	**465**

Notes and Assumptions:

Total number of offsite full-time equivalents = 13.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

I.2.7 Tank Closure Alternative 4: Existing WTP Vitrification with Supplemental Treatment Technologies; Selective Clean Closure/Landfill Closure

Table I–25. Tank Closure Alternative 4 Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Canister Storage Building (CON_CSB)							
Radiological workers	116,000	2006	2016	11	10,500	6	12
Nonradiological workers							
On site	136,000	2006	2016	11	12,400	6	
Off site	50,300	2006	2016	11	4,570	3	
Immobilized High-Level Radioactive Waste Shipping/Transfer Facility (CON_STF)							
Radiological workers	N/A						381
Nonradiological workers							
Onsite construction	1,760,000	2011	2013	3	587,000	283	
Onsite exempt	610,000	2011	2013	3	203,000	98	
Offsite design	748,000	2011	2013	3	249,000	120	
Immobilized High-Level Radioactive Waste Interim Storage Modules (CON_ISM)							
Radiological workers	N/A						231
Nonradiological workers							
Onsite construction	2,670,000	2014	2022	9	297,000	143	
Onsite exempt	1,650,000	2014	2022	9	183,000	88	
Offsite design	2,030,000	2014	2022	9	226,000	109	
Other Infrastructure Upgrades (CON_OIU)							
Radiological workers	782,000	2006	2034	29	27,000	13	45
Nonradiological workers							
On site	1,920,000	2006	2034	29	66,200	32	
Off site	743,000	2006	2034	29	25,600	13	
Tank Upgrades (CON_TU)							
Radiological workers	1,200,000	2006	2025	20	60,000	29	104
Nonradiological workers							
On site	3,110,000	2006	2025	20	156,000	75	
Off site	1,180,000	2006	2025	20	59,000	29	
Underground Transfer Lines (CON_UTL)							
Radiological workers	N/A						61
Nonradiological workers							
On site	126,000	2009	2009	1	126,000	61	
Off site	17,400	2009	2009	1	17,400	9	
Waste Treatment Plant (CON_WTP)							
Radiological workers	N/A						904
Nonradiological workers							
On site	22,600,000	2006	2017	12	1,880,000	904	
Off site	7,540,000	2006	2017	12	628,000	302	
Cesium and Strontium Capsule Processing Facility (CON_CSC)							
Radiological workers	N/A						190
Nonradiological workers							
On site	1,580,000	2038	2041	4	395,000	190	
Off site	466,000	2038	2041	4	117,000	57	

Table I–25. Tank Closure Alternative 4 Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Waste Receiver Facilities (CON_WRF)							
Radiological workers	N/A						454
Nonradiological workers							
On site	4,720,000	2013	2017	5	944,000	454	
Off site	1,700,000	2013	2017	5	340,000	164	
Tank Risers (CON_RIS)							
Radiological workers	189,000	2013	2016	4	47,300	23	54
Nonradiological workers							
On site	255,000	2013	2016	4	63,800	31	
Off site	N/A						
Mobile Retrieval System (CON_MRS)							
Radiological workers	21,700,000	2013	2042	30	723,000	348	733
Nonradiological workers							
On site	24,000,000	2013	2042	30	800,000	385	
Off site	12,900,000	2013	2042	30	430,000	207	
Vacuum-Based Retrieval System (CON_VBR)							
Radiological workers	11,200,000	2013	2042	30	373,000	180	373
Nonradiological workers							
On site	12,000,000	2013	2042	30	400,000	193	
Off site	6,820,000	2013	2042	30	227,000	110	
Chemical Wash System (CON_CHW)							
Radiological workers	2,380,000	2013	2042	30	79,300	39	47
Nonradiological workers							
On site	472,000	2013	2042	30	15,700	8	
Off site	635,000	2013	2042	30	21,200	11	
High-Level Radioactive Waste Melter Interim Storage Facilities (CON_PAD)							
Radiological workers	N/A						1
Nonradiological workers							
On site	2,810	2015	2016	2	1,410	1	
Off site	N/A						
Contact-Handled Mixed Transuranic Waste Facilities (CON_CH)							
Radiological workers	N/A						61
Nonradiological workers							
On site	125,000	2008	2008	1	125,000	61	
Off site	42,100	2008	2008	1	42,100	21	
Remote-Handled Mixed Transuranic Waste Facility (CON_RH)							
Radiological workers	N/A						38
Nonradiological workers							
On site	154,000	2013	2014	2	77,000	38	
Off site	51,900	2013	2014	2	26,000	13	
Transuranic Waste Interim Storage Facility (CON_TRU)							
Radiological workers	N/A						4
Nonradiological workers							
On site	16,400	2008	2009	2	8,200	4	
Off site	N/A						

Table I–25. Tank Closure Alternative 4 Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Bulk Vitrification Facility (200-West Area) (CON_BV)							
Radiological workers	N/A						165
Nonradiological workers							
On site	684,000	2016	2017	2	342,000	165	
Off site	231,000	2016	2017	2	116,000	56	
Solid-Liquid Separations Facility (200-West Area) (CON_SEPW)							
Radiological workers	N/A						38
Nonradiological workers							
On site	156,000	2016	2017	2	78,000	38	
Off site	52,800	2016	2017	2	26,400	13	
Cast Stone Facility (200-East Area) (CON_CG)							
Radiological workers	N/A						113
Nonradiological workers							
On site	467,000	2016	2017	2	234,000	113	
Off site	158,000	2016	2017	2	79,000	38	
Effluent Treatment Facility Replacement (CON_ETF)							
Radiological workers	N/A						329
Nonradiological workers							
On site	2,050,000	2023	2025	3	683,000	329	
Off site	704,000	2023	2025	3	235,000	113	
242-A Evaporator Replacement (CON_EVA)							
Radiological workers	N/A						102
Nonradiological workers							
On site	635,000	2015	2017	3	212,000	102	
Off site	218,000	2015	2017	3	72,700	35	
Total	**156,000,000**				**12,200,000**	**5,860**	**4,440**

Notes and Assumptions:
Total number of offsite full-time equivalents = 1,420.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

Table I–26. Tank Closure Alternative 4 Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (OPS_ISF)							
Radiological workers	4,130,000	2018	2043	26	159,000	77	120
Nonradiological workers							
On site	2,310,000	2018	2043	26	88,800	43	
Off site	N/A						
Other Infrastructure Upgrades (OPS_OIU)							
Radiological workers	43,700	2006	2042	37	1,180	1	4
Nonradiological workers							
On site	160,000	2006	2042	37	4,320	3	
Off site	114,000	2006	2042	37	3,080	2	

Table I–26. Tank Closure Alternative 4 Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Routine Operations (OPS_ROUT)							
Radiological workers	9,620,000	2006	2042	37	260,000	125	650
Nonradiological workers							
On site	40,400,000	2006	2042	37	1,090,000	525	
Off site	5,740,000	2006	2042	37	155,000	75	
Retrieval Operations (OPS_RET)							
Radiological workers	12,600	2006	2042	37	341	1	28
Nonradiological workers							
On site	2,060,000	2006	2042	37	55,700	27	
Off site	16,000	2006	2042	37	432	1	
Interim Stabilization/Double-Shell Tanks (OPS_IST)							
Radiological workers	1,360,000	2006	2042	37	36,800	18	44
Nonradiological workers							
On site	1,940,000	2006	2042	37	52,400	26	
Off site	2,150,000	2006	2042	37	58,100	28	
Waste Treatment Plant (OPS_WTP)							
Radiological workers	52,300,000	2018	2042	25	2,090,000	1,010	1,700
Nonradiological workers							
On site	35,800,000	2018	2042	25	1,430,000	688	
Off site	5,250	2018	2042	25	210	1	
Waste Treatment Plant—Cesium and Strontium Capsules (OPS_WTPCSC)							
Radiological workers	2,090,000	2043	2043	1	2,090,000	1,010	1,700
Nonradiological workers							
On site	1,430,000	2043	2043	1	1,430,000	688	
Off site	210	2043	2043	1	210	1	
Cesium and Strontium Capsule Processing Facility (OPS_CSC)							
Radiological workers	103,000	2042	2043	2	51,500	25	25
Nonradiological workers							
On site	N/A						
Off site	N/A						
Mobile Retrieval System (OPS_MRS)							
Radiological workers	13,900,000	2013	2042	30	463,000	223	425
Nonradiological workers							
On site	12,600,000	2013	2042	30	420,000	202	
Off site	N/A						
Vacuum-Based Retrieval System (OPS_VBR)							
Radiological workers	7,670,000	2013	2042	30	256,000	124	236
Nonradiological workers							
On site	6,940,000	2013	2042	30	231,000	112	
Off site	N/A						
Chemical Wash System (OPS_CHW)							
Radiological workers	10,800,000	2013	2042	30	360,000	174	331
Nonradiological workers							
On site	9,750,000	2013	2042	30	325,000	157	
Off site	N/A						

Table I–26. Tank Closure Alternative 4 Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
High-Level Radioactive Waste Melter Interim Storage Facilities (OPS_PAD)							
Radiological workers	N/A	2018	2144	127	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Contact-Handled Mixed Transuranic Waste Facilities (OPS_CH)							
Radiological workers	200,000	2009	2010	2	100,000	49	49
Nonradiological workers							
On site	N/A						
Off site	N/A						
Remote-Handled Mixed Transuranic Waste Facility (OPS_RH)							
Radiological workers	1,000,000	2015	2019	5	200,000	97	97
Nonradiological workers							
On site	N/A						
Off site	N/A						
Transuranic Waste Interim Storage Facility (OPS_TRU)							
Radiological workers	N/A	2009	2034	26	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Bulk Vitrification Facility (200-West Area) (OPS_BV)							
Radiological workers	3,400,000	2018	2039	22	155,000	75	94
Nonradiological workers							
On site	828,000	2018	2039	22	37,600	19	
Off site	N/A						
Solid-Liquid Separations Facility (200-West Area) (OPS_SEPW)							
Radiological workers	2,800,000	2018	2039	22	127,000	62	81
Nonradiological workers							
On site	850,000	2018	2039	22	38,600	19	
Off site	N/A						
Cast Stone Facility (200-East Area) (OPS_CG)							
Radiological workers	912,000	2018	2039	22	41,500	20	43
Nonradiological workers							
On site	1,030,000	2018	2039	22	46,800	23	
Off site	N/A						
Effluent Treatment Facility Replacement (OPS_ETF)							
Radiological workers	6,180,000	2006	2045	40	155,000	75	94
Nonradiological workers							
On site	1,550,000	2006	2045	40	38,800	19	
Off site	N/A						
242-A Evaporator Replacement (OPS_EVA)							
Radiological workers	1,810,000	2006	2042	37	48,900	24	32
Nonradiological workers							
On site	553,000	2006	2042	37	14,900	8	
Off site	N/A						

Table I–26. Tank Closure Alternative 4 Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Borrow Area C (OPS_CAREA)							
Radiological workers	N/A						
Nonradiological workers							
On site	4,200,000	2006	2052	47	89,400	43	43
Off site	N/A						
Total	**249,000,000**				**12,200,000**	**5,900**	**5,800**

Notes and Assumptions:

Total number of offsite full-time equivalents = 100.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

For Waste Treatment Plant operations, no allowance was made for full-time equivalents in ramp-up years.

For 200-East and 200-West Area Bulk Vitrification Facility operations, no allowance was made for full-time equivalents in ramp-up years.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–27. Tank Closure Alternative 4 Deactivation Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (DEA_ISF)							
Radiological workers	N/A						
Nonradiological workers							
On site	160	2044	2044	1	160	1	1
Off site	N/A						
Waste Treatment Plant (DEA_WTP)							
Radiological workers	4,190,000	2044	2045	2	2,100,000	1,010	
Nonradiological workers							
On site	2,880,000	2044	2045	2	1,440,000	693	1,700
Off site	N/A						
Cesium and Strontium Capsule Processing Facility (DEA_CSC)							
Radiological workers	23,900	2044	2044	1	23,900	12	
Nonradiological workers							
On site	N/A						12
Off site	N/A						
Mobile Retrieval System (DEA_MRS)							
Radiological workers	1,820,000	2013	2042	30	60,700	30	
Nonradiological workers							
On site	N/A						30
Off site	N/A						
Vacuum-Based Retrieval System (DEA_VBR)							
Radiological workers	258,000	2013	2042	30	8,600	5	
Nonradiological workers							
On site	N/A						5
Off site	N/A						

Table I–27. Tank Closure Alternative 4 Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Chemical Wash System (DEA_CHW)							
Radiological workers	144,000	2013	2042	30	4,800	3	3
Nonradiological workers							
On site	N/A						
Off site	N/A						
Contact-Handled Mixed Transuranic Waste Facilities (DEA_CH)							
Radiological workers	100,000	2011	2012	2	50,000	25	25
Nonradiological workers							
On site	N/A						
Off site	N/A						
Remote-Handled Mixed Transuranic Waste Facility (DEA_RH)							
Radiological workers	200,000	2020	2021	2	100,000	49	49
Nonradiological workers							
On site	N/A						
Off site	N/A						
Transuranic Waste Interim Storage Facility (DEA_TRU)							
Radiological workers	N/A						1
Nonradiological workers							
On site	80	2035	2035	1	80	1	
Off site	N/A						
Bulk Vitrification Facility (200-West Area) (DEA_BV)							
Radiological workers	148,000	2040	2041	2	74,000	36	45
Nonradiological workers							
On site	36,000	2040	2041	2	18,000	9	
Off site	N/A						
Solid-Liquid Separations Facility (200-West Area) (DEA_SEPW)							
Radiological workers	122,000	2040	2041	2	61,000	30	39
Nonradiological workers							
On site	37,000	2040	2041	2	18,500	9	
Off site	N/A						
Cast Stone Facility (200-East Area) (DEA_CG)							
Radiological workers	48,000	2040	2041	2	24,000	12	25
Nonradiological workers							
On site	54,000	2040	2041	2	27,000	13	
Off site	N/A						
Effluent Treatment Facility (Original) (DEA_ETFO)							
Radiological workers	77,300	2026	2026	1	77,300	38	48
Nonradiological workers							
On site	19,300	2026	2026	1	19,300	10	
Off site	N/A						
Effluent Treatment Facility Replacement (DEA_ETF)							
Radiological workers	77,300	2046	2046	1	77,300	38	48
Nonradiological workers							
On site	19,300	2046	2046	1	19,300	10	
Off site	N/A						

Table I–27. Tank Closure Alternative 4 Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
242-A Evaporator (Original) (DEA_EVAO)							
Radiological workers	24,400	2018	2018	1	24,400	12	16
Nonradiological workers							
On site	7,480	2018	2018	1	7,480	4	
Off site	N/A						
242-A Evaporator Replacement (DEA_EVA)							
Radiological workers	24,400	2043	2043	1	24,400	12	16
Nonradiological workers							
On site	7,480	2043	2043	1	7,480	4	
Off site	N/A						
Total	**10,300,000**				**4,270,000**	**2,070**	**2,060**

Notes and Assumptions:
Total number of offsite full-time equivalents = 10.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

Table I–28. Tank Closure Alternative 4 Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Tank-Filling Grout Facility Construction (CLO_CONGRO)							
Radiological workers	480	2031	2032	2	240	1	5
Nonradiological workers							
On site	13,400	2031	2032	2	6,700	4	
Off site	4,160	2031	2032	2	2,080	1	
Tank-Filling Grout Facility Operations (CLO_OPSGRO)							
Radiological workers	54,400	2033	2042	10	5,440	3	11
Nonradiological workers							
On site	148,000	2033	2042	10	14,800	8	
Off site	104,000	2033	2042	10	10,400	5	
Tank-Filling Grout Facility Deactivation (CLO_DEAGRO)							
Radiological workers	480	2043	2043	1	480	1	4
Nonradiological workers							
On site	4,320	2043	2043	1	4,320	3	
Off site	1,040	2043	2043	1	1,040	1	
Ancillary Equipment Grouting (CLO_ANCFIL)							
Radiological workers	262,000	2012	2032	21	12,500	7	7
Nonradiological workers							
On site	N/A						
Off site	N/A						

Table I–28. Tank Closure Alternative 4 Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Containment Structure Construction (CLO_CONCS)							
Radiological workers	2,000	2018	2021	4	500	1	4
Nonradiological workers							
On site	20,000	2018	2021	4	5,000	3	
Off site	N/A						
Containment Structure Deactivation (CLO_DEACS)							
Radiological workers	2,000	2042	2044	3	667	1	5
Nonradiological workers							
On site	20,000	2042	2044	3	6,670	4	
Off site	N/A						
Modified Resource Conservation and Recovery Act Subtitle C Barrier Construction (CLO_RCRA)							
Radiological workers	800,000	2038	2044	7	114,000	55	220
Nonradiological workers							
On site	2,400,000	2038	2044	7	343,000	165	
Off site	N/A						
Decontamination and Decommissioning of 10 Selected Facilities (CLO_D&DTEN)							
Radiological workers	44,400	2018	2028	11	4,040	2	9
Nonradiological workers							
On site	147,000	2018	2028	11	13,400	7	
Off site	79,000	2018	2028	11	7,180	4	
Postclosure Care (CLO_POST)							
Radiological workers	N/A						3
Nonradiological workers							
On site	471,000	2045	2144	100	4,710	3	
Off site	N/A						
Removal of BX Tank Farm Tanks, Ancillary Equipment, and Soils (CLO_REMTBX)							
Radiological workers	520,000	2022	2033	12	43,300	21	55
Nonradiological workers							
On site	824,000	2022	2033	12	68,700	34	
Off site	N/A						
Removal of Deep Soil–BX Tank Farm (CLO_REMSBX)							
Radiological workers	293,000	2034	2041	8	36,600	18	39
Nonradiological workers							
On site	339,000	2034	2041	8	42,400	21	
Off site	N/A						
Removal of SX Tank Farm Tanks, Ancillary Equipment, and Soils (CLO_REMTSX)							
Radiological workers	649,000	2022	2033	12	54,100	27	69
Nonradiological workers							
On site	1,030,000	2022	2033	12	85,800	42	
Off site	N/A						
Removal of Deep Soil–SX Tank Farm (CLO_REMSSX)							
Radiological workers	896,000	2034	2041	8	112,000	54	117
Nonradiological workers							
On site	1,040,000	2034	2041	8	130,000	63	
Off site	N/A						

Table I–28. Tank Closure Alternative 4 Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Preprocessing Facility Construction (CLO_CONPPF)							
Radiological workers	N/A						2,390
Nonradiological workers							
On site	14,900,000	2019	2021	3	4,970,000	2,390	
Off site	5,040,000	2019	2021	3	1,680,000	808	
Preprocessing Facility Operations (CLO_OPSPPF)							
Radiological workers	3,890,000	2022	2042	21	185,000	89	92
Nonradiological workers							
On site	120,000	2022	2042	21	5,710	3	
Off site	N/A						
Preprocessing Facility Deactivation (CLO_DEAPPF)							
Radiological workers	195,000	2043	2043	1	195,000	94	97
Nonradiological workers							
On site	5,990	2043	2043	1	5,990	3	
Off site	N/A						
Total	**34,300,000**				**8,170,000**	**3,950**	**3,130**

Notes and Assumptions:
Total number of offsite full-time equivalents = 820.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

I.2.8 Tank Closure Alternative 5: Expanded WTP Vitrification with Supplemental Treatment Technologies; Landfill Closure

Table I–29. Tank Closure Alternative 5 Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Canister Storage Building (CON_CSB)							
Radiological workers	116,000	2006	2016	11	10,500	6	12
Nonradiological workers							
On site	136,000	2006	2016	11	12,400	6	
Off site	50,300	2006	2016	11	4,570	3	
Immobilized High-Level Radioactive Waste Shipping/Transfer Facility (CON_STF)							
Radiological workers	N/A						381
Nonradiological workers							
Onsite construction	1,760,000	2011	2013	3	587,000	283	
Onsite exempt	610,000	2011	2013	3	203,000	98	
Offsite design	748,000	2011	2013	3	249,000	120	

Table I–29. Tank Closure Alternative 5 Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Module (CON_ISM)							
Radiological workers	N/A						
Nonradiological workers							
Onsite construction	1,780,000	2014	2019	6	297,000	143	231
Onsite exempt	1,100,000	2014	2019	6	183,000	88	
Offsite design	1,350,000	2014	2019	6	225,000	109	
Other Infrastructure Upgrades (CON_OIU)							
Radiological workers	782,000	2006	2034	29	27,000	13	
Nonradiological workers							45
On site	1,920,000	2006	2034	29	66,200	32	
Off site	743,000	2006	2034	29	25,600	13	
Tank Upgrades (CON_TU)							
Radiological workers	1,200,000	2006	2025	20	60,000	29	
Nonradiological workers							104
On site	3,110,000	2006	2025	20	156,000	75	
Off site	1,180,000	2006	2025	20	59,000	29	
Underground Transfer Lines (CON_UTL)							
Radiological workers	N/A						
Nonradiological workers							61
On site	126,000	2009	2009	1	126,000	61	
Off site	17,400	2009	2009	1	17,400	9	
Waste Treatment Plant (CON_WTP)							
Radiological workers	N/A						
Nonradiological workers							904
On site	22,600,000	2006	2017	12	1,880,000	904	
Off site	7,540,000	2006	2017	12	628,000	302	
Cesium and Strontium Capsule Processing Facility (CON_CSC)							
Radiological workers	N/A						
Nonradiological workers							190
On site	1,580,000	2029	2032	4	395,000	190	
Off site	466,000	2029	2032	4	117,000	57	
Waste Receiver Facilities (CON_WRF)							
Radiological workers	N/A						
Nonradiological workers							454
On site	4,720,000	2013	2017	5	944,000	454	
Off site	1,700,000	2013	2017	5	340,000	164	
Tank Risers (CON_RIS)							
Radiological workers	173,000	2013	2016	4	43,300	21	
Nonradiological workers							50
On site	233,000	2013	2016	4	58,300	29	
Off site	N/A						
Double-Shell Tank Replacement (CON_DST)							
Radiological workers	N/A						
Nonradiological workers							144
On site	1,790,000	2014	2019	6	298,000	144	
Off site	644,000	2014	2019	6	107,000	52	

Table I–29. Tank Closure Alternative 5 Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Sulfate Removal Facility (CON_SUL)							
Radiological workers	N/A						722
Nonradiological workers							
On site	3,000,000	2016	2017	2	1,500,000	722	
Off site	1,010,000	2016	2017	2	505,000	243	
Modified Sluicing Retrieval System (CON_MS)							
Radiological workers	2,780,000	2013	2033	21	132,000	64	165
Nonradiological workers							
On site	4,390,000	2013	2033	21	209,000	101	
Off site	1,550,000	2013	2033	21	73,800	36	
Mobile Retrieval System (CON_MRS)							
Radiological workers	8,100,000	2013	2023	11	736,000	354	745
Nonradiological workers							
On site	8,940,000	2013	2023	11	813,000	391	
Off site	4,790,000	2013	2023	11	435,000	210	
Vacuum-Based Retrieval System (CON_VBR)							
Radiological workers	11,200,000	2024	2033	10	1,120,000	539	1,120
Nonradiological workers							
On site	12,000,000	2024	2033	10	1,200,000	577	
Off site	6,820,000	2024	2033	10	682,000	328	
High-Level Radioactive Waste Melter Interim Storage Facilities (CON_PAD)							
Radiological workers	N/A						1
Nonradiological workers							
On site	2,810	2015	2016	2	1,410	1	
Off site	N/A						
Contact-Handled Mixed Transuranic Waste Facilities (CON_CH)							
Radiological workers	N/A						61
Nonradiological workers							
On site	125,000	2008	2008	1	125,000	61	
Off site	42,100	2008	2008	1	42,100	21	
Remote-Handled Mixed Transuranic Waste Facility (CON_RH)							
Radiological workers	N/A						38
Nonradiological workers							
On site	154,000	2013	2014	2	77,000	38	
Off site	51,900	2013	2014	2	26,000	13	
Transuranic Waste Interim Storage Facility (CON_TRU)							
Radiological workers	N/A						4
Nonradiological workers							
On site	16,400	2008	2009	2	8,200	4	
Off site	N/A						
Bulk Vitrification Facility (200-West Area) (CON_BV)							
Radiological workers	N/A						165
Nonradiological workers							
On site	684,000	2016	2017	2	342,000	165	
Off site	231,000	2016	2017	2	116,000	56	

Table I–29. Tank Closure Alternative 5 Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Solid-Liquid Separations Facility (200-West Area) (CON_SEPW)							
Radiological workers	N/A						38
Nonradiological workers							
On site	156,000	2016	2017	2	78,000	38	
Off site	52,800	2016	2017	2	26,400	13	
Cast Stone Facility (200-East Area) (CON_CG)							
Radiological workers	N/A						113
Nonradiological workers							
On site	467,000	2016	2017	2	234,000	113	
Off site	158,000	2015	2016	2	79,000	38	
Effluent Treatment Facility Replacement (CON_ETF)							
Radiological workers	N/A						329
Nonradiological workers							
On site	2,050,000	2023	2025	3	683,000	329	
Off site	704,000	2023	2025	3	235,000	113	
242-A Evaporator Replacement (CON_EVA)							
Radiological workers	N/A						102
Nonradiological workers							
On site	635,000	2015	2017	3	212,000	102	
Off site	218,000	2015	2017	3	72,700	35	
Total	**129,000,000**				**16,900,000**	**8,140**	**6,180**

Notes and Assumptions:
Total number of offsite full-time equivalents = 1,960.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

Table I–30. Tank Closure Alternative 5 Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (OPS_ISF)							
Radiological workers	2,700,000	2018	2034	17	159,000	77	120
Nonradiological workers							
On site	1,510,000	2018	2034	17	88,800	43	
Off site	N/A						
Other Infrastructure Upgrades (OPS_OIU)							
Radiological workers	33,100	2006	2033	28	1,180	1	4
Nonradiological workers							
On site	121,000	2006	2033	28	4,320	3	
Off site	86,500	2006	2033	28	3,090	2	
Routine Operations (OPS_ROUT)							
Radiological workers	7,280,000	2006	2033	28	260,000	125	650
Nonradiological workers							
On site	30,600,000	2006	2033	28	1,090,000	525	
Off site	4,340,000	2006	2033	28	155,000	75	

Table I–30. Tank Closure Alternative 5 Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Retrieval Operations (OPS_RET)							
Radiological workers	9,550	2006	2033	28	341	1	28
Nonradiological workers							
On site	1,560,000	2006	2033	28	55,700	27	
Off site	12,100	2006	2033	28	432	1	
Interim Stabilization/Double-Shell Tanks (OPS_IST)							
Radiological workers	1,030,000	2006	2033	28	36,800	18	44
Nonradiological workers							
On site	1,470,000	2006	2033	28	52,500	26	
Off site	1,620,000	2006	2033	28	57,900	28	
Waste Treatment Plant (OPS_WTP)							
Radiological workers	33,500,000	2018	2033	16	2,090,000	1,010	1,700
Nonradiological workers							
On site	23,000,000	2018	2033	16	1,440,000	693	
Off site	3,000	2018	2033	16	188	1	
Waste Treatment Plant—Cesium and Strontium Capsules (OPS_WTPCSC)							
Radiological workers	2,100,000	2034	2034	1	2,100,000	1,010	1,700
Nonradiological workers							
On site	1,440,000	2034	2034	1	1,440,000	693	
Off site	N/A						
Cesium and Strontium Capsule Processing Facility (OPS_CSC)							
Radiological workers	103,000	2033	2034	2	51,500	25	25
Nonradiological workers							
On site	N/A						
Off site	N/A						
Double-Shell Tank Replacements (OPS_DST)							
Radiological workers	2,140	2020	2033	14		1	13
Nonradiological workers							
On site	349,000	2020	2033	14	24,900	12	
Off site	2,710	2020	2033	14	194	1	
Sulfate Removal Facility (OPS_SUL)							
Radiological workers	6,280,000	2018	2033	16	393,000	189	236
Nonradiological workers							
On site	1,560,000	2018	2033	16	97,500	47	
Off site	N/A						
Modified Sluicing Retrieval System (OPS_MS)							
Radiological workers	4,180,000	2013	2033	21	199,000	96	159
Nonradiological workers							
On site	2,730,000	2013	2033	21	130,000	63	
Off site	N/A						
Mobile Retrieval System (OPS_MRS)							
Radiological workers	5,170,000	2013	2023	11	470,000	226	431
Nonradiological workers							
On site	4,680,000	2013	2023	11	425,000	205	
Off site	N/A						

Table I–30. Tank Closure Alternative 5 Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Vacuum-Based Retrieval System (OPS_VBR)							
Radiological workers	7,670,000	2024	2033	10	767,000	369	703
Nonradiological workers							
On site	6,940,000	2024	2033	10	694,000	334	
Off site	N/A						
High-Level Radioactive Waste Melter Interim Storage Facilities (OPS_PAD)							
Radiological workers	N/A	2018	2139	122	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Contact-Handled Mixed Transuranic Waste Facilities (OPS_CH)							
Radiological workers	200,000	2009	2010	2	100,000	49	49
Nonradiological workers							
On site	N/A						
Off site	N/A						
Remote-Handled Mixed Transuranic Waste Facility (OPS_RH)							
Radiological workers	1,000,000	2015	2019	5	200,000	97	97
Nonradiological workers							
On site	N/A						
Off site	N/A						
Transuranic Waste Interim Storage Facility (OPS_TRU)							
Radiological workers	N/A	2009	2034	26	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Bulk Vitrification Facility (200-West Area) (OPS_BV)							
Radiological workers	3,400,000	2018	2033	16	213,000	103	128
Nonradiological workers							
On site	828,000	2018	2033	16	51,800	25	
Off site	N/A						
Solid-Liquid Separations Facility (200-West Area) (OPS_SEPW)							
Radiological workers	2,800,000	2018	2033	16	175,000	85	111
Nonradiological workers							
On site	850,000	2018	2033	16	53,100	26	
Off site	N/A						
Cast Stone Facility (200-East Area) (OPS_CG)							
Radiological workers	912,000	2018	2033	16	57,000	28	59
Nonradiological workers							
On site	1,030,000	2018	2033	16	64,400	31	
Off site	N/A						
Effluent Treatment Facility Replacement (OPS_ETF)							
Radiological workers	4,790,000	2006	2036	31	155,000	75	94
Nonradiological workers							
On site	1,200,000	2006	2036	31	38,700	19	
Off site	N/A						

Table I–30. Tank Closure Alternative 5 Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
242-A Evaporator Replacement (OPS_EVA)							
Radiological workers	1,420,000	2006	2034	29	49,000	24	32
Nonradiological workers							
On site	434,000	2006	2034	29	15,000	8	
Off site	N/A						
Borrow Area C (OPS_CAREA)							
Radiological workers	N/A						43
Nonradiological workers							
On site	4,200,000	2006	2052	47	89,400	43	
Off site	N/A						
Total	**175,000,000**				**13,500,000**	**6,540**	**6,430**

Notes and Assumptions:
Total number of offsite full-time equivalents = 110.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
For Waste Treatment Plant, Sulfate Removal Facility, 200-East and 200-West Area Bulk Vitrification Facility, and Cast Stone Facility operations, no allowance was made for full-time equivalents in ramp-up years.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

Table I–31. Tank Closure Alternative 5 Deactivation Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (DEA_ISF)							
Radiological workers	N/A						1
Nonradiological workers							
On site	160	2035	2035	1	160	1	
Off site	N/A						
Waste Treatment Plant (DEA_WTP)							
Radiological workers	4,190,000	2035	2036	2	2,100,000	1,010	1,700
Nonradiological workers							
On site	2,880,000	2035	2036	2	1,440,000	693	
Off site	N/A						
Cesium and Strontium Capsule Processing Facility (DEA_CSC)							
Radiological workers	23,900	2035	2035	1	23,900	12	12
Nonradiological workers							
On site	N/A						
Off site	N/A						
Modified Sluicing Retrieval System (DEA_MS)							
Radiological workers	210,000	2013	2033	21	10,000	5	5
Nonradiological workers							
On site	N/A						
Off site	N/A						

Table I–31. Tank Closure Alternative 5 Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Mobile Retrieval System (DEA_MRS)							
Radiological workers	680,000	2013	2023	11	61,800	30	30
Nonradiological workers							
On site	N/A						
Off site	N/A						
Vacuum-Based Retrieval System (DEA_VBR)							
Radiological workers	258,000	2024	2033	10	25,800	13	13
Nonradiological workers							
On site	N/A						
Off site	N/A						
Sulfate Removal Facility (DEA_SUL)							
Radiological workers	661,000	2034	2035	2	331,000	160	200
Nonradiological workers							
On site	164,000	2034	2035	2	82,000	40	
Off site	N/A						
Contact-Handled Mixed Transuranic Waste Facilities (DEA_CH)							
Radiological workers	100,000	2011	2012	2	50,000	25	25
Nonradiological workers							
On site	N/A						
Off site	N/A						
Remote-Handled Mixed Transuranic Waste Facility (DEA_RH)							
Radiological workers	200,000	2020	2021	2	100,000	49	49
Nonradiological workers							
On site	N/A						
Off site	N/A						
Transuranic Waste Interim Storage Facility (DEA_TRU)							
Radiological workers	N/A						1
Nonradiological workers							
On site	80	2035	2035	1	80	1	
Off site	N/A						
Bulk Vitrification Facility (200-West Area) (DEA_BV)							
Radiological workers	148,000	2034	2035	2	74,000	36	45
Nonradiological workers							
On site	36,000	2034	2035	2	18,000	9	
Off site	N/A						
Solid-Liquid Separations Facility (200-West Area) (DEA_SEPW)							
Radiological workers	122,000	2034	2035	2	61,000	30	39
Nonradiological workers							
On site	37,000	2034	2035	2	18,500	9	
Off site	N/A						
Cast Stone Facility (200-East Area) (DEA_CG)							
Radiological workers	48,000	2034	2035	2	24,000	12	25
Nonradiological workers							
On site	54,000	2034	2035	2	27,000	13	
Off site	N/A						

Table I–31. Tank Closure Alternative 5 Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Effluent Treatment Facility (Original) (DEA_ETFO)							
Radiological workers	77,300	2026	2026	1	77,300	38	48
Nonradiological workers							
On site	19,300	2026	2026	1	19,300	10	
Off site	N/A						
Effluent Treatment Facility Replacement (DEA_ETF)							
Radiological workers	77,300	2037	2037	1	77,300	38	48
Nonradiological workers							
On site	19,300	2037	2037	1	19,300	10	
Off site	N/A						
242-A Evaporator (Original) (DEA_EVAO)							
Radiological workers	24,400	2018	2018	1	24,400	12	16
Nonradiological workers							
On site	7,480	2018	2018	1	7,480	4	
Off site	N/A						
242-A Evaporator Replacement (DEA_EVA)							
Radiological workers	24,400	2035	2035	1	24,400	12	16
Nonradiological workers							
On site	7,480	2035	2035	1	7,480	4	
Off site	N/A						
Total	**10,100,000**				**4,700,000**	**2,280**	**2,270**

Notes and Assumptions:
Total number of offsite full-time equivalents = 10.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

Table I–32. Tank Closure Alternative 5 Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Tank-Filling Grout Facility Construction (CLO_CONGRO)							
Radiological workers	480	2022	2023	2	240	1	5
Nonradiological workers							
On site	13,400	2022	2023	2	6,700	4	
Off site	4,160	2022	2023	2	2,080	1	
Tank-Filling Grout Facility Operations (CLO_OPSGRO)							
Radiological workers	68,000	2024	2033	10	6,800	4	13
Nonradiological workers							
On site	185,000	2024	2033	10	18,500	9	
Off site	130,000	2024	2033	10	13,000	7	
Tank-Filling Grout Facility Deactivation (CLO_DEAGRO)							
Radiological workers	480	2034	2034	1	480	1	4
Nonradiological workers							
On site	4,320	2034	2034	1	4,320	3	
Off site	1,040	2034	2034	1	1,040	1	

Table I–32. Tank Closure Alternative 5 Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Ancillary Equipment Grouting (CLO_ANCFIL)							
Radiological workers	287,000	2013	2033	21	13,700	7	7
Nonradiological workers							
On site	N/A						
Off site	N/A						
Hanford Barrier Construction (CLO_HAN)							
Radiological workers	2,380,000	2029	2039	11	216,000	104	417
Nonradiological workers							
On site	7,150,000	2029	2039	11	650,000	313	
Off site	N/A						
Decontamination and Decommissioning of 10 Selected Facilities (CLO_D&DTEN)							
Radiological workers	44,400	2012	2022	11	4,040	2	9
Nonradiological workers							
On site	147,000	2012	2022	11	13,400	7	
Off site	79,000	2012	2022	11	7,180	4	
Postclosure Care (CLO_POST)							
Radiological workers	N/A						3
Nonradiological workers							
On site	471,000	2040	2139	100	4,710	3	
Off site	N/A						
Total	**11,000,000**				**962,000**	**471**	**458**

Notes and Assumptions:
Total number of offsite full-time equivalents = 13.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

I.2.9 Tank Closure Alternative 6A: All Vitrification/No Separations; Clean Closure–Base Case

Table I–33. Tank Closure Alternative 6A, Base Case, Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Canister Storage Building (CON_CSB)							
Radiological workers	116,000	2006	2016	11	10,500	6	12
Nonradiological workers							
On site	136,000	2006	2016	11	12,400	6	
Off site	50,300	2006	2016	11	4,570	3	
Immobilized High-Level Radioactive Waste Shipping/Transfer Facility (CON_STF)							
Radiological workers	N/A						381
Nonradiological workers							
Onsite construction	1,760,000	2011	2013	3	587,000	283	
Onsite exempt	610,000	2011	2013	3	203,000	98	
Offsite design	748,000	2011	2013	3	249,000	120	

Table I–33. Tank Closure Alternative 6A, Base Case, Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Modules (CON_ISM)							
Radiological workers	N/A						
Nonradiological workers							
Onsite construction	57,000,000	2014	2142	129	442,000	213	345
Onsite exempt	35,200,000	2014	2142	129	273,000	132	
Offsite design	43,200,000	2014	2142	129	335,000	162	
Other Infrastructure Upgrades (CON_OIU)							
Radiological workers	782,000	2006	2034	29	27,000	13	
Nonradiological workers							45
On site	1,920,000	2006	2034	29	66,200	32	
Off site	743,000	2006	2034	29	25,600	13	
Tank Upgrades (CON_TU)							
Radiological workers	1,200,000	2006	2025	20	60,000	29	
Nonradiological workers							104
On site	3,110,000	2006	2025	20	156,000	75	
Off site	1,180,000	2006	2025	20	59,000	29	
Underground Transfer Lines (CON_UTL)							
Radiological workers	N/A						
Nonradiological workers							61
On site	126,000	2009	2009	1	126,000	61	
Off site	17,400	2009	2009	1	17,400	9	
Waste Treatment Plant (CON_WTP)							
Radiological workers	N/A						
Nonradiological workers							904
On site	22,600,000	2006	2017	12	1,880,000	904	
Off site	7,540,000	2006	2017	12	628,000	302	
Cesium and Strontium Capsule Processing Facility (CON_CSC)							
Radiological workers	N/A						
Nonradiological workers							190
On site	1,580,000	2158	2161	4	395,000	190	
Off site	466,000	2158	2161	4	117,000	57	
Tank Risers (CON_RIS)							
Radiological workers	189,000	2013	2016	4	47,300	23	
Nonradiological workers							54
On site	255,000	2013	2016	4	63,800	31	
Off site	N/A						
Double-Shell Tank Replacements (CON_DST)[a]							
Radiological workers	N/A						
Nonradiological workers							1,010
On site	37,600,000	2029	2114	18	2,090,000	1,010	
Off site	13,500,000	2029	2114	18	750,000	361	

Table I–33. Tank Closure Alternative 6A, Base Case, Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Mobile Retrieval System (CON_MRS)							
Radiological workers	33,100,000	2013	2162	150	221,000	107	224
Nonradiological workers							
On site	36,500,000	2013	2162	150	243,000	117	
Off site	19,600,000	2013	2162	150	131,000	63	
Vacuum-Based Retrieval System (CON_VBR)							
Radiological workers	9,690,000	2013	2162	150	64,600	32	66
Nonradiological workers							
On site	10,300,000	2013	2162	150	68,700	34	
Off site	5,900,000	2013	2162	150	39,300	19	
Chemical Wash System (CON_CHW)							
Radiological workers	3,060,000	2013	2162	150	20,400	10	12
Nonradiological workers							
On site	607,000	2013	2162	150	4,050	2	
Off site	818,000	2013	2162	150	5,450	3	
High-Level Radioactive Waste Melter Interim Storage Facilities (CON_PAD)[b]							
Radiological workers	N/A						1
Nonradiological workers							
On site	19,700	2017	2138	14	1,410	1	
Off site	N/A						
Underground Transfer Line Replacements (CON_UTLU)							
Radiological workers	N/A						61
Nonradiological workers							
On site	126,000	2064	2064	1	126,000	61	
Off site	17,400	2064	2064	1	17,400	9	
Waste Treatment Plant Replacement (CON_WTPU)[c]							
Radiological workers	N/A						678
Nonradiological workers							
On site	33,800,000	2067	2138	24	1,410,000	678	
Off site	11,300,000	2067	2138	24	471,000	227	
Immobilized High-Level Radioactive Waste Shipping/Transfer Facility Replacement (CON_STFU)[d]							
Radiological workers	N/A						380
Nonradiological workers							
Onsite construction	3,510,000	2070	2132	6	585,000	282	
Onsite exempt	1,220,000	2070	2132	6	203,000	98	
Offsite design	1,500,000	2070	2132	6	250,000	121	
Immobilized High-Level Radioactive Waste Interim Storage Module Replacement (CON_ISMU)							
Radiological workers	N/A						351
Nonradiological workers							
Onsite construction	39,200,000	2074	2160	87	451,000	217	
Onsite exempt	24,200,000	2074	2160	87	278,000	134	
Offsite design	29,700,000	2074	2160	87	341,000	164	

Table I–33. Tank Closure Alternative 6A, Base Case, Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
High-Level Radioactive Waste Debris Storage Facilities (CON_HLWST)							
Radiological workers	N/A						
Nonradiological workers							
On site	577,000	2041	2110	70	8,240	4	4
Off site	N/A						
Effluent Treatment Facility Replacement (CON_ETF)							
Radiological workers	N/A						
Nonradiological workers							
On site	2,050,000	2023	2025	3	683,000	329	329
Off site	704,000	2023	2025	3	235,000	113	
Effluent Treatment Facility Replacement (CON_ETFU)[e]							
Radiological workers	N/A						
Nonradiological workers							
On site	8,190,000	2053	2145	12	683,000	329	329
Off site	865,000	2053	2145	12	72,100	35	
242-A Evaporator Replacement (CON_EVA)							
Radiological workers	N/A						
Nonradiological workers							
On site	635,000	2015	2017	3	212,000	102	102
Off site	218,000	2015	2017	3	72,700	35	
242-A Evaporator Replacement (CON_EVAU) Five 3-year construction periods[f]							
Radiological workers	N/A						
Nonradiological workers							
On site	3,180,000	2040	2142	15	212,000	102	102
Off site	1,150,000	2040	2142	15	76,700	37	
Total	**513,000,000**				**15,800,000**	**7,630**	**5,740**

[a] Replacement double-shell tanks construction activities would occur over three 6-year periods, totaling 18 years.
Period 1, 2029–2034
Period 2, 2069–2074
Period 3, 2109–2114

[b] High-Level Radioactive Waste Melter Interim Storage Facilities construction activities would occur over seven 2-year periods, totaling 14 years.
Period 1, 2017–2018
Period 2, 2037–2038
Period 3, 2057–2058
Period 4, 2077–2078
Period 5, 2097–2098
Period 6, 2117–2118
Period 7, 2137–2138

[c] Replacement Waste Treatment Plant construction activities would occur over two 12-year periods, totaling 24 years.
Period 1, 2067–2078
Period 2, 2127–2138

[d] Replacement Immobilized High-Level Radioactive Waste Shipping/Transfer Facility construction activities would occur over two 3-year periods, totaling 6 years.
Period 1, 2070–2072
Period 2, 2130–2132

Table I–33. Tank Closure Alternative 6A, Base Case, Construction Rollup Workforce Estimate *(continued)*

[e] Replacement Effluent Treatment Facility construction activities would occur over four 3-year periods, totaling 12 years.
Period 1, 2053–2055
Period 2, 2083–2085
Period 3, 2113–2115
Period 4, 2143–2145

[f] Replacement 242-A Evaporator construction activities would occur over five 3-year periods, totaling 15 years.
Period 1, 2040–2042
Period 2, 2065–2067
Period 3, 2090–2092
Period 4, 2115–2117
Period 5, 2140–2142

Notes and Assumptions:
Total number of offsite full-time equivalents = 1,890.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–34. Tank Closure Alternative 6A, Base Case, Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (OPS_ISF)							
Radiological workers	256,000,000	2018	2163	146	1,750,000	842	1,310
Nonradiological workers							
On site	143,000,000	2018	2163	146	979,000	471	
Off site	N/A						
Other Infrastructure Upgrades (OPS_OIU)							
Radiological workers	186,000	2006	2162	157	1,180	1	4
Nonradiological workers							
On site	680,000	2006	2162	157	4,330	3	
Off site	485,000	2006	2162	157	3,090	2	
Routine Operations (OPS_ROUT)							
Radiological workers	40,800,000	2006	2162	157	260,000	125	654
Nonradiological workers							
On site	172,000,000	2006	2162	157	1,100,000	529	
Off site	24,300,000	2006	2162	157	155,000	75	
Retrieval Operations (OPS_RET)							
Radiological workers	53,500	2006	2162	157	341	1	28
Nonradiological workers							
On site	8,720,000	2006	2162	157	55,500	27	
Off site	67,800	2006	2162	157	432	1	
Interim Stabilization/Double-Shell Tanks (OPS_IST)							
Radiological workers	5,760,000	2006	2162	157	36,700	18	44
Nonradiological workers							
On site	8,250,000	2006	2162	157	52,500	26	
Off site	9,110,000	2006	2162	157	58,000	28	

Table I–34. Tank Closure Alternative 6A, Base Case, Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Waste Treatment Plant (OPS_WTP)							
Radiological workers	388,000,000	2018	2162	145	2,680,000	1,290	2,170
Nonradiological workers							
On site	266,000,000	2018	2162	145	1,830,000	880	
Off site	39,000	2018	2162	145	269	1	
Waste Treatment Plant—Cesium and Strontium Capsules (OPS_WTPCSC)							
Radiological workers	2,680,000	2163	2163	1	2,680,000	1,290	2,180
Nonradiological workers							
On site	1,840,000	2163	2163	1	1,840,000	885	
Off site	269	2163	2163	1	269	1	
Cesium and Strontium Capsule Processing Facility (OPS_CSC)							
Radiological workers	103,000	2162	2163	2	51,500	25	25
Nonradiological workers							
On site	N/A						
Off site	N/A						
Mobile Retrieval System (OPS_MRS)							
Radiological workers	21,100,000	2013	2162	150	141,000	68	130
Nonradiological workers							
On site	19,100,000	2013	2162	150	127,000	62	
Off site	N/A						
Vacuum-Based Retrieval System (OPS_VBR)							
Radiological workers	6,630,000	2013	2162	150	44,200	22	42
Nonradiological workers							
On site	6,000,000	2013	2162	150	40,000	20	
Off site	N/A						
Chemical Wash System (OPS_CHW)							
Radiological workers	13,900,000	2013	2162	150	92,700	45	86
Nonradiological workers							
On site	12,600,000	2013	2162	150	84,000	41	
Off site	N/A						
High-Level Radioactive Waste Melter Interim Storage Facilities (OPS_PAD)							
Radiological workers	N/A	2018	2262	245	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
High-Level Radioactive Waste Debris Storage Facilities (OPS_HLWST)							
Radiological workers	N/A	2042	2153	112	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Effluent Treatment Facility Replacement (OPS_ETF)							
Radiological workers	24,900,000	2006	2166	161	155,000	75	94
Nonradiological workers							
On site	6,220,000	2006	2166	161	38,600	19	
Off site	N/A						

Table I–34. Tank Closure Alternative 6A, Base Case, Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
242-A Evaporator Replacement (OPS_EVA)							
Radiological workers	7,140,000	2018	2163	146	48,900	24	32
Nonradiological workers							
On site	2,180,000	2018	2163	146	14,900	8	
Off site	N/A						
Borrow Area C (OPS_CAREA)							
Radiological workers	N/A						44
Nonradiological workers							
On site	14,500,000	2006	2167	162	89,500	44	
Off site	N/A						
Total	**1,460,000,000**				**14,400,000**	**6,950**	**6,840**

Notes and Assumptions:
Total number of offsite full-time equivalents = 110.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

Table I–35. Tank Closure Alternative 6A, Base Case, Deactivation Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (DEA_ISF)							
Radiological workers	N/A						1
Nonradiological workers							
On site	3,040	2078	2188	111	27	1	
Off site	N/A						
Waste Treatment Plant (DEA_WTP)[a]							
Radiological workers	13,500,000	2078	2166	9	1,500,000	722	1,220
Nonradiological workers							
On site	9,240,000	2078	2166	9	1,030,000	496	
Off site	N/A						
Mobile Retrieval System (DEA_MRS)							
Radiological workers	2,780,000	2013	2162	150	18,500	9	9
Nonradiological workers							
On site	N/A						
Off site	N/A						
Vacuum-Based Retrieval System (DEA_VBR)							
Radiological workers	223,000	2013	2162	150	1,490	1	1
Nonradiological workers							
On site	N/A						
Off site	N/A						

Table I–35. Tank Closure Alternative 6A, Base Case, Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Chemical Wash System (DEA_CHW)							
Radiological workers	185,000	2013	2162	150	1,230	1	1
Nonradiological workers							
On site	N/A						
Off site	N/A						
Cesium and Strontium Capsule Processing Facility (DEA_CSC)							
Radiological workers	23,900	2164	2164	1	23,900	12	12
Nonradiological workers							
On site	N/A						
Off site	N/A						
Effluent Treatment Facility Replacement (DEA_ETF)[b]							
Radiological workers	464,000	2026	2167	6	77,300	38	48
Nonradiological workers							
On site	116,000	2026	2167	6	19,300	10	
Off site	N/A						
Packaged HLW Debris Storage Facility (DEA_HLWST)							
Radiological workers	N/A						1
Nonradiological workers							
On site	35	2154	2154	1	35	1	
Off site	N/A						
242-A Evaporator Replacement (DEA_EVA)[c]							
Radiological workers	171,000	2018	2168	7	24,400	12	16
Nonradiological workers							
On site	52,300	2018	2168	7	7,470	4	
Off site	N/A						
Total	**26,800,000**				**2,700,000**	**1,310**	**1,310**

[a] Waste Treatment Plant deactivation activities would occur over three 3-year periods, totaling 9 years.
Period 1, 2078–2080
Period 2, 2138–2140
Period 3, 2164–2166

[b] Effluent Treatment Facility deactivation activities would occur over six 1-year periods, totaling 6 years.
Period 1, 2026–2026
Period 2, 2056–2056
Period 3, 2086–2086
Period 4, 2116–2116
Period 5, 2146–2146
Period 6, 2167–2167

[c] Replacement 242-A Evaporator deactivation activities would occur over seven 1-year periods, totaling 7 years.
Period 1, 2018–2018
Period 2, 2043–2043
Period 3, 2068–2068
Period 4, 2093–2093
Period 5, 2118–2118
Period 6, 2143–2143
Period 7, 2168–2168

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: HLW=high-level radioactive waste; N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–36. Tank Closure Alternative 6A, Base Case, Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Containment Structure Construction (CLO_CONCS)[a]							
Radiological workers	12,000	2038	2141	24	500	1	4
Nonradiological workers							
On site	120,000	2038	2141	24	5,000	3	
Off site	N/A						
Containment Structure Deactivation (CLO_DEACS)[b]							
Radiological workers	12,000	2062	2164	21	571	1	4
Nonradiological workers							
On site	120,000	2062	2164	21	5,710	3	
Off site	N/A						
Decontamination and Decommissioning of 10 Selected Facilities (CLO_D&DTEN)							
Radiological workers	44,400	2018	2028	11	4,040	2	9
Nonradiological workers							
On site	147,000	2018	2028	11	13,400	7	
Off site	79,000	2018	2028	11	7,180	4	
Modified Resource Conservation and Recovery Act Subtitle C Barrier (CLO_RCRA)							
Radiological workers	429,000	2149	2150	2	215,000	104	415
Nonradiological workers							
On site	1,290,000	2149	2150	2	645,000	311	
Off site	N/A						
Postclosure Care (CLO_POST)							
Radiological workers	N/A						3
Nonradiological workers							
On site	471,000	2151	2250	100	4,710	3	
Off site	N/A						
Removal of B Tank Farm (CLO_REMTB)							
Radiological workers	693,000	2065	2076	12	57,800	28	73
Nonradiological workers							
On site	1,100,000	2065	2076	12	91,700	45	
Off site	N/A						
Removal of T Tank Farm (CLO_REMTT)							
Radiological workers	693,000	2126	2137	12	57,800	28	73
Nonradiological workers							
On site	1,100,000	2126	2137	12	91,700	45	
Off site	N/A						
Removal of BY Tank Farm (CLO_REMTBY)							
Radiological workers	520,000	2111	2122	12	43,300	21	55
Nonradiological workers							
On site	824,000	2111	2122	12	68,700	34	
Off site	N/A						
Removal of BX Tank Farm (CLO_REMTBX)							
Radiological workers	520,000	2042	2053	12	43,300	21	55
Nonradiological workers							
On site	824,000	2042	2053	12	68,700	34	
Off site	N/A						

Table I–36. Tank Closure Alternative 6A, Base Case, Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Removal of C Tank Farm (CLO_REMTC)							
Radiological workers	693,000	2088	2099	12	57,800	28	73
Nonradiological workers							
On site	1,100,000	2088	2099	12	91,700	45	
Off site	N/A						
Removal of A Tank Farm (CLO_REMTA)							
Radiological workers	260,000	2142	2153	12	21,700	11	28
Nonradiological workers							
On site	412,000	2142	2153	12	34,300	17	
Off site	N/A						
Removal of AX Tank Farm (CLO_REMTAX)							
Radiological workers	173,000	2142	2153	12	14,400	7	19
Nonradiological workers							
On site	275,000	2142	2153	12	22,900	12	
Off site	N/A						
Removal of S Tank Farm (CLO_REMTS)							
Radiological workers	520,000	2126	2137	12	43,300	21	55
Nonradiological workers							
On site	824,000	2126	2137	12	68,700	34	
Off site	N/A						
Removal of TY Tank Farm (CLO_REMTTY)							
Radiological workers	260,000	2111	2122	12	21,700	11	28
Nonradiological workers							
On site	412,000	2111	2122	12	34,300	17	
Off site	N/A						
Removal of TX Tank Farm (CLO_REMTTX)							
Radiological workers	779,000	2088	2099	12	64,900	32	82
Nonradiological workers							
On site	1,240,000	2088	2099	12	103,000	50	
Off site	N/A						
Removal of U Tank Farm (CLO_REMTU)							
Radiological workers	693,000	2065	2076	12	57,800	28	73
Nonradiological workers							
On site	1,100,000	2065	2076	12	91,700	45	
Off site	N/A						
Removal of SX Tank Farm (CLO_REMTSX)							
Radiological workers	649,000	2042	2053	12	54,100	27	69
Nonradiological workers							
On site	1,030,000	2042	2053	12	85,800	42	
Off site	N/A						
Removal of Deep Soil–B Tank Farm (CLO_REMSB)							
Radiological workers	73,400	2077	2084	8	9,180	5	11
Nonradiological workers							
On site	84,900	2077	2084	8	10,600	6	
Off site	N/A						

Table I–36. Tank Closure Alternative 6A, Base Case, Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Removal of Deep Soil–T Tank Farm (CLO_REMST)							
Radiological workers	564,000	2138	2145	8	70,500	34	74
Nonradiological workers							
On site	652,000	2138	2145	8	81,500	40	
Off site	N/A						
Removal of Deep Soil–BX Tank Farm (CLO_REMSBX)							
Radiological workers	293,000	2054	2061	8	36,600	18	39
Nonradiological workers							
On site	339,000	2054	2061	8	42,400	21	
Off site	N/A						
Removal of Deep Soil–C Tank Farm (CLO_REMSC)							
Radiological workers	4,450	2100	2107	8	556	1	2
Nonradiological workers							
On site	5,140	2100	2107	8	643	1	
Off site	N/A						
Removal of Deep Soil–A Tank Farm (CLO_REMSA)							
Radiological workers	13,300	2154	2161	8	1,660	1	2
Nonradiological workers							
On site	15,400	2154	2161	8	1,930	1	
Off site	N/A						
Removal of Deep Soil–AX Tank Farm (CLO_REMSAX)							
Radiological workers	222,000	2154	2161	8	27,800	14	30
Nonradiological workers							
On site	257,000	2154	2161	8	32,100	16	
Off site	N/A						
Removal of Deep Soil–TX Tank Farm (CLO_REMSTX)							
Radiological workers	701,000	2100	2107	8	87,600	43	92
Nonradiological workers							
On site	810,000	2100	2107	8	101,000	49	
Off site	N/A						
Removal of Deep Soil–U Tank Farm (CLO_REMSU)							
Radiological workers	367,000	2077	2084	8	45,900	23	49
Nonradiological workers							
On site	424,000	2077	2084	8	53,000	26	
Off site	N/A						
Removal of Deep Soil–SX Tank Farm (CLO_REMSSX)							
Radiological workers	896,000	2054	2061	8	112,000	54	117
Nonradiological workers							
On site	1,040,000	2054	2061	8	130,000	63	
Off site	N/A						
Preprocessing Facility Construction (CLO_CONPPF)							
Radiological workers	N/A						2,390
Nonradiological workers							
On site	14,900,000	2039	2041	3	4,970,000	2,390	
Off site	5,040,000	2039	2041	3	1,680,000	808	

Table I–36. Tank Closure Alternative 6A, Base Case, Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Preprocessing Facility Operations (CLO_OPSPPF)							
Radiological workers	13,100,000	2042	2162	121	108,000	52	54
Nonradiological workers							
On site	403,000	2042	2162	121	3,330	2	
Off site	N/A						
Preprocessing Facility Deactivation (CLO_DEAPPF)							
Radiological workers	108,000	2163	2163	1	108,000	52	54
Nonradiological workers							
On site	3,330	2163	2163	1	3,330	2	
Off site	N/A						
Total	**59,700,000**				**10,000,000**	**4,840**	**4,030**

[a] Containment Structure construction activities would occur over six 4-year periods, totaling 24 years.
Period 1, 2038–2041; 2 facilities
Period 2, 2061–2064; 2 facilities
Period 3, 2084–2087; 2 facilities
Period 4, 2107–2110; 2 facilities
Period 5, 2122–2125; 2 facilities
Period 6, 2138–2141; 2 facilities

[b] Containment Structure deactivation activities would occur over seven 3-year periods, totaling 21 years.
Period 1, 2062–2064; 2 facilities
Period 2, 2085–2087; 2 facilities
Period 3, 2108–2110; 2 facilities
Period 4, 2123–2125; 2 facilities
Period 5, 2146–2148; 1 facility
Period 6, 2138–2140; 1 facility
Period 7, 2162–2164; 2 facilities
Formula: Hours per year = (total hours/12 containment structures)/3 years of deactivation per deactivation period.

Notes and Assumptions:
Total number of offsite full-time equivalents = 810.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

I.2.10 Tank Closure Alternative 6A: All Vitrification/No Separations; Clean Closure–Option Case

Table I–37. Tank Closure Alternative 6A, Option Case, Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Canister Storage Building (CON_CSB)							
Radiological workers	116,000	2006	2016	11	10,500	6	12
Nonradiological workers							
On site	136,000	2006	2016	11	12,400	6	
Off site	50,300	2006	2016	11	4,570	3	

Table I–37. Tank Closure Alternative 6A, Option Case, Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Shipping/Transfer Facility (CON_STF)							
Radiological Workers	N/A						
Nonradiological workers							
Onsite construction	1,760,000	2011	2013	3	587,000	283	381
Onsite exempt	610,000	2011	2013	3	203,000	98	
Offsite design	748,000	2011	2013	3	249,000	120	
Immobilized High-Level Radioactive Waste Interim Storage Modules (CON_ISM)							
Radiological Workers	N/A						
Nonradiological workers							
Onsite construction	57,000,000	2014	2142	129	442,000	213	345
Onsite exempt	35,200,000	2014	2142	129	273,000	132	
Offsite design	43,200,000	2014	2142	129	335,000	162	
Other Infrastructure Upgrades (CON_OIU)							
Radiological workers	782,000	2006	2034	29	27,000	13	
Nonradiological workers							45
On site	1,920,000	2006	2034	29	66,200	32	
Off site	743,000	2006	2034	29	25,600	13	
Tank Upgrades (CON_TU)							
Radiological workers	1,200,000	2006	2025	20	60,000	29	
Nonradiological workers							104
On site	3,110,000	2006	2025	20	156,000	75	
Off site	1,180,000	2006	2025	20	59,000	29	
Underground Transfer Lines (CON_UTL)							
Radiological workers	N/A						
Nonradiological workers							61
On site	126,000	2009	2009	1	126,000	61	
Off site	17,400	2009	2009	1	17,400	9	
Waste Treatment Plant (CON_WTP)							
Radiological workers	N/A						
Nonradiological workers							904
On site	22,600,000	2006	2017	12	1,880,000	904	
Off site	7,540,000	2006	2017	12	628,000	302	
Cesium and Strontium Capsule Processing Facility (CON_CSC)							
Radiological workers	N/A						
Nonradiological workers							190
On site	1,580,000	2158	2161	4	395,000	190	
Off site	466,000	2158	2161	4	117,000	57	
Tank Risers (CON_RIS)							
Radiological workers	189,000	2013	2016	4	47,300	23	
Nonradiological workers							54
On site	255,000	2013	2016	4	63,800	31	
Off site	N/A						

Table I–37. Tank Closure Alternative 6A, Option Case, Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Double-Shell Tank Replacement (CON_DST)[a]							
Radiological workers	N/A						
Nonradiological workers							
On site	37,600,000	2029	2114	18	2,090,000	1,010	1,010
Off site	13,500,000	2029	2114	18	750,000	361	
Mobile Retrieval System (CON_MRS)							
Radiological workers	33,100,000	2013	2162	150	221,000	107	
Nonradiological workers							
On site	36,500,000	2013	2162	150	243,000	117	224
Off site	19,600,000	2013	2162	150	131,000	63	
Vacuum-Based Retrieval System (CON_VBR)							
Radiological workers	9,690,000	2013	2162	150	64,600	32	
Nonradiological workers							
On site	10,300,000	2013	2162	150	68,700	34	66
Off site	5,900,000	2013	2162	150	39,300	19	
Chemical Wash System (CON_CHW)							
Radiological workers	3,060,000	2013	2162	150	20,400	10	
Nonradiological workers							
On site	607,000	2013	2162	150	4,050	2	12
Off site	818,000	2013	2162	150	5,450	3	
High-Level Radioactive Waste Melter Interim Storage Facilities (CON_PAD)[b]							
Radiological workers	N/A						
Nonradiological workers							
On site	19,700	2017	2138	14	1,410	1	1
Off site	N/A						
Underground Transfer Line Replacements (CON_UTLU)							
Radiological workers	N/A						
Nonradiological workers							
On site	126,000	2064	2064	1	126,000	61	61
Off site	17,400	2064	2064	1	17,400	9	
Waste Treatment Plant Replacement (CON_WTPU)[c]							
Radiological workers	N/A						
Nonradiological workers							
On site	33,800,000	2067	2138	24	1,410,000	678	678
Off site	11,300,000	2067	2138	24	471,000	227	
Immobilized High-Level Radioactive Waste Shipping/Transfer Facility Replacement (CON_STFU)[d]							
Radiological workers	N/A						
Nonradiological workers							
Onsite construction	3,510,000	2070	2132	6	585,000	282	380
Onsite exempt	1,220,000	2070	2132	6	203,000	98	
Offsite design	1,500,000	2070	2132	6	250,000	121	

Table I–37. Tank Closure Alternative 6A, Option Case, Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Module Replacement (CON_ISMU)							
Radiological workers	N/A						
Nonradiological workers							
Onsite construction	39,200,000	2074	2160	87	451,000	217	351
Onsite exempt	24,200,000	2074	2160	87	278,000	134	
Offsite design	29,700,000	2074	2160	87	341,000	164	
High-Level Radioactive Waste Debris Storage Facilities (CON_HLWST)							
Radiological workers	N/A						
Nonradiological workers							
On site	577,000	2041	2110	70	8,240	4	4
Off site	N/A						
Effluent Treatment Facility Replacement (CON_ETF)							
Radiological workers	N/A						
Nonradiological workers							
On site	2,050,000	2023	2025	3	683,000	329	329
Off site	704,000	2023	2025	3	235,000	113	
Effluent Treatment Facility Replacement (CON_ETFU)[e]							
Radiological workers	N/A						
Nonradiological workers							
On site	8,190,000	2053	2145	12	683,000	329	329
Off site	865,000	2053	2145	12	72,100	35	
242-A Evaporator Replacement (CON_EVA)							
Radiological workers	N/A						
Nonradiological workers							
On site	635,000	2015	2017	3	212,000	102	102
Off site	218,000	2015	2017	3	72,700	35	
242-A Evaporator Replacement (CON_EVAU)[f]							
Radiological workers	N/A						
Nonradiological workers							
On site	3,180,000	2040	2142	15	212,000	102	102
Off site	1,150,000	2040	2142	15	76,700	37	
Total	**513,000,000**				**15,800,000**	**7,630**	**5,750**

[a] Replacement double-shell tanks construction activities would occur over three 6-year periods, totaling 18 years.
Period 1, 2029–2034
Period 2, 2069–2074
Period 3, 2109–2114

[b] High-Level Radioactive Waste Melter Interim Storage Facilities construction activities would occur over seven 2-year periods, totaling 14 years.
Period 1, 2017–2018
Period 2, 2037–2038
Period 3, 2057–2058
Period 4, 2077–2078
Period 5, 2097–2098
Period 6, 2117–2118
Period 7, 2137–2138

[c] Replacement Waste Treatment Plant construction activities would occur over two 12-year periods, totaling 24 years.
Period 1, 2067–2078
Period 2, 2127–2138

Table I–37. Tank Closure Alternative 6A, Option Case, Construction Rollup Workforce Estimate *(continued)*

[d] Replacement Immobilized High-Level Radioactive Waste Shipping/Transfer Facility construction activities would occur over two 3-year periods, totaling 6 years.
Period 1, 2070–2072
Period 2, 2130–2132

[e] Replacement Effluent Treatment Facility construction activities would occur over four 3-year periods, totaling 12 years.
Period 1, 2053–2055
Period 2, 2083–2085
Period 3, 2113–2115
Period 4, 2143–2145

[f] Replacement 242-A Evaporator construction activities would occur over five 3-year periods, totaling 15 years.
Period 1, 2040–2042
Period 2, 2065–2067
Period 3, 2090–2092
Period 4, 2115–2117
Period 5, 2140–2142

Notes and Assumptions:
Total number of offsite full-time equivalents = 1,880.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–38. Tank Closure Alternative 6A, Option Case, Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (OPS_ISF)							
Radiological workers	256,000,000	2018	2163	146	1,750,000	842	1,310
Nonradiological workers							
On site	143,000,000	2018	2163	146	979,000	471	
Off site	N/A						
Other Infrastructure Upgrades (OPS_OIU)							
Radiological workers	186,000	2006	2162	157	1,180	1	4
Nonradiological workers							
On site	680,000	2006	2162	157	4,330	3	
Off site	485,000	2006	2162	157	3,090	2	
Routine Operations (OPS_ROUT)							
Radiological workers	40,800,000	2006	2162	157	260,000	125	654
Nonradiological workers							
On site	172,000,000	2006	2162	157	1,100,000	529	
Off site	24,300,000	2006	2162	157	155,000	75	
Retrieval Operations (OPS_RET)							
Radiological workers	53,500	2006	2162	157	341	1	28
Nonradiological workers							
On site	8,720,000	2006	2162	157	55,500	27	
Off site	67,800	2006	2162	157	432	1	
Interim Stabilization/Double-Shell Tanks (OPS_IST)							
Radiological workers	5,760,000	2006	2162	157	36,700	18	44
Nonradiological workers							
On site	8,250,000	2006	2162	157	52,500	26	
Off site	9,110,000	2006	2162	157	58,000	28	

Table I–38. Tank Closure Alternative 6A, Option Case, Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Waste Treatment Plant—Cesium and Strontium Capsules (OPS_WTP)							
Radiological workers	388,000,000	2018	2162	145	2,680,000	1,290	2,170
Nonradiological workers							
On site	266,000,000	2018	2162	145	1,830,000	880	
Off site	39,000	2018	2162	145	269	1	
Waste Treatment Plant (OPS_WTPCSC)							
Radiological workers	2,680,000	2163	2163	1	2,680,000	1,290	2,180
Nonradiological workers							
On site	1,840,000	2163	2163	1	1,840,000	885	
Off site	269	2163	2163	1	269	1	
Cesium and Strontium Capsule Processing Facility (OPS_CSC)							
Radiological workers	103,000	2162	2163	2	51,500	25	25
Nonradiological workers							
On site	N/A						
Off site	N/A						
Mobile Retrieval System (OPS_MRS)							
Radiological workers	21,100,000	2013	2162	150	141,000	68	130
Nonradiological workers							
On site	19,100,000	2013	2162	150	127,000	62	
Off site	N/A						
Vacuum-Based Retrieval System (OPS_VBR)							
Radiological workers	6,630,000	2013	2162	150	44,200	22	42
Nonradiological workers							
On site	6,000,000	2013	2162	150	40,000	20	
Off site	N/A						
Chemical Wash System (OPS_CHW)							
Radiological workers	13,900,000	2013	2162	150	92,700	45	86
Nonradiological workers							
On site	12,600,000	2013	2162	150	84,000	41	
Off site	N/A						
High-Level Radioactive Waste Melter Interim Storage Facilities (OPS_PAD)							
Radiological workers	N/A	2018	2262	245	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
High-Level Radioactive Waste Debris Storage Facilities (OPS_HLWST)							
Radiological workers	N/A	2042	2153	112	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Effluent Treatment Facility Replacement (OPS_ETF)							
Radiological workers	24,900,000	2006	2166	161	155,000	75	94
Nonradiological workers							
On site	6,220,000	2006	2166	161	38,600	19	
Off site	N/A						

Table I–38. Tank Closure Alternative 6A, Option Case, Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
242-A Evaporator Replacement (OPS_EVA)							
Radiological workers	7,140,000	2018	2163	146	48,900	24	32
Nonradiological workers							
On site	2,180,000	2018	2163	146	14,900	8	
Off site	N/A						
Borrow Area C (OPS_CAREA)							
Radiological workers	N/A						44
Nonradiological workers							
On site	14,500,000	2006	2167	162	89,500	44	
Off site	N/A						
Total	**1,460,000,000**				**14,400,000**	**6,950**	**6,840**

Notes and Assumptions:
Total number of offsite full-time equivalents = 110.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

Table I–39. Tank Closure Alternative 6A, Option Case, Deactivation Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (DEA_ISF)							
Radiological workers	N/A						1
Nonradiological workers							
On site	3,040	2078	2188	111	27	1	
Off site	N/A						
Waste Treatment Plant (DEA_WTP)[a]							
Radiological workers	13,500,000	2079	2166	9	1,500,000	722	1,220
Nonradiological workers							
On site	9,230,000	2079	2166	9	1,030,000	496	
Off site	N/A						
Mobile Retrieval System (DEA_MRS)							
Radiological workers	2,780,000	2013	2162	150	18,500	9	9
Nonradiological workers							
On site	N/A						
Off site	N/A						
Vacuum-Based Retrieval System (DEA_VBR)							
Radiological workers	223,000	2013	2162	150	1,490	1	1
Nonradiological workers							
On site	N/A						
Off site	N/A						

Table I–39. Tank Closure Alternative 6A, Option Case, Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Chemical Wash System (DEA_CHW)							
Radiological workers	185,000	2013	2162	150	1,230	1	1
Nonradiological workers							
On site	N/A						
Off site	N/A						
Cesium and Strontium Capsule Processing Facility (DEA_CSC)							
Radiological workers	23,900	2164	2164	1	23,900	12	12
Nonradiological workers							
On site	N/A						
Off site	N/A						
Packaged HLW Debris Storage Facility (DEA_HLWST)							
Radiological workers	N/A	2154	2154	1			1
Nonradiological workers							
On site	35	2154	2154	1	35	1	
Off site	N/A	2154	2154	1			
Effluent Treatment Facility Replacement (DEA_ETF)[b]							
Radiological workers	464,000	2026	2167	6	77,300	38	48
Nonradiological workers							
On site	116,000	2026	2167	6	19,300	10	
Off site	N/A						
242-A Evaporator Replacement (DEA_EVA)[c]							
Radiological workers	171,000	2018	2168	7	24,400	12	16
Nonradiological workers							
On site	52,300	2018	2168	7	7,470	4	
Off site	N/A						
Total	**26,700,000**				**2,700,000**	**1,310**	**1,310**

[a] Waste Treatment Plant deactivation activities would occur over three 3-year periods, totaling 9 years.
Period 1, 2079–2081
Period 2, 2139–2141
Period 3, 2164–2166

[b] Replacement Effluent Treatment Facility deactivation activities would occur over six 1-year periods, totaling 6 years.
Period 1, 2026–2026
Period 2, 2056–2056
Period 3, 2086–2086
Period 4, 2116–2116
Period 5, 2146–2146
Period 6, 2167–2167

[c] Replacement 242-A Evaporator deactivation activities would occur over seven 1-year periods, totaling 7 years.
Period 1, 2018–2018
Period 2, 2043–2043
Period 3, 2068–2068
Period 4, 2093–2093
Period 5, 2118–2118
Period 6, 2143–2143
Period 7, 2168–2168

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–40. Tank Closure Alternative 6A, Option Case, Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Containment Structure Construction (CLO_CONCS1)[a]							
Radiological workers	12,000	2038	2141	24	500	1	4
Nonradiological workers							
On site	120,000	2038	2141	24	5,000	3	
Off site	N/A						
Containment Structure Deactivation (CLO_DEACS1)[b]							
Radiological workers	12,000	2062	2164	21	571	1	4
Nonradiological workers							
On site	120,000	2062	2164	21	5,710	3	
Off site	N/A						
Decontamination and Decommissioning of 10 Selected Facilities (CLO_D&DTEN)							
Radiological workers	44,400	2018	2028	11	4,040	2	9
Nonradiological workers							
On site	147,000	2018	2028	11	13,400	7	
Off site	79,000	2018	2028	11	7,180	4	
Removal of B Tank Farm (CLO_REMTB)							
Radiological workers	693,000	2065	2076	12	57,800	28	73
Nonradiological workers							
On site	1,100,000	2065	2076	12	91,700	45	
Off site	N/A						
Removal of T Tank Farm (CLO_REMTT)							
Radiological workers	693,000	2126	2137	12	57,800	28	73
Nonradiological workers							
On site	1,100,000	2126	2137	12	91,700	45	
Off site	N/A						
Removal of BY Tank Farm (CLO_REMTBY)							
Radiological workers	520,000	2111	2122	12	43,300	21	55
Nonradiological workers							
On site	824,000	2111	2122	12	68,700	34	
Off site	N/A						
Removal of BX Tank Farm (CLO_REMTBX)							
Radiological workers	520,000	2042	2053	12	43,300	21	55
Nonradiological workers							
On site	824,000	2042	2053	12	68,700	34	
Off site	N/A						
Removal of C Tank Farm (CLO_REMTC)							
Radiological workers	693,000	2088	2099	12	57,800	28	73
Nonradiological workers							
On site	1,100,000	2088	2099	12	91,700	45	
Off site	N/A						
Removal of A Tank Farm (CLO_REMTA)							
Radiological workers	260,000	2142	2153	12	21,700	11	28
Nonradiological workers							
On site	412,000	2142	2153	12	34,300	17	
Off site	N/A						

Table I–40. Tank Closure Alternative 6A, Option Case, Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Removal of AX Tank Farm (CLO_REMTAX)							
Radiological workers	173,000	2142	2153	12	14,400	7	19
Nonradiological workers							
On site	275,000	2142	2153	12	22,900	12	
Off site	N/A						
Removal of S Tank Farm (CLO_REMTS)							
Radiological workers	520,000	2126	2137	12	43,300	21	55
Nonradiological workers							
On site	824,000	2126	2137	12	68,700	34	
Off site	N/A						
Removal of TY Tank Farm (CLO_REMTTY)							
Radiological workers	260,000	2111	2122	12	21,700	11	28
Nonradiological workers							
On site	412,000	2111	2122	12	34,300	17	
Off site	N/A						
Removal of TX Tank Farm (CLO_REMTTX)							
Radiological workers	779,000	2088	2099	12	64,900	32	82
Nonradiological workers							
On site	1,240,000	2088	2099	12	103,000	50	
Off site	N/A						
Removal of U Tank Farm (CLO_REMTU)							
Radiological workers	693,000	2065	2076	12	57,800	28	73
Nonradiological workers							
On site	1,100,000	2065	2076	12	91,700	45	
Off site	N/A						
Removal of SX Tank Farm (CLO_REMTSX)							
Radiological workers	649,000	2042	2053	12	54,100	27	69
Nonradiological workers							
On site	1,030,000	2042	2053	12	85,800	42	
Off site	N/A						
Removal of Deep Soil–B Tank Farm (CLO_REMSB)							
Radiological workers	73,400	2077	2084	8	9,180	5	11
Nonradiological workers							
On site	84,900	2077	2084	8	10,600	6	
Off site	N/A						
Removal of Deep Soil–T Tank Farm (CLO_REMST)							
Radiological workers	564,000	2138	2145	8	70,500	34	74
Nonradiological workers							
On site	652,000	2138	2145	8	81,500	40	
Off site	N/A						
Removal of Deep Soil–BX Tank Farm (CLO_REMSBX)							
Radiological workers	293,000	2054	2061	8	36,600	18	39
Nonradiological workers							
On site	339,000	2054	2061	8	42,400	21	
Off site	N/A						

Table I–40. Tank Closure Alternative 6A, Option Case, Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Removal of Deep Soil–C Tank Farm (CLO_REMSC)							
Radiological workers	4,450	2100	2107	8	556	1	2
Nonradiological workers							
On site	5,140	2100	2107	8	643	1	
Off site	N/A						
Removal of Deep Soil–A Tank Farm (CLO_REMSA)							
Radiological workers	13,300	2154	2161	8	1,660	1	2
Nonradiological workers							
On site	15,400	2154	2161	8	1,930	1	
Off site	N/A						
Removal of Deep Soil–AX Tank Farm (CLO_REMSAX)							
Radiological workers	222,000	2154	2161	8	27,800	14	30
Nonradiological workers							
On site	257,000	2154	2161	8	32,100	16	
Off site	N/A						
Removal of Deep Soil–TX Tank Farm (CLO_REMSTX)							
Radiological workers	701,000	2100	2107	8	87,600	43	92
Nonradiological workers							
On site	810,000	2100	2107	8	101,000	49	
Off site	N/A						
Removal of Deep Soil–U Tank Farm (CLO_REMSU)							
Radiological workers	367,000	2077	2084	8	45,900	23	49
Nonradiological workers							
On site	424,000	2077	2084	8	53,000	26	
Off site	N/A						
Removal of Deep Soil–SX Tank Farm (CLO_REMSSX)							
Radiological workers	896,000	2054	2061	8	112,000	54	117
Nonradiological workers							
On site	1,040,000	2054	2061	8	130,000	63	
Off site	N/A						
Clean Closure of B Area Cribs and Trenches (Ditches) (CLO_REMBC&T)							
Radiological workers	4,000,000	2054	2084	31	129,000	63	135
Nonradiological workers							
On site	4,630,000	2054	2084	31	149,000	72	
Off site	N/A						
Clean Closure of T Area Cribs and Trenches (Ditches) (CLO_REMTC&T)							
Radiological workers	4,000,000	2100	2145	46	87,000	42	91
Nonradiological workers							
On site	4,630,000	2100	2145	46	101,000	49	
Off site	N/A						
Containment Structure Construction–B and T Area Cribs and Trenches (Ditches) (CLO_CONCS2)[c]							
Radiological workers	4,000	2050	2099	8	500	1	4
Nonradiological workers							
On site	40,000	2050	2099	8	5,000	3	
Off site	N/A						

Table I–40. Tank Closure Alternative 6A, Option Case, Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Decontamination and Decommissioning of the Structure over the Tank Farm after Soil Removal (CLO_DEACS2)[d]							
Radiological workers	4,000	2085	2148	6	667	1	5
Nonradiological workers							
On site	40,000	2085	2148	6	6,670	4	
Off site	N/A						
Preprocessing Facility Construction (CLO_CONPPF)							
Radiological workers	N/A						4,780
Nonradiological workers							
On site	29,800,000	2039	2041	3	9,930,000	4,780	
Off site	10,100,000	2039	2041	3	3,370,000	1,620	
Preprocessing Facility Operations (CLO_OPSPPF)							
Radiological workers	50,400,000	2042	2162	121	417,000	201	208
Nonradiological workers							
On site	1,550,000	2042	2162	121	12,800	7	
Off site	N/A						
Preprocessing Facility Deactivation (CLO_DEAPPF)							
Radiological workers	380,000	2163	2163	1	380,000	183	189
Nonradiological workers							
On site	11,700	2163	2163	1	11,700	6	
Off site	N/A						
Total	**134,000,000**				**16,900,000**	**8,150**	**6,530**

[a] Tank Farm Containment Structure construction activities would occur over six 4-year periods, totaling 24 years.
Period 1, 2038–2041; 2 facilities
Period 2, 2061–2064; 2 facilities
Period 3, 2084–2087; 2 facilities
Period 4, 2107–2110; 2 facilities
Period 5, 2122–2125; 2 facilities
Period 6, 2138–2141; 2 facilities

[b] Tank Farm Containment Structure deactivation activities would occur over seven 3-year periods, totaling 21 years.
Period 1, 2062–2064; 2 facilities
Period 2, 2085–2087; 2 facilities
Period 3, 2108–2110; 2 facilities
Period 4, 2123–2125; 2 facilities
Period 5, 2138–2140; 1 facility
Period 6, 2146–2148; 1 facility
Period 7, 2162–2164; 2 facilities

[c] B and T Area cribs and trenches (ditches) Containment Structure construction activities would occur over two 4-year periods, totaling 8 years.
Period 1, 2050–2053; 2 facilities
Period 2, 2096–2099; 2 facilities

[d] B and T Area cribs and trenches (ditches) Containment Structure deactivation activities would occur over two 3-year periods, totaling 6 years.
Period 1, 2085–2087; 2 facilities
Period 2, 2146–2148; 2 facilities

Notes and Assumptions:
Total number of offsite full-time equivalents = 1,620.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

I.2.11 Tank Closure Alternative 6B: All Vitrification with Separations; Clean Closure–Base Case

Table I–41. Tank Closure Alternative 6B, Base Case, Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Canister Storage Building (CON_CSB)							
Radiological workers	116,000	2006	2016	11	10,500	6	12
Nonradiological workers							
On site	136,000	2006	2016	11	12,400	6	
Off site	50,300	2006	2016	11	4,570	3	
Immobilized High-Level Radioactive Waste Shipping/Transfer Facility (CON_STF)							
Radiological workers	N/A						381
Nonradiological workers							
Onsite construction	1,760,000	2011	2013	3	587,000	283	
Onsite exempt	610,000	2011	2013	3	203,000	98	
Offsite design	748,000	2011	2013	3	249,000	120	
Immobilized High-Level Radioactive Waste Interim Storage Modules (CON_ISM)							
Radiological workers	N/A						222
Nonradiological workers							
Onsite construction	3,120,000	2014	2024	11	284,000	137	
Onsite exempt	1,930,000	2014	2024	11	175,000	85	
Offsite design	2,360,000	2014	2024	11	215,000	104	
Other Infrastructure Upgrades (CON_OIU)							
Radiological workers	782,000	2006	2034	29	27,000	13	45
Nonradiological workers							
On site	1,920,000	2006	2034	29	66,200	32	
Off site	743,000	2006	2034	29	25,600	13	
Tank Upgrades (CON_TU)							
Radiological workers	1,200,000	2006	2025	20	60,000	29	104
Nonradiological workers							
On site	3,110,000	2006	2025	20	156,000	75	
Off site	1,180,000	2006	2025	20	59,000	29	
Underground Transfer Lines (CON_UTL)							
Radiological workers	N/A						61
Nonradiological workers							
On site	126,000	2009	2009	1	126,000	61	
Off site	17,400	2009	2009	1	17,400	9	
Waste Treatment Plant (CON_WTP)							
Radiological workers	N/A						1,190
Nonradiological workers							
On site	29,700,000	2006	2017	12	2,480,000	1,190	
Off site	9,930,000	2006	2017	12	828,000	399	
Additional Low-Activity Waste Melters (CON_LAW)							
Radiological workers	N/A						340
Nonradiological workers							
On site	7,060,000	2008	2017	10	706,000	340	
Off site	2,390,000	2008	2017	10	239,000	115	

Table I–41. Tank Closure Alternative 6B, Base Case, Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Cesium and Strontium Capsule Processing Facility (CON_CSC)							
Radiological workers	N/A						190
Nonradiological workers							
On site	1,580,000	2035	2038	4	395,000	190	
Off site	466,000	2035	2038	4	117,000	57	
Waste Receiver Facilities (CON_WRF)							
Radiological workers	N/A						454
Nonradiological workers							
On site	4,720,000	2013	2017	5	944,000	454	
Off site	1,700,000	2013	2017	5	340,000	164	
Tank Risers (CON_RIS)							
Radiological workers	189,000	2013	2016	4	47,300	23	54
Nonradiological workers							
On site	255,000	2013	2016	4	63,800	31	
Off site	N/A						
Mobile Retrieval System (CON_MRS)							
Radiological workers	21,700,000	2013	2043	31	700,000	337	710
Nonradiological workers							
On site	24,000,000	2013	2043	31	774,000	373	
Off site	12,900,000	2013	2043	31	416,000	200	
Vacuum-Based Retrieval System (CON_VBR)							
Radiological workers	11,200,000	2013	2043	31	361,000	174	361
Nonradiological workers							
On site	12,000,000	2013	2043	31	387,000	187	
Off site	6,820,000	2013	2043	31	220,000	106	
Chemical Wash System (CON_CHW)							
Radiological workers	2,380,000	2013	2043	31	76,800	37	45
Nonradiological workers							
On site	472,000	2013	2043	31	15,200	8	
Off site	635,000	2013	2043	31	20,500	10	
High-Level Radioactive Waste Melter Interim Storage Facilities (CON_PAD)[a]							
Radiological workers	N/A						1
Nonradiological workers							
On site	5,620	2015	2030	4	1,410	1	
Off site	N/A						
Effluent Treatment Facility Replacement (CON_ETF)							
Radiological workers	N/A						329
Nonradiological workers							
On site	2,050,000	2023	2025	3	683,000	329	
Off site	704,000	2023	2025	3	235,000	113	

Table I–41. Tank Closure Alternative 6B, Base Case, Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Effluent Treatment Facility Replacement (CON_ETFU)[b]							
Radiological workers	N/A						328
Nonradiological workers							
On site	4,090,000	2053	2085	6	682,000	328	
Off site	736,000	2053	2085	6	123,000	60	
242-A Evaporator Replacement (CON_EVA)							
Radiological workers	N/A						102
Nonradiological workers							
On site	635,000	2015	2017	3	212,000	102	
Off site	218,000	2015	2017	3	72,700	35	
Immobilized Low-Activity Waste Interim Storage Facility (CON_ILAWST)							
Radiological workers	N/A						11
Nonradiological workers							
On site	603,000	2016	2043	28	21,500	11	
Off site	N/A						
High-Level Radioactive Waste Debris Storage Facilities (CON_HLWST)							
Radiological workers	N/A						4
Nonradiological workers							
On site	577,000	2021	2090	70	8,240	4	
Off site	N/A						
Total	**180,000,000**				**13,400,000**	**6,480**	**4,940**

[a] High-Level Radioactive Waste Melter Interim Storage Facilities construction activities would occur over two 2-year construction periods.
Period 1, 2015–2016
Period 2, 2029–2030

[b] Replacement Effluent Treatment Facility construction activities would occur over two 3-year construction periods.
Period 1, 2053–2055
Period 2, 2083–2085

Notes and Assumptions:
Total number of offsite full-time equivalents = 1,540.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–42. Tank Closure Alternative 6B, Base Case, Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (OPS_ISF)							
Radiological workers	3,650,000	2018	2040	23	159,000	77	120
Nonradiological workers							
On site	2,040,000	2018	2040	23	88,700	43	
Off site	N/A						

Table I–42. Tank Closure Alternative 6B, Base Case, Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Other Infrastructure Upgrades (OPS_OIU)							
Radiological workers	44,900	2006	2043	38	1,180	1	4
Nonradiological workers							
On site	165,000	2006	2043	38	4,340	3	
Off site	117,000	2006	2043	38	3,080	2	
Routine Operations (OPS_ROUT)							
Radiological workers	9,880,000	2006	2043	38	260,000	125	650
Nonradiological workers							
On site	41,500,000	2006	2043	38	1,090,000	525	
Off site	5,890,000	2006	2043	38	155,000	75	
Interim Stabilization/Double-Shell Tanks (OPS_IST)							
Radiological workers	1,390,000	2006	2043	38	36,600	18	44
Nonradiological workers							
On site	2,000,000	2006	2043	38	52,600	26	
Off site	2,200,000	2006	2043	38	57,900	28	
Retrieval Operations (OPS_RET)							
Radiological workers	13,000	2006	2043	38	342	1	28
Nonradiological workers							
On site	2,110,000	2006	2043	38	55,500	27	
Off site	16,400	2006	2043	38	432	1	
Waste Treatment Plant (OPS_WTP)							
Radiological workers	62,800,000	2018	2043	26	2,420,000	1,160	1,940
Nonradiological workers							
On site	42,100,000	2018	2043	26	1,620,000	779	
Off site	8,000	2018	2043	26	308	1	
Waste Treatment Plant—Cesium and Strontium Capsules (OPS_WTPCSC)							
Radiological workers	2,410,000	2040	2040	1	2,410,000	1,160	1,940
Nonradiological workers							
On site	1,620,000	2040	2040	1	1,620,000	779	
Off site	308	2040	2040	1	308	1	
Cesium and Strontium Capsule Processing Facility (OPS_CSC)							
Radiological workers	103,000	2039	2040	2	51,500	25	25
Nonradiological workers							
On site	N/A						
Off site	N/A						
Mobile Retrieval System (OPS_MRS)							
Radiological workers	13,900,000	2013	2043	31	448,000	216	412
Nonradiological workers							
On site	12,600,000	2013	2043	31	406,000	196	
Off site	N/A						

Table I–42. Tank Closure Alternative 6B, Base Case, Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Vacuum-Based Retrieval System (OPS_VBR)							
Radiological workers	7,670,000	2013	2043	31	247,000	119	227
Nonradiological workers							
On site	6,940,000	2013	2043	31	224,000	108	
Off site	N/A						
Chemical Wash System (OPS_CHW)							
Radiological workers	10,800,000	2013	2043	31	348,000	168	320
Nonradiological workers							
On site	9,750,000	2013	2043	31	315,000	152	
Off site	N/A						
High-Level Radioactive Waste Melter Interim Storage Facilities (OPS_PAD)							
Radiological workers	N/A	2018	2199	182	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Effluent Treatment Facility Replacement (OPS_ETF)							
Radiological workers	14,700,000	2006	2100	95	155,000	75	94
Nonradiological workers							
On site	3,670,000	2006	2100	95	38,600	19	
Off site	N/A						
242-A Evaporator Replacement (OPS_EVA)							
Radiological workers	1,860,000	2006	2043	38	48,900	24	32
Nonradiological workers							
On site	568,000	2006	2043	38	14,900	8	
Off site	N/A						
Borrow Area C (OPS_CAREA)							
Radiological workers	N/A						43
Nonradiological workers							
On site	8,670,000	2006	2102	97	89,400	43	
Off site	N/A						
High-Level Radioactive Waste Debris Storage Facility (OPS_ILAWST)							
Radiological workers	N/A	2018	2199	182	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
High-Level Radioactive Waste Debris Storage Facilities (OPS_HLWST)							
Radiological workers	N/A	2023	2199	177	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Total	**271,000,000**				**12,400,000**	**5,990**	**5,880**

Notes and Assumptions:

Total number of offsite full-time equivalents = 110.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–43. Tank Closure Alternative 6B, Base Case, Deactivation Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (DEA_ISF)							
Radiological workers	N/A						
Nonradiological workers							
On site	160	2041	2041	1	160	1	1
Off site	N/A						
Waste Treatment Plant (DEA_WTP)							
Radiological workers	3,800,000	2044	2045	2	1,900,000	914	
Nonradiological workers							
On site	2,550,000	2044	2045	2	1,280,000	616	1,530
Off site	500	2044	2045	2	250	1	
Mobile Retrieval System (DEA_MRS)							
Radiological workers	1,820,000	2013	2043	31	58,700	29	
Nonradiological workers							
On site	N/A						29
Off site	N/A						
Vacuum-Based Retrieval System (DEA_VBR)							
Radiological workers	258,000	2013	2043	31	8,320	4	
Nonradiological workers							
On site	N/A						4
Off site	N/A						
Chemical Wash System (DEA_CHW)							
Radiological workers	144,000	2013	2043	31	4,650	3	
Nonradiological workers							
On site	N/A						3
Off site	N/A						
Cesium and Strontium Capsule Processing Facility (DEA_CSC)							
Radiological workers	23,900	2041	2041	1	23,900	12	
Nonradiological workers							
On site	N/A						12
Off site	N/A						
Packaged HLW Debris Storage Facility (DEA_HLWST)							
Radiological workers	N/A						
Nonradiological workers							
On site	35	2089	2089	1	35	1	1
Off site	N/A						
Effluent Treatment Facility Replacement (DEA_ETF)[a]							
Radiological workers	309,000	2026	2101	4	77,300	38	
Nonradiological workers							
On site	77,300	2026	2101	4	19,300	10	48
Off site	N/A						

Table I–43. Tank Closure Alternative 6B, Base Case, Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
242-A Evaporator (Original) (DEA_EVAO)							
Radiological workers	24,400	2018	2018	1	24,400	12	16
Nonradiological workers							
On site	7,480	2018	2018	1	7,480	4	
Off site	N/A						
242-A Evaporator Replacement (DEA_EVA)							
Radiological workers	24,400	2044	2044	1	24,400	12	16
Nonradiological workers							
On site	7,480	2044	2044	1	7,480	4	
Off site	N/A						
Total	**9,050,000**				**3,440,000**	**1,660**	**1,660**

[a] Replacement Effluent Treatment Facility deactivation activities would occur over four 1-year periods.
Period 1, 2026–2026
Period 2, 2056–2056
Period 3, 2086–2086
Period 4, 2101–2101

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: HLW=high-level radioactive waste; N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–44. Tank Closure Alternative 6B, Base Case, Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Containment Structure Construction (CLO_CONCS)[a]							
Radiological workers	12,000	2019	2076	12	1,000	1	6
Nonradiological workers							
On site	120,000	2019	2076	12	10,000	5	
Off site	N/A						
Containment Structure Deactivation (CLO_DEACS)[b]							
Radiological workers	12,000	2043	2099	15	800	1	5
Nonradiological workers							
On site	120,000	2043	2099	15	8,000	4	
Off site	N/A						
Decontamination and Decommissioning of 10 Selected Facilities (CLO_D&DTEN)							
Radiological workers	44,400	2018	2028	11	4,040	2	9
Nonradiological workers							
On site	147,000	2018	2028	11	13,400	7	
Off site	79,000	2018	2028	11	7,180	4	

Table I–44. Tank Closure Alternative 6B, Base Case, Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Modified Resource Conservation and Recovery Act Subtitle C Barrier (CLO_RCRA)							
Radiological workers	429,000	2100	2101	2	215,000	104	415
Nonradiological workers							
On site	1,290,000	2100	2101	2	645,000	311	
Off site	N/A						
Postclosure Care (CLO_POST)							
Radiological workers	N/A						3
Nonradiological workers							
On site	471,000	2102	2201	100	4,710	3	
Off site	N/A						
Removal of B Tank Farm (CLO_REMTB)							
Radiological workers	693,000	2023	2034	12	57,800	28	73
Nonradiological workers							
On site	1,100,000	2023	2034	12	91,700	45	
Off site	N/A						
Removal of T Tank Farm (CLO_REMTT)							
Radiological workers	693,000	2077	2088	12	57,800	28	73
Nonradiological workers							
On site	1,100,000	2077	2088	12	91,700	45	
Off site	N/A						
Removal of BY Tank Farm (CLO_REMTBY)							
Radiological workers	520,000	2050	2061	12	43,300	21	55
Nonradiological workers							
On site	824,000	2050	2061	12	68,700	34	
Off site	N/A						
Removal of BX Tank Farm (CLO_REMTBX)							
Radiological workers	520,000	2023	2034	12	43,300	21	55
Nonradiological workers							
On site	824,000	2023	2034	12	68,700	34	
Off site	N/A						
Removal of C Tank Farm (CLO_REMTC)							
Radiological workers	693,000	2050	2061	12	57,800	28	73
Nonradiological workers							
On site	1,100,000	2050	2061	12	91,700	45	
Off site	N/A						
Removal of A Tank Farm (CLO_REMTA)							
Radiological workers	260,000	2077	2088	12	21,700	11	28
Nonradiological workers							
On site	412,000	2077	2088	12	34,300	17	
Off site	N/A						
Removal of AX Tank Farm (CLO_REMTAX)							
Radiological workers	173,000	2077	2088	12	14,400	7	19
Nonradiological workers							
On site	275,000	2077	2088	12	22,900	12	
Off site	N/A						

Table I–44. Tank Closure Alternative 6B, Base Case, Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Removal of S Tank Farm (CLO_REMTS)							
Radiological workers	520,000	2077	2088	12	43,300	21	55
Nonradiological workers							
On site	824,000	2077	2088	12	68,700	34	
Off site	N/A						
Removal of TY Tank Farm (CLO_REMTTY)							
Radiological workers	260,000	2050	2061	12	21,700	11	28
Nonradiological workers							
On site	412,000	2050	2061	12	34,300	17	
Off site	N/A						
Removal of TX Tank Farm (CLO_REMTTX)							
Radiological workers	779,000	2050	2061	12	64,900	32	82
Nonradiological workers							
On site	1,240,000	2050	2061	12	103,000	50	
Off site	N/A						
Removal of U Tank Farm (CLO_REMTU)							
Radiological workers	693,000	2023	2034	12	57,800	28	73
Nonradiological workers							
On site	1,100,000	2023	2034	12	91,700	45	
Off site	N/A						
Removal of SX Tank Farm (CLO_REMTSX)							
Radiological workers	649,000	2023	2034	12	54,100	27	69
Nonradiological workers							
On site	1,030,000	2023	2034	12	85,800	42	
Off site	N/A						
Removal of Deep Soil–B Tank Farm (CLO_REMSB)							
Radiological workers	73,400	2035	2042	8	9,180	5	11
Nonradiological workers							
On site	84,900	2035	2042	8	10,600	6	
Off site	N/A						
Removal of Deep Soil–T Tank Farm (CLO_REMST)							
Radiological workers	564,000	2089	2096	8	70,500	34	74
Nonradiological workers							
On site	652,000	2089	2096	8	81,500	40	
Off site	N/A						
Removal of Deep Soil–BX Tank Farm (CLO_REMSBX)							
Radiological workers	293,000	2035	2042	8	36,600	18	39
Nonradiological workers							
On site	339,000	2035	2042	8	42,400	21	
Off site	N/A						
Removal of Deep Soil–C Tank Farm (CLO_REMSC)							
Radiological workers	4,450	2062	2069	8	556	1	2
Nonradiological workers							
On site	5,140	2062	2069	8	643	1	
Off site	N/A						

Table I–44. Tank Closure Alternative 6B, Base Case, Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Removal of Deep Soil–A Tank Farm (CLO_REMSA)							
Radiological workers	13,300	2089	2096	8	1,660	1	2
Nonradiological workers							
On site	15,400	2089	2096	8	1,930	1	
Off site	N/A						
Removal of Deep Soil–AX Tank Farm (CLO_REMSAX)							
Radiological workers	222,000	2089	2096	8	27,800	14	30
Nonradiological workers							
On site	257,000	2089	2096	8	32,100	16	
Off site	N/A						
Removal of Deep Soil–TX Tank Farm (CLO_REMSTX)							
Radiological workers	701,000	2062	2069	8	87,600	43	92
Nonradiological workers							
On site	810,000	2062	2069	8	101,000	49	
Off site	N/A						
Removal of Deep Soil–U Tank Farm (CLO_REMSU)							
Radiological workers	367,000	2035	2042	8	45,900	23	49
Nonradiological workers							
On site	424,000	2035	2042	8	53,000	26	
Off site	N/A						
Removal of Deep Soil–SX Tank Farm (CLO_REMSSX)							
Radiological workers	896,000	2035	2042	8	112,000	54	117
Nonradiological workers							
On site	1,040,000	2035	2042	8	130,000	63	
Off site	N/A						
Preprocessing Facility Construction (CLO_CONPPF)							
Radiological workers	N/A						2,390
Nonradiological workers							
On site	14,900,000	2020	2022	3	4,970,000	2,390	
Off site	5,040,000	2020	2022	3	1,680,000	808	
Preprocessing Facility Operations (CLO_OPSPPF)							
Radiological workers	8,330,000	2023	2099	77	108,000	52	54
Nonradiological workers							
On site	256,000	2023	2099	77	3,320	2	
Off site	N/A						
Preprocessing Facility Deactivation (CLO_DEAPPF)							
Radiological workers	108,000	2100	2100	1	108,000	52	54
Nonradiological workers							
On site	3,330	2100	2100	1	3,330	2	
Off site	N/A						
Total	**54,800,000**				**10,000,000**	**4,850**	**4,040**

[a] Containment Structure construction activities would occur over three 4-year periods.
Period 1, 2019–2022
Period 2, 2046–2049
Period 3, 2073–2076

Table I–44. Tank Closure Alternative 6B, Base Case, Closure Rollup Workforce Estimate *(continued)*

[b] Containment Structure deactivation activities would occur over five 3-year periods.
Period 1, 2043–2045
Period 2, 2062–2064
Period 3, 2070–2072
Period 4, 2089–2091
Period 5, 2097–2099

Notes and Assumptions:
Total number of offsite full-time equivalents = 810.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

I.2.12 Tank Closure Alternative 6B: All Vitrification with Separations; Clean Closure–Option Case

Table I–45. Tank Closure Alternative 6B, Option Case, Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Canister Storage Building (CON_CSB)							
Radiological workers	116,000	2006	2016	11	10,500	6	12
Nonradiological workers							
On site	136,000	2006	2016	11	12,400	6	
Off site	50,300	2006	2016	11	4,570	3	
Immobilized High-Level Radioactive Waste Shipping/Transfer Facility (CON_STF)							
Radiological workers	N/A						381
Nonradiological workers							
Onsite construction	1,760,000	2011	2013	3	587,000	283	
Onsite exempt	610,000	2011	2013	3	203,000	98	
Offsite design	748,000	2011	2013	3	249,000	120	
Immobilized High-Level Radioactive Waste Interim Storage Modules (CON_ISM)							
Radiological workers	N/A						222
Nonradiological workers							
Onsite construction	3,120,000	2014	2024	11	284,000	137	
Onsite exempt	1,930,000	2014	2024	11	175,000	85	
Offsite design	2,360,000	2014	2024	11	215,000	104	
Other Infrastructure Upgrades (CON_OIU)							
Radiological workers	782,000	2006	2034	29	27,000	13	45
Nonradiological workers							
On site	1,920,000	2006	2034	29	66,200	32	
Off site	743,000	2006	2034	29	25,600	13	
Tank Upgrades (CON_TU)							
Radiological workers	1,200,000	2006	2025	20	60,000	29	104
Nonradiological workers							
On site	3,110,000	2006	2025	20	156,000	75	
Off site	1,180,000	2006	2025	20	59,000	29	

Table I–45. Tank Closure Alternative 6B, Option Case, Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Underground Transfer Lines (CON_UTL)							
Radiological workers	N/A						61
Nonradiological workers							
On site	126,000	2009	2009	1	126,000	61	
Off site	17,400	2009	2009	1	17,400	9	
Waste Treatment Plant (CON_WTP)							
Radiological workers	N/A						1,190
Nonradiological workers							
On site	29,700,000	2006	2017	12	2,480,000	1,190	
Off site	9,930,000	2006	2017	12	828,000	399	
Additional Low-Activity Waste Melters (CON_LAW)							
Radiological workers	N/A						340
Nonradiological workers							
On site	7,060,000	2008	2017	10	706,000	340	
Off site	2,390,000	2008	2017	10	239,000	115	
Cesium and Strontium Capsule Processing Facility (CON_CSC)							
Radiological workers	N/A						190
Nonradiological workers							
On site	1,580,000	2035	2038	4	395,000	190	
Off site	466,000	2035	2038	4	117,000	57	
Waste Receiver Facilities (CON_WRF)							
Radiological workers	N/A						454
Nonradiological workers							
On site	4,720,000	2013	2017	5	944,000	454	
Off site	1,700,000	2013	2017	5	340,000	164	
Tank Risers (CON_RIS)							
Radiological workers	189,000	2013	2016	4	47,300	23	54
Nonradiological workers							
On site	255,000	2013	2016	4	63,800	31	
Off site	N/A						
Mobile Retrieval System (CON_MRS)							
Radiological workers	21,700,000	2013	2043	31	700,000	337	710
Nonradiological workers							
On site	24,000,000	2013	2043	31	774,000	373	
Off site	12,900,000	2013	2043	31	416,000	200	
Vacuum-Based Retrieval System (CON_VBR)							
Radiological workers	11,200,000	2013	2043	31	361,000	174	361
Nonradiological workers							
On site	12,000,000	2013	2043	31	387,000	187	
Off site	6,820,000	2013	2043	31	220,000	106	
Chemical Wash System (CON_CHW)							
Radiological workers	2,380,000	2013	2043	31	76,800	37	45
Nonradiological workers							
On site	472,000	2013	2043	31	15,200	8	
Off site	635,000	2013	2043	31	20,500	10	

Table I–45. Tank Closure Alternative 6B, Option Case, Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
High-Level Radioactive Waste Melter Interim Storage Facilities (CON_PAD)[a]							
Radiological workers	N/A						
Nonradiological workers							
On site	5,620	2015	2030	4	1,410	1	1
Off site	N/A						
Effluent Treatment Facility Replacement (CON_ETF)							
Radiological workers	N/A						
Nonradiological workers							
On site	2,050,000	2023	2025	3	683,000	329	329
Off site	704,000	2023	2025	3	235,000	113	
Effluent Treatment Facility Replacement (CON_ETFU)[b]							
Radiological workers	N/A						
Nonradiological workers							
On site	4,090,000	2053	2085	6	682,000	328	328
Off site	736,000	2053	2085	6	123,000	60	
242-A Evaporator Replacement (CON_EVA)							
Radiological workers	N/A						
Nonradiological workers							
On site	635,000	2015	2017	3	212,000	102	102
Off site	218,000	2015	2017	3	72,700	35	
Immobilized Low-Activity Waste Interim Storage Facility (CON_ILAWST)							
Radiological workers	N/A						
Nonradiological workers							
On site	603,000	2016	2043	28	21,500	11	11
Off site	N/A						
High-Level Radioactive Waste Debris Storage Facilities (CON_HLWST)							
Radiological workers	N/A						
Nonradiological workers							
On site	577,000	2021	2090	70	8,240	4	4
Off site	N/A						
Total	**180,000,000**				**13,400,000**	**6,480**	**4,940**

[a] High-Level Radioactive Waste Melter Interim Storage Facilities construction activities would occur over two 2-year construction periods.
Period 1, 2015–2016
Period 2, 2029–2030

[b] Replacement Effluent Treatment Facility construction activities would occur over two 3-year construction periods.
Period 1, 2053–2055
Period 2, 2083–2085

Notes and Assumptions:
Total number of offsite full-time equivalents = 1,540.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–46. Tank Closure Alternative 6B, Option Case, Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (OPS_ISF)							
Radiological workers	3,650,000	2018	2040	23	159,000	77	120
Nonradiological workers							
On site	2,040,000	2018	2040	23	88,700	43	
Off site	N/A						
Other Infrastructure Upgrades (OPS_OIU)							
Radiological workers	44,900	2006	2043	38	1,180	1	4
Nonradiological workers							
On site	165,000	2006	2043	38	4,340	3	
Off site	117,000	2006	2043	38	3,080	2	
Routine Operations (OPS_ROUT)							
Radiological workers	9,880,000	2006	2043	38	260,000	125	650
Nonradiological workers							
On site	41,500,000	2006	2043	38	1,090,000	525	
Off site	5,890,000	2006	2043	38	155,000	75	
Interim Stabilization/Double-Shell Tanks (OPS_IST)							
Radiological workers	1,390,000	2006	2043	38	36,600	18	44
Nonradiological workers							
On site	2,000,000	2006	2043	38	52,600	26	
Off site	2,200,000	2006	2043	38	57,900	28	
Retrieval Operations (OPS_RET)							
Radiological workers	13,000	2006	2043	38	342	1	28
Nonradiological workers							
On site	2,110,000	2006	2043	38	55,500	27	
Off site	16,400	2006	2043	38	432	1	
Waste Treatment Plant (OPS_WTP)							
Radiological workers	62,800,000	2018	2043	26	2,420,000	1,160	1,940
Nonradiological workers							
On site	42,100,000	2018	2043	26	1,620,000	779	
Off site	8,000	2018	2043	26	308	1	
Waste Treatment Plant—Cesium and Strontium Capsules (OPS_WTPCSC)							
Radiological workers	2,410,000	2040	2040	1	2,410,000	1,160	1,940
Nonradiological workers							
On site	1,620,000	2040	2040	1	1,620,000	779	
Off site	308	2040	2040	1	308	1	
Cesium and Strontium Capsule Processing Facility (OPS_CSC)							
Radiological workers	103,000	2039	2040	2	51,500	25	25
Nonradiological workers							
On site	N/A						
Off site	N/A						
Mobile Retrieval System (OPS_MRS)							
Radiological workers	13,900,000	2013	2043	31	448,000	216	412
Nonradiological workers							
On site	12,600,000	2013	2043	31	406,000	196	
Off site	N/A						

Table I–46. Tank Closure Alternative 6B, Option Case, Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Vacuum-Based Retrieval System (OPS_VBR)							
Radiological workers	7,670,000	2013	2043	31	247,000	119	227
Nonradiological workers							
On site	6,940,000	2013	2043	31	224,000	108	
Off site	N/A						
Chemical Wash System (OPS_CHW)							
Radiological workers	10,800,000	2013	2043	31	348,000	168	320
Nonradiological workers							
On site	9,750,000	2013	2043	31	315,000	152	
Off site	N/A						
High-Level Radioactive Waste Melter Interim Storage Facilities (OPS_PAD)							
Radiological workers	N/A	2018	2199	182	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Effluent Treatment Facility Replacement (OPS_ETF)							
Radiological workers	14,700,000	2006	2100	95	155,000	75	94
Nonradiological workers							
On site	3,670,000	2006	2100	95	38,600	19	
Off site	N/A						
242-A Evaporator Replacement (OPS_EVA)							
Radiological workers	1,860,000	2006	2043	38	48,900	24	32
Nonradiological workers							
On site	568,000	2006	2043	38	14,900	8	
Off site	N/A						
Borrow Area C (OPS_CAREA)							
Radiological workers	N/A						43
Nonradiological workers							
On site	8,670,000	2006	2102	97	89,400	43	
Off site	N/A						
Immobilized Low-Activity Waste Interim Storage Facility (OPS_ILAWST)							
Radiological workers	N/A	2018	2043	26	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
High-Level Radioactive Waste Debris Storage Facilities (OPS_HLWST)							
Radiological workers	N/A	2023	2088	66	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Total	**271,000,000**				**12,400,000**	**5,990**	**5,880**

Notes and Assumptions:

Total number of offsite full-time equivalents = 110.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–47. Tank Closure Alternative 6B, Option Case, Deactivation Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (DEA_ISF)							
Radiological workers	N/A						
Nonradiological workers							
On site	160	2041	2041	1	160	1	1
Off site	N/A						
Waste Treatment Plant (DEA_WTP)							
Radiological workers	3,800,000	2044	2045	2	1,900,000	914	
Nonradiological workers							
On site	2,550,000	2044	2045	2	1,280,000	616	1,530
Off site	500	2044	2045	2	250	1	
Mobile Retrieval System (DEA_MRS)							
Radiological workers	1,820,000	2013	2043	31	58,700	29	
Nonradiological workers							
On site	N/A						29
Off site	N/A						
Vacuum-Based Retrieval System (DEA_VBR)							
Radiological workers	258,000	2013	2043	31	8,320	4	
Nonradiological workers							
On site	N/A						4
Off site	N/A						
Chemical Wash System (DEA_CHW)							
Radiological workers	144,000	2013	2043	31	4,650	3	
Nonradiological workers							
On site	N/A						3
Off site	N/A						
Cesium and Strontium Capsule Processing Facility (DEA_CSC)							
Radiological workers	23,900	2041	2041	1	23,900	12	
Nonradiological workers							
On site	N/A						12
Off site	N/A						
Effluent Treatment Facility Replacement (DEA_ETF)[a]							
Radiological workers	309,000	2026	2101	4	77,300	38	
Nonradiological workers							
On site	77,300	2026	2101	4	19,300	10	48
Off site	N/A						
Packaged HLW Debris Storage Facility (DEA_HLWST)							
Radiological workers	N/A	2089	2089	1			
Nonradiological workers							
On site	35	2089	2089	1	35	1	1
Off site	N/A	2089	2089	1			
242-A Evaporator (Original) (DEA_EVAO)							
Radiological workers	24,400	2018	2018	1	24,400	12	
Nonradiological workers							
On site	7,480	2018	2018	1	7,480	4	16
Off site	N/A						

Table I–47. Tank Closure Alternative 6B, Option Case, Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
242-A Evaporator Replacement (DEA_EVA)							
Radiological workers	24,400	2044	2044	1	24,400	12	16
Nonradiological workers							
On site	7,480	2044	2044	1	7,480	4	
Off site	N/A						
Total	**9,050,000**				**3,440,000**	**1,660**	**1,660**

[a] Replacement Effluent Treatment Facility deactivation activities would occur over four 1-year periods.
Period 1, 2026–2026
Period 2, 2056–2056
Period 3, 2086–2086
Period 4, 2101–2101

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: HLW=high-level radioactive waste; N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–48. Tank Closure Alternative 6B, Option Case, Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Containment Structure Construction (CLO_CONCS1) Three 4-Year Construction Periods[a]							
Radiological workers	12,000	2019	2076	12	1,000	1	6
Nonradiological workers							
On site	120,000	2019	2076	12	10,000	5	
Off site	N/A						
Containment Structure Deactivation (CLO_DEACS1) Five 3-Year Deactivation Periods[b]							
Radiological workers	12,000	2043	2099	15	800	1	5
Nonradiological workers							
On site	120,000	2043	2099	15	8,000	4	
Off site	N/A						
Decontamination and Decommissioning of 10 Selected Facilities (CLO_D&DTEN)							
Radiological workers	44,400	2018	2028	11	4,040	2	9
Nonradiological workers							
On site	147,000	2018	2028	11	13,400	7	
Off site	79,000	2018	2028	11	7,180	4	
Removal of B Tank Farm (CLO_REMTB)							
Radiological workers	693,000	2023	2034	12	57,800	28	73
Nonradiological workers							
On site	1,100,000	2023	2034	12	91,700	45	
Off site	N/A						

Table I–48. Tank Closure Alternative 6B, Option Case, Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Removal of T Tank Farm (CLO_REMTT)							
Radiological workers	693,000	2077	2088	12	57,800	28	73
Nonradiological workers							
On site	1,100,000	2077	2088	12	91,700	45	
Off site	N/A						
Removal of BY Tank Farm (CLO_REMTBY)							
Radiological workers	520,000	2050	2061	12	43,300	21	55
Nonradiological workers							
On site	824,000	2050	2061	12	68,700	34	
Off site	N/A						
Removal of BX Tank Farm (CLO_REMTBX)							
Radiological workers	520,000	2023	2034	12	43,300	21	55
Nonradiological workers							
On site	824,000	2023	2034	12	68,700	34	
Off site	N/A						
Removal of C Tank Farm (CLO_REMTC)							
Radiological workers	693,000	2050	2061	12	57,800	28	73
Nonradiological workers							
On site	1,100,000	2050	2061	12	91,700	45	
Off site	N/A						
Removal of A Tank Farm (CLO_REMTA)							
Radiological workers	260,000	2077	2088	12	21,700	11	28
Nonradiological workers							
On site	412,000	2077	2088	12	34,300	17	
Off site	N/A						
Removal of AX Tank Farm (CLO_REMTAX)							
Radiological workers	173,000	2077	2088	12	14,400	7	19
Nonradiological workers							
On site	275,000	2077	2088	12	22,900	12	
Off site	N/A						
Removal of S Tank Farm (CLO_REMTS)							
Radiological workers	520,000	2077	2088	12	43,300	21	55
Nonradiological workers							
On site	824,000	2077	2088	12	68,700	34	
Off site	N/A						
Removal of TY Tank Farm (CLO_REMTTY)							
Radiological workers	260,000	2050	2061	12	21,700	11	28
Nonradiological workers							
On site	412,000	2050	2061	12	34,300	17	
Off site	N/A						
Removal of TX Tank Farm (CLO_REMTTX)							
Radiological workers	779,000	2050	2061	12	64,900	32	82
Nonradiological workers							
On site	1,240,000	2050	2061	12	103,000	50	
Off site	N/A						

Table I–48. Tank Closure Alternative 6B, Option Case, Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Removal of U Tank Farm (CLO_REMTU)							
Radiological workers	693,000	2023	2034	12	57,800	28	73
Nonradiological workers							
On site	1,100,000	2023	2034	12	91,700	45	
Off site	N/A						
Removal of SX Tank Farm (CLO_REMTSX)							
Radiological workers	649,000	2023	2034	12	54,100	27	69
Nonradiological workers							
On site	1,030,000	2023	2034	12	85,800	42	
Off site	N/A						
Removal of Deep Soil–B Tank Farm (CLO_REMSB)							
Radiological workers	73,400	2035	2042	8	9,180	5	11
Nonradiological workers							
On site	84,900	2035	2042	8	10,600	6	
Off site	N/A						
Removal of Deep Soil–T Tank Farm (CLO_REMST)							
Radiological workers	564,000	2089	2096	8	70,500	34	74
Nonradiological workers							
On site	652,000	2089	2096	8	81,500	40	
Off site	N/A						
Removal of Deep Soil–BX Tank Farm (CLO_REMSBX)							
Radiological workers	293,000	2035	2042	8	36,600	18	39
Nonradiological workers							
On site	339,000	2035	2042	8	42,400	21	
Off site	N/A						
Removal of Deep Soil–C Tank Farm (CLO_REMSC)							
Radiological workers	4,450	2062	2069	8	556	1	2
Nonradiological workers							
On site	5,140	2062	2069	8	643	1	
Off site	N/A						
Removal of Deep Soil–A Tank Farm (CLO_REMSA)							
Radiological workers	13,300	2089	2096	8	1,660	1	2
Nonradiological workers							
On site	15,400	2089	2096	8	1,930	1	
Off site	N/A						
Removal of Deep Soil–AX Tank Farm (CLO_REMSAX)							
Radiological workers	222,000	2089	2096	8	27,800	14	30
Nonradiological workers							
On site	257,000	2089	2096	8	32,100	16	
Off site	N/A						
Removal of Deep Soil–TX Tank Farm (CLO_REMSTX)							
Radiological workers	701,000	2062	2069	8	87,600	43	92
Nonradiological workers							
On site	810,000	2062	2069	8	101,000	49	
Off site	N/A						

Table I–48. Tank Closure Alternative 6B, Option Case, Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Removal of Deep Soil–U Tank Farm (CLO_REMSU)							
Radiological workers	367,000	2035	2042	8	45,900	23	49
Nonradiological workers							
On site	424,000	2035	2042	8	53,000	26	
Off site	N/A						
Removal of Deep Soil–SX Tank Farm (CLO_REMSSX)							
Radiological workers	896,000	2035	2042	8	112,000	54	117
Nonradiological workers							
On site	1,040,000	2035	2042	8	130,000	63	
Off site	N/A						
Clean Closure of B Area Cribs and Trenches (Ditches) (CLO_REMBC&T)							
Radiological workers	4,000,000	2035	2061	27	148,000	72	155
Nonradiological workers							
On site	4,630,000	2035	2061	27	171,000	83	
Off site	N/A						
Clean Closure of T Area Cribs and Trenches (Ditches) (CLO_REMTC&T)							
Radiological workers	4,000,000	2062	2096	35	114,000	55	119
Nonradiological workers							
On site	4,630,000	2062	2096	35	132,000	64	
Off site	N/A						
Containment Structure Construction–B and T Area Cribs and Trenches (Ditches) (CLO_CONCS2)[c]							
Radiological workers	4,000	2029	2059	8	500	1	4
Nonradiological workers							
On site	40,000	2029	2059	8	5,000	3	
Off site	N/A						
Containment Structure Deactivation–T Area Cribs and Trenches (Ditches) (CLO_DEACS2)[d]							
Radiological workers	4,000	2062	2099	6	667	1	5
Nonradiological workers							
On site	40,000	2062	2099	6	6,670	4	
Off site	N/A						
Preprocessing Facility Construction (CLO_CONPPF)							
Radiological workers	N/A						4,780
Nonradiological workers							
On site	29,800,000	2020	2022	3	9,930,000	4,780	
Off site	10,100,000	2020	2022	3	3,370,000	1,620	
Preprocessing Facility Operations (CLO_OPSPPF)							
Radiological workers	29,300,000	2023	2099	77	381,000	184	190
Nonradiological workers							
On site	901,000	2023	2099	77	11,700	6	
Off site	N/A						

Table I–48. Tank Closure Alternative 6B, Option Case, Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Preprocessing Facility Deactivation (CLO_DEAPPF)							
Radiological workers	380,000	2100	2100	1	380,000	183	189
Nonradiological workers							
On site	11,700	2100	2100	1	11,700	6	
Off site	N/A						
Total	**112,000,000**				**16,900,000**	**8,190**	**6,560**

[a] Tank Farm Containment Structure construction activities would occur over three 4-year periods.
Period 1, 2019–2022
Period 2, 2046–2049
Period 3, 2073–2076

[b] Tank Farm Containment Structure deactivation activities would occur over five 3-year periods.
Period 1, 2043–2045
Period 2, 2062–2064
Period 3, 2070–2072
Period 4, 2089–2091
Period 5, 2097–2099

[c] B and T Area cribs and trenches (ditches) Containment Structure construction activities would occur over two 4-year periods.
Period 1, 2029–2032
Period 2, 2056–2059

[d] T Area cribs and trenches (ditches) Containment Structure deactivation activities would occur over two 3-year periods.
Period 1, 2062–2064
Period 2, 2097–2099

Notes and Assumptions:
Total number of offsite full-time equivalents = 1,630.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

I.2.13 Tank Closure Alternative 6C: All Vitrification with Separations; Landfill Closure

Table I–49. Tank Closure Alternative 6C Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Canister Storage Building (CON_CSB)							
Radiological workers	116,000	2006	2016	11	10,500	6	12
Nonradiological workers							
On site	136,000	2006	2016	11	12,400	6	
Off site	50,300	2006	2016	11	4,570	3	
Immobilized High-Level Radioactive Waste Shipping/Transfer Facility (CON_STF)							
Radiological workers	N/A						381
Nonradiological workers							
Onsite construction	1,760,000	2011	2013	3	587,000	283	
Onsite exempt	610,000	2011	2013	3	203,000	98	
Offsite design	748,000	2011	2013	3	249,000	120	

Table I–49. Tank Closure Alternative 6C Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Modules (CON_ISM)							
Radiological workers	N/A						
Nonradiological workers							
Onsite construction	3,120,000	2014	2024	11	284,000	137	222
Onsite exempt	1,930,000	2014	2024	11	175,000	85	
Offsite design	2,360,000	2014	2024	11	215,000	104	
Other Infrastructure Upgrades (CON_OIU)							
Radiological workers	782,000	2006	2034	29	27,000	13	
Nonradiological workers							45
On site	1,920,000	2006	2034	29	66,200	32	
Off site	743,000	2006	2034	29	25,600	13	
Tank Upgrades (CON_TU)							
Radiological workers	1,200,000	2006	2025	20	60,000	29	
Nonradiological workers							104
On site	3,110,000	2006	2025	20	156,000	75	
Off site	1,180,000	2006	2025	20	59,000	29	
Underground Transfer Lines (CON_UTL)							
Radiological workers	N/A						
Nonradiological workers							61
On site	126,000	2009	2009	1	126,000	61	
Off site	17,400	2009	2009	1	17,400	9	
Waste Treatment Plant (CON_WTP)							
Radiological workers	N/A						
Nonradiological workers							1,190
On site	29,700,000	2006	2017	12	2,480,000	1,190	
Off site	9,930,000	2006	2017	12	828,000	399	
Additional Low-Activity Waste Melters (CON_LAW)							
Radiological workers	N/A						
Nonradiological workers							340
On site	7,060,000	2008	2017	10	706,000	340	
Off site	2,390,000	2008	2017	10	239,000	115	
Cesium and Strontium Capsule Processing Facility (CON_CSC)							
Radiological workers	N/A						
Nonradiological workers							190
On site	1,580,000	2035	2038	4	395,000	190	
Off site	466,000	2035	2038	4	117,000	57	
Waste Receiver Facilities (CON_WRF)							
Radiological workers	N/A						
Nonradiological workers							454
On site	4,720,000	2013	2017	5	944,000	454	
Off site	1,700,000	2013	2017	5	340,000	164	
Tank Risers (CON_RIS)							
Radiological workers	173,000	2013	2016	4	43,300	21	
Nonradiological workers							50
On site	233,000	2013	2016	4	58,300	29	
Off site	N/A						

Table I–49. Tank Closure Alternative 6C Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Modified Sluicing Retrieval System (CON_MS)							
Radiological workers	3,850,000	2013	2043	31	124,000	60	155
Nonradiological workers							
On site	6,080,000	2013	2043	31	196,000	95	
Off site	2,140,000	2013	2043	31	69,000	34	
Mobile Retrieval System (CON_MRS)							
Radiological workers	8,100,000	2013	2028	16	506,000	244	513
Nonradiological workers							
On site	8,940,000	2013	2028	16	559,000	269	
Off site	4,790,000	2013	2028	16	299,000	144	
Vacuum-Based Retrieval System (CON_VBR)							
Radiological workers	11,200,000	2029	2043	15	747,000	360	745
Nonradiological workers							
On site	12,000,000	2029	2043	15	800,000	385	
Off site	6,820,000	2029	2043	15	455,000	219	
High-Level Radioactive Waste Melter Interim Storage Facilities (CON_PAD)[a]							
Radiological workers	N/A						1
Nonradiological workers							
On site	5,620	2015	2030	4	1,410	1	
Off site	N/A						
Effluent Treatment Facility Replacement (CON_ETF)							
Radiological workers	N/A						329
Nonradiological workers							
On site	2,050,000	2023	2025	3	683,000	329	
Off site	704,000	2023	2025	3	235,000	113	
242-A Evaporator Replacement (CON_EVA)							
Radiological workers	N/A						102
Nonradiological workers							
On site	635,000	2015	2017	3	212,000	102	
Off site	218,000	2015	2017	3	72,700	35	
Immobilized Low-Activity Waste Interim Storage Facility (CON_ILAWST)							
Radiological workers	N/A						11
Nonradiological workers							
On site	603,000	2016	2043	28	21,500	11	
Off site	N/A						
Total	**146,000,000**				**13,400,000**	**6,460**	**4,910**

[a] High-Level Radioactive Waste Melter Interim Storage Facilities construction activities would occur over two 2-year periods.
Period 1, 2015–2016
Period 2, 2029–2030

Notes and Assumptions:
Total number of offsite full-time equivalents = 1,550.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–50. Tank Closure Alternative 6C Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (OPS_ISF)							
Radiological workers	3,650,000	2018	2040	23	159,000	77	120
Nonradiological workers							
On site	2,040,000	2018	2040	23	88,700	43	
Off site	N/A						
Other Infrastructure Upgrades (OPS_OIU)							
Radiological workers	44,900	2006	2043	38	1,180	1	4
Nonradiological workers							
On site	165,000	2006	2043	38	4,340	3	
Off site	117,000	2006	2043	38	3,080	2	
Routine Operations (OPS_ROUT)							
Radiological workers	9,880,000	2006	2043	38	260,000	125	650
Nonradiological workers							
On site	41,500,000	2006	2043	38	1,090,000	525	
Off site	5,890,000	2006	2043	38	155,000	75	
Retrieval Operations (OPS_RET)							
Radiological workers	13,000	2006	2043	38	342	1	28
Nonradiological workers							
On site	2,110,000	2006	2043	38	55,500	27	
Off site	16,400	2006	2043	38	432	1	
Interim Stabilization/Double-Shell Tanks (OPS_IST)							
Radiological workers	1,390,000	2006	2043	38	36,600	18	44
Nonradiological workers							
On site	2,000,000	2006	2043	38	52,600	26	
Off site	2,200,000	2006	2043	38	57,900	28	
Waste Treatment Plant (OPS_WTP)							
Radiological workers	62,800,000	2018	2043	26	2,420,000	1,160	1,940
Nonradiological workers							
On site	42,100,000	2018	2043	26	1,620,000	779	
Off site	8,000	2018	2043	26	308	1	
Waste Treatment Plant—Cesium and Strontium Capsules (OPS_WTPCSC)							
Radiological workers	2,410,000	2040	2040	1	2,410,000	1,160	1,940
Nonradiological workers							
On site	1,620,000	2040	2040	1	1,620,000	779	
Off site	308	2040	2040	1	308	1	
Cesium and Strontium Capsule Processing Facility (OPS_CSC)							
Radiological workers	103,000	2039	2040	2	51,500	25	25
Nonradiological workers							
On site	N/A						
Off site	N/A						
Modified Sluicing Retrieval System (OPS_MS)							
Radiological workers	5,780,000	2013	2043	31	186,000	90	149
Nonradiological workers							
On site	3,780,000	2013	2043	31	122,000	59	
Off site	N/A						

Table I–50. Tank Closure Alternative 6C Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Mobile Retrieval System (OPS_MRS)							
Radiological workers	5,170,000	2013	2028	16	323,000	156	297
Nonradiological workers							
On site	4,680,000	2013	2028	16	293,000	141	
Off site	N/A						
Vacuum-Based Retrieval System (OPS_VBR)							
Radiological workers	7,670,000	2029	2043	15	511,000	246	469
Nonradiological workers							
On site	6,940,000	2029	2043	15	463,000	223	
Off site	N/A						
High-Level Radioactive Waste Melter Interim Storage Facilities (OPS_PAD)							
Radiological workers	N/A	2018	2145	128	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Effluent Treatment Facility Replacement (OPS_ETF)							
Radiological workers	6,180,000	2006	2045	40	155,000	75	94
Nonradiological workers							
On site	1,550,000	2006	2045	40	38,800	19	
Off site	N/A						
242-A Evaporator Replacement (OPS_EVA)							
Radiological workers	1,860,000	2006	2043	38	48,900	24	32
Nonradiological workers							
On site	568,000	2006	2043	38	14,900	8	
Off site	N/A						
Borrow Area C (OPS_CAREA)							
Radiological workers	N/A						43
Nonradiological workers							
On site	4,200,000	2006	2052	47	89,400	43	
Off site	N/A						
Immobilized Low-Activity Waste Interim Storage Facility (OPS_ILAWST)							
Radiological workers	N/A	2018	2043	26	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Total	**228,000,000**				**12,300,000**	**5,940**	**5,840**

Notes and Assumptions:

Total number of offsite full-time equivalents = 100.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

Table I–51. Tank Closure Alternative 6C Deactivation Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Immobilized High-Level Radioactive Waste Interim Storage Facilities (DEA_ISF)							
Radiological workers	N/A						1
Nonradiological workers							
On site	160	2041	2041	1	160	1	
Off site	N/A						
Waste Treatment Plant (DEA_WTP)							
Radiological workers	3,800,000	2044	2045	2	1,900,000	914	1,530
Nonradiological workers							
On site	2,550,000	2044	2045	2	1,280,000	616	
Off site	500	2044	2045	2	250	1	
Modified Sluicing Retrieval System (DEA_MS)							
Radiological workers	291,000	2013	2043	31	9,390	5	5
Nonradiological workers							
On site	N/A						
Off site	N/A						
Mobile Retrieval System (DEA_MRS)							
Radiological workers	680,000	2013	2028	16	42,500	21	21
Nonradiological workers							
On site	N/A						
Off site	N/A						
Vacuum-Based Retrieval System (DEA_VBR)							
Radiological workers	258,000	2029	2043	15	17,200	9	9
Nonradiological workers							
On site	N/A						
Off site	N/A						
Cesium and Strontium Capsule Processing Facility (DEA_CSC)							
Radiological workers	23,900	2041	2041	1	23,900	12	12
Nonradiological workers							
On site	N/A						
Off site	N/A						
Effluent Treatment Facility (Original) (DEA_ETFO)							
Radiological workers	77,300	2026	2026	1	77,300	38	48
Nonradiological workers							
On site	19,300	2026	2026	1	19,300	10	
Off site	N/A						
Effluent Treatment Facility (DEA_ETF)							
Radiological workers	77,300	2046	2046	1	77,300	38	48
Nonradiological workers							
On site	19,300	2046	2046	1	19,300	10	
Off site	N/A						
242-A Evaporator (Original) (DEA_EVAO)							
Radiological workers	24,400	2018	2018	1	24,400	12	16
Nonradiological workers							
On site	7,480	2018	2018	1	7,480	4	
Off site	N/A						

Table I–51. Tank Closure Alternative 6C Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
242-A Evaporator Replacement (DEA_EVA)							
Radiological workers	24,400	2044	2044	1	24,400	12	16
Nonradiological workers							
On site	7,480	2044	2044	1	7,480	4	
Off site	N/A						
Total	**7,860,000**				**3,530,000**	**1,710**	**1,710**

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010a.

Table I–52. Tank Closure Alternative 6C Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Tank-Filling Grout Facility Construction (CLO_CONGRO)							
Radiological workers	480	2032	2033	2	240	1	5
Nonradiological workers							
On site	13,400	2032	2033	2	6,700	4	
Off site	4,160	2032	2033	2	2,080	1	
Tank-Filling Grout Facility Operations (CLO_OPSGRO)							
Radiological workers	68,000	2034	2043	10	6,800	4	13
Nonradiological workers							
On site	185,000	2034	2043	10	18,500	9	
Off site	130,000	2034	2043	10	13,000	7	
Tank-Filling Grout Facility Deactivation (CLO_DEAGRO)							
Radiological workers	480	2044	2044	1	480	1	4
Nonradiological workers							
On site	4,320	2044	2044	1	4,320	3	
Off site	1,040	2044	2044	1	1,040	1	
Ancillary Equipment Grouting (CLO_ANCFIL)							
Radiological workers	338,000	2013	2037	25	13,500	7	7
Nonradiological workers							
On site	N/A						
Off site	N/A						
Ancillary Equipment Removal (CLO_ANCREM)							
Radiological workers	166,000	2032	2037	6	27,700	14	14
Nonradiological workers							
On site	N/A						
Off site	N/A						

Table I–52. Tank Closure Alternative 6C Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
BX and SX Tank Farm Soil Removal (CLO_SOIL)							
Radiological workers	33,000	2032	2037	6	5,500	3	6
Nonradiological workers							
On site	30,000	2032	2037	6	5,000	3	
Off site	N/A						
Containment Structure Construction (CLO_CONCS)							
Radiological workers	2,000	2028	2031	4	500	1	4
Nonradiological workers							
On site	20,000	2028	2031	4	5,000	3	
Off site	N/A						
Containment Structure Deactivation (CLO_DEACS)							
Radiological workers	2,000	2038	2040	3	667	1	5
Nonradiological workers							
On site	20,000	2038	2040	3	6,670	4	
Off site	N/A						
Modified Resource Conservation and Recovery Act Subtitle C Barrier Construction (CLO_RCRA)							
Radiological workers	1,430,000	2039	2045	7	204,000	99	394
Nonradiological workers							
On site	4,290,000	2039	2045	7	613,000	295	
Off site	N/A						
Decontamination and Decommissioning of 10 Selected Facilities (CLO_D&DTEN)							
Radiological workers	44,400	2018	2028	11	4,040	2	9
Nonradiological workers							
On site	147,000	2018	2028	11	13,400	7	
Off site	79,000	2018	2028	11	7,180	4	
Postclosure Care (CLO_POST)							
Radiological workers	N/A						3
Nonradiological workers							
On site	471,000	2046	2145	100	4,710	3	
Off site	N/A						
Total	**7,480,000**				**964,000**	**477**	**464**

Notes and Assumptions:

Total number of offsite full-time equivalents = 13.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010a.

I.2.14 FFTF Decommissioning Alternative 1: No Action

Table I–53. FFTF Decommissioning Alternative 1 Deactivation Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Administrative Controls (DEA_ADM)							
Radiological workers	41,600	2008	2107	100	416	1	1
Nonradiological workers							
On site	N/A						
Off site	N/A						
Total	**41,600**				**416**	**1**	**1**

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: FFTF=Fast Flux Test Facility; N/A=not applicable.
Source: Compiled from SAIC 2010b.

I.2.15 FFTF Decommissioning Alternative 2: Entombment

Table I–54. FFTF Decommissioning Alternative 2, Facility Disposition, Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Above-Grade Structure and Equipment Removal (DEC_AGSR)							
Radiological workers	N/A						33
Nonradiological workers							
On site	546,000	2013	2020	8	68,300	33	
Off site	20,000	2013	2020	8	2,500	2	
Removal of Reactor Containment Building Below-Grade Vessels, Piping, Components (DEC_GB1)							
Radiological workers	7,680	2017	2017	1	7,680	4	6
Nonradiological workers							
On site	3,840	2017	2017	1	3,840	2	
Off site	N/A						
491 East and West Backfill with Grout (DEC_GB2)							
Radiological workers	N/A	2017	2017	1	N/A	0	0
Nonradiological workers							
On site	N/A						
Off site	N/A						
Grout Facility Resource Calculation (DEC_OGFC)							
Radiological workers	N/A						11
Nonradiological workers							
On site	22,400	2016	2016	1	22,400	11	
Off site	N/A						
Grout Facility Resource Calculation–Operation (DEC_OGFO)							
Radiological workers	N/A						6
Nonradiological workers							
On site	10,600	2017	2017	1	10,600	6	
Off site	N/A						

Table I–54. FFTF Decommissioning Alternative 2, Facility Disposition, Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Grout Facility Resource Calculation–Deactivation (DEC_OGFD)							
Radiological workers	N/A						
Nonradiological workers							
On site	7,210	2018	2018	1	7,210	4	4
Off site	N/A						
Nonhazardous Waste Transportation (DEC_WTR)							
Radiological workers	N/A						
Nonradiological workers							
On site	95	2013	2020	8	12	1	1
Off site	9	2013	2020	8	1	1	
Site Regrading (CLO_SRG)							
Radiological workers	N/A						
Nonradiological workers							
On site	45,200	2021	2021	1	45,200	22	22
Off site	4,520	2021	2021	1	4,520	3	
Site Revegetation (CLO_REV)							
Radiological workers	N/A						
Nonradiological workers							
On site	942	2021	2021	1	942	1	1
Off site	94	2021	2021	1	94	1	
Modified Resource Conservation and Recovery Act Subtitle C Barrier (CLO_RCRA)							
Radiological workers	N/A						
Nonradiological workers							
On site	55,700	2021	2021	1	55,700	27	27
Off site	5,570	2021	2021	1	5,570	3	
Institutional Controls (CLO_POST)							
Radiological workers	N/A						
Nonradiological workers							
On site	80,000	2022	2121	100	800	1	1
Off site	N/A						
Total	**810,000**				**235,000**	**122**	**112**

Notes and Assumptions:

Total number of offsite full-time equivalents = 10.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: FFTF=Fast Flux Test Facility; N/A=not applicable.

Source: Compiled from SAIC 2010b.

I.2.16 FFTF Decommissioning Alternative 3: Removal

Table I–55. FFTF Decommissioning Alternative 3, Facility Disposition, Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Above-Grade Structure and Equipment Removal (DEC_AGSR)							
Radiological workers	N/A						33
Nonradiological workers							
On site	546,000	2013	2020	8	68,300	33	
Off site	20,000	2013	2020	8	2,500	2	
Removal of Reactor Containment Building Below-Grade Vessels, Piping, Components (DEC_RVRG)							
Radiological workers	131,000	2013	2014	2	65,500	32	48
Nonradiological workers							
On site	64,600	2013	2014	2	32,300	16	
Off site	N/A						
Grout Facility Resource Calculation (DEC_OGFC)							
Radiological workers	N/A						11
Nonradiological workers							
On site	22,400	2012	2012	1	22,400	11	
Off site	N/A						
Grout Facility Resource Calculation–Operation (DEC_OGFO)							
Radiological workers	N/A						3
Nonradiological workers							
On site	10,600	2013	2014	2	5,300	3	
Off site	N/A						
Grout Facility Resource Calculation–Deactivation (DEC_OGFD)							
Radiological workers	N/A						4
Nonradiological workers							
On site	7,210	2015	2015	1	7,210	4	
Off site	N/A						
Nonhazardous Waste Transportation (DEC_WTR)							
Radiological workers	N/A						1
Nonradiological workers							
On site	95	2013	2020	8	12	1	
Off site	9	2013	2020	8	1	1	
Site Regrading (CLO_SRG)							
Radiological workers	N/A						30
Nonradiological workers							
On site	61,600	2021	2021	1	61,600	30	
Off site	6,160	2021	2021	1	6,160	3	
Site Revegetation (CLO_REV)							
Radiological workers	N/A						1
Nonradiological workers							
On site	1,060	2021	2021	1	1,060	1	
Off site	106	2021	2021	1	106	1	

Table I–55. FFTF Decommissioning Alternative 3, Facility Disposition, Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Institutional Controls (CLO_POST)							
Radiological workers	N/A						
Nonradiological workers							
On site	80,000	2022	2121	100	800	1	1
Off site	N/A						
Total	**951,000**				**273,000**	**139**	**132**

Notes and Assumptions:
Total number of offsite full-time equivalents = 7.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: FFTF=Fast Flux Test Facility; N/A=not applicable.
Source: Compiled from SAIC 2010b.

Table I–56. FFTF Decommissioning Alternatives 2 and 3, Disposition of Remote-Handled Special Components, Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
HANFORD OPTION							
Remote Treatment Project–Hanford 200-West Area (CON_HRTP)							
Radiological workers	N/A						
Nonradiological workers							
On site	219,000	2015	2016	2	110,000	53	53
Off site	124,000	2015	2016	2	62,000	30	
Remote Treatment Project–Hanford (OPS_HRTP)							
Radiological workers	83,200	2017	2017	1	83,200	40	
Nonradiological workers							40
On site	N/A						
Off site	5	2017	2017	1	5	1	
Remote Treatment Project–Hanford 200-West Area (DEA_HRTP)							
Radiological workers	41,600	2018	2018	1	41,600	20	
Nonradiological workers							20
On site	N/A						
Off site	N/A						
Total	**468,000**				**297,000**	**144**	**113**
IDAHO OPTION							
Remote Treatment Project–Idaho National Laboratory Materials and Fuels Complex (OPS_IRTP)							
Radiological workers	83,200	2017	2017	1	83,200	40	
Nonradiological workers							40
On site	N/A						
Off site	87	2017	2017	1	87	1	

Table I–56. FFTF Decommissioning Alternatives 2 and 3, Disposition of Remote-Handled Special Components, Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
IDAHO OPTION *(continued)*							
Remote Treatment Project–Idaho National Laboratory Materials and Fuels Complex (DEA_IRTP)							
Radiological workers	41,600	2018	2018	1	41,600	20	20
Nonradiological workers							
On site	N/A						
Off site	N/A						
Total	**125,000**				**125,000**	**61**	**60**

Notes and Assumptions:
Total number of offsite full-time equivalents at Hanford = 31.
Total number of offsite full-time equivalents at Idaho National Laboratory = 1.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; N/A=not applicable.
Source: Compiled from SAIC 2010b.

Table I–57. FFTF Decommissioning Alternatives 2 and 3, Disposition of Bulk Sodium, Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
HANFORD REUSE OPTION							
Hanford Sodium Reaction Facility (CON_HSRF)							
Radiological workers	N/A						44
Nonradiological workers							
On site	179,000	2015	2016	2	89,500	44	
Off site	87,000	2015	2016	2	43,500	21	
Hanford Sodium Reaction Facility (OPS_HSP)							
Radiological workers	10,400	2017	2017	1	10,400	5	5
Nonradiological workers							
On site	N/A						
Off site	N/A						
Hanford Sodium Reaction Facility (OPS_HSRF)							
Radiological workers	185,000	2017	2018	2	92,500	45	60
Nonradiological workers							
On site	61,800	2017	2018	2	30,900	15	
Off site	5,890	2017	2018	2	2,950	2	
Hanford Sodium Reaction Facility (DEA_HSRF)							
Radiological workers	11,000	2019	2019	1	11,000	6	18
Nonradiological workers							
On site	22,900	2019	2019	1	22,900	12	
Off site	16,400	2019	2019	1	16,400	8	
Total	**579,000**				**320,000**	**158**	**127**

Table I–57. FFTF Decommissioning Alternatives 2 and 3, Disposition of Bulk Sodium, Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
IDAHO REUSE OPTION							
Materials and Fuels Complex Sodium Processing Facility (CON_ISPF)							
Radiological workers	21,000	2014	2014	1	21,000	11	19
Nonradiological workers							
On site	15,600	2014	2014	1	15,600	8	
Off site	12,600	2014	2014	1	12,600	7	
Idaho National Laboratory Materials and Fuels Complex–Sodium Processing Facility and Fast Flux Test Facility Sodium Storage Facility (OPS_ISP)							
Radiological workers	10,400	2015	2015	1	10,400	5	5
Nonradiological workers							
On site	N/A						
Off site	N/A						
Sodium Processing Facility (OPS_ISPF)							
Radiological workers	169,000	2015	2016	2	84,500	41	50
Nonradiological workers							
On site	35,800	2015	2016	2	17,900	9	
Off site	N/A						
Fast Flux Test Facility Sodium Disposition–Idaho Reuse Option (DEA_ISPF)							
Radiological workers	828	2016	2016	1	828	1	2
Nonradiological workers							
On site	379	2016	2016	1	379	1	
Off site	N/A						
Total	**266,000**				**163,000**	**83**	**76**

Notes and Assumptions:

Total number of offsite full-time equivalents at Hanford = 31.

Total number of offsite full-time equivalents at Idaho National Laboratory = 7.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; N/A=not applicable.

Source: Compiled from SAIC 2010b.

I.2.17 Waste Management Alternative 1: No Action

Table I–58. Waste Management Alternative 1 Operations/Deactivation Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Low-Level Radioactive Waste Burial Grounds (OPS_LLBG)							
Radiological workers	387,000	2007	2035	29	13,300	7	9
Nonradiological workers							
On site	114,000	2007	2035	29	3,930	2	
Off site	194,000	2007	2035	29	6,690	4	
Integrated Disposal Facility (DEA_IDF)							
Radiological workers	6,240	2009	2009	1	6,240	3	100
Nonradiological workers							
On site	200,000	2009	2009	1	200,000	97	
Off site	31,200	2009	2009	1	31,200	15	

Table I–58. Waste Management Alternative 1 Operations/Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Postclosure Care (DEA_ADM)							
Radiological workers	N/A						
Nonradiological workers							
On site	72,700	2036	2135	100	727	1	1
Off site	N/A						
Total	**1,010,000**				**262,000**	**129**	**110**

Notes and Assumptions:
Total number of offsite full-time equivalents = 19.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010c.

I.2.18 Waste Management Alternative 2: Disposal in IDF, 200-East Area Only

Table I–59. Waste Management Alternative 2 Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
A 2706T/TA/TB Facility (CON_TPLANT)							
Radiological workers	N/A						
Nonradiological workers							
On site	78,500	2011	2012	2	39,300	19	19
Off site	31,000	2011	2012	2	15,500	8	
Central Waste Complex (CON_WRAPCH)							
Radiological workers	N/A						
Nonradiological workers							
On site	883,000	2011	2012	2	442,000	213	213
Off site	133,000	2011	2012	2	66,500	32	
Waste Receiving and Processing Facility (CON_WRAPRH)							
Radiological workers	N/A						
Nonradiological workers							
On site	1,480,000	2013	2018	6	247,000	119	119
Off site	509,000	2013	2018	6	84,800	41	
Central Waste Complex (CON_CWCE)							
Radiological workers	N/A						
Nonradiological workers							
On site	294,000	2011	2012	2	147,000	71	71
Off site	105,000	2011	2012	2	52,500	26	
Total	**3,510,000**				**1,090,000**	**529**	**422**

Notes and Assumptions:
Total number of offsite full-time equivalents = 107.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010c.

Table I–60. Waste Management Alternative 2 Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
T Plant Solid Waste Activities (OPS_TPLANT)							
Radiological workers	1,260,000	2013	2050	38	33,200	16	20
Nonradiological workers							
On site	316,000	2013	2050	38	8,320	4	
Off site	N/A						
Solid Waste Operations Complex Waste Receiving and Processing Facility (OPS_WRAPCH)							
Radiological workers	21,700,000	2013	2050	38	571,000	275	301
Nonradiological workers							
On site	1,980,000	2013	2050	38	52,100	26	
Off site	N/A						
Solid Waste Operations Complex Waste Receiving and Processing Facility (OPS_WRAPRH)							
Radiological workers	7,300,000	2019	2050	32	228,000	110	120
Nonradiological workers							
On site	666,000	2019	2050	32	20,800	10	
Off site	N/A						
Central Waste Complex (OPS_CWCE)							
Radiological workers	623,000	2013	2050	38	16,400	8	9
Nonradiological workers							
On site	69,200	2013	2050	38	1,820	1	
Off site	N/A						
Total	**33,900,000**				**932,000**	**450**	**450**

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010c.

Table I–61. Waste Management Alternative 2 Deactivation Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
T Plant Solid Waste Activities (DEA_TPLANT)							
Radiological workers	22,200	2051	2051	1	22,200	11	14
Nonradiological workers							
On site	5,550	2051	2051	1	5,550	3	
Off site	N/A						
Solid Waste Operations Complex Waste Receiving and Processing Facility–Deactivation of the Contact-Handled Mixed Transuranic/Transuranic Waste Facility (DEA_WRAPCH)							
Radiological workers	285,000	2051	2051	1	285,000	138	151
Nonradiological workers							
On site	26,000	2051	2051	1	26,000	13	
Off site	N/A						

Table I–61. Waste Management Alternative 2 Deactivation Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Solid Waste Operations Complex Waste Receiving and Processing Facility–Remote-Handled Mixed Transuranic/Transuranic Waste Facility (DEA_WRAPRH)							
Radiological workers	114,000	2051	2051	1	114,000	55	60
Nonradiological workers							
On site	10,400	2051	2051	1	10,400	5	
Off site	N/A						
Central Waste Complex (DEA_CWCE)							
Radiological workers	8,190	2051	2051	1	8,190	4	5
Nonradiological workers							
On site	911	2051	2051	1	911	1	
Off site	N/A						
Total	**472,000**				**472,000**	**230**	**230**

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010c.

Table I–62. Waste Management Alternative 2, Disposal Group 1, Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Single Integrated Disposal Facility (CON_IDF)							
Radiological workers	N/A						160
Nonradiological workers							
On site	993,000	2006	2008	3	331,000	160	
Off site	N/A						
River Protection Project Disposal Facility (CON_RPPDF)							
Radiological workers	N/A						170
Nonradiological workers							
On site	1,060,000	2019	2021	3	353,000	170	
Off site	N/A						
Total	**2,050,000**				**684,000**	**330**	**330**

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010c.

Table I–63. Waste Management Alternative 2, Disposal Group 1, Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Low-Level Radioactive Waste Burial Grounds (OPS_LLBG)							
Radiological workers	587,000	2007	2050	44	13,300	7	9
Nonradiological workers							
On site	173,000	2007	2050	44	3,930	2	
Off site	294,000	2007	2050	44	6,680	4	
Single Integrated Disposal Facility (OPS_IDF)							
Radiological workers	1,510,000	2009	2050	42	36,000	18	42
Nonradiological workers							
On site	2,090,000	2009	2050	42	49,800	24	
Off site	2,790,000	2009	2050	42	66,400	32	
River Protection Project Disposal Facility (OPS_RPPDF)							
Radiological workers	1,660,000	2022	2050	29	57,200	28	43
Nonradiological workers							
On site	898,000	2022	2050	29	31,000	15	
Off site	1,660,000	2022	2050	29	57,200	28	
Total	**11,700,000**				**322,000**	**158**	**94**

Notes and Assumptions:

Total number of offsite full-time equivalents = 64.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Source: Compiled from SAIC 2010c.

Table I–64. Waste Management Alternative 2, Disposal Group 1, Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Modified Resource Conservation and Recovery Act Subtitle C Barrier (CLO_IDF)							
Radiological workers	N/A						621
Nonradiological workers							
On site	2,570,000	2051	2052	2	1,290,000	621	
Off site	257,000	2051	2052	2	129,000	63	
Postclosure Care (CLO_POSTIDF)							
Radiological workers	N/A						2
Nonradiological workers							
On site	391,000	2053	2152	100	3,910	2	
Off site	N/A						
Modified Resource Conservation and Recovery Act Subtitle C Barrier (CLO_RPPDF)							
Radiological workers	N/A						558
Nonradiological workers							
On site	2,320,000	2051	2052	2	1,160,000	558	
Off site	232,000	2051	2052	2	116,000	56	

Table I–64. Waste Management Alternative 2, Disposal Group 1, Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Postclosure Care (CLO_POSTRPPDF)							
Radiological workers	N/A						
Nonradiological workers							
On site	353,000	2053	2152	100	3,530	2	2
Off site	N/A						
Total	**6,120,000**				**2,700,000**	**1,300**	**1,180**

Notes and Assumptions:
Total number of offsite full-time equivalents = 120.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010c.

Table I–65. Waste Management Alternative 2, Disposal Group 2, Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Single Integrated Disposal Facility (CON_IDF)							
Radiological workers	N/A						
Nonradiological workers							
On site	701,000	2006	2008	3	234,000	113	113
Off site	N/A						
River Protection Project Disposal Facility (CON_RPPDF)							
Radiological workers	N/A						
Nonradiological workers							
On site	8,190,000	2019	2021	3	2,730,000	1,310	1,310
Off site	N/A						
Total	**8,890,000**				**2,960,000**	**1,420**	**1,420**

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010c.

Table I–66. Waste Management Alternative 2, Disposal Group 2, Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Low-Level Radioactive Waste Burial Grounds (OPS_LLBG)							
Radiological workers	587,000	2007	2050	44	13,300	7	9
Nonradiological workers							
On site	173,000	2007	2050	44	3,930	2	
Off site	294,000	2007	2050	44	6,680	4	

Table I–66. Waste Management Alternative 2, Disposal Group 2, Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Single Integrated Disposal Facility (OPS_IDF)							
Radiological workers	1,170,000	2009	2100	92	12,700	7	16
Nonradiological workers							
On site	1,620,000	2009	2100	92	17,600	9	
Off site	2,160,000	2009	2100	92	23,500	12	
River Protection Project Disposal Facility (OPS_RPPDF)							
Radiological workers	35,100,000	2022	2100	79	444,000	214	329
Nonradiological workers							
On site	18,900,000	2022	2100	79	239,000	115	
Off site	35,100,000	2022	2100	79	444,000	214	
Total	**95,100,000**				**1,200,000**	**584**	**354**

Notes and Assumptions:
Total number of offsite full-time equivalents = 230.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Source: Compiled from SAIC 2010c.

Table I–67. Waste Management Alternative 2, Disposal Group 2, Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Modified Resource Conservation and Recovery Act Subtitle C Barrier (CLO_IDF)							
Radiological workers	N/A						219
Nonradiological workers							
On site	909,000	2101	2102	2	455,000	219	
Off site	90,900	2101	2102	2	45,500	22	
Postclosure Care (CLO_POSTIDF)							
Radiological workers	N/A						1
Nonradiological workers							
On site	138,000	2103	2202	100	1,380	1	
Off site	N/A						
Modified Resource Conservation and Recovery Act Subtitle C Barrier (CLO_RPPDF)							
Radiological workers	N/A						4,330
Nonradiological workers							
On site	18,000,000	2101	2102	2	9,000,000	4,330	
Off site	1,800,000	2101	2102	2	900,000	433	
Postclosure Care (CLO_POSTRPPDF)							
Radiological workers	N/A						14
Nonradiological workers							
On site	2,730,000	2103	2202	100	27,300	14	
Off site	N/A						
Total	**23,700,000**				**10,400,000**	**5,020**	**4,560**

Notes and Assumptions:
Total number of offsite full-time equivalents = 460.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010c.

Table I–68. Waste Management Alternative 2, Disposal Group 3, Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Single Integrated Disposal Facility (CON_IDF)							
Radiological workers	N/A						
Nonradiological workers							
On site	701,000	2006	2008	3	234,000	113	113
Off site	N/A						
River Protection Project Disposal Facility (CON_RPPDF)							
Radiological workers	N/A						
Nonradiological workers							
On site	8,190,000	2019	2021	3	2,730,000	1,310	1,310
Off site	N/A						
Total	**8,890,000**				**2,960,000**	**1,420**	**1,420**

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010c.

Table I–69. Waste Management Alternative 2, Disposal Group 3, Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Low-Level Radioactive Waste Burial Grounds (OPS_LLBG)							
Radiological workers	587,000	2007	2050	44	13,300	7	
Nonradiological workers							9
On site	173,000	2007	2050	44	3,930	2	
Off site	294,000	2007	2050	44	6,680	4	
Single Integrated Disposal Facility (OPS_IDF)							
Radiological workers	2,000,000	2009	2165	157	12,700	7	
Nonradiological workers							16
On site	2,760,000	2009	2165	157	17,600	9	
Off site	3,680,000	2009	2165	157	23,400	12	
River Protection Project Disposal Facility (OPS_RPPDF)							
Radiological workers	64,100,000	2022	2165	144	445,000	214	
Nonradiological workers							330
On site	34,500,000	2022	2165	144	240,000	116	
Off site	64,100,000	2022	2165	144	445,000	214	
Total	**171,000,000**				**1,210,000**	**585**	**355**

Notes and Assumptions:
Total number of offsite full-time equivalents = 230.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Source: Compiled from SAIC 2010c.

Table I–70. Waste Management Alternative 2, Disposal Group 3, Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Modified Resource Conservation and Recovery Act Subtitle C Barrier (CLO_IDF)							
Radiological workers	N/A						219
Nonradiological workers							
On site	909,000	2166	2167	2	455,000	219	
Off site	90,900	2166	2167	2	45,500	22	
Postclosure Care (CLO_POSTIDF)							
Radiological workers	N/A						1
Nonradiological workers							
On site	138,000	2168	2267	100	1,380	1	
Off site	N/A						
Modified Resource Conservation and Recovery Act Subtitle C Barrier (CLO_RPPDF)							
Radiological workers	N/A						4,330
Nonradiological workers							
On site	18,000,000	2166	2167	2	9,000,000	4,330	
Off site	1,800,000	2166	2167	2	900,000	433	
Postclosure Care (CLO_POSTRPPDF)							
Radiological workers	N/A						14
Nonradiological workers							
On site	2,730,000	2168	2267	100	27,300	14	
Off site	N/A						
Total	**23,700,000**				**10,400,000**	**5,020**	**4,560**

Notes and Assumptions:
Total number of offsite full-time equivalents = 460.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010c.

I.2.19 Waste Management Alternative 3: Disposal in IDF, 200-East and 200-West Areas

Table I–71. Waste Management Alternative 3 Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
A 2706T/TA/TB Facility (CON_TPLANT)							
Radiological workers	N/A						19
Nonradiological workers							
On site	78,500	2011	2012	2	39,300	19	
Off site	31,000	2011	2012	2	15,500	8	
Central Waste Complex (CON_WRAPCH)							
Radiological workers	N/A						213
Nonradiological workers							
On site	883,000	2011	2012	2	442,000	213	
Off site	133,000	2011	2012	2	66,500	32	

Table I–71. Waste Management Alternative 3 Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Waste Receiving and Processing Facility (CON_WRAPRH)							
Radiological workers	N/A						119
Nonradiological workers							
On site	1,480,000	2013	2018	6	247,000	119	
Off site	509,000	2013	2018	6	84,800	41	
Central Waste Complex (CON_CWCE)							
Radiological workers	N/A						71
Nonradiological workers							
On site	294,000	2011	2012	2	147,000	71	
Off site	105,000	2011	2012	2	52,500	26	
Total	**3,510,000**				**1,090,000**	**529**	**422**

Notes and Assumptions:
Total number of offsite full-time equivalents = 107.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010c.

Table I–72. Waste Management Alternative 3 Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
T Plant Solid Waste Activities (OPS_TPLANT)							
Radiological workers	1,260,000	2013	2050	38	33,200	16	20
Nonradiological workers							
On site	316,000	2013	2050	38	8,320	4	
Off site	N/A						
Solid Waste Operations Complex Waste Receiving and Processing Facility (OPS_WRAPCH)							
Radiological workers	21,700,000	2013	2050	38	571,000	275	301
Nonradiological workers							
On site	1,980,000	2013	2050	38	52,100	26	
Off site	N/A						
Solid Waste Operations Complex Waste Receiving and Processing Facility (OPS_WRAPRH)							
Radiological workers	7,300,000	2019	2050	32	228,000	110	120
Nonradiological workers							
On site	666,000	2019	2050	32	20,800	10	
Off site	N/A						
Central Waste Complex (OPS_CWCE)							
Radiological workers	623,000	2013	2050	38	16,400	8	9
Nonradiological workers							
On site	69,200	2013	2050	38	1,820	1	
Off site	N/A						
Total	**33,900,000**				**932,000**	**450**	**450**

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010c.

Table I–73. Waste Management Alternative 3 Deactivation Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
T Plant Solid Waste Activities (DEA_TPLANT)							
Radiological workers	22,200	2051	2051	1	22,200	11	14
Nonradiological workers							
On site	5,550	2051	2051	1	5,550	3	
Off site	N/A						
Solid Waste Operations Complex Waste Receiving and Processing Facility–Deactivation of the Contact-Handled Mixed Transuranic/Transuranic Waste Facility (DEA_WRAPCH)							
Radiological workers	285,000	2051	2051	1	285,000	138	151
Nonradiological workers							
On site	26,000	2051	2051	1	26,000	13	
Off site	N/A						
Solid Waste Operations Complex Waste Receiving and Processing Facility–Remote-Handled Mixed Transuranic/Transuranic Waste Facility (DEA_WRAPRH)							
Radiological workers	114,000	2051	2051	1	114,000	55	60
Nonradiological workers							
On site	10,400	2051	2051	1	10,400	5	
Off site	N/A						
Central Waste Complex (DEA_CWCE)							
Radiological workers	8,190	2051	2051	1	8,190	4	5
Nonradiological workers							
On site	911	2051	2051	1	911	1	
Off site	N/A						
Total	**472,000**				**472,000**	**230**	**230**

Notes and Assumptions:

Total number of offsite full-time equivalents = 0.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010c.

Table I–74. Waste Management Alternative 3, Disposal Group 1, Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Two Integrated Disposal Facilities (One in 200-West Area and One in 200-East Area) (CON_IDFE)							
Radiological workers	N/A						241
Nonradiological workers							
On site	1,500,000	2006	2008	3	500,000	241	
Off site	N/A						
Two Integrated Disposal Facilities (One in 200-West Area and One in 200-East Area) (CON_IDFW)							
Radiological workers	N/A						180
Nonradiological workers							
On site	1,120,000	2006	2008	3	373,000	180	
Off site	N/A						

Table I–74. Waste Management Alternative 3, Disposal Group 1, Construction Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
River Protection Project Disposal Facility (CON_RPPDF)							
Radiological workers	N/A						
Nonradiological workers							
On site	1,060,000	2019	2021	3	353,000	170	170
Off site	N/A						
Total	**3,680,000**				**1,230,000**	**591**	**591**

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010c.

Table I–75. Waste Management Alternative 3, Disposal Group 1, Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Low-Level Radioactive Waste Burial Grounds (OPS_LLBG)							
Radiological workers	587,000	2007	2050	44	13,300	7	
Nonradiological workers							9
On site	173,000	2007	2050	44	3,930	2	
Off site	294,000	2007	2050	44	6,680	4	
Integrated Disposal Facility–200-East Area (OPS_IDFE)							
Radiological workers	1,390,000	2009	2050	42	33,100	16	
Nonradiological workers							38
On site	1,920,000	2009	2050	42	45,700	22	
Off site	2,560,000	2009	2050	42	61,000	30	
Integrated Disposal Facility–200-West Area (OPS_IDFW)							
Radiological workers	114,000	2009	2050	42	2,710	2	
Nonradiological workers							4
On site	157,000	2009	2050	42	3,740	2	
Off site	210,000	2009	2050	42	5,000	3	
River Protection Project Disposal Facility (OPS_RPPDF)							
Radiological workers	1,660,000	2022	2050	29	57,200	28	
Nonradiological workers							43
On site	898,000	2022	2050	29	31,000	15	
Off site	1,660,000	2022	2050	29	57,200	28	
Total	**11,600,000**				**321,000**	**159**	**94**

Notes and Assumptions:
Total number of offsite full-time equivalents = 65.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Source: Compiled from SAIC 2010c.

Table I–76. Waste Management Alternative 3, Disposal Group 1, Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Integrated Disposal Facility–200-East Area (CLO_IDFE)							
Radiological workers	N/A						568
Nonradiological workers							
On site	2,360,000	2051	2052	2	1,180,000	568	
Off site	236,000	2051	2052	2	118,000	57	
Integrated Disposal Facility–200-West Area (CLO_IDFW)							
Radiological workers	N/A						47
Nonradiological workers							
On site	193,000	2051	2052	2	96,500	47	
Off site	19,300	2051	2052	2	9,650	5	
Postclosure Care–Integrated Disposal Facility 200-East Area (CLO_POSTIDFE)							
Radiological workers	N/A						2
Nonradiological workers							
On site	366,000	2053	2152	100	3,660	2	
Off site	N/A						
Postclosure Care–Integrated Disposal Facility 200-West Area (CLO_POSTIDFW)							
Radiological workers	N/A						1
Nonradiological workers							
On site	30,000	2053	2152	100	300	1	
Off site	N/A						
Modified Resource Conservation and Recovery Act Subtitle C Barrier (CLO_RPPDF)							
Radiological workers	N/A						558
Nonradiological workers							
On site	2,320,000	2051	2052	2	1,160,000	558	
Off site	232,000	2051	2052	2	116,000	56	
Postclosure Care–River Protection Project Disposal Facility (CLO_POSTRPPDF)							
Radiological workers	N/A						2
Nonradiological workers							
On site	353,000	2053	2152	100	3,530	2	
Off site	N/A						
Total	**6,110,000**				**2,690,000**	**1,300**	**1,180**

Notes and Assumptions:

Total number of offsite full-time equivalents = 120.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Key: N/A=not applicable.

Source: Compiled from SAIC 2010c.

Table I–77. Waste Management Alternative 3, Disposal Group 2, Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Two Integrated Disposal Facilities (One in 200-West Area and One in 200-East Area) (CON_IDFE)							
Radiological workers	N/A						
Nonradiological workers							
On site	1,210,000	2006	2008	3	403,000	194	194
Off site	N/A						
Two Integrated Disposal Facilities (One in 200-West Area and One in 200-East Area) (CON_IDFW)							
Radiological workers	N/A						
Nonradiological workers							
On site	1,120,000	2006	2008	3	373,000	180	180
Off site	N/A						
River Protection Project Disposal Facility (CON_RPPDF)							
Radiological workers	N/A						
Nonradiological workers							
On site	8,190,000	2019	2021	3	2,730,000	1,310	1,310
Off site	N/A						
Total	**10,500,000**				**3,510,000**	**1,680**	**1,680**

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010c.

Table I–78. Waste Management Alternative 3, Disposal Group 2, Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Low-Level Radioactive Waste Burial Grounds (OPS_LLBG)							
Radiological workers	587,000	2007	2050	44	13,300	7	
Nonradiological workers							9
On site	173,000	2007	2050	44	3,930	2	
Off site	294,000	2007	2050	44	6,680	4	
Integrated Disposal Facility–200-East Area (OPS_IDFE)							
Radiological workers	945,000	2009	2100	92	10,300	5	
Nonradiological workers							12
On site	1,310,000	2009	2100	92	14,200	7	
Off site	1,750,000	2009	2100	92	19,000	10	
Integrated Disposal Facility–200-West Area (OPS_IDFW)							
Radiological workers	114,000	2009	2050	42	2,710	2	
Nonradiological workers							4
On site	157,000	2009	2050	42	3,740	2	
Off site	210,000	2009	2050	42	5,000	3	

Table I–78. Waste Management Alternative 3, Disposal Group 2, Operations Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
River Protection Project Disposal Facility (OPS_RPPDF)							
Radiological workers	35,100,000	2022	2100	79	444,000	214	329
Nonradiological workers							
On site	18,900,000	2022	2100	79	239,000	115	
Off site	35,100,000	2022	2100	79	444,000	214	
Total	**94,600,000**				**1,210,000**	**585**	**354**

Notes and Assumptions:
Total number of offsite full-time equivalents = 231.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Source: Compiled from SAIC 2010c.

Table I–79. Waste Management Alternative 3, Disposal Group 2, Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Integrated Disposal Facility–200-East Area (CLO_IDFE)							
Radiological workers	N/A						177
Nonradiological workers							
On site	735,000	2101	2102	2	368,000	177	
Off site	73,500	2101	2102	2	36,800	18	
Integrated Disposal Facility–200-West Area (CLO_IDFW)							
Radiological workers	N/A						47
Nonradiological workers							
On site	193,000	2051	2052	2	96,500	47	
Off site	19,300	2051	2052	2	9,650	5	
Postclosure Care–Integrated Disposal Facility 200-East Area (CLO_POSTIDFE)							
Radiological workers	N/A						1
Nonradiological workers							
On site	114,000	2103	2202	100	1,140	1	
Off site	N/A						
Postclosure Care–Integrated Disposal Facility 200-West Area (CLO_POSTIDFW)							
Radiological workers	N/A						1
Nonradiological workers							
On site	30,000	2053	2152	100	300	1	
Off site	N/A						
Modified Resource Conservation and Recovery Act Subtitle C Barrier (CLO_RPPDF)							
Radiological workers	N/A						4,330
Nonradiological workers							
On site	18,000,000	2101	2102	2	9,000,000	4,330	
Off site	1,800,000	2101	2102	2	900,000	433	

Table I–79. Waste Management Alternative 3, Disposal Group 2, Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Postclosure Care–River Protection Project Disposal Facility (CLO_POSTRPPDF)							
Radiological workers	N/A						
Nonradiological workers							
On site	2,730,000	2103	2202	100	27,300	14	14
Off site	N/A						
Total	**23,700,000**				**10,400,000**	**5,030**	**4,570**

Notes and Assumptions:
Total number of offsite full-time equivalents = 456.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010c.

Table I–80. Waste Management Alternative 3, Disposal Group 3, Construction Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Two Integrated Disposal Facilities (One in 200-West Area and One in 200-East Area) (CON_IDFE)							
Radiological workers	N/A						
Nonradiological workers							
On site	1,210,000	2006	2008	3	403,000	194	194
Off site	N/A						
Two Integrated Disposal Facilities (One in 200-West Area and One in 200-East Area) (CON_IDFW)							
Radiological workers	N/A						
Nonradiological workers							
On site	1,120,000	2006	2008	3	373,000	180	180
Off site	N/A						
River Protection Project Disposal Facility (CON_RPPDF)							
Radiological workers	N/A						
Nonradiological workers							
On site	8,190,000	2019	2021	3	2,730,000	1,310	1,310
Off site	N/A						
Total	**10,500,000**				**3,510,000**	**1,680**	**1,680**

Notes and Assumptions:
Total number of offsite full-time equivalents = 0.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010c.

Table I–81. Waste Management Alternative 3, Disposal Group 3, Operations Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Low-Level Radioactive Waste Burial Grounds (OPS_LLBG)							
Radiological workers	587,000	2007	2050	44	13,300	7	9
Nonradiological workers							
On site	173,000	2007	2050	44	3,930	2	
Off site	294,000	2007	2050	44	6,680	4	
Integrated Disposal Facility–200-East Area (OPS_IDFE)							
Radiological workers	1,610,000	2009	2165	157	10,300	5	12
Nonradiological workers							
On site	2,230,000	2009	2165	157	14,200	7	
Off site	2,980,000	2009	2165	157	19,000	10	
Integrated Disposal Facility–200-West Area (OPS_IDFW)							
Radiological workers	114,000	2009	2050	42	2,710	2	4
Nonradiological workers							
On site	157,000	2009	2050	42	3,740	2	
Off site	210,000	2009	2050	42	5,000	3	
River Protection Project Disposal Facility (OPS_RPPDF)							
Radiological workers	64,100,000	2022	2165	144	445,000	214	330
Nonradiological workers							
On site	34,500,000	2022	2165	144	240,000	116	
Off site	64,100,000	2022	2165	144	445,000	214	
Total	**171,000,000**				**1,210,000**	**586**	**355**

Notes and Assumptions:

Total number of offsite full-time equivalents = 231.

Hours worked per year = 2,080.

One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.

Source: Compiled from SAIC 2010c.

Table I–82. Waste Management Alternative 3, Disposal Group 3, Closure Rollup Workforce Estimate

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Integrated Disposal Facility–200-East Area (CLO_IDFE)							
Radiological workers	N/A						177
Nonradiological workers							
On site	735,000	2166	2167	2	368,000	177	
Off site	73,500	2166	2167	2	36,800	18	
Integrated Disposal Facility–200-West Area (CLO_IDFW)							
Radiological workers	N/A						47
Nonradiological workers							
On site	193,000	2051	2052	2	96,500	47	
Off site	19,300	2051	2052	2	9,650	5	

Table I–82. Waste Management Alternative 3, Disposal Group 3, Closure Rollup Workforce Estimate *(continued)*

Activity	Total Hours	Duration			Hours per Year	Full-Time Equivalents per Year	Onsite Full-Time Equivalents
		Start	Finish	Years			
Postclosure Care–Integrated Disposal Facility 200-East Area (CLO_POSTIDFE)							
Radiological workers	N/A						
Nonradiological workers							
On site	114,000	2168	2267	100	1,140	1	1
Off site	N/A						
Postclosure Care–Integrated Disposal Facility 200-West Area (CLO_POSTIDFW)							
Radiological workers	N/A						
Nonradiological workers							
On site	30,000	2053	2152	100	300	1	1
Off site	N/A						
Modified Resource Conservation and Recovery Act Subtitle C Barrier (CLO_RPPDF)							
Radiological workers	N/A						
Nonradiological workers							
On site	18,000,000	2166	2167	2	9,000,000	4,330	4,330
Off site	1,800,000	2166	2167	2	900,000	433	
Postclosure Care–River Protection Project Disposal Facility (CLO_POSTRPPDF)							
Radiological workers	N/A						
Nonradiological workers							
On site	2,730,000	2168	2267	100	27,300	14	14
Off site	N/A						
Total	**23,700,000**				**10,400,000**	**5,030**	**4,570**

Notes and Assumptions:
Total number of offsite full-time equivalents = 460.
Hours worked per year = 2,080.
One full-time equivalent was assumed for activities estimated to require less than 2,080 hours per year.
Key: N/A=not applicable.
Source: Compiled from SAIC 2010c.

I.3 REFERENCES

SAIC (Science Applications International Corporation), 2010a, *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.

SAIC (Science Applications International Corporation), 2010b, *Fast Flux Test Facility Alternatives, Scaled Data Sets to Support the "Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington,"* Germantown, Maryland, November 8.

SAIC (Science Applications International Corporation), 2010c, *Waste Management 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.

APPENDIX J
ENVIRONMENTAL JUSTICE

This appendix provides an assessment of the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations resulting from implementation of the alternatives described in Chapter 2 of this *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*.

J.1 INTRODUCTION

Environmental justice is defined as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group[s,] should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies" (EPA 1998).

The purpose of this appendix is to identify the various populations that could be affected by U.S. Department of Energy (DOE)–proposed actions at the Hanford Site (Hanford) and Idaho National Laboratory (INL), and to present a comparison of the impacts on subpopulations with potential for environmental justice concerns to the impacts on the remainder of the population to identify any disproportionately high and adverse impacts under the alternatives evaluated in this *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)*.

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 populations and low-income populations.

The Council on Environmental Quality (CEQ) has oversight responsibility for documentation prepared in compliance with the National Environmental Policy Act (NEPA). In December 1997, the CEQ released its guidance for analyzing environmental justice issues under NEPA (CEQ 1997). The CEQ guidance was adopted as the basis for analysis of environmental justice in this environmental impact statement (EIS).

J.2 DEFINITIONS

J.2.1 Minority Individuals and Populations

The following definitions of minority individuals and populations were used in this analysis of environmental justice:

Minority individuals. Individuals who are members of the following population groups: Hispanic or Latino, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, Some Other Race, or two or more races. This definition is similar to that given in the CEQ environmental justice guidance (CEQ 1997), except that it has been modified to reflect "Revisions to the Standards for the Classification of Federal Data on Race and Ethnicity" (62 FR 58782) and recent guidance published by the Office of Management and Budget. These revisions were adopted and used by the U.S. Census Bureau (Census Bureau) in collecting data for the 2000 census (OMB 2000). When data from the 1990 census are used, a minority individual is defined as someone self-identified as: Hispanic; American Indian, Eskimo, or Aleut; Asian or Pacific Islander; or Black. As discussed below, racial and ethnic data from the 1990 census cannot be directly compared with that from the 2000 census.

The Office of Management and Budget also recommends counting a person self-identified as multiracial as a minority individual if at least one of the races is a minority race (OMB 2000). During the 2010 census, approximately 3 percent of the population identified themselves as members of more than one race, and 92 percent of that population reported exactly two races. The largest multiple-race combination was the White and Black or African American population, accounting for approximately 20 percent of the population reporting two or more races (Humes, Jones, and Ramirez 2011).

Minority populations. Minority populations should be identified where either (1) the minority population of the affected area exceeds 50 percent of the total population or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis. For analysis purposes, "meaningfully greater" is defined in this *TC & WM EIS* as 20 percentage points greater than the comparable population in the general population. In identifying minority populations, agencies may consider a population as either a group of individuals living in geographic proximity to one another or a geographically dispersed and transient set of individuals (such as migrant workers or American Indians/Alaska Natives), where either type of group experiences common conditions of environmental exposure or effect. The selection of the appropriate unit of geographic analysis may be a governing body's jurisdiction or a neighborhood, census tract, or other similar unit that is chosen to avoid artificially diluting or inflating the affected minority population. A minority population also exists if there is more than one minority group present and the minority percentage, as calculated by aggregating all minority persons, meets one of the above-stated thresholds.

Data for the analysis of minority populations in this *TC & WM EIS* were extracted from the *2010 Decennial Census, Summary File 1*, Table P5, Hispanic or Latino Origin by Race (Census 2011a). The CEQ guidance recommends that impacts on the minority population be examined, as well as impacts specific to American Indian tribes (CEQ 1997). Because the area has a large Hispanic population, this EIS also examines impacts on that specific population.

In the discussions of environmental justice in this *TC & WM EIS*, people who designated themselves as Hispanic or Latino are included in the total Hispanic population, regardless of race. For example, the Asian population is composed of people self-designated as Asian regardless of whether they indicated Hispanic or Latino origin. Asians who designated themselves as having Hispanic or Latino origins are also included in the total Hispanic population.

J.2.2 Low-Income Populations and Individuals

Executive Order 12898 specifically addresses disproportionately high and adverse effects on low-income populations. The CEQ recommends that poverty thresholds be used to identify low-income individuals (CEQ 1997).

The following definition of low-income population was used in this analysis:

> "Low-income population: Low-income populations in an affected area should be identified with the annual statistical poverty thresholds from the Bureau of Census' Current Population Reports, Series P-60 on Income and Poverty. In identifying low-income populations, agencies may consider as a community either a group of individuals living in geographic proximity to one another or a set of individuals (such as migrant workers or American Indians), where either type of group experiences common conditions of environmental exposure or effect" (CEQ 1997).

Thresholds used by the Census Bureau to identify low-income individuals during the 2010 census are published in the Census Bureau's Current Population Reports, Consumer Income, Series P60-239, *Income, Poverty, and Health Insurance Coverage in the United States: 2010* (DeNavas-Walt, Proctor, and

Smith 2011). Low-income population estimates generated from the American Community Survey (ACS) period estimates (multiyear samples) use annual poverty thresholds adjusted for increases in costs of living as reflected in the Consumer Price Index (CPI) for all urban consumers published by the Bureau of Labor Statistics (Census 2011b).

Data for the analysis of low-income populations were extracted from *2006–2010 American Community Survey 5-Year Estimates*, Table C17002, Ratio of Income to Poverty in the Past 12 Months (Census 2011c). The ACS 5-year estimates are the only data sets currently published by the Census Bureau that provide current population data relative to income and poverty at the block-group level of geography. The geographic boundaries used in the 2006–2010 ACS 5-year estimates are the same as those used during the 2010 census (Census 2011d). Unlike the data from the analysis of minority populations, data relative to income are generated from a smaller sample universe (i.e., the population for whom poverty status is determined).

J.2.3 Disproportionately High and Adverse Human Health Effects

Adverse health effects are measured in risks and rates that could result in latent cancer fatalities (LCFs), as well as other fatal or nonfatal adverse impacts on human health. Adverse health effects may include bodily impairment, infirmity, illness, or death. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant (as defined by NEPA) and appreciably exceeds the risk or exposure rate for the general population or another appropriate comparison group (CEQ 1997).

J.2.4 Disproportionately High and Adverse Environmental Effects

A "disproportionately high environmental impact" refers to an impact or the risk of an impact on the natural or physical environment in a low-income or minority population that is significant (as defined by NEPA) or appreciably exceeds the environmental impact on the larger population. Such effects may include ecological, cultural, human health, economic, or social impacts. An adverse environmental impact is an impact that is determined to be both harmful and significant (as defined by NEPA). In assessing cultural and aesthetic environmental impacts, impacts that uniquely affect geographically dislocated or dispersed minority or low-income populations, including American Indian tribes, are also considered (CEQ 1997).

J.3 SPATIAL RESOLUTION

For the purposes of enumeration and analysis, the Census Bureau has defined a variety of areal units. Areal units of concern in this document include (in order of increasing spatial resolution) states, counties, census tracts, block groups, and blocks. The block is the smallest geographic entity for which the Census Bureau collects and tabulates data and, therefore, offers the finest spatial resolution. This term refers to a relatively small geographical area bounded on all sides by visible features such as streets or streams or by invisible boundaries such as city limits and property lines. During the 2010 census, the Census Bureau subdivided the United States and its territories into 11,078,297 blocks (Census 2011e). For comparison, the number of counties, census tracts, and block groups used in the 2010 census were 3,143; 73,057; and 217,740; respectively. While blocks offer the finest spatial resolution, economic data required for the identification of low-income populations are not available at the block level of spatial resolution. In the analysis discussed in the following paragraphs, block-group-level resolution was used to identify minority and low-income populations. The Census Bureau's ACS 5-year estimates are the only data sets currently published that provide current data relative to income at the block-group level of spatial resolution. This data set is a replacement for the Census Bureau's Summary File 3, which has historically provided sample data from the decennial census long form. The 2010 census questionnaire contained no long form and no

sample data, as all sample data have been transitioned to the ACS. The geographic boundaries used in the 2006–2010 ACS 5-year estimates are the same as those used during the 2010 census (Census 2011d).

During preparation of this *TC & WM EIS*, consequences and risks from normal operations and accidents were evaluated for the following potential release locations at Hanford: the Supplemental Treatment Technology Sites in the 200-East and 200-West Areas (STTS-East and STTS-West), the Waste Treatment Plant (WTP) in the 200-East Area, and the Fast Flux Test Facility (FFTF) in the 400 Area. The location of the WTP is approximately 600 meters (1,979 feet) northeast of STTS-East. Potential release locations at INL, including the Materials and Fuels Complex (MFC) and the Idaho Nuclear Technology and Engineering Center (INTEC), were also evaluated. In the analysis of health impacts of normal operations and accidents, all persons living within 80 kilometers (50 miles) of these facilities were assumed to be potentially affected. The same 80-kilometer (50-mile) regions of influence were used in this analysis of environmental justice to identify potentially affected minority and low-income populations.

In general, the boundary of a circle with an 80-kilometer (50-mile) radius centered on a facility site would not coincide with boundaries used by the Census Bureau for enumeration of the population in the potentially affected area. Some block groups lie completely inside or outside of the radius used for health effects calculation, while others are only partially included. As a result of these partial inclusions, uncertainties were introduced into the estimate of the potentially affected population.

To estimate the populations in the partially included block groups, it was assumed that populations are uniformly distributed throughout the area of each block group. For example, if 30 percent of the area of a block group lies within 80 kilometers (50 miles) of the facility site, it was assumed that 30 percent of the population residing in that block group would be potentially affected.

J.4 MAP DEVELOPMENT

The geographic information system (GIS) statistics maps and diagrams provided in Chapter 3 of this *TC & WM EIS* and Section J.5 were developed using ArcMap 9.3.1 and ArcMap 10. These programs allow standard base maps to be projected in a variety of projection systems. In this document, maps and diagrams were developed using the North American Standard 1983 projection. Standard GIS geospatially attributed data sets, known as shapefiles, were downloaded from two public access websites: the Census Bureau, http://www.census.gov,[1] and the Environmental Systems Research Institute, http://www.esri.com/data/download/census2000_tigerline/index.html.[2]

The downloaded shapefiles were reprojected to the North American Standard 1983 projection to prevent potential data misalignment. Additional shapefiles either were developed as necessary using the above-referenced ArcMap software and actual geographic coordinates (e.g., the facility sites) or were provided by Hanford personnel to show specific site landmarks (e.g., the fence lines of limited-access areas).

Each shapefile stores nontopological geometry and tabular attribute information for spatial features (point, line, or polygon) in a data set. The geometry for a feature is stored as a shape comprising a set of vector coordinates; the attributes, as tabular files in dBASE® format. Each feature in the shapefile represents a single geographic feature and its attributes; that is, each shape record has a one-to-one relationship with an attribute record. Maps and diagrams were developed by importing all shapefiles into the Hanford GIS project. The development of each map involved different combinations of the shapefiles to visually display data on a standard base map of Idaho, Oregon, and Washington.

[1] Block Data, Block Group Data, Key Geographical Locations, Landmark Locations, Hydrography, Railroads, County Roads, Federal Lands.

[2] Data for Washington and Oregon.

J.5 ENVIRONMENTAL JUSTICE ANALYSIS

This analysis of environmental justice is based on assessment of the impacts reported in Chapter 4. This analysis was performed to identify any disproportionately high and adverse human health or environmental impacts on minority or low-income populations surrounding the facility sites. Demographic information obtained from the Census Bureau was used to identify the minority and low-income populations surrounding these sites (Census 2011a, 2011c). Consistent with CEQ guidance, minority and low-income populations were identified where the percentage of either of those populations in the impacted areas was "meaningfully greater" than those percentages in other reasonable geographic areas of comparison, defined here as the potentially affected counties and states in which the impacted areas are located. While this analysis is based on CEQ guidance, CEQ does not provide numerical (percentage point) guidance; however, the U.S. Nuclear Regulatory Commission, when identifying minority and low-income populations, defines "significantly," similar to "meaningfully greater," as 20 percentage points and that percentage point guidance definition is used in this *TC & WM EIS* (69 FR 52040), as discussed in Section J.2.1. Therefore, minority and low-income populations are identified where the total minority or low-income population in the impacted area exceeds that population county- or statewide percentage by 20 percentage points, or where either the minority or low-income population is more than 50 percent of the general population in the impacted area. Table J–1 displays the thresholds used to determine meaningfully greater minority and low-income populations.

Table J–1. Thresholds for Identifying Meaningfully Greater Minority and Low-Income Populations

Site	Minority (percentage of the general population)	Low-Income (percentage of the general population)
Hanford Site	45.3	32.8
Idaho National Laboratory	36.0	33.6

Chapter 3, Sections 3.2.11 and 3.3.11, discusses the affected environment to be included in the environmental justice analysis. Potentially affected minority and low-income populations are shown graphically within each facility site's 80-kilometer (50-mile) region of influence (see Section J.3). Tables show the potentially affected populations by county, as well as the percentage of the minority or low-income population considered to be potentially affected. In addition, figures are presented that identify minority and low-income populations by block group, and graphs showing cumulative populations by distance are used to visually locate concentrations of minority and low-income populations.

J.5.1 Minority and Low-Income Populations Surrounding the 200-West Area Supplemental Treatment Technology Site

Figure J–1 shows minority and nonminority populations living in block groups surrounding STTS-West. There are 406 block groups within the 80-kilometer (50-mile) potentially affected radius. Out of these block groups, 145 were determined to contain meaningfully greater minority populations. The potentially affected counties include eight counties in the state of Washington (Adams, Benton, Franklin, Grant, Kittitas, Klickitat, Walla Walla, and Yakima) and two counties in Oregon (Morrow and Umatilla). As indicated in Table J–2, approximately 46 percent of the potentially affected minority population resides in Yakima County, and about 92 percent of the potentially affected minority population lives in four Washington counties: Benton, Franklin, Grant, and the city of Yakima.

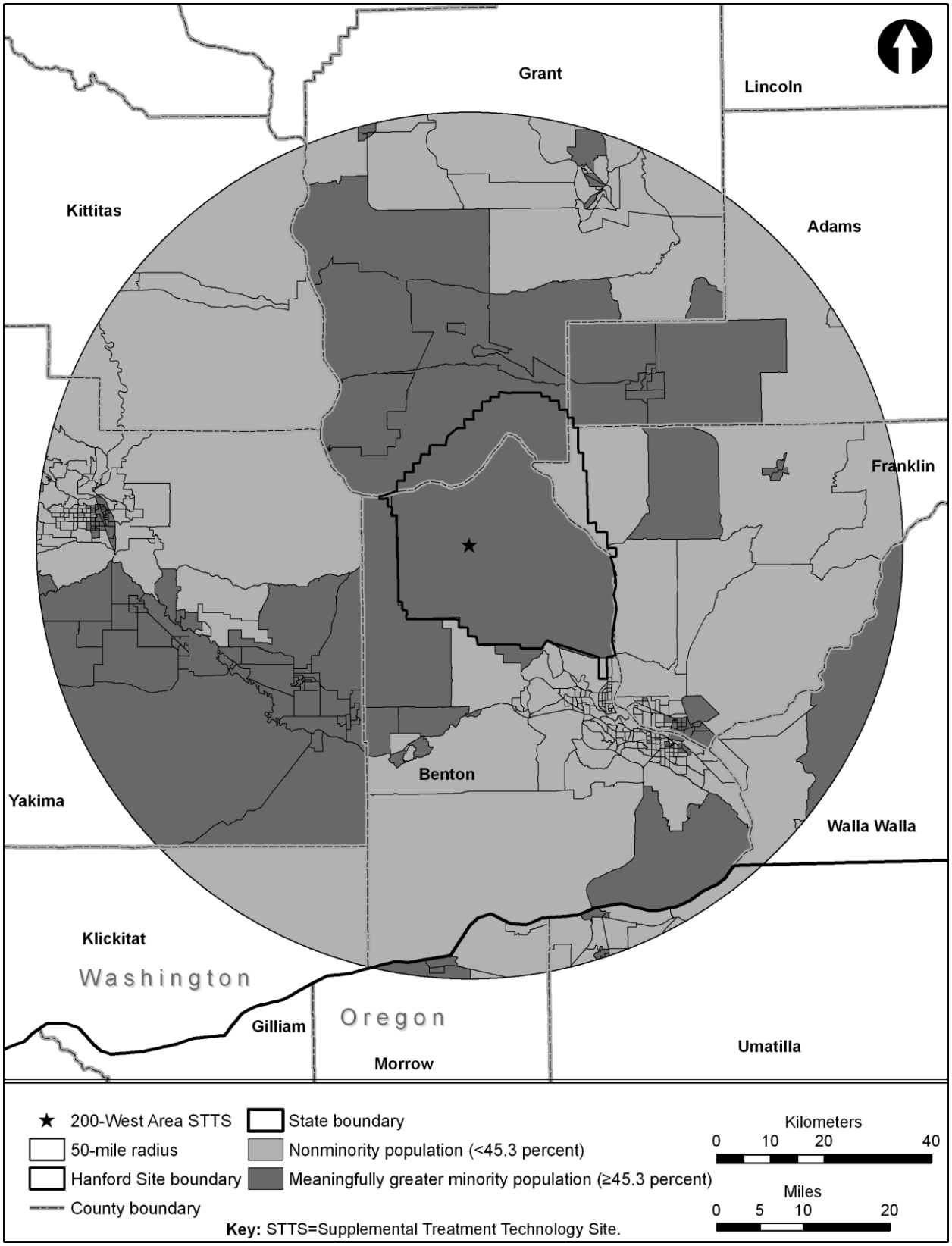

Figure J–1. Meaningfully Greater Minority and Nonminority Populations Living in Potentially Affected Block Groups Surrounding the 200-West Area Supplemental Treatment Technology Site

Table J–2. Minority Populations Living in Potentially Affected Counties Surrounding the 200-West Area Supplemental Treatment Technology Site

County (State)	Total County Population[a]	Total Minority Population[a]	Potentially Affected Total Population[b]	Potentially Affected Minority Population[b]	Percentage of the Potentially Affected Minority Population Total
Adams (Washington)	18,728	11,466	14,849	11,086	4.2
Benton (Washington)	175,177	44,740	175,177	44,740	16.9
Franklin (Washington)	78,163	44,359	77,906	44,334	16.8
Grant (Washington)	89,120	38,054	67,967	33,424	12.6
Kittitas (Washington)	40,915	5,701	4,568	493	0.2
Klickitat (Washington)	20,318	3,296	281	86	0.0
Walla Walla (Washington)	58,781	15,177	4,153	939	0.4
Yakima (Washington)	243,231	127,207	223,657	120,502	45.6
Morrow (Oregon)	11,173	3,955	6,306	2,737	1.0
Umatilla (Oregon)	75,889	23,198	14,811	6,147	2.3
Total	**811,495**	**317,153**	**589,674**	**264,489**	**100.0**

[a] Census 2011a.

[b] Potentially affected population totals may differ slightly from those presented in Chapter 3, Section 3.2.11.1.2, due to rounding.

Figures J–2 and J–3 show cumulative minority populations as a function of distance from STTS-West. Values along the vertical axes of these figures show minority populations living within a given distance from STTS-West. Moving outward from the facilities, the cumulative minority populations increase sharply starting at the outskirts of the population centers of Richland, Kennewick/Pasco, and the city of Yakima. Approximately 18 percent of the potentially affected minority population lives within about 40 kilometers (25 miles) of the facility, and 57 percent resides within about 56 kilometers (35 miles). The potentially affected total minority population surrounding STTS-West is approximately 264,000 persons, accounting for approximately 45 percent of the total potentially affected population of approximately 590,000 persons. Approximately 86 percent of the minority population surrounding STTS-West is Hispanic or Latino.

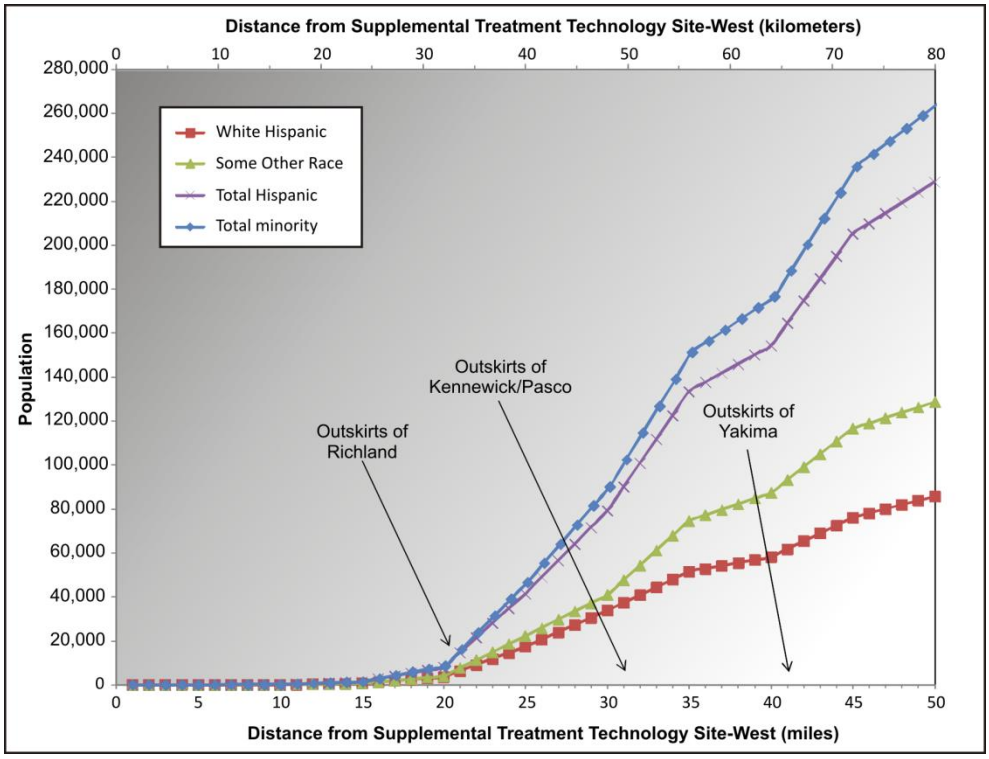

Figure J–2. Cumulative Larger-Scale Minority Populations as a Function of Distance from the 200-West Area Supplemental Treatment Technology Site

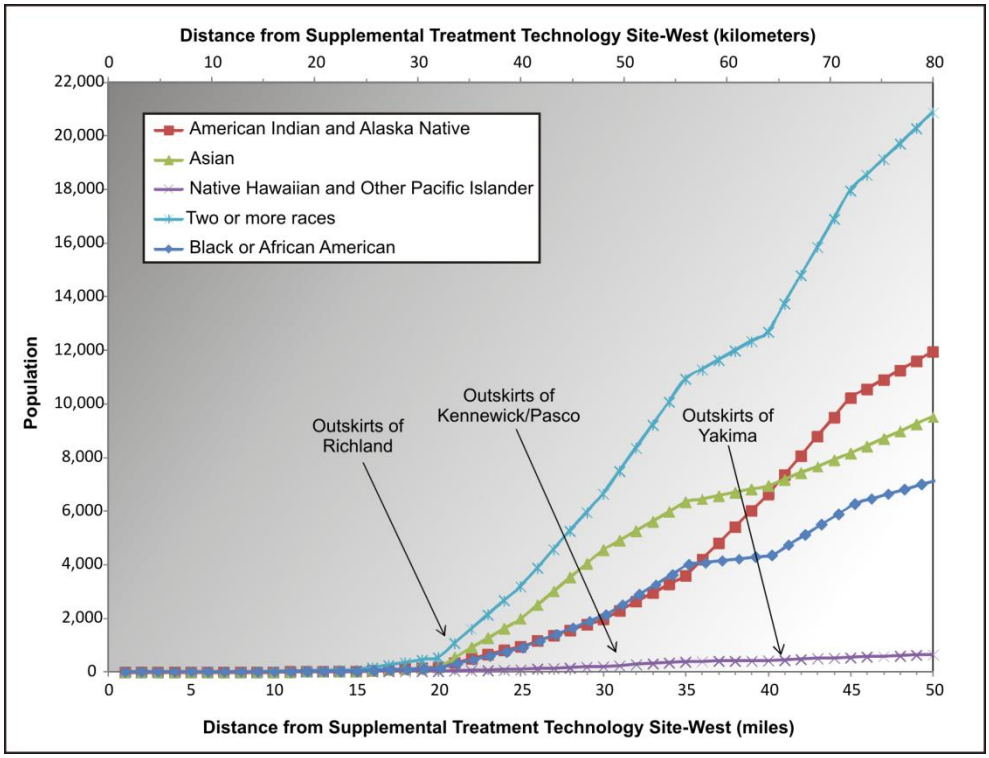

Figure J–3. Cumulative Smaller-Scale Minority Populations as a Function of Distance from the 200-West Area Supplemental Treatment Technology Site

Figure J–4 shows block groups surrounding STTS-West and low-income and non-low-income populations living in the potentially affected area. Of the 406 block groups surrounding STTS-West, an estimated 69 block groups contain meaningfully greater low-income populations. As indicated in Table J–3, approximately 46 percent of the potentially affected low-income population lives in Yakima County, and over 92 percent of the potentially affected low-income population lives in the counties of Benton, Franklin, Grant, and Yakima. Low-income persons constitute approximately 19 percent of the total population living in the potentially affected area.

Table J–3. Low-Income Populations Living in Potentially Affected Counties Surrounding the 200-West Area Supplemental Treatment Technology Site

County (State)	Total County Population[a]	Total Low-Income Population[a]	Potentially Affected Total Population[b]	Potentially Affected Low-Income Population[b]	Percentage of the Potentially Affected Low-Income Population Total
Adams (Washington)	17,537	4,395	13,664	3,685	3.5
Benton (Washington)	165,026	20,962	165,026	20,962	20.0
Franklin (Washington)	70,208	14,000	69,967	13,952	13.3
Grant (Washington)	83,907	17,120	64,582	13,707	13.1
Kittitas (Washington)	37,409	7,942	4,550	532	0.5
Klickitat (Washington)	19,861	3,865	365	79	0.1
Walla Walla (Washington)	53,173	9,314	4,364	475	0.5
Yakima (Washington)	232,438	50,608	213,145	47,895	45.7
Morrow (Oregon)	11,089	1,700	6,066	1,064	1.0
Umatilla (Oregon)	69,838	11,000	12,418	2,402	2.3
Total	**760,486**	**140,906**	**554,148**	**104,753**	**100.0**

[a] Census 2011c.

[b] Potentially affected population totals may differ slightly from those presented in Chapter 3, Section 3.2.11.2.2, due to rounding.

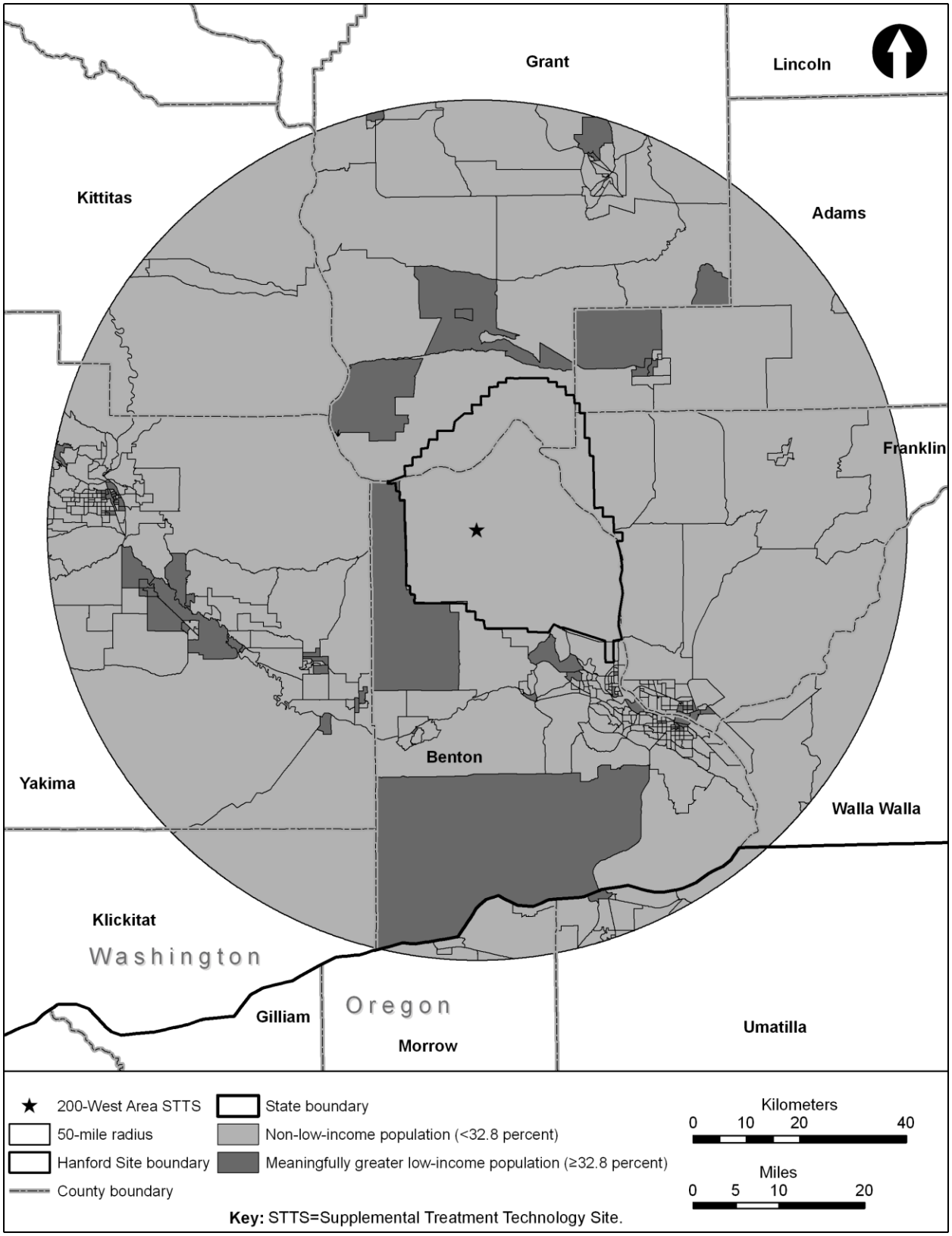

Figure J–4. Meaningfully Greater Low-Income and Non-Low-Income Populations Living in Potentially Affected Block Groups Surrounding the 200-West Area Supplemental Treatment Technology Site

Figure J–5 shows cumulative low-income populations as a function of distance from STTS-West. Low-income populations surrounding STTS-West show patterns of growth similar to those reflected in Figures J–2 and J–3, increasing near the outskirts of the population centers of Richland, Kennewick/Pasco, and the city of Yakima.

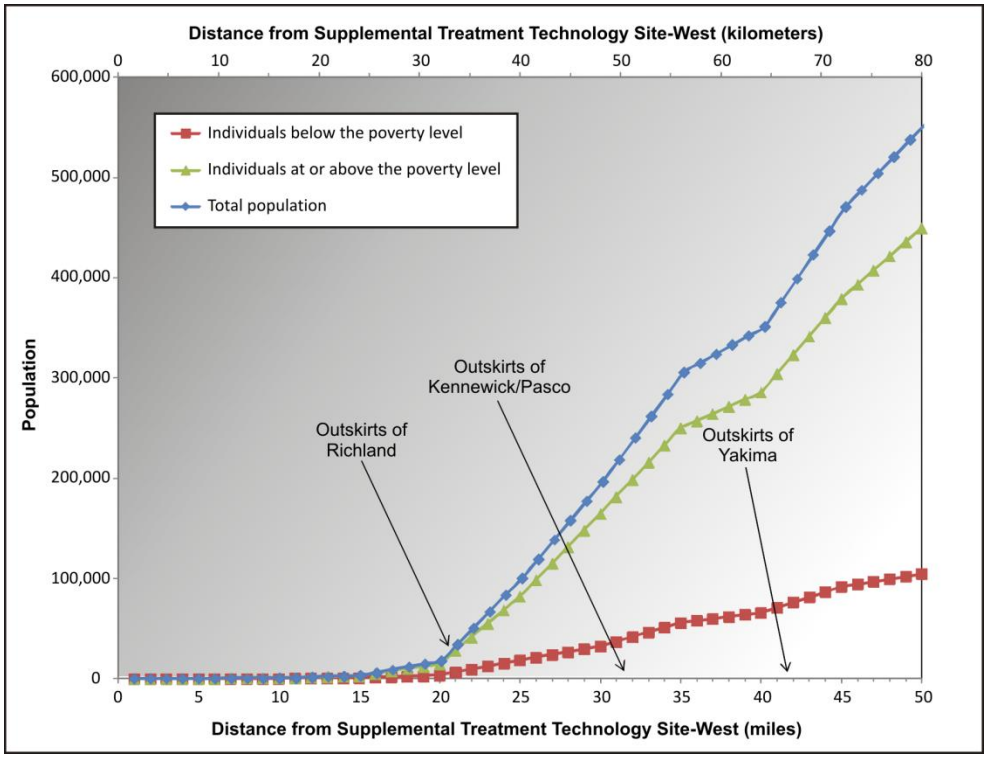

Figure J–5. Cumulative Low-Income Populations as a Function of Distance from the 200-West Area Supplemental Treatment Technology Site

J.5.2 Minority and Low-Income Populations Surrounding the Waste Treatment Plant

Figure J–6 shows minority and nonminority populations living in block groups surrounding the WTP. Of the 388 block groups that surround the WTP, an estimated 148 contain meaningfully greater minority populations. Potentially affected counties include eight counties in Washington (Adams, Benton, Franklin, Grant, Kittitas, Klickitat, Walla Walla, and Yakima) and two counties in Oregon (Morrow and Umatilla).

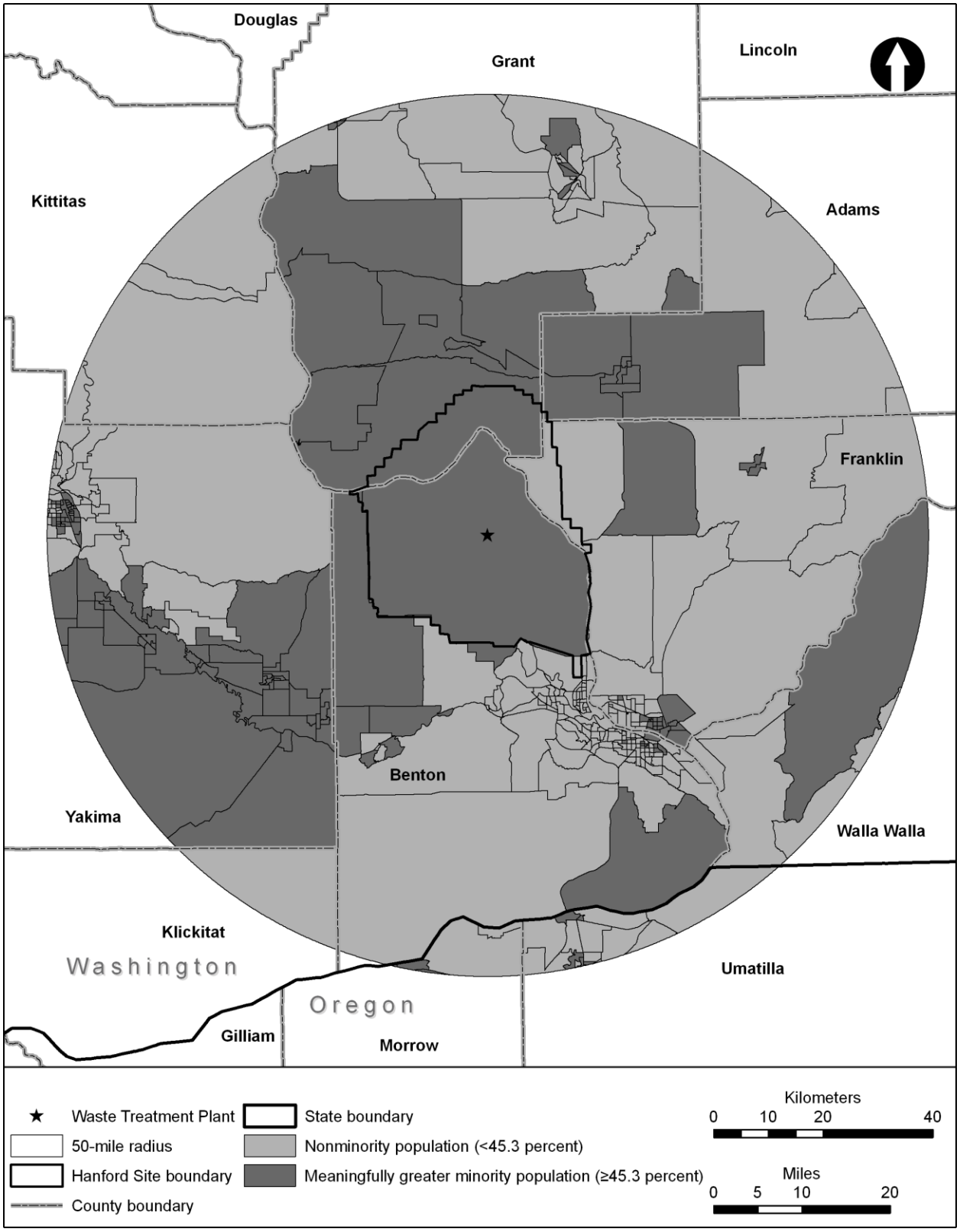

Figure J–6. Meaningfully Greater Minority and Nonminority Populations Living in Potentially Affected Block Groups Surrounding the Waste Treatment Plant

As indicated in Table J–4, approximately 43 percent of the potentially affected minority population resides in Yakima County, and approximately 91 percent of the potentially affected minority population lives in four Washington counties: Benton, Franklin, Grant, and Yakima.

Table J–4. Minority Populations Living in Potentially Affected Counties Surrounding the Waste Treatment Plant

County (State)	Total County Population[a]	Total Minority Population[a]	Potentially Affected Total Population	Potentially Affected Minority Population	Percentage of the Potentially Affected Minority Population Total
Adams (Washington)	18,728	11,466	15,127	11,143	4.4
Benton (Washington)	175,177	44,740	175,167	44,736	17.7
Franklin (Washington)	78,163	44,359	77,991	44,343	17.6
Grant (Washington)	89,120	38,054	65,570	31,160	12.4
Kittitas (Washington)	40,915	5,701	3,208	347	0.1
Klickitat (Washington)	20,318	3,296	173	53	0.0
Walla Walla (Washington)	58,781	15,177	4,953	1,246	0.5
Yakima (Washington)	243,231	127,207	173,887	108,580	43.1
Morrow (Oregon)	11,173	3,955	4,525	1,544	0.6
Umatilla (Oregon)	75,889	23,198	21,727	8,986	3.6
Total	**811,495**	**317,153**	**542,327**	**252,136**	**100.0**

[a] Census 2011a.

Figures J–7 and J–8 show cumulative minority populations as a function of distance from the WTP. Values along the vertical axes of these figures show minority populations living within a given distance from the WTP. Moving outward from the facilities, the cumulative minority populations increase sharply near the outskirts of the population centers of Richland, Kennewick/Pasco, and the city of Yakima. Approximately 25 percent of the potentially affected minority population lives within about 40 kilometers (25 miles) of the facility, and 50 percent resides within about 51 kilometers (32 miles). The potentially affected total minority population surrounding the WTP is approximately 252,000 persons, accounting for approximately 46 percent of the total potentially affected population of approximately 542,000 persons. Approximately 87 percent of the minority population surrounding the WTP is Hispanic or Latino.

Figure J–9 shows block groups surrounding the WTP, as well as low-income and non-low-income populations living in the potentially affected area. Of the 388 block groups that surround the WTP, an estimated 69 contain meaningfully greater low-income populations.

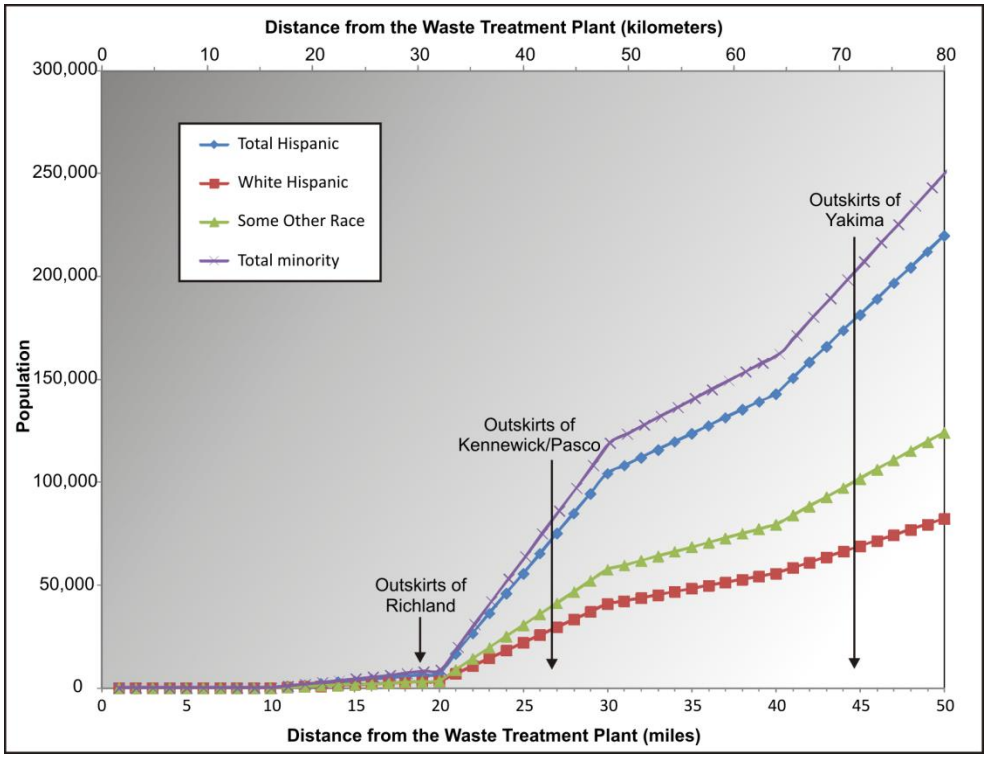

Figure J–7. Cumulative Larger-Scale Minority Populations as a Function of Distance from the Waste Treatment Plant

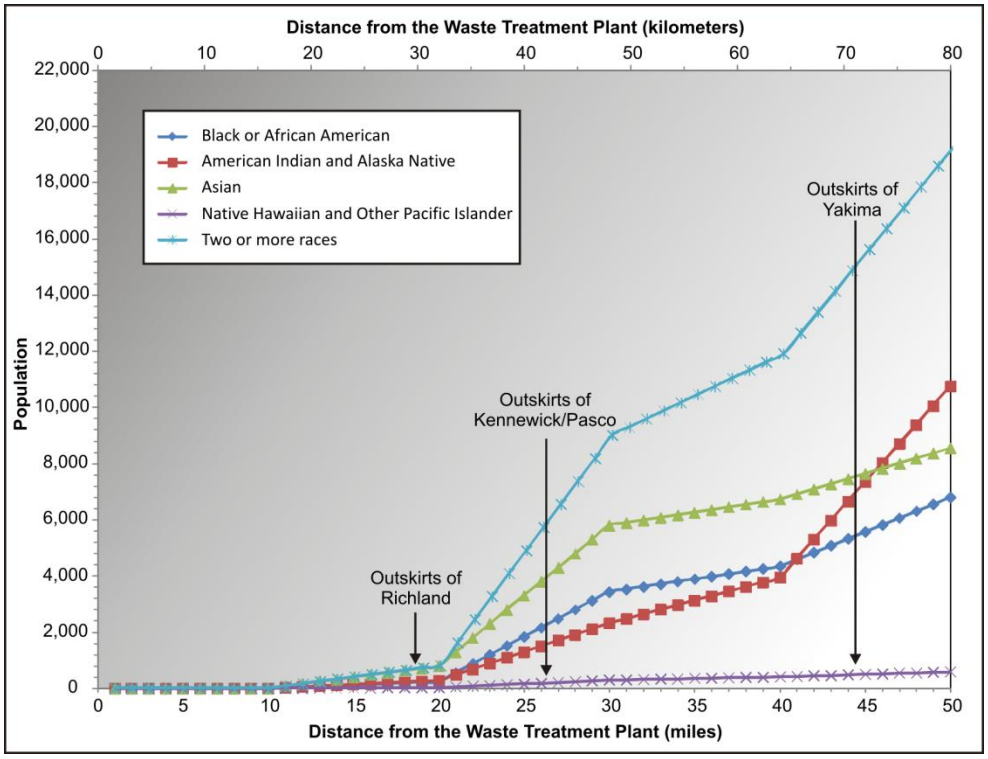

Figure J–8. Cumulative Smaller-Scale Minority Populations as a Function of Distance from the Waste Treatment Plant

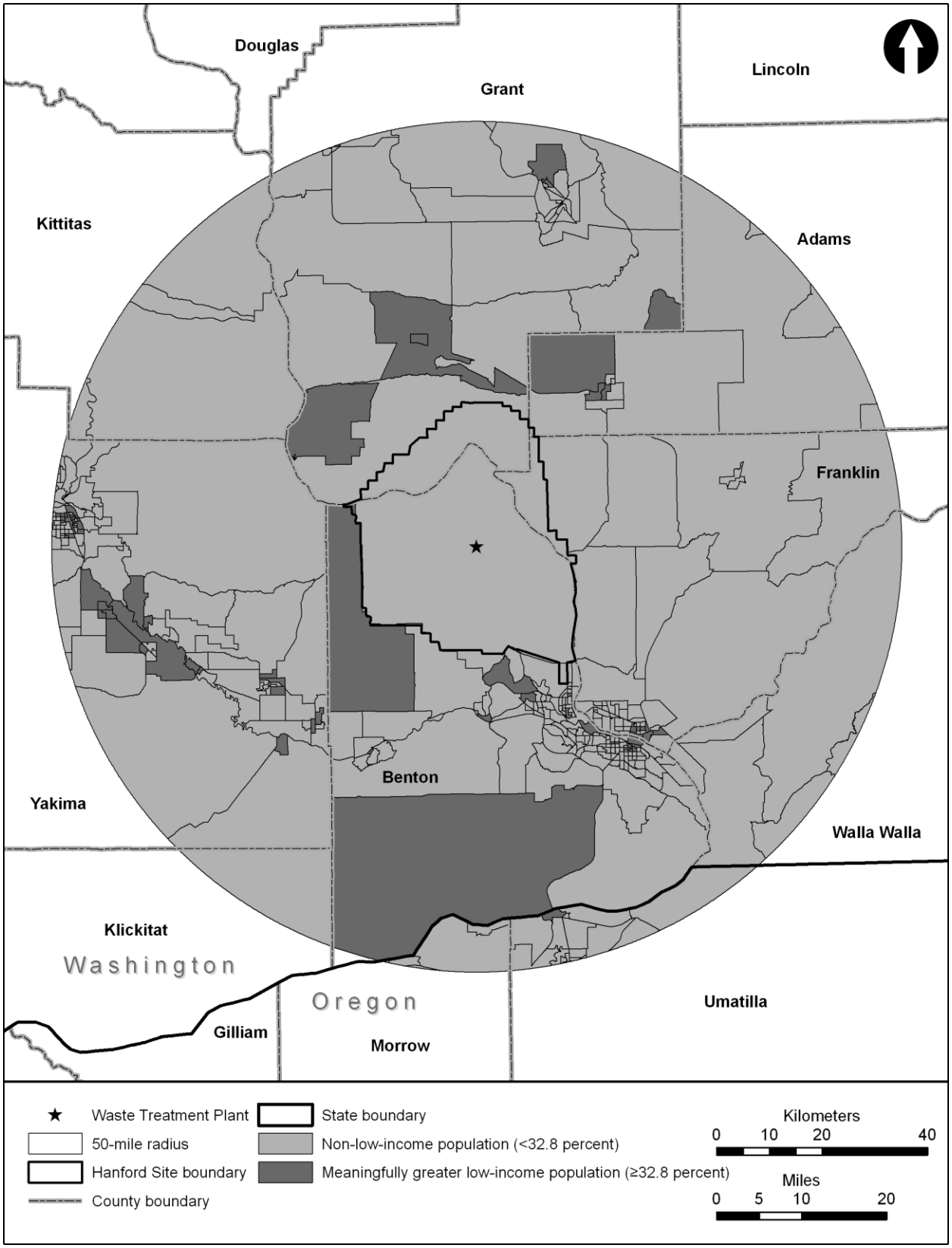

Figure J–9. Meaningfully Greater Low-Income and Non-Low-Income Populations Living in Potentially Affected Block Groups Surrounding the Waste Treatment Plant

As indicated in Table J–5, approximately 43 percent of the potentially affected low-income population lives in Yakima County, and over 90 percent of the potentially affected low-income population lives in the counties of Benton, Franklin, Grant, and Yakima. Low-income persons constitute approximately 20 percent of the total population living in the potentially affected area.

Table J–5. Low-Income Populations Living in Potentially Affected Counties Surrounding the Waste Treatment Plant

County (State)	Total County Population[a]	Total Low-Income Population[a]	Potentially Affected Total Population	Potentially Affected Low-Income Population	Percentage of the Potentially Affected Low-Income Population Total
Adams (Washington)	17,537	4,395	13,938	3,747	3.7
Benton (Washington)	165,026	20,962	165,018	20,959	21.0
Franklin (Washington)	70,208	14,000	70,047	13,968	14.0
Grant (Washington)	83,907	17,120	62,487	12,782	12.8
Kittitas (Washington)	37,409	7,942	3,179	381	0.4
Klickitat (Washington)	19,861	3,865	225	48	0.0
Walla Walla (Washington)	53,173	9,314	5,311	674	0.7
Yakima (Washington)	232,438	50,608	165,859	43,032	43.1
Morrow (Oregon)	11,089	1,700	4,543	913	0.9
Umatilla (Oregon)	69,838	11,000	19,374	3,450	3.5
Total	**760,486**	**140,906**	**509,980**	**99,953**	**100.0**

[a] Census 2011c.

Figure J–10 shows cumulative low-income populations as a function of distance from the WTP. Low-income populations surrounding the WTP show patterns of growth similar to those reflected in Figures J–7 and J–8, increasing near the outskirts of the population centers of Richland, Kennewick/Pasco, and the city of Yakima.

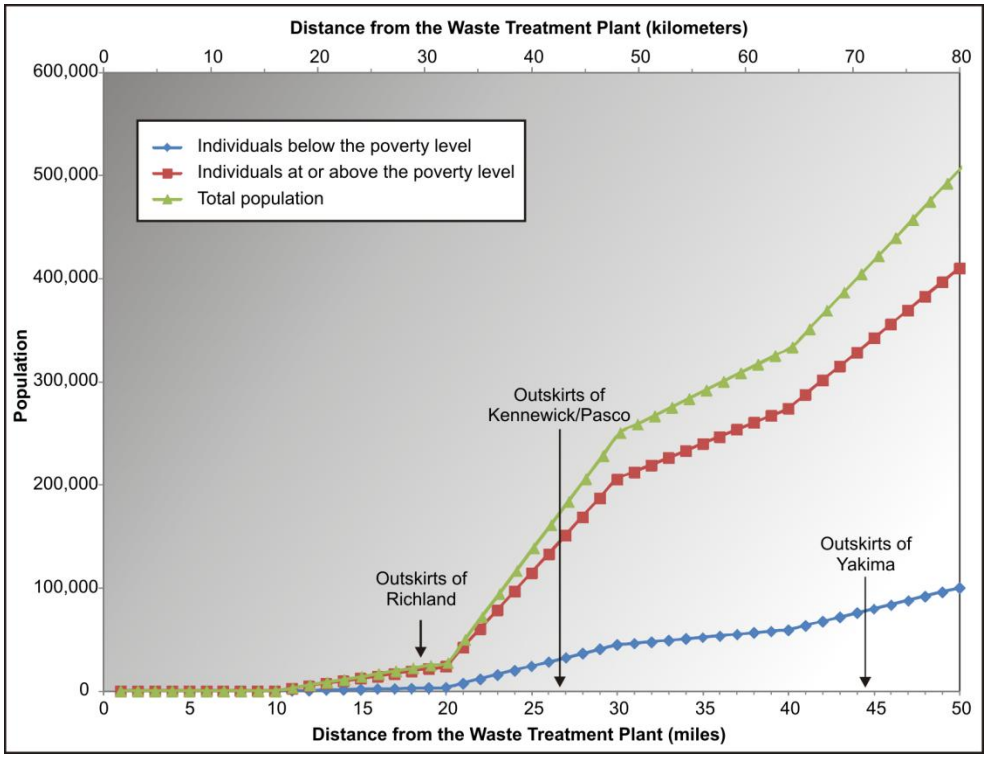

Figure J–10. Cumulative Low-Income Populations as a Function of Distance from the Waste Treatment Plant

J.5.3 Minority and Low-Income Populations Surrounding the 200-East Area Supplemental Treatment Technology Site

Figure J–11 shows minority and nonminority populations living in block groups surrounding STTS-East. Of the 392 block groups that surround STTS-East, an estimated 148 contain meaningfully greater minority populations. STTS-East is located within approximately 600 meters (1,969 feet) of the WTP, and the populations surrounding STTS-East are nearly the same as those surrounding the WTP. Counties that would be potentially affected by activities at STTS-East include eight counties in Washington (Adams, Benton, Franklin, Grant, Kittitas, Klickitat, Walla Walla, and Yakima) and two counties in Oregon (Morrow and Umatilla).

As indicated in Table J–6, approximately 43 percent of the potentially affected minority population resides in Yakima County, and approximately 90 percent of the potentially affected minority population lives in four Washington counties: Benton, Franklin, Grant, and Yakima. Due to the close proximity of the WTP and STTS-East, data for minority populations surrounding STTS-East are nearly identical to those shown for WTP minority populations in Figures J–7 and J–8 in Section J.5.2.

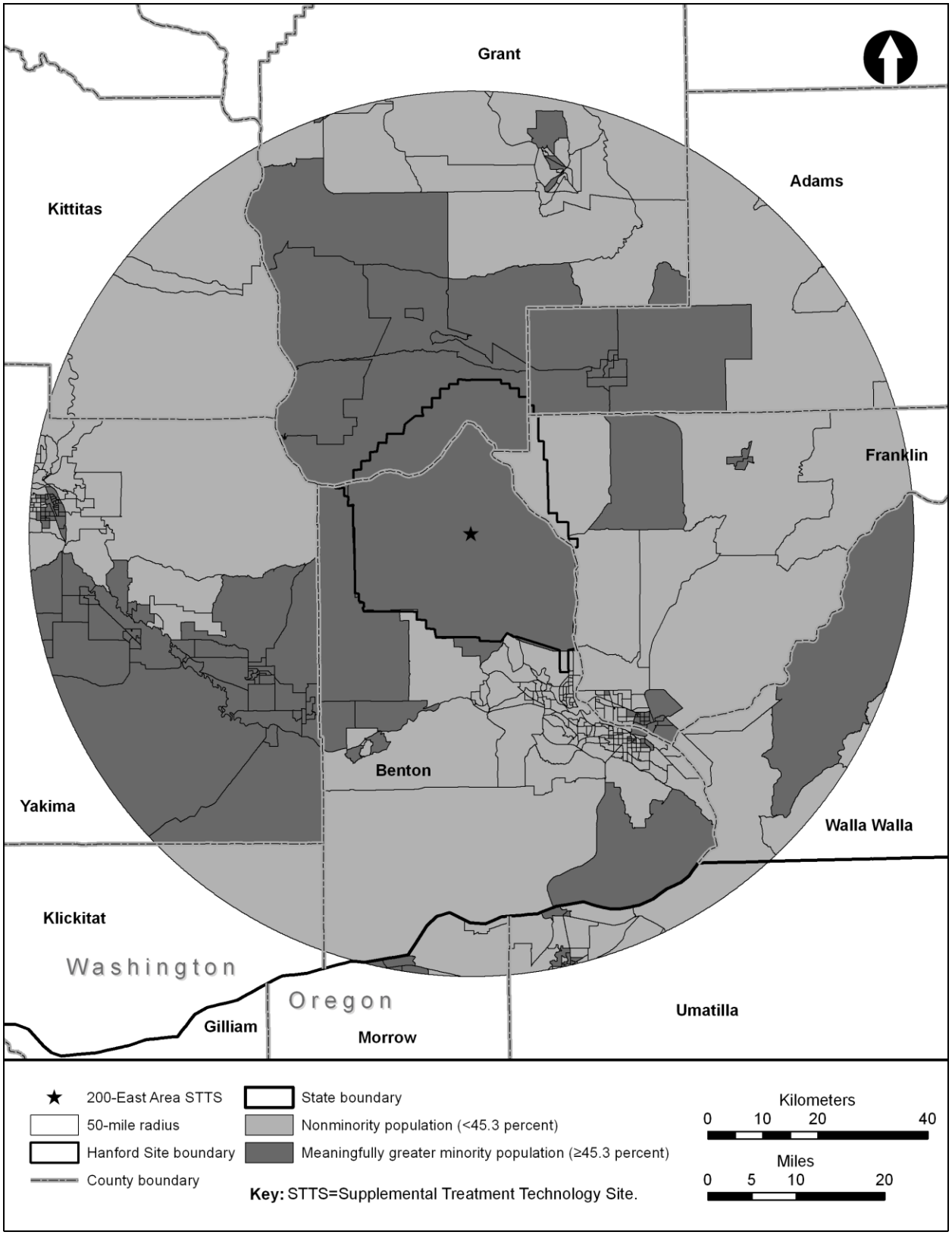

Figure J–11. Meaningfully Greater Minority and Nonminority Populations Living in Potentially Affected Block Groups Surrounding the 200-East Area Supplemental Treatment Technology Site

Table J–6. Minority Populations Living in Potentially Affected Counties Surrounding the 200-East Area Supplemental Treatment Technology Site

County (State)	Total County Population[a]	Total Minority Population[a]	Potentially Affected Total Population	Potentially Affected Minority Population	Percentage of the Potentially Affected Minority Population Total
Adams (Washington)	18,728	11,466	15,104	11,139	4.4
Benton (Washington)	175,177	44,740	175,171	44,737	17.7
Franklin (Washington)	78,163	44,359	77,989	44,342	17.5
Grant (Washington)	89,120	38,054	63,453	29,713	11.7
Kittitas (Washington)	40,915	5,701	3,166	343	0.1
Klickitat (Washington)	20,318	3,296	185	56	0.0
Walla Walla (Washington)	58,781	15,177	4,981	1,252	0.5
Yakima (Washington)	243,231	127,207	175,231	108,990	43.0
Morrow (Oregon)	11,173	3,955	5,374	2,092	0.8
Umatilla (Oregon)	75,889	23,198	26,095	10,673	4.2
Total	**811,495**	**317,153**	**546,748**	**253,337**	**100.0**

[a] Census 2011a.

Figure J–12 shows block groups surrounding STTS-East and low-income and non-low-income populations living in the potentially affected area. Of the 392 block groups that surround STTS-East, an estimated 69 contain meaningfully greater low-income populations.

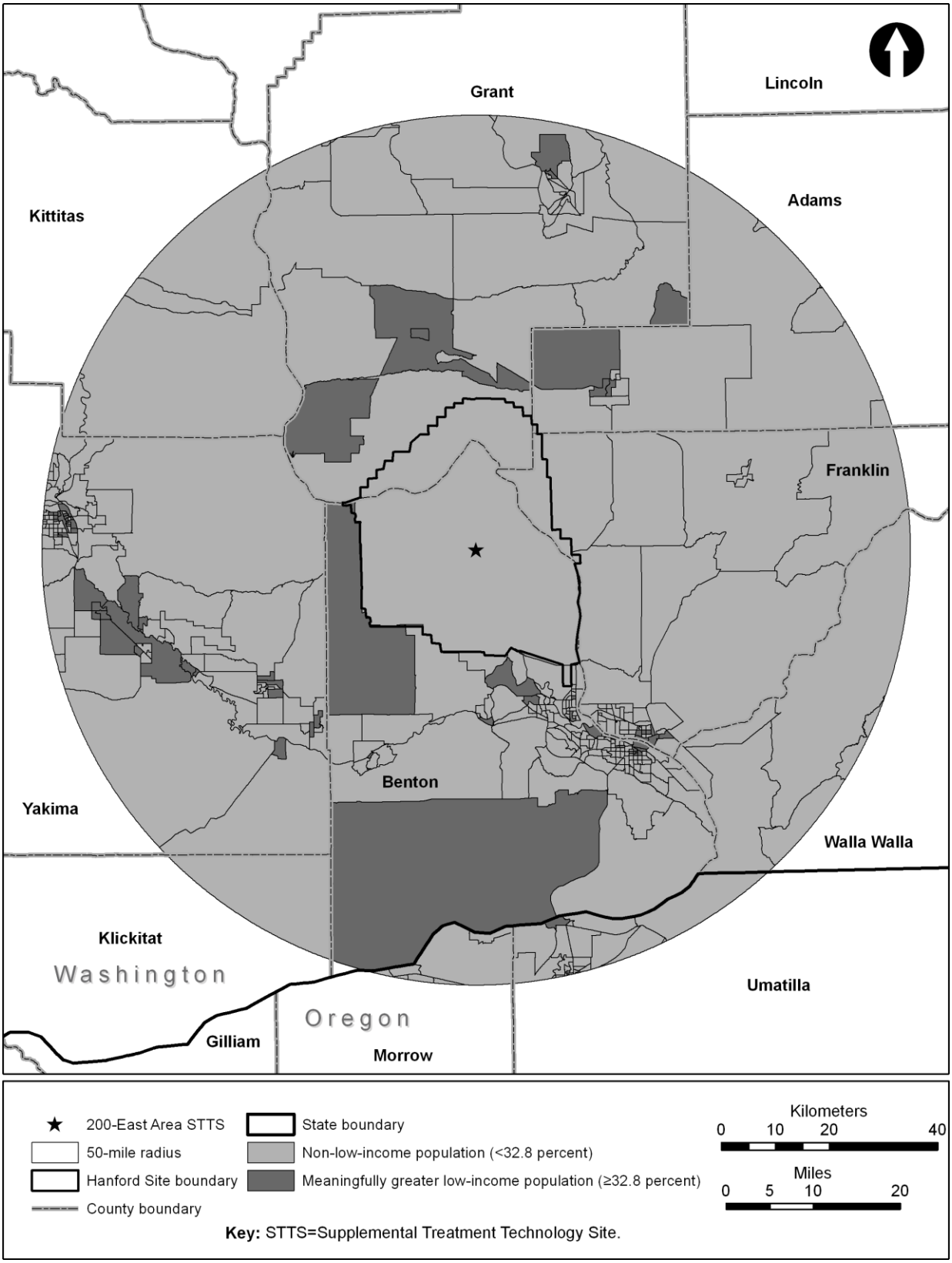

Figure J–12. Meaningfully Greater Low-Income and Non-Low-Income Populations Living in Potentially Affected Block Groups Surrounding the 200-East Area Supplemental Treatment Technology Site

As indicated in Table J–7, approximately 43 percent of the potentially affected low-income population lives in Yakima County, and approximately 90 percent of the potentially affected low-income population lives in the counties of Benton, Franklin, Grant, and Yakima. Low-income persons constitute approximately 20 percent of the total population living in the potentially affected area. Due to the close proximity of the WTP and STTS-East, data for the low-income population as a function of distance from STTS-East are nearly identical to those for the low-income population as a function of distance from the WTP in Figure J–10 in Section J.5.2. Low-income populations surrounding STTS-East show patterns of growth similar to those reflected in Figure J–10, increasing near the outskirts of the population centers of Richland, Kennewick/Pasco, and the city of Yakima.

Table J–7. Low-Income Populations Living in Potentially Affected Counties Surrounding the 200-East Area Supplemental Treatment Technology Site

County (State)	Total County Population[a]	Total Low-Income Population[a]	Potentially Affected Total Population	Potentially Affected Low-Income Population	Percentage of the Potentially Affected Low-Income Population Total
Adams (Washington)	17,537	4,395	13,916	3,742	3.7
Benton (Washington)	165,026	20,962	165,021	20,960	20.9
Franklin (Washington)	70,208	14,000	70,045	13,968	13.9
Grant (Washington)	83,907	17,120	60,456	12,261	12.2
Kittitas (Washington)	37,409	7,942	3,137	375	0.4
Klickitat (Washington)	19,861	3,865	240	52	0.1
Walla Walla (Washington)	53,173	9,314	5,336	676	0.7
Yakima (Washington)	232,438	50,608	167,135	43,170	43.0
Morrow (Oregon)	11,089	1,700	5,277	998	1.0
Umatilla (Oregon)	69,838	11,000	23,317	4,273	4.3
Total	**760,486**	**140,906**	**513,879**	**100,475**	**100.0**

[a] Census 2011c.

J.5.4 Minority and Low-Income Populations Surrounding the Fast Flux Test Facility

Figure J–13 shows minority and nonminority populations living in block groups surrounding FFTF, which is located in the 400 Area at Hanford. Of the 323 block groups that surround FFTF, an estimated 111 contain meaningfully greater minority populations. Potentially affected counties include eight counties in Washington (Adams, Benton, Franklin, Grant, Kittitas, Klickitat, Walla Walla, and Yakima) and two counties in Oregon (Morrow and Umatilla).

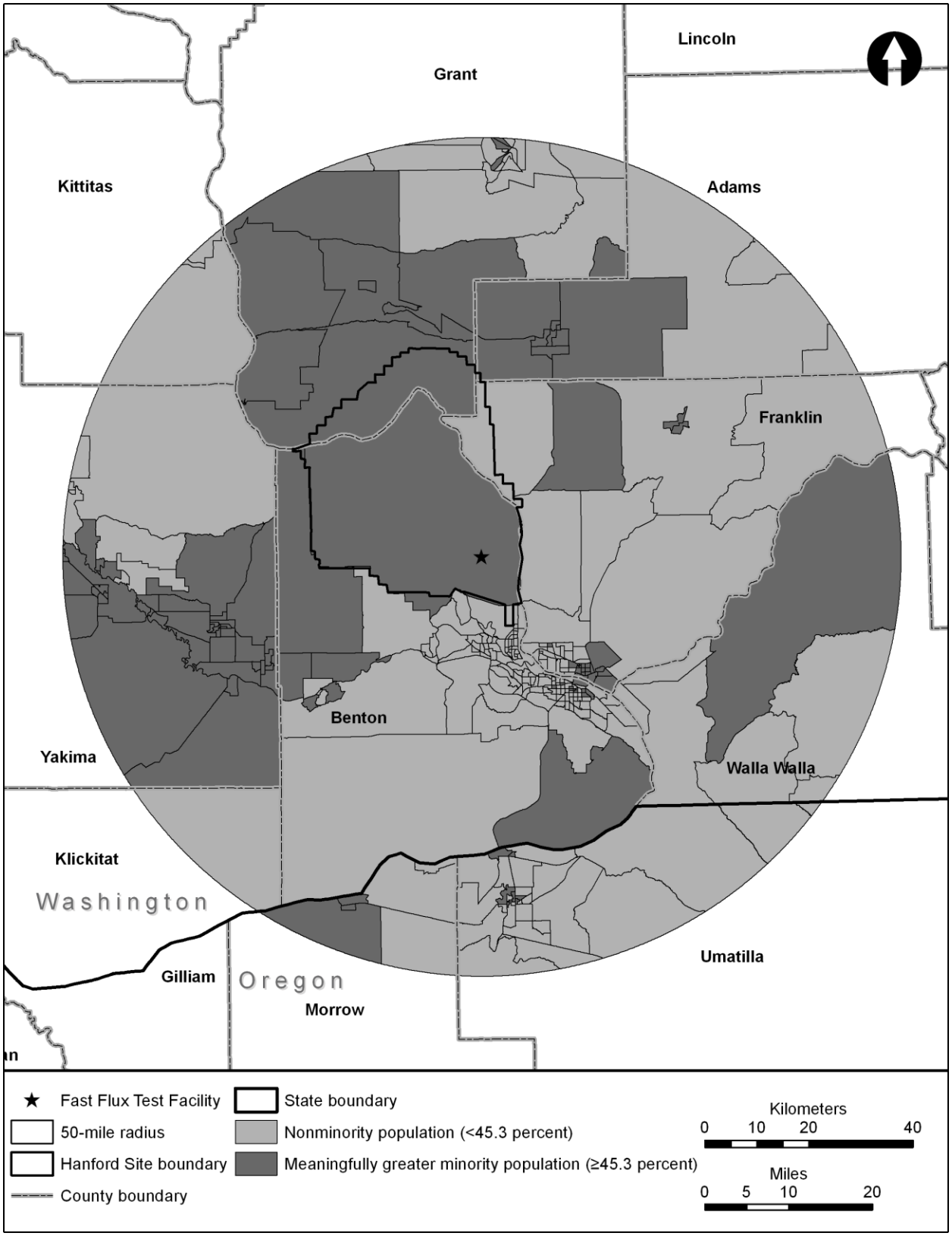

Figure J–13. Meaningfully Greater Minority and Nonminority Populations Living in Potentially Affected Block Groups Surrounding the Fast Flux Test Facility

As indicated in Table J–8, approximately 28 percent of the potentially affected minority population resides in Yakima County, and approximately 92 percent of the potentially affected minority population lives in five counties: Benton, Franklin, Grant, and Yakima Counties in Washington and Umatilla County in Oregon.

Table J–8. Minority Populations Living in Potentially Affected Counties Surrounding the Fast Flux Test Facility

County (State)	Total County Population[a]	Total Minority Population[a]	Potentially Affected Total Population[b]	Potentially Affected Minority Population[b]	Percentage of the Potentially Affected Minority Population Total
Adams (Washington)	18,728	11,466	15,123	11,138	5.6
Benton (Washington)	175,177	44,740	175,177	44,740	22.6
Franklin (Washington)	78,163	44,359	78,065	44,350	22.4
Grant (Washington)	89,120	38,054	49,468	24,288	12.3
Kittitas (Washington)	40,915	5,701	1,004	125	0.1
Klickitat (Washington)	20,318	3,296	229	70	0.0
Walla Walla (Washington)	58,781	15,177	6,884	1,761	0.9
Yakima (Washington)	243,231	127,207	73,915	54,581	27.5
Morrow (Oregon)	11,173	3,955	6,886	2,971	1.5
Umatilla (Oregon)	75,889	23,198	38,255	14,194	7.2
Total	**811,495**	**317,153**	**445,006**	**198,218**	**100.0**

[a] Census 2011a.

[b] Potentially affected population totals may differ slightly from those presented in Chapter 3, Section 3.2.11.1.3, due to rounding.

The total population of the potentially affected area surrounding FFTF is estimated to be approximately 445,000 persons. The significant reduction in population compared with other areas at Hanford that are analyzed in this EIS can be attributed to the city of Yakima's location beyond the reach of the 80-kilometer (50-mile) radius of the potentially affected area. Figures J–14 and J–15 show cumulative minority populations as a function of distance from FFTF. Values along the vertical axes of these figures show minority populations living within a given distance from FFTF. Moving outward from FFTF, sharp increases in the cumulative minority populations can still be seen near the outskirts of the population centers of Richland and Kennewick/Pasco, Washington; however, they occur roughly 16 kilometers (10 miles) closer than similar increases observed in the potentially affected area surrounding the 200 Area facilities. An additional population spurt can be observed approximately 64 kilometers (40 miles) from FFTF, most likely attributed to the population center of Hermiston, Oregon. Additional increases in population are attributed to the outlying areas in Yakima County, Washington. Approximately 30 percent of the potentially affected minority population lives within about 31 kilometers (19 miles) of the facility, and 50 percent resides within about 45 kilometers (28 miles). The potentially affected total minority population surrounding FFTF is approximately 198,000 persons, accounting for approximately 45 percent of the total population. Approximately 88 percent of the minority population surrounding FFTF is Hispanic or Latino.

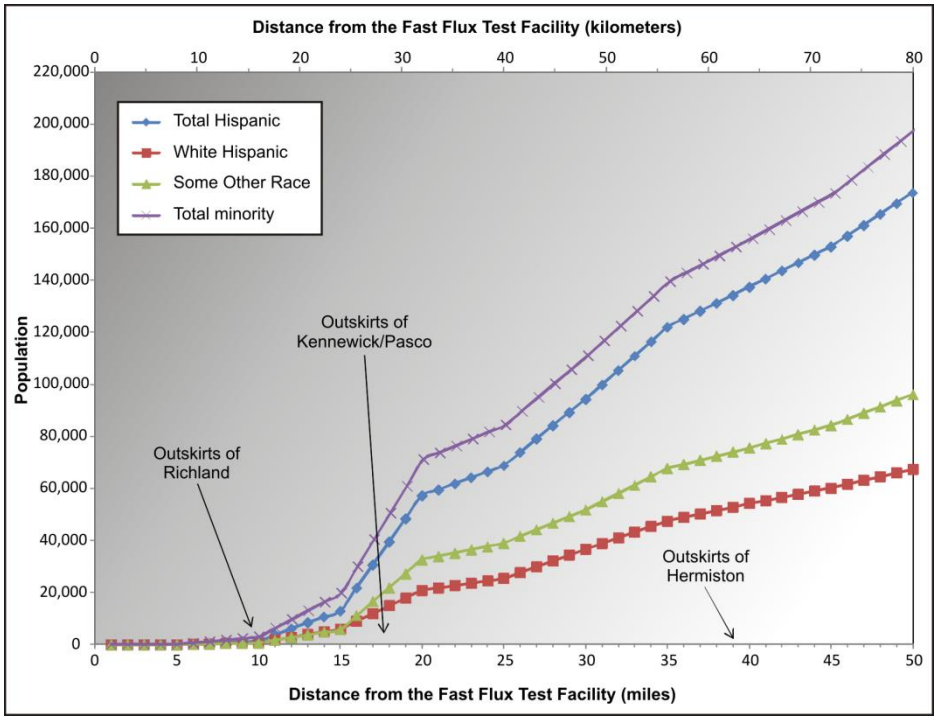

Figure J–14. Cumulative Larger-Scale Minority Populations as a Function of Distance from the Fast Flux Test Facility

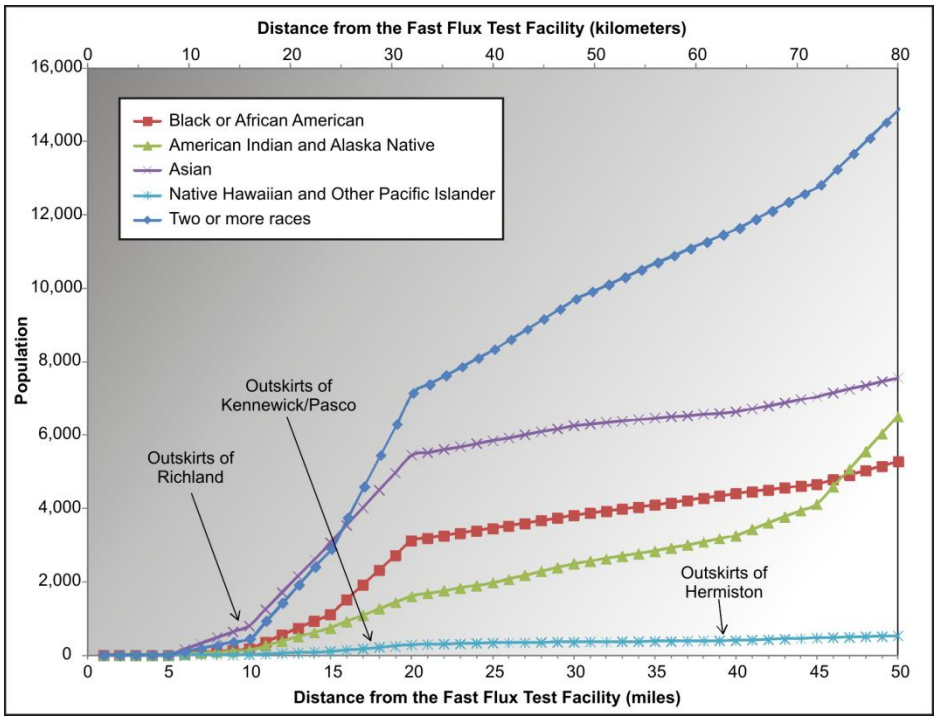

Figure J–15. Cumulative Smaller-Scale Minority Populations as a Function of Distance from the Fast Flux Test Facility

Figure J–16 shows block groups surrounding FFTF and low-income and non-low-income populations living in the potentially affected area. Of the 323 block groups that surround FFTF, an estimated 51 contain meaningfully greater low-income populations.

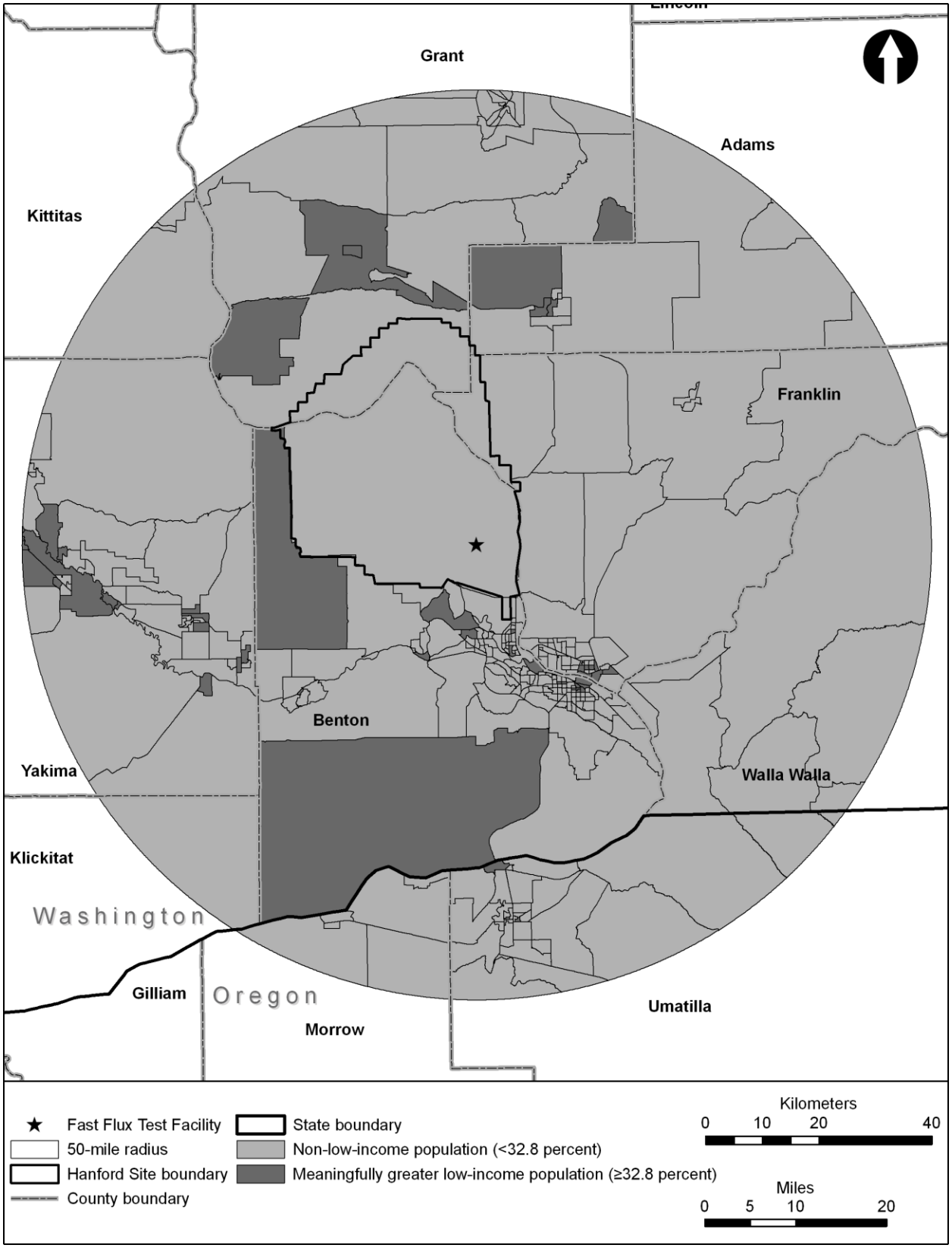

Figure J–16. Meaningfully Greater Low-Income and Non-Low-Income Populations Living in Potentially Affected Block Groups Surrounding the Fast Flux Test Facility

As indicated in Table J–9, approximately 25 percent of the potentially affected low-income population lives in Yakima County, and approximately 92 percent of the potentially affected low-income population lives in five counties: Benton, Franklin, Grant, and Yakima Counties in Washington and Umatilla County in Oregon. Low-income persons constitute approximately 18 percent of the total population living in the potentially affected area.

Table J–9. Low-Income Populations Living in Potentially Affected Counties Surrounding the Fast Flux Test Facility

County (State)	Total County Population[a]	Total Low-Income Population[a]	Potentially Affected Total Population[b]	Potentially Affected Low-Income Population[b]	Percentage of the Potentially Affected Low-Income Population Total
Adams (Washington)	17,537	4,395	13,937	3,746	5.0
Benton (Washington)	165,026	20,962	165,026	20,962	28.1
Franklin (Washington)	70,208	14,000	70,117	13,982	18.7
Grant (Washington)	83,907	17,120	46,589	8,805	11.8
Kittitas (Washington)	37,409	7,942	984	91	0.1
Klickitat (Washington)	19,861	3,865	298	64	0.1
Walla Walla (Washington)	53,173	9,314	7,244	936	1.3
Yakima (Washington)	232,438	50,608	69,414	18,948	25.4
Morrow (Oregon)	11,089	1,700	6,609	1,105	1.5
Umatilla (Oregon)	69,838	11,000	33,904	5,956	8.0
Total	**760,486**	**140,906**	**414,122**	**74,596**	**100.0**

[a] Census 2011c.

[b] Potentially affected population totals may differ slightly from those presented in Chapter 3, Section 3.2.11.2.3, due to rounding.

Figure J–17 shows cumulative low-income populations as a function of distance from FFTF. The cumulative low-income populations surrounding FFTF show patterns of growth similar to those reflected in Figures J–14 and J–15, increasing near the outskirts of the population centers of Richland, Kennewick/Pasco, and Hermiston, Oregon.

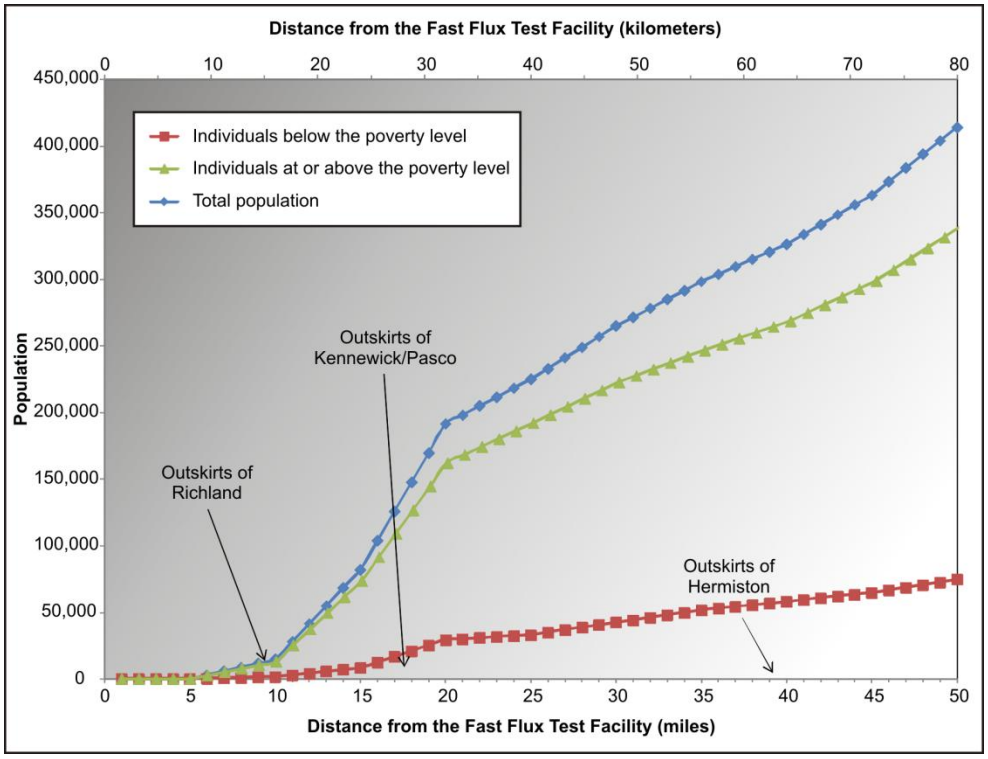

Figure J–17. Cumulative Low-Income Populations as a Function of Distance from the Fast Flux Test Facility

J.5.5 Minority and Low-Income Populations Surrounding the Materials and Fuels Complex at Idaho National Laboratory

Figure J–18 shows minority and nonminority populations living in block groups surrounding INL. Of the 184 block groups that surround the MFC within INL, an estimated 11 contain meaningfully greater minority populations. Potentially affected counties include 14 counties in Idaho (Bannock, Bingham, Blaine, Bonneville, Butte, Caribou, Clark, Custer, Fremont, Jefferson, Lemhi, Madison, Minidoka, and Power). As indicated in Table J–10, approximately 67 percent of the potentially affected minority population resides in Bingham and Bonneville Counties, while another 30 percent of the potentially affected minority population lives in Bannock, Jefferson, and Madison Counties.

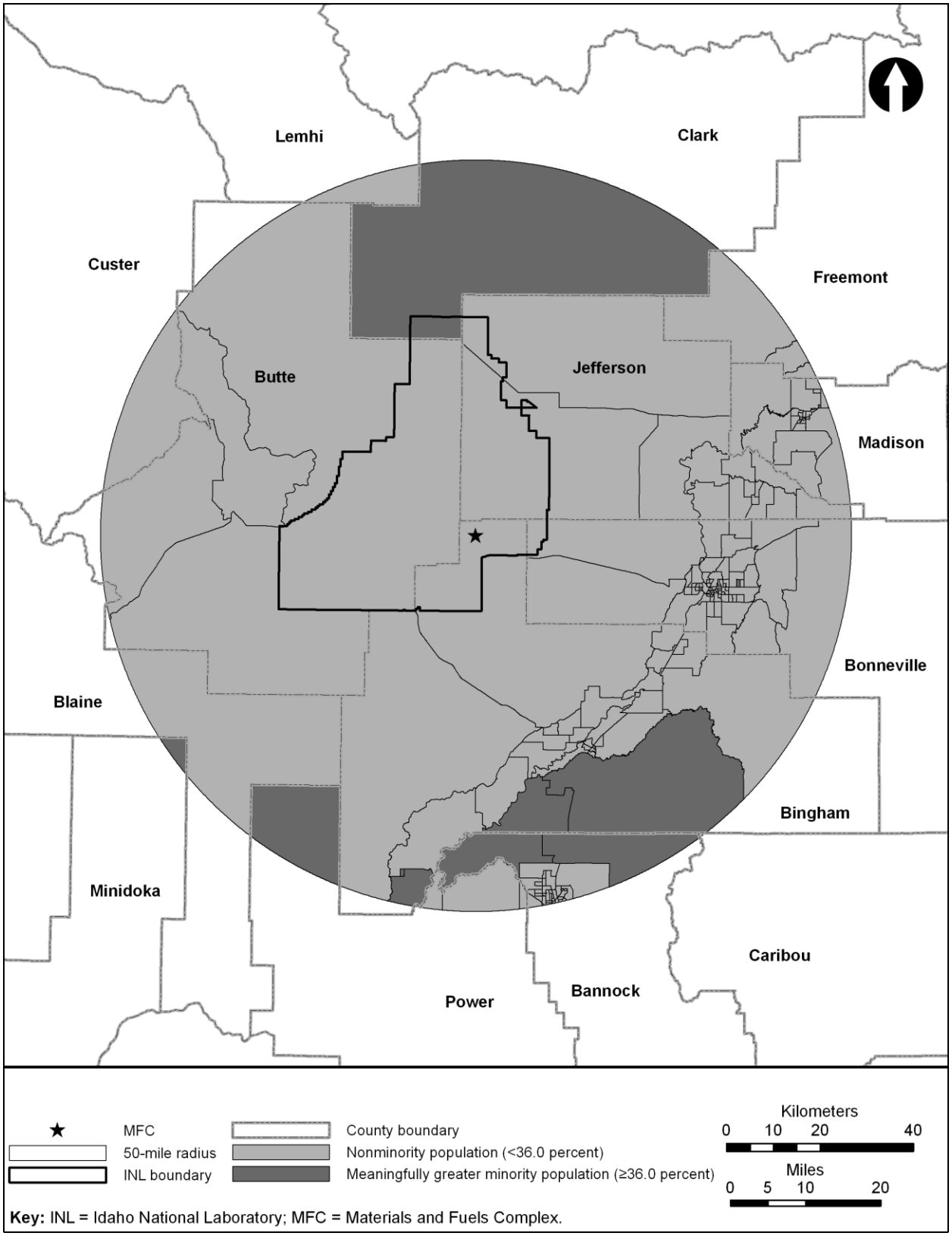

Figure J–18. Meaningfully Greater Minority and Nonminority Populations Living in Potentially Affected Block Groups Surrounding the Materials and Fuels Complex

Table J–10. Minority Populations Living in Potentially Affected Counties Surrounding the Materials and Fuels Complex

County (Idaho)	Total County Population[a]	Total Minority Population[a]	Potentially Affected Total Population[b]	Potentially Affected Minority Population[b]	Percentage of the Potentially Affected Minority Population Total
Bannock	82,839	11,273	37,909	5,690	14.5
Bingham	45,607	11,431	44,416	11,176	28.4
Blaine	21,376	4,707	314	49	0.1
Bonneville	104,234	15,361	103,102	15,327	39.0
Butte	2,891	178	2,731	170	0.4
Caribou	6,963	482	0	0	0.0
Clark	982	424	441	190	0.5
Custer	4,368	260	177	9	0.0
Fremont	13,242	1,969	1,492	264	0.7
Jefferson	26,140	3,215	25,859	3,197	8.1
Lemhi	7,936	393	24	1	0.0
Madison	37,536	3,318	33,935	3,071	7.8
Minidoka	20,069	6,974	14	8	0.0
Power	7,817	2,653	428	138	0.4
Total	**382,000**	**62,638**	**250,842**	**39,293**	**100.0**

[a] Census 2011a.
[b] Potentially affected population totals may differ slightly from those presented in Chapter 3, Section 3.3.11.1.2, due to rounding.

Figures J–19 and J–20 show cumulative minority populations as a function of distance from the MFC at INL. Values along the vertical axes of these figures show minority populations living within a given distance from the MFC. Moving outward from the MFC, the cumulative minority populations increase sharply near the outskirts of large population centers. Unlike the candidate facilities at Hanford, these large spikes do not occur until a distance of approximately 48 kilometers (30 miles), where the outskirts of Idaho Falls start. The next significant jump in population occurs at approximately 72 kilometers (45 miles), near Pocatello. Approximately 10 percent of the potentially affected minority population lives within about 47 kilometers (29 miles) of the MFC, and 50 percent resides within about 56 kilometers (35 miles). The potentially affected total minority population surrounding the MFC is approximately 39,000 persons, accounting for approximately 16 percent of the total population. Approximately 70 percent of the minority population surrounding the MFC is Hispanic or Latino.

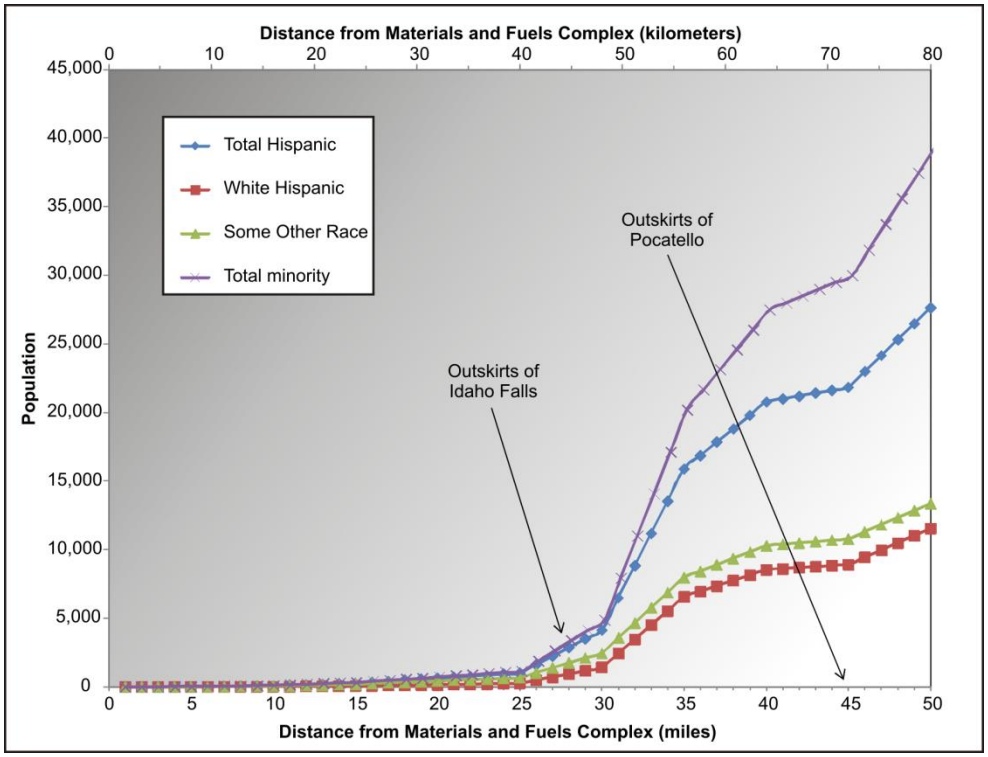

Figure J–19. Cumulative Larger-Scale Minority Populations as a Function of Distance from the Materials and Fuels Complex

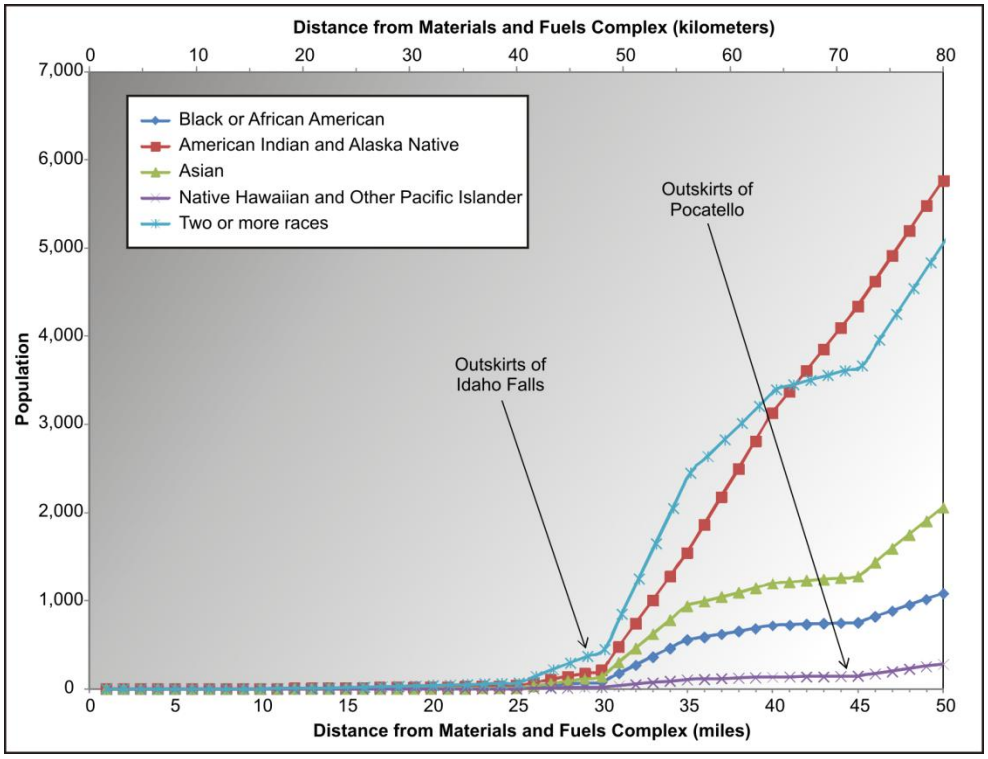

Figure J–20. Cumulative Smaller-Scale Minority Populations as a Function of Distance from the Materials and Fuels Complex

Figure J–21 shows the block groups surrounding INL and the low-income and non-low-income populations living in the potentially affected area. Of the 184 block groups that surround the MFC within INL, it is estimated that 13 contain meaningfully greater low-income populations. As indicated in Table J–11, approximately 61 percent of the potentially affected low-income population lives in Bonneville and Madison Counties. Another 30 percent of the potentially affected low-income population lives in Bannock and Bingham Counties. Low-income persons constitute approximately 14 percent of the total population living in the potentially affected area. Figure J–22 shows cumulative low-income populations as a function of distance from the MFC. Low-income populations surrounding the MFC are concentrated in the Fort Hall, Idaho Falls, and Rexburg areas.

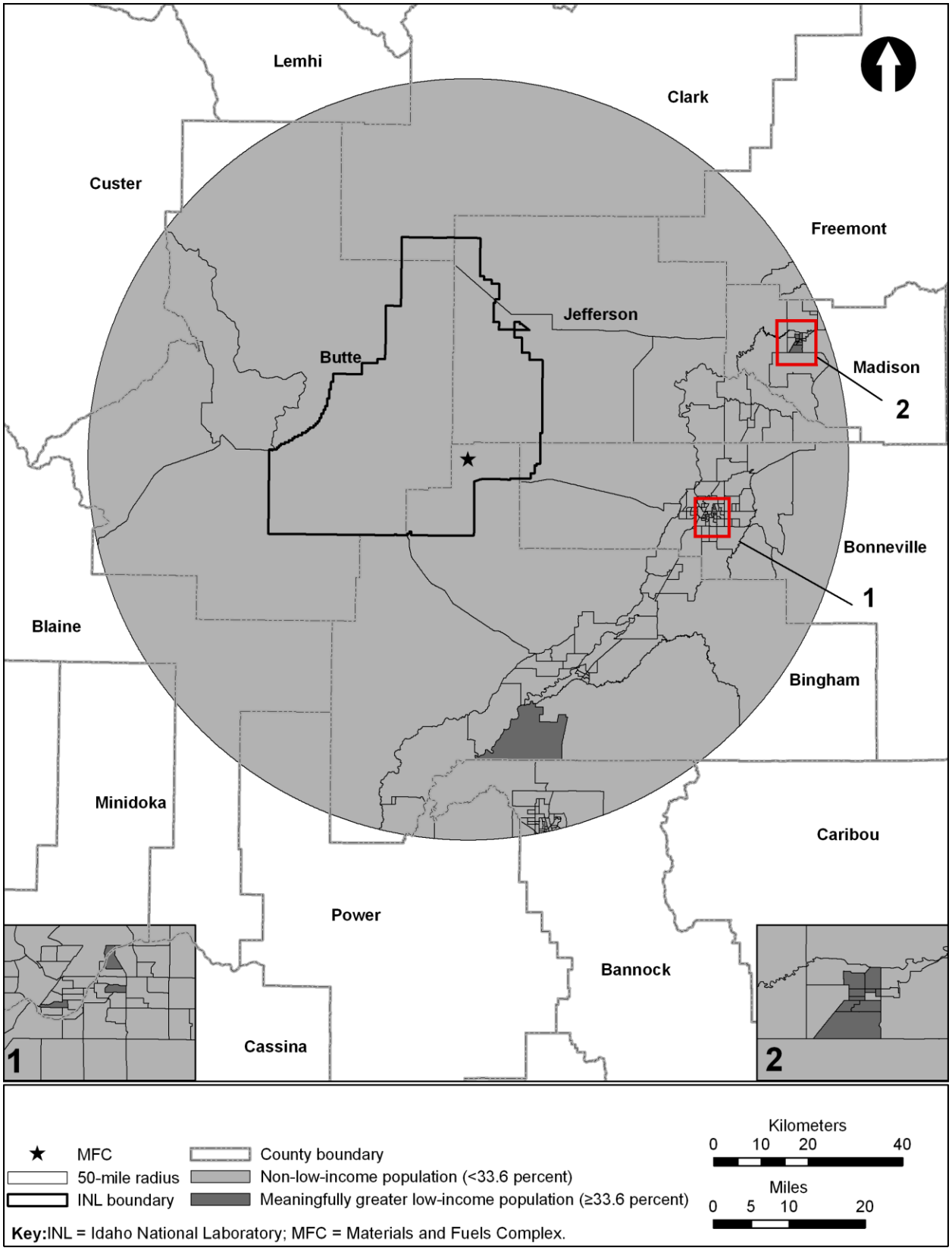

Figure J–21. Meaningfully Greater Low-Income and Non-Low-Income Populations Living in Potentially Affected Block Groups Surrounding the Materials and Fuels Complex

Table J–11. Low-Income Populations Living in Potentially Affected Counties Surrounding the Materials and Fuels Complex

County (Idaho)	Total County Population[a]	Total Low-Income Population[a]	Potentially Affected Total Population[b]	Potentially Affected Low-Income Population[b]	Percentage of the Potentially Affected Low-Income Population Total
Bannock	79,103	11,098	36,616	4,041	11.8
Bingham	44,125	6,498	42,946	6,299	18.3
Blaine	21,172	1,979	378	34	0.1
Bonneville	99,305	10,882	98,389	10,745	31.3
Butte	2,768	381	2,609	363	1.1
Caribou	6,794	569	0	0	0.0
Clark	857	97	385	44	0.1
Custer	4,277	592	162	17	0.0
Fremont	12,960	1,104	1,593	114	0.3
Jefferson	24,411	2,479	24,138	2,453	7.1
Lemhi	7,753	1,553	22	2	0.0
Madison	34,372	11,082	31,302	10,223	29.7
Minidoka	19,254	2,518	17	1	0.0
Power	7,633	848	473	36	0.1
Total	**364,784**	**51,680**	**239,029**	**34,371**	**100.0**

[a] Census 2011c.

[b] Potentially affected population totals may differ slightly from those presented in Chapter 3, Section 3.3.11.2.2, due to rounding.

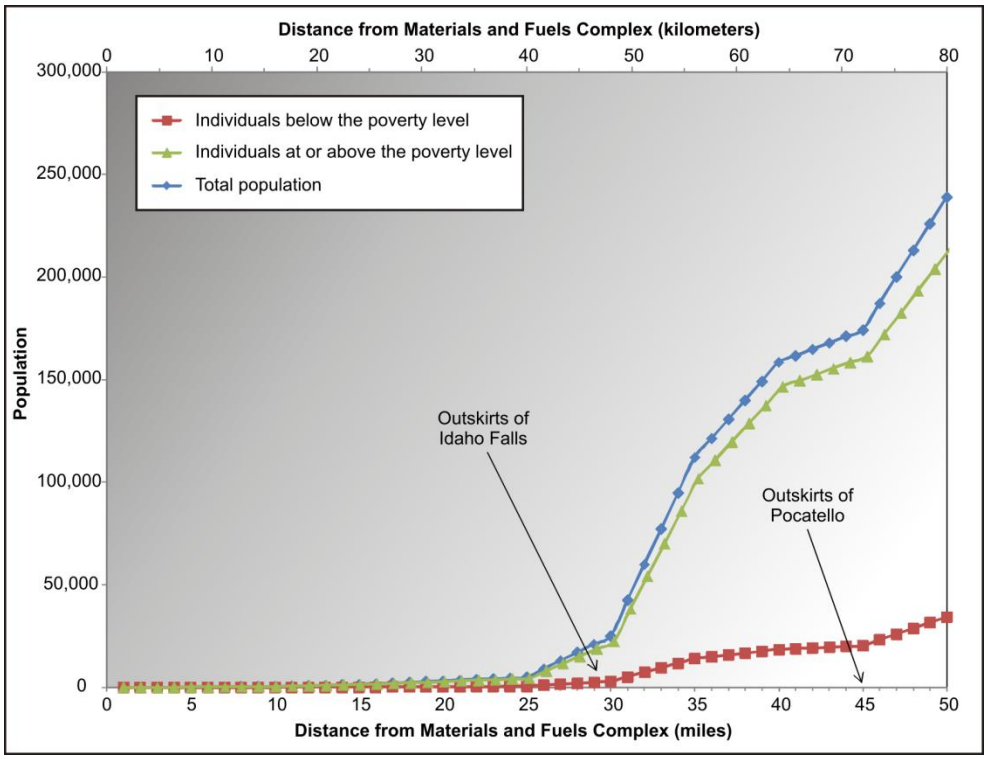

Figure J–22. Cumulative Low-Income Populations as a Function of Distance from the Materials and Fuels Complex

J.5.6 Minority and Low-Income Populations Surrounding the Idaho Nuclear Technology and Engineering Center at Idaho National Laboratory

Figure J–23 shows minority and nonminority populations living in block groups surrounding INTEC at INL. Of the 127 block groups that surround INTEC, an estimated 11 contain meaningfully greater minority populations. Potentially affected counties include 14 counties in Idaho (Bannock, Bingham, Blaine, Bonneville, Butte, Clark, Custer, Fremont, Jefferson, Lemhi, Lincoln, Madison, Minidoka, and Power). As indicated in Table J–12, approximately 87 percent of the potentially affected minority population resides in Bingham and Bonneville Counties.

Table J–12. Minority Populations Living in Potentially Affected Counties Surrounding the Idaho Nuclear Technology and Engineering Center

County (Idaho)	Total County Population[a]	Total Minority Population[a]	Potentially Affected Total Population[b]	Potentially Affected Minority Population[b]	Percentage of the Potentially Affected Minority Population Total
Bannock	82,839	11,273	7,238	1,403	4.9
Bingham	45,607	11,431	43,572	10,733	37.8
Blaine	21,376	4,707	1,024	122	0.4
Bonneville	104,234	15,361	87,263	14,038	49.4
Butte	2,891	178	2,888	178	0.6
Clark	982	424	281	122	0.4
Custer	4,368	260	723	38	0.1
Fremont	13,242	1,969	4	0	0.0
Jefferson	26,140	3,215	8,607	1,426	5.0
Lemhi	7,936	393	34	2	0.0
Lincoln	5,208	1,601	15	3	0.0
Madison	37,536	3,318	21	1	0.0
Minidoka	20,069	6,974	256	153	0.5
Power	7,817	2,653	575	190	0.7
Total	**380,245**	**63,757**	**152,502**	**28,409**	**100.0**

[a] Census 2011a.

[b] Potentially affected population totals may differ slightly from those presented in Chapter 3, Section 3.3.11.1.1, due to rounding.

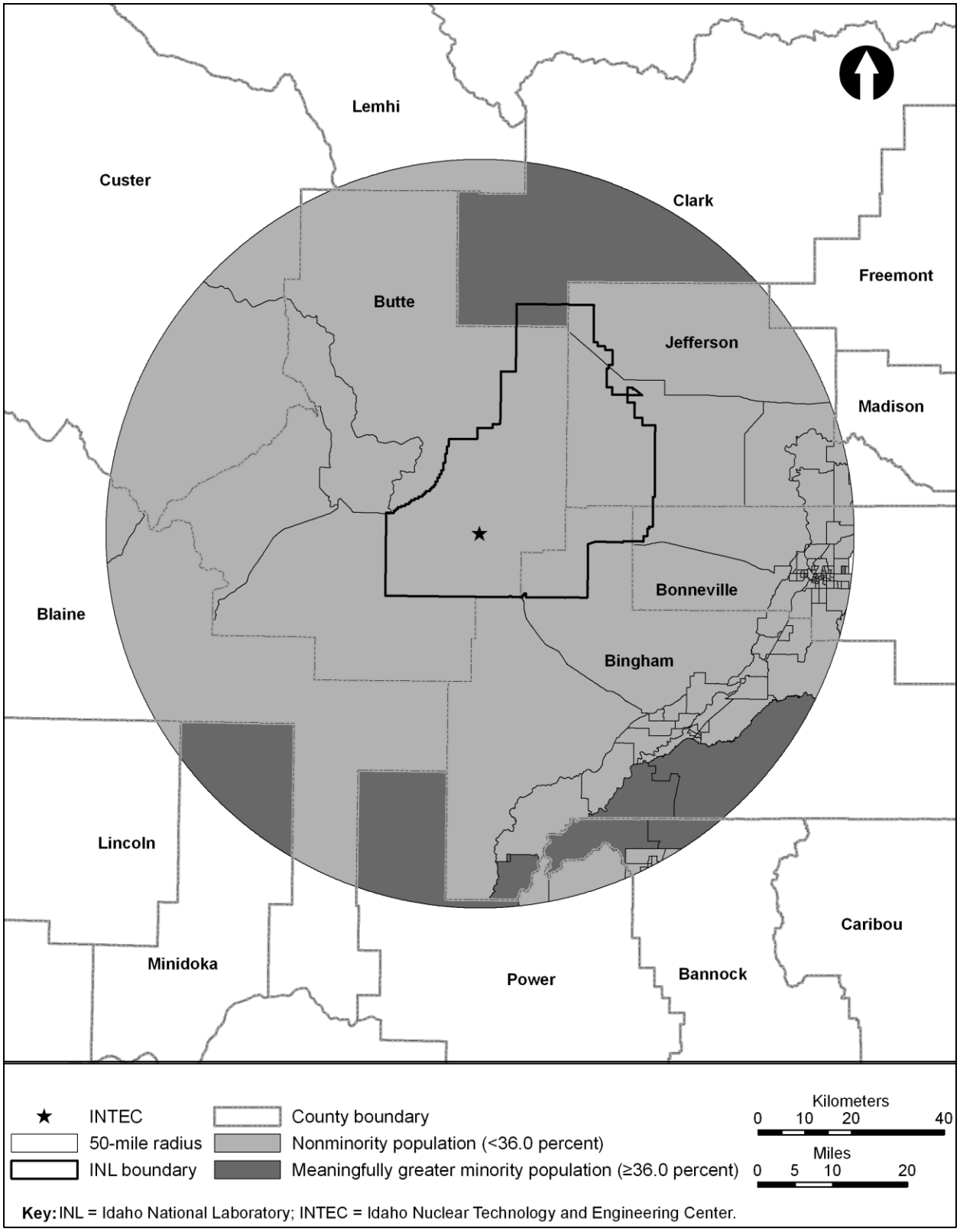

Figure J–23. Meaningfully Greater Minority and Nonminority Populations Living in Potentially Affected Block Groups Surrounding the Idaho Nuclear Technology and Engineering Center

Figures J–24 and J–25 show cumulative minority populations as a function of distance from INTEC at INL. Values along the vertical axes of these figures show minority populations living within a given distance from INTEC. Moving outward from INTEC, the cumulative minority populations increase sharply near the outskirts of large population centers. These large spikes occur at approximately 64 kilometers (40 miles), near the outskirts of Idaho Falls, and again at approximately 76 kilometers (47 miles), near Pocatello. Approximately 15 percent of the potentially affected minority population lives within about 58 kilometers (36 miles) of INTEC, and approximately 54 percent resides within about 71 kilometers (44 miles). The potentially affected total minority population surrounding INTEC is approximately 28,000 persons, accounting for approximately 19 percent of the total population. Approximately 74 percent of the minority population surrounding INTEC is Hispanic or Latino.

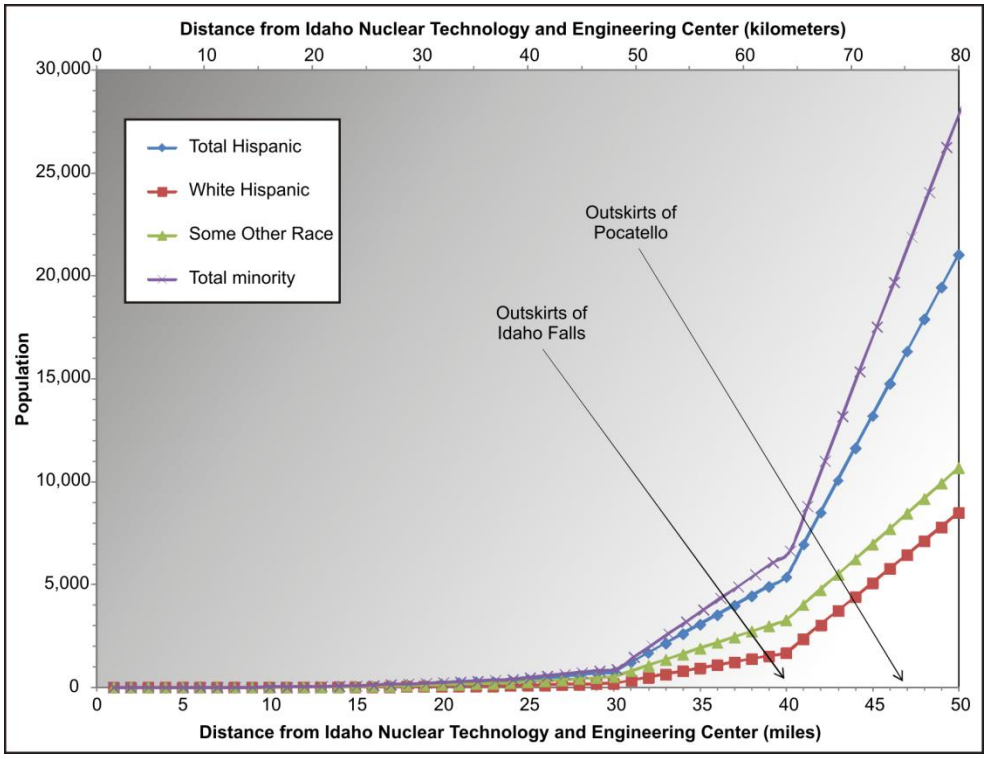

Figure J–24. Cumulative Larger-Scale Minority Populations as a Function of Distance from the Idaho Nuclear Technology and Engineering Center

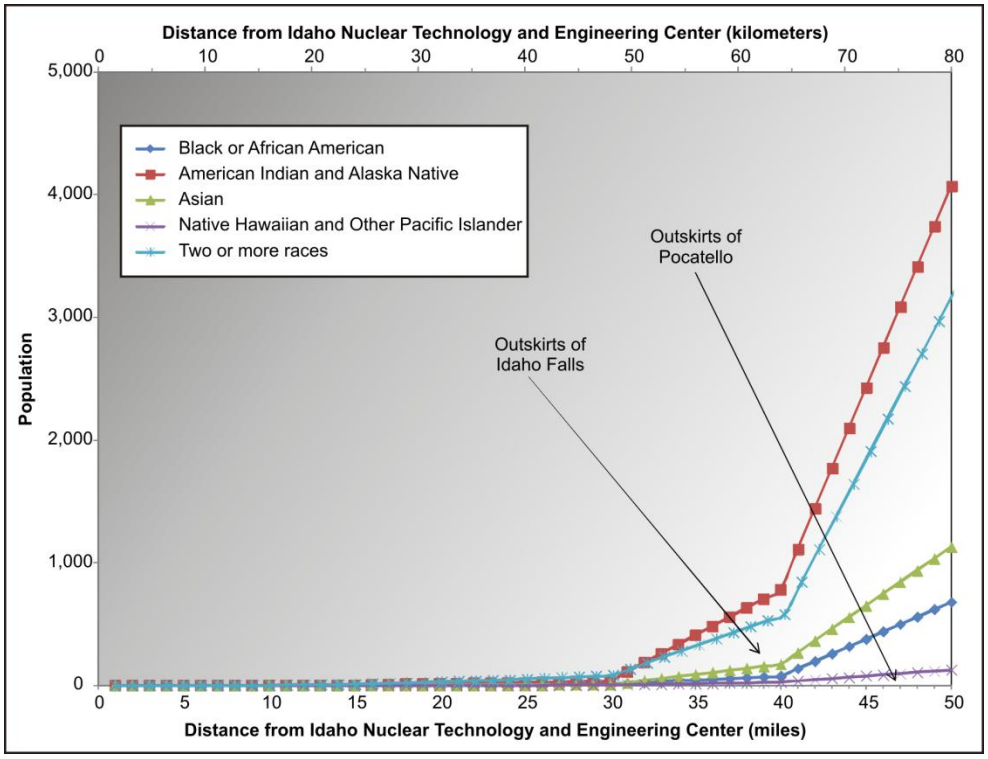

Figure J–25. Cumulative Smaller-Scale Minority Populations as a Function of Distance from the Idaho Nuclear Technology and Engineering Center

Figure J–26 shows the block groups surrounding INTEC at INL, as well as the low-income and non-low-income populations living in the potentially affected area. Of the 127 block groups that surround INTEC, an estimated 4 contain meaningfully greater low-income populations. As indicated in Table J–13, approximately 90 percent of the potentially affected low-income population lives in Bingham and Bonneville Counties. Low-income persons constitute approximately 12 percent of the total population living in the potentially affected area. Figure J–27 shows cumulative low-income populations as a function of distance from INTEC. Low-income populations surrounding INL are concentrated in the Blackfoot and Idaho Falls areas.

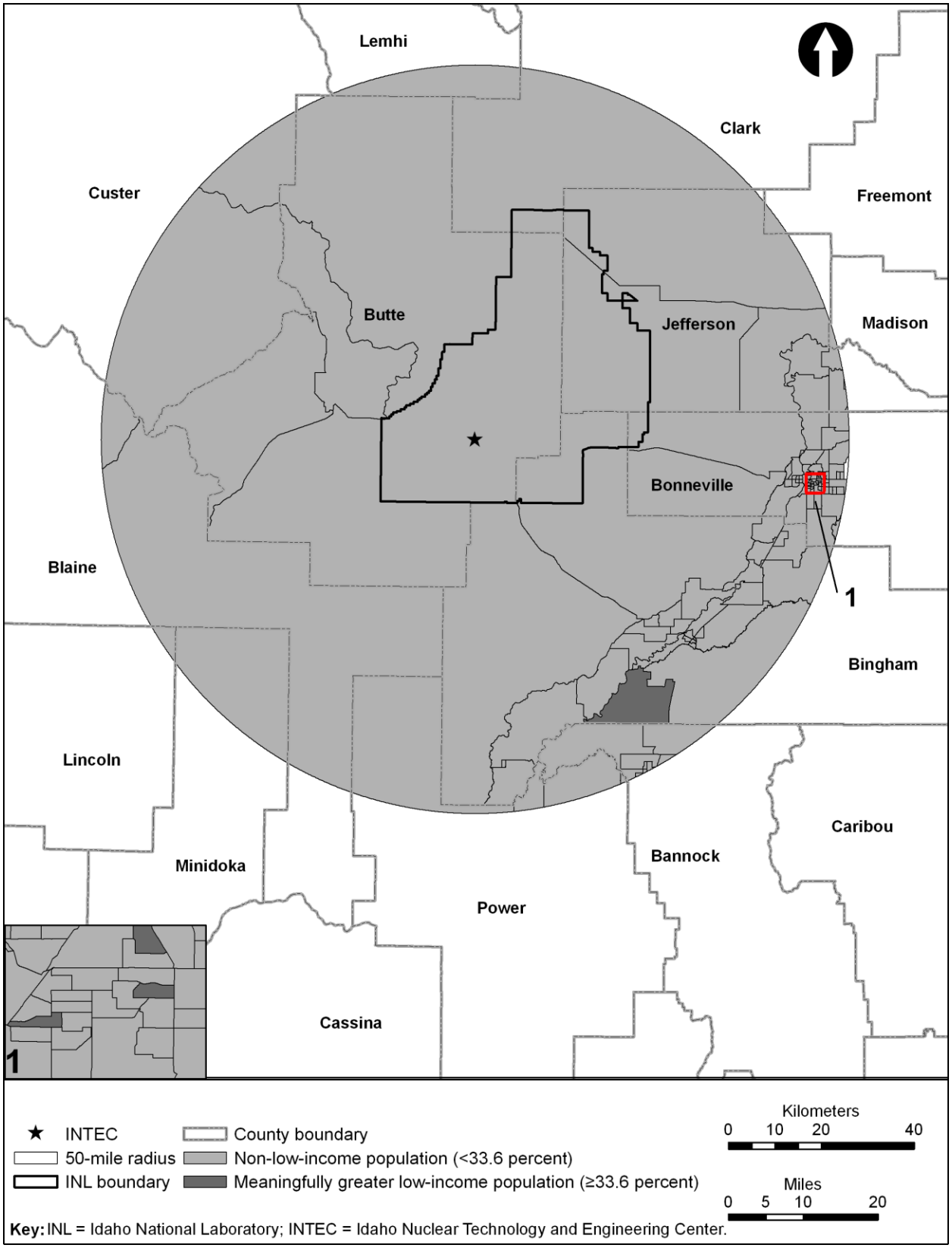

Figure J–26. Meaningfully Greater Low-Income and Non-Low-Income Populations Living in Potentially Affected Block Groups Surrounding the Idaho Nuclear Technology and Engineering Center

Table J–13. Low-Income Populations Living in Potentially Affected Counties Surrounding the Idaho Nuclear Technology and Engineering Center

County (Idaho)	Total County Population[a]	Total Low-Income Population[a]	Potentially Affected Total Population[b]	Potentially Affected Low-Income Population[b]	Percentage of the Potentially Affected Low-Income Population Total
Bannock	79,103	11,098	6,696	491	2.7
Bingham	44,125	6,498	42,238	6,254	35.0
Blaine	21,172	1,979	1,147	89	0.5
Bonneville	99,305	10,882	83,967	9,771	54.7
Butte	2,768	381	2,765	381	2.1
Clark	857	97	246	28	0.2
Custer	4,277	592	668	79	0.4
Fremont	12,960	1,104	4	0	0.0
Jefferson	24,411	2,479	8,095	721	4.0
Lemhi	7,753	1,553	31	2	0.0
Lincoln	4,935	757	11	0	0.0
Madison	34,372	11,082	19	1	0.0
Minidoka	19,254	2,518	313	18	0.1
Power	7,633	848	631	32	0.2
Total	**362,925**	**51,868**	**146,832**	**17,867**	**100.0**

[a] Census 2011c.

[b] Potentially affected population totals may differ slightly from those presented in Chapter 3, Section 3.2.11.2.1, due to rounding.

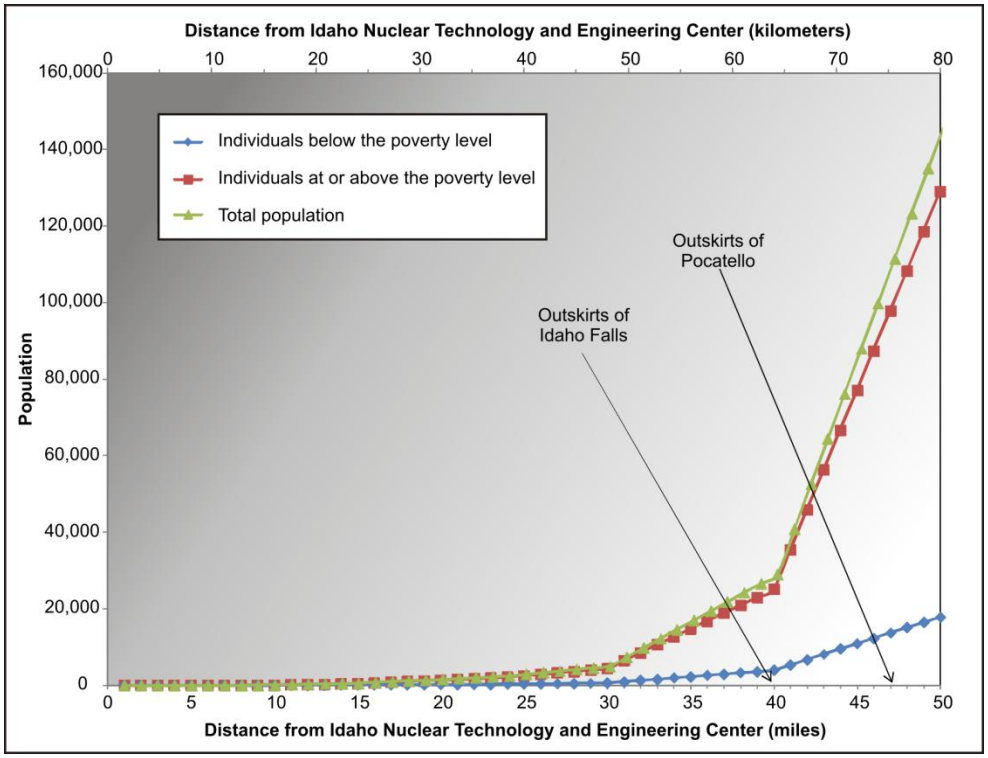

Figure J–27. Cumulative Low-Income Populations as a Function of Distance from the Idaho Nuclear Technology and Engineering Center

J.5.7 Impacts on Minority and Low-Income Populations

This environmental justice analysis is based on assessment of the impacts reported in Chapter 4 of this *TC & WM EIS*. Initially, all resource areas were examined to identify those with the potential for disproportionately high and adverse health or environmental impacts on minority and low-income populations. Access to Hanford is restricted, so the majority of impacts would be associated with onsite activities and would not affect populations residing off site; thus the potential for environmental justice concerns is small. Resource areas that could be impacted and that may affect populations residing off site include public health and safety due to normal operations and facility accidents, air quality, groundwater resources, and long-term human health. These areas were further analyzed because they have the potential to pose environmental justice concerns.

J.5.7.1 Normal Operations and Facility Accidents

Radiological impacts of normal operations on minority, Hispanic, American Indian, and low-income populations were determined by applying the same methodology used to determine impacts of normal operations on the general public (total population). Concentrations of radioactive air emissions originating from the appropriate facilities under each alternative were modeled using meteorological data and population distributions relative to the release sites to determine the impacts on each subset population. This approach is discussed in detail in Appendix K, Sections K.2.1.1.1, K.2.2.1.1, and K.2.3.1.1. Note that the exposure scenarios used to model the minority, Hispanic, American Indian, and low-income populations assume that these individuals would be exposed in the same manner as the general population, that is, by external exposure to the plume and deposited radioactive materials and by internal exposure from inhalation of contaminated air and deposited radioactive materials and ingestion of contaminated food, including homegrown produce and animal products from regional livestock.

For purposes of evaluating the potential for disproportionately high and adverse impacts caused by radioactive emissions from normal operations, the average dose to an individual of the minority or low-income population is compared with the average dose to an individual of the remainder of the population. Data relative to income from the 2006–2010 ACS 5-year estimates, Table C17002 (Census 2011c), are not directly comparable to the total populations from the 2010 census, Table P5 (Census 2011a). The data relative to income from the ACS are estimated using multiyear sample data from a smaller sample universe (population for whom poverty status is determined) than is used for data relative to race and ethnicity (total population). Therefore, estimates of the low-income population have been scaled up to be directly comparable to the total population from the 2010 census by applying the distribution of the population identified to be low-income from the ACS to the total population from the 2010 census of corresponding geographic areas. Table J–14 shows the population values used for this environmental justice analysis. The maximum annual dose (the maximum estimated dose in a single year of a particular alternative) and the project lifetime dose (the estimated dose received over the duration of a particular alternative) are used for this comparison. A maximum annual dose and a project lifetime dose were calculated for each subset of the population being evaluated (minority, Hispanic, American Indian, and low-income). The average dose to an individual of the population subset being evaluated is derived by dividing the population dose for the subset by the number of people in the subset, as follows:

$$D_{is} = \frac{D_{ps}}{n_s}$$

where:

D_{is} = average dose to an individual in the population subset *s*, millirem
D_{ps} = population dose received by the population subset *s*, person-rem
n_s = number of people in the population subset *s*

Table J–14. Potentially Affected Populations[a]

Facility Site	Total Population[b]	Total Minority Population	Hispanic Population[c]	American Indian Population	Low-Income Population[d]
WTP	542,324	252,134	219,632	10,739	106,374
STTS-East	546,746	253,334	220,513	10,839	107,032
STTS-West	589,668	264,483	228,660	11,933	111,310
FFTF	445,002	198,216	173,540	6,504	80,254
INTEC	152,493	28,408	21,006	4,068	18,556
MFC	250,838	39,297	27,634	5,763	36,309

[a] Reflects populations living within an 80-kilometer (50-mile) radius of the indicated facility sites.
[b] Populations in this table may vary slightly from those presented in Sections J.5.1 through J.5.6 due to rounding.
[c] Includes all individuals, regardless of race, who identified themselves as Hispanic or Latino.
[d] Low-income population values are based on data from a smaller sample universe than data on race and ethnicity; therefore, the distribution of low-income populations have been scaled up to be directly comparable to the total population of corresponding geographic areas.

Key: FFTF=Fast Flux Test Facility; INTEC=Idaho Nuclear Technology and Engineering Center; MFC=Materials and Fuels Complex; STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

The result is then compared with the average dose to an individual who is not a member of the subset being evaluated. The average dose to a member of the remaining population is derived by dividing the population dose to the remainder of the population (population dose to the total population minus the population dose to the subset population) by the number of people in the remainder of the population (living within 80 kilometers [50 miles] of the candidate facilities that are not in the population subset), as follows:

$$D_{ir} = \frac{D_{pr}}{n_r}$$

where:

D_{ir} = average dose to an individual in the remainder of the population (not a member of population subset *s*), millirem

D_{pr} = population dose received by the remainder of the population (the population that is not a member of subset *s*), person-rem

n_r = number of people in the remainder of the population (total population minus population of subset *s*)

J.5.7.1.1 Tank Closure Alternatives

Table J–15 compares average individual doses to minority and nonminority populations under each Tank Closure alternative to examine the potential for disproportionately high and adverse impacts. There are no appreciable differences between the average dose to a minority individual and a nonminority individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on minority populations surrounding each facility site.

Table J–15. Tank Closure Alternatives – Total, Minority, and Nonminority Population and Average Individual Doses in Year of Maximum Impact

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Minority Population Dose (person-rem)	Minority Individual Average Dose (millirem)	Nonminority Population Dose (person-rem)	Nonminority Individual Average Dose (millirem)
Alternative 1						
WTP	0	0	0	0	0	0
STTS-East	4.0×10^{-1}	7.2×10^{-4}	1.7×10^{-1}	6.7×10^{-4}	2.3×10^{-1}	7.7×10^{-4}
STTS-West	3.9×10^{-1}	6.6×10^{-4}	1.5×10^{-1}	5.9×10^{-4}	2.3×10^{-1}	7.2×10^{-4}
Total	$\mathbf{7.8\times10^{-1}}$	$\mathbf{1.4\times10^{-3}}$	$\mathbf{3.2\times10^{-1}}$	$\mathbf{1.3\times10^{-3}}$	$\mathbf{4.6\times10^{-1}}$	$\mathbf{1.5\times10^{-3}}$
Alternative 2A						
WTP	2.8×10^{2}	5.1×10^{-1}	1.1×10^{2}	4.6×10^{-1}	1.6×10^{2}	5.6×10^{-1}
STTS-East	6.4×10^{-8}	1.2×10^{-10}	2.6×10^{-8}	1.0×10^{-10}	3.7×10^{-8}	1.3×10^{-10}
STTS-West	0	0	0	0	0	0
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{1.1\times10^{2}}$	$\mathbf{4.6\times10^{-1}}$	$\mathbf{1.6\times10^{2}}$	$\mathbf{5.6\times10^{-1}}$
Alternative 2B						
WTP	3.3×10^{2}	6.1×10^{-1}	1.4×10^{2}	5.5×10^{-1}	1.9×10^{2}	6.6×10^{-1}
STTS-East	2.6×10^{-2}	4.7×10^{-5}	1.1×10^{-2}	4.2×10^{-5}	1.5×10^{-2}	5.1×10^{-5}
STTS-West	2.5×10^{-2}	4.2×10^{-5}	9.1×10^{-3}	3.5×10^{-5}	1.6×10^{-2}	4.9×10^{-5}
Total	$\mathbf{3.3\times10^{2}}$	$\mathbf{6.1\times10^{-1}}$	$\mathbf{1.4\times10^{2}}$	$\mathbf{5.5\times10^{-1}}$	$\mathbf{1.9\times10^{2}}$	$\mathbf{6.6\times10^{-1}}$
Alternative 3A						
WTP	2.8×10^{2}	5.1×10^{-1}	1.1×10^{2}	4.6×10^{-1}	1.6×10^{2}	5.6×10^{-1}
STTS-East	1.0	1.8×10^{-3}	4.3×10^{-1}	1.7×10^{-3}	5.7×10^{-1}	1.9×10^{-3}
STTS-West	9.0×10^{-1}	1.5×10^{-3}	3.7×10^{-1}	1.4×10^{-3}	5.3×10^{-1}	1.6×10^{-3}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{1.2\times10^{2}}$	$\mathbf{4.6\times10^{-1}}$	$\mathbf{1.6\times10^{2}}$	$\mathbf{5.6\times10^{-1}}$
Alternative 3B						
WTP	2.8×10^{2}	5.1×10^{-1}	1.1×10^{2}	4.6×10^{-1}	1.6×10^{2}	5.6×10^{-1}
STTS-East	4.1×10^{-5}	7.4×10^{-8}	1.7×10^{-5}	6.7×10^{-8}	2.4×10^{-5}	8.0×10^{-8}
STTS-West	7.4×10^{-4}	1.2×10^{-6}	2.7×10^{-4}	1.0×10^{-6}	4.7×10^{-4}	1.4×10^{-6}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{1.1\times10^{2}}$	$\mathbf{4.6\times10^{-1}}$	$\mathbf{1.6\times10^{2}}$	$\mathbf{5.6\times10^{-1}}$
Alternative 3C						
WTP	2.8×10^{2}	5.1×10^{-1}	1.1×10^{2}	4.6×10^{-1}	1.6×10^{2}	5.6×10^{-1}
STTS-East	1.1	2.1×10^{-3}	4.9×10^{-1}	1.9×10^{-3}	6.5×10^{-1}	2.2×10^{-3}
STTS-West	1.0	1.7×10^{-3}	4.1×10^{-1}	1.6×10^{-3}	6.1×10^{-1}	1.9×10^{-3}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{1.2\times10^{2}}$	$\mathbf{4.6\times10^{-1}}$	$\mathbf{1.6\times10^{2}}$	$\mathbf{5.6\times10^{-1}}$

Table J–15. Tank Closure Alternatives – Total, Minority, and Nonminority Population and Average Individual Doses in Year of Maximum Impact *(continued)*

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Minority Population Dose (person-rem)	Minority Individual Average Dose (millirem)	Nonminority Population Dose (person-rem)	Nonminority Individual Average Dose (millirem)
Alternative 4						
WTP	2.8×10^{2}	5.1×10^{-1}	1.1×10^{2}	4.6×10^{-1}	1.6×10^{2}	5.6×10^{-1}
STTS-East	4.8×10^{-3}	8.9×10^{-6}	2.0×10^{-3}	7.9×10^{-6}	2.8×10^{-3}	9.7×10^{-6}
STTS-West	4.9×10^{-3}	8.2×10^{-6}	1.8×10^{-3}	6.7×10^{-6}	3.1×10^{-3}	9.4×10^{-6}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{1.1\times10^{2}}$	$\mathbf{4.6\times10^{-1}}$	$\mathbf{1.6\times10^{2}}$	$\mathbf{5.6\times10^{-1}}$
Alternative 5						
WTP	2.8×10^{2}	5.1×10^{-1}	1.2×10^{2}	4.6×10^{-1}	1.6×10^{2}	5.6×10^{-1}
STTS-East	1.9×10^{-5}	3.5×10^{-8}	8.1×10^{-6}	3.2×10^{-8}	1.1×10^{-5}	3.8×10^{-8}
STTS-West	1.1	1.9×10^{-3}	4.6×10^{-1}	1.8×10^{-3}	6.7×10^{-1}	2.1×10^{-3}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{1.2\times10^{2}}$	$\mathbf{4.6\times10^{-1}}$	$\mathbf{1.6\times10^{2}}$	$\mathbf{5.6\times10^{-1}}$
Alternative 6A, Base Case						
WTP	2.8×10^{2}	5.1×10^{-1}	1.1×10^{2}	4.6×10^{-1}	1.6×10^{2}	5.6×10^{-1}
STTS-East	4.1×10^{-2}	7.6×10^{-5}	1.7×10^{-2}	6.8×10^{-5}	2.4×10^{-2}	8.2×10^{-5}
STTS-West	3.9×10^{-2}	6.7×10^{-5}	1.4×10^{-2}	5.5×10^{-5}	2.5×10^{-2}	7.6×10^{-5}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{1.1\times10^{2}}$	$\mathbf{4.6\times10^{-1}}$	$\mathbf{1.6\times10^{2}}$	$\mathbf{5.6\times10^{-1}}$
Alternative 6A, Option Case						
WTP	2.8×10^{2}	5.1×10^{-1}	1.1×10^{2}	4.6×10^{-1}	1.6×10^{2}	5.6×10^{-1}
STTS-East	5.2×10^{-2}	9.4×10^{-5}	2.1×10^{-2}	8.4×10^{-5}	3.0×10^{-2}	1.0×10^{-4}
STTS-West	5.0×10^{-2}	8.4×10^{-5}	1.8×10^{-2}	6.9×10^{-5}	3.1×10^{-2}	9.6×10^{-5}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{1.1\times10^{2}}$	$\mathbf{4.6\times10^{-1}}$	$\mathbf{1.6\times10^{2}}$	$\mathbf{5.6\times10^{-1}}$
Alternative 6B, Base Case						
WTP	3.2×10^{2}	6.0×10^{-1}	1.3×10^{2}	5.3×10^{-1}	1.9×10^{2}	6.5×10^{-1}
STTS-East	5.0×10^{-1}	9.2×10^{-4}	2.1×10^{-1}	8.2×10^{-4}	2.9×10^{-1}	1.0×10^{-3}
STTS-West	4.7×10^{-1}	7.9×10^{-4}	1.7×10^{-1}	6.5×10^{-4}	2.9×10^{-1}	9.0×10^{-4}
Total	$\mathbf{3.2\times10^{2}}$	$\mathbf{6.0\times10^{-1}}$	$\mathbf{1.4\times10^{2}}$	$\mathbf{5.4\times10^{-1}}$	$\mathbf{1.9\times10^{2}}$	$\mathbf{6.5\times10^{-1}}$
Alternative 6B, Option Case						
WTP	3.2×10^{2}	6.0×10^{-1}	1.3×10^{2}	5.3×10^{-1}	1.9×10^{2}	6.5×10^{-1}
STTS-East	6.5×10^{-1}	1.2×10^{-3}	2.7×10^{-1}	1.1×10^{-3}	3.8×10^{-1}	1.3×10^{-3}
STTS-West	5.7×10^{-1}	9.6×10^{-4}	2.1×10^{-1}	7.9×10^{-4}	3.6×10^{-1}	1.1×10^{-3}
Total	$\mathbf{3.2\times10^{2}}$	$\mathbf{6.0\times10^{-1}}$	$\mathbf{1.3\times10^{2}}$	$\mathbf{5.4\times10^{-1}}$	$\mathbf{1.9\times10^{2}}$	$\mathbf{6.5\times10^{-1}}$
Alternative 6C						
WTP	3.2×10^{2}	6.0×10^{-1}	1.3×10^{2}	5.3×10^{-1}	1.9×10^{2}	6.5×10^{-1}
STTS-East	2.6×10^{-2}	4.7×10^{-5}	1.1×10^{-2}	4.2×10^{-5}	1.5×10^{-2}	5.1×10^{-5}
STTS-West	2.5×10^{-2}	4.2×10^{-5}	9.1×10^{-3}	3.5×10^{-5}	1.6×10^{-2}	4.9×10^{-5}
Total	$\mathbf{3.2\times10^{2}}$	$\mathbf{6.0\times10^{-1}}$	$\mathbf{1.3\times10^{2}}$	$\mathbf{5.3\times10^{-1}}$	$\mathbf{1.9\times10^{2}}$	$\mathbf{6.5\times10^{-1}}$

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Table J–16 compares average individual doses to American Indian and non–American Indian populations under each Tank Closure alternative to examine the potential for disproportionately high and adverse impacts. There are no appreciable differences between the average dose to an American Indian individual and a non–American Indian individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on American Indian populations surrounding each facility site.

Table J–16. Tank Closure Alternatives – Total, American Indian, and Non–American Indian Population and Average Individual Doses in Year of Maximum Impact

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	American Indian Population Dose (person-rem)	American Indian Individual Average Dose (millirem)	Non–American Indian Population Dose (person-rem)	Non–American Indian Individual Average Dose (millirem)
Alternative 1						
WTP	0	0	0	0	0	0
STTS-East	4.0×10^{-1}	7.2×10^{-4}	4.9×10^{-3}	4.5×10^{-4}	3.9×10^{-1}	7.3×10^{-4}
STTS-West	3.9×10^{-1}	6.6×10^{-4}	5.2×10^{-3}	4.3×10^{-4}	3.8×10^{-1}	6.6×10^{-4}
Total	**7.8×10^{-1}**	**1.4×10^{-3}**	**1.0×10^{-2}**	**8.9×10^{-4}**	**7.7×10^{-1}**	**1.4×10^{-3}**
Alternative 2A						
WTP	2.8×10^{2}	5.1×10^{-1}	2.8	2.6×10^{-1}	2.7×10^{2}	5.1×10^{-1}
STTS-East	6.4×10^{-8}	1.2×10^{-10}	6.3×10^{-10}	5.8×10^{-11}	6.3×10^{-8}	1.2×10^{-10}
STTS-West	0	0	0	0	0	0
Total	**2.8×10^{2}**	**5.1×10^{-1}**	**2.8**	**2.6×10^{-1}**	**2.7×10^{2}**	**5.1×10^{-1}**
Alternative 2B						
WTP	3.3×10^{2}	6.1×10^{-1}	3.4	3.2×10^{-1}	3.3×10^{2}	6.2×10^{-1}
STTS-East	2.6×10^{-2}	4.7×10^{-5}	2.5×10^{-4}	2.3×10^{-5}	2.5×10^{-2}	4.7×10^{-5}
STTS-West	2.5×10^{-2}	4.2×10^{-5}	2.7×10^{-4}	2.2×10^{-5}	2.5×10^{-2}	4.3×10^{-5}
Total	**3.3×10^{2}**	**6.1×10^{-1}**	**3.4**	**3.2×10^{-1}**	**3.3×10^{2}**	**6.2×10^{-1}**
Alternative 3A						
WTP	2.8×10^{2}	5.1×10^{-1}	2.8	2.6×10^{-1}	2.7×10^{2}	5.1×10^{-1}
STTS-East	1.0	1.8×10^{-3}	1.3×10^{-2}	1.2×10^{-3}	9.8×10^{-1}	1.8×10^{-3}
STTS-West	9.0×10^{-1}	1.5×10^{-3}	1.3×10^{-2}	1.1×10^{-3}	8.9×10^{-1}	1.5×10^{-3}
Total	**2.8×10^{2}**	**5.1×10^{-1}**	**2.8**	**2.6×10^{-1}**	**2.8×10^{2}**	**5.2×10^{-1}**
Alternative 3B						
WTP	2.8×10^{2}	5.1×10^{-1}	2.8	2.6×10^{-1}	2.7×10^{2}	5.1×10^{-1}
STTS-East	4.1×10^{-5}	7.4×10^{-8}	4.4×10^{-7}	4.0×10^{-8}	4.0×10^{-5}	7.5×10^{-8}
STTS-West	7.4×10^{-4}	1.2×10^{-6}	7.9×10^{-6}	6.6×10^{-7}	7.3×10^{-4}	1.3×10^{-6}
Total	**2.8×10^{2}**	**5.1×10^{-1}**	**2.8**	**2.6×10^{-1}**	**2.7×10^{2}**	**5.1×10^{-1}**
Alternative 3C						
WTP	2.8×10^{2}	5.1×10^{-1}	2.8	2.6×10^{-1}	2.7×10^{2}	5.1×10^{-1}
STTS-East	1.1	2.1×10^{-3}	1.5×10^{-2}	1.4×10^{-3}	1.1	2.1×10^{-3}
STTS-West	1.0	1.7×10^{-3}	1.4×10^{-2}	1.2×10^{-3}	1.0	1.7×10^{-3}
Total	**2.8×10^{2}**	**5.1×10^{-1}**	**2.8**	**2.6×10^{-1}**	**2.8×10^{2}**	**5.2×10^{-1}**
Alternative 4						
WTP	2.8×10^{2}	5.1×10^{-1}	2.8	2.6×10^{-1}	2.7×10^{2}	5.1×10^{-1}
STTS-East	4.8×10^{-3}	8.9×10^{-6}	4.8×10^{-5}	4.4×10^{-6}	4.8×10^{-3}	9.0×10^{-6}
STTS-West	4.9×10^{-3}	8.2×10^{-6}	5.2×10^{-5}	4.4×10^{-6}	4.8×10^{-3}	8.3×10^{-6}
Total	**2.8×10^{2}**	**5.1×10^{-1}**	**2.8**	**2.6×10^{-1}**	**2.7×10^{2}**	**5.1×10^{-1}**

Table J–16. Tank Closure Alternatives – Total, American Indian, and Non–American Indian Population and Average Individual Doses in Year of Maximum Impact *(continued)*

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	American Indian Population Dose (person-rem)	American Indian Individual Average Dose (millirem)	Non–American Indian Population Dose (person-rem)	Non–American Indian Individual Average Dose (millirem)
Alternative 5						
WTP	2.8×10^{2}	5.1×10^{-1}	2.8	2.6×10^{-1}	2.8×10^{2}	5.2×10^{-1}
STTS-East	1.9×10^{-5}	3.5×10^{-8}	2.1×10^{-7}	1.9×10^{-8}	1.9×10^{-5}	3.6×10^{-8}
STTS-West	1.1	1.9×10^{-3}	1.6×10^{-2}	1.4×10^{-3}	1.1	1.9×10^{-3}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	**2.8**	$\mathbf{2.6\times10^{-1}}$	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.2\times10^{-1}}$
Alternative 6A, Base Case						
WTP	2.8×10^{2}	5.1×10^{-1}	2.8	2.6×10^{-1}	2.7×10^{2}	5.1×10^{-1}
STTS-East	4.1×10^{-2}	7.6×10^{-5}	4.2×10^{-4}	3.9×10^{-5}	4.1×10^{-2}	7.6×10^{-5}
STTS-West	3.9×10^{-2}	6.7×10^{-5}	4.3×10^{-4}	3.6×10^{-5}	3.9×10^{-2}	6.7×10^{-5}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	**2.8**	$\mathbf{2.6\times10^{-1}}$	$\mathbf{2.7\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$
Alternative 6A, Option Case						
WTP	2.8×10^{2}	5.1×10^{-1}	2.8	2.6×10^{-1}	2.7×10^{2}	5.1×10^{-1}
STTS-East	5.2×10^{-2}	9.4×10^{-5}	5.3×10^{-4}	4.9×10^{-5}	5.1×10^{-2}	9.5×10^{-5}
STTS-West	5.0×10^{-2}	8.4×10^{-5}	5.5×10^{-4}	4.6×10^{-5}	4.9×10^{-2}	8.5×10^{-5}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	**2.8**	$\mathbf{2.6\times10^{-1}}$	$\mathbf{2.7\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$
Alternative 6B, Base Case						
WTP	3.2×10^{2}	6.0×10^{-1}	3.3	3.1×10^{-1}	3.2×10^{2}	6.0×10^{-1}
STTS-East	5.0×10^{-1}	9.2×10^{-4}	5.1×10^{-3}	4.7×10^{-4}	5.0×10^{-1}	9.3×10^{-4}
STTS-West	4.7×10^{-1}	7.9×10^{-4}	5.1×10^{-3}	4.2×10^{-4}	4.6×10^{-1}	8.0×10^{-4}
Total	$\mathbf{3.2\times10^{2}}$	$\mathbf{6.0\times10^{-1}}$	**3.3**	$\mathbf{3.1\times10^{-1}}$	$\mathbf{3.2\times10^{2}}$	$\mathbf{6.0\times10^{-1}}$
Alternative 6B, Option Case						
WTP	3.2×10^{2}	6.0×10^{-1}	3.3	3.1×10^{-1}	3.2×10^{2}	6.0×10^{-1}
STTS-East	6.5×10^{-1}	1.2×10^{-3}	6.6×10^{-3}	6.1×10^{-4}	6.4×10^{-1}	1.2×10^{-3}
STTS-West	5.7×10^{-1}	9.6×10^{-4}	6.2×10^{-3}	5.2×10^{-4}	5.6×10^{-1}	9.7×10^{-4}
Total	$\mathbf{3.2\times10^{2}}$	$\mathbf{6.0\times10^{-1}}$	**3.3**	$\mathbf{3.1\times10^{-1}}$	$\mathbf{3.2\times10^{2}}$	$\mathbf{6.0\times10^{-1}}$
Alternative 6C						
WTP	3.2×10^{2}	6.0×10^{-1}	3.3	3.1×10^{-1}	3.2×10^{2}	6.0×10^{-1}
STTS-East	2.6×10^{-2}	4.7×10^{-5}	2.5×10^{-4}	2.3×10^{-5}	2.5×10^{-2}	4.7×10^{-5}
STTS-West	2.5×10^{-2}	4.2×10^{-5}	2.7×10^{-4}	2.2×10^{-5}	2.5×10^{-2}	4.3×10^{-5}
Total	$\mathbf{3.2\times10^{2}}$	$\mathbf{6.0\times10^{-1}}$	**3.3**	$\mathbf{3.1\times10^{-1}}$	$\mathbf{3.2\times10^{2}}$	$\mathbf{6.0\times10^{-1}}$

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Table J–17 compares average individual doses to Hispanic and non-Hispanic populations under each Tank Closure alternative to examine the potential for disproportionately high and adverse impacts. There are no appreciable differences between the average dose to a Hispanic individual and a non-Hispanic individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on Hispanic populations surrounding each facility site.

Table J–17. Tank Closure Alternatives – Total, Hispanic, and Non-Hispanic Population and Average Individual Doses in Year of Maximum Impact

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Hispanic Population Dose[a] (person-rem)	Hispanic Individual Average Dose[a] (millirem)	Non-Hispanic Population Dose (person-rem)	Non-Hispanic Individual Average Dose (millirem)
Alternative 1						
WTP	0	0	0	0	0	0
STTS-East	4.0×10^{-1}	7.2×10^{-4}	1.4×10^{-1}	6.6×10^{-4}	2.5×10^{-1}	7.7×10^{-4}
STTS-West	3.9×10^{-1}	6.6×10^{-4}	1.3×10^{-1}	5.7×10^{-4}	2.6×10^{-1}	7.2×10^{-4}
Total	**7.8×10^{-1}**	**1.4×10^{-3}**	**2.8×10^{-1}**	**1.2×10^{-3}**	**5.1×10^{-1}**	**1.5×10^{-3}**
Alternative 2A						
WTP	2.8×10^{2}	5.1×10^{-1}	9.8×10^{1}	4.5×10^{-1}	1.8×10^{2}	5.5×10^{-1}
STTS-East	6.4×10^{-8}	1.2×10^{-10}	2.2×10^{-8}	1.0×10^{-10}	4.1×10^{-8}	1.3×10^{-10}
STTS-West	0	0	0	0	0	0
Total	**2.8×10^{2}**	**5.1×10^{-1}**	**9.8×10^{1}**	**4.5×10^{-1}**	**1.8×10^{2}**	**5.5×10^{-1}**
Alternative 2B						
WTP	3.3×10^{2}	6.1×10^{-1}	1.2×10^{2}	5.3×10^{-1}	2.1×10^{2}	6.6×10^{-1}
STTS-East	2.6×10^{-2}	4.7×10^{-5}	9.0×10^{-3}	4.1×10^{-5}	1.7×10^{-2}	5.1×10^{-5}
STTS-West	2.5×10^{-2}	4.2×10^{-5}	7.5×10^{-3}	3.3×10^{-5}	1.7×10^{-2}	4.8×10^{-5}
Total	**3.3×10^{2}**	**6.1×10^{-1}**	**1.2×10^{2}**	**5.3×10^{-1}**	**2.1×10^{2}**	**6.6×10^{-1}**
Alternative 3A						
WTP	2.8×10^{2}	5.1×10^{-1}	9.8×10^{1}	4.5×10^{-1}	1.8×10^{2}	5.5×10^{-1}
STTS-East	1.0	1.8×10^{-3}	3.7×10^{-1}	1.7×10^{-3}	6.3×10^{-1}	1.9×10^{-3}
STTS-West	9.0×10^{-1}	1.5×10^{-3}	3.1×10^{-1}	1.4×10^{-3}	5.9×10^{-1}	1.6×10^{-3}
Total	**2.8×10^{2}**	**5.1×10^{-1}**	**9.8×10^{1}**	**4.5×10^{-1}**	**1.8×10^{2}**	**5.6×10^{-1}**
Alternative 3B						
WTP	2.8×10^{2}	5.1×10^{-1}	9.8×10^{1}	4.5×10^{-1}	1.8×10^{2}	5.5×10^{-1}
STTS-East	4.1×10^{-5}	7.4×10^{-8}	1.5×10^{-5}	6.6×10^{-8}	2.6×10^{-5}	8.0×10^{-8}
STTS-West	7.4×10^{-4}	1.2×10^{-6}	2.2×10^{-4}	9.7×10^{-7}	5.1×10^{-4}	1.4×10^{-6}
Total	**2.8×10^{2}**	**5.1×10^{-1}**	**9.8×10^{1}**	**4.5×10^{-1}**	**1.8×10^{2}**	**5.5×10^{-1}**
Alternative 3C						
WTP	2.8×10^{2}	5.1×10^{-1}	9.8×10^{1}	4.5×10^{-1}	1.8×10^{2}	5.5×10^{-1}
STTS-East	1.1	2.1×10^{-3}	4.2×10^{-1}	1.9×10^{-3}	7.2×10^{-1}	2.2×10^{-3}
STTS-West	1.0	1.7×10^{-3}	3.5×10^{-1}	1.5×10^{-3}	6.7×10^{-1}	1.9×10^{-3}
Total	**2.8×10^{2}**	**5.1×10^{-1}**	**9.9×10^{1}**	**4.5×10^{-1}**	**1.8×10^{2}**	**5.6×10^{-1}**

Table J–17. Tank Closure Alternatives – Total, Hispanic, and Non-Hispanic Population and Average Individual Doses in Year of Maximum Impact *(continued)*

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Hispanic Population Dose[a] (person-rem)	Hispanic Individual Average Dose[a] (millirem)	Non-Hispanic Population Dose (person-rem)	Non-Hispanic Individual Average Dose (millirem)
Alternative 4						
WTP	2.8×10^{2}	5.1×10^{-1}	9.8×10^{1}	4.5×10^{-1}	1.8×10^{2}	5.5×10^{-1}
STTS-East	4.8×10^{-3}	8.9×10^{-6}	1.7×10^{-3}	7.7×10^{-6}	3.1×10^{-3}	9.6×10^{-6}
STTS-West	4.9×10^{-3}	8.2×10^{-6}	1.5×10^{-3}	6.5×10^{-6}	3.4×10^{-3}	9.4×10^{-6}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{9.8\times10^{1}}$	$\mathbf{4.5\times10^{-1}}$	$\mathbf{1.8\times10^{2}}$	$\mathbf{5.5\times10^{-1}}$
Alternative 5						
WTP	2.8×10^{2}	5.1×10^{-1}	9.8×10^{1}	4.5×10^{-1}	1.8×10^{2}	5.6×10^{-1}
STTS-East	1.9×10^{-5}	3.5×10^{-8}	6.9×10^{-6}	3.2×10^{-8}	1.2×10^{-5}	3.8×10^{-8}
STTS-West	1.1	1.9×10^{-3}	3.9×10^{-1}	1.7×10^{-3}	7.4×10^{-1}	2.0×10^{-3}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{9.9\times10^{1}}$	$\mathbf{4.5\times10^{-1}}$	$\mathbf{1.8\times10^{2}}$	$\mathbf{5.6\times10^{-1}}$
Alternative 6A, Base Case						
WTP	2.8×10^{2}	5.1×10^{-1}	9.8×10^{1}	4.5×10^{-1}	1.8×10^{2}	5.5×10^{-1}
STTS-East	4.1×10^{-2}	7.6×10^{-5}	1.5×10^{-2}	6.6×10^{-5}	2.7×10^{-2}	8.2×10^{-5}
STTS-West	3.9×10^{-2}	6.7×10^{-5}	1.2×10^{-2}	5.2×10^{-5}	2.7×10^{-2}	7.6×10^{-5}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{9.8\times10^{1}}$	$\mathbf{4.5\times10^{-1}}$	$\mathbf{1.8\times10^{2}}$	$\mathbf{5.5\times10^{-1}}$
Alternative 6A, Option Case						
WTP	2.8×10^{2}	5.1×10^{-1}	9.8×10^{1}	4.5×10^{-1}	1.8×10^{2}	5.5×10^{-1}
STTS-East	5.2×10^{-2}	9.4×10^{-5}	1.8×10^{-2}	8.3×10^{-5}	3.3×10^{-2}	1.0×10^{-4}
STTS-West	5.0×10^{-2}	8.4×10^{-5}	1.5×10^{-2}	6.7×10^{-5}	3.4×10^{-2}	9.5×10^{-5}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{9.8\times10^{1}}$	$\mathbf{4.5\times10^{-1}}$	$\mathbf{1.8\times10^{2}}$	$\mathbf{5.5\times10^{-1}}$
Alternative 6B, Base Case						
WTP	3.2×10^{2}	6.0×10^{-1}	1.1×10^{2}	5.2×10^{-1}	2.1×10^{2}	6.5×10^{-1}
STTS-East	5.0×10^{-1}	9.2×10^{-4}	1.8×10^{-1}	8.1×10^{-4}	3.3×10^{-1}	1.0×10^{-3}
STTS-West	4.7×10^{-1}	7.9×10^{-4}	1.4×10^{-1}	6.2×10^{-4}	3.2×10^{-1}	9.0×10^{-4}
Total	$\mathbf{3.2\times10^{2}}$	$\mathbf{6.0\times10^{-1}}$	$\mathbf{1.2\times10^{2}}$	$\mathbf{5.2\times10^{-1}}$	$\mathbf{2.1\times10^{2}}$	$\mathbf{6.5\times10^{-1}}$
Alternative 6B, Option Case						
WTP	3.2×10^{2}	6.0×10^{-1}	1.1×10^{2}	5.2×10^{-1}	2.1×10^{2}	6.5×10^{-1}
STTS-East	6.5×10^{-1}	1.2×10^{-3}	2.3×10^{-1}	1.0×10^{-3}	4.2×10^{-1}	1.3×10^{-3}
STTS-West	5.7×10^{-1}	9.6×10^{-4}	1.7×10^{-1}	7.6×10^{-4}	3.9×10^{-1}	1.1×10^{-3}
Total	$\mathbf{3.2\times10^{2}}$	$\mathbf{6.0\times10^{-1}}$	$\mathbf{1.2\times10^{2}}$	$\mathbf{5.2\times10^{-1}}$	$\mathbf{2.1\times10^{2}}$	$\mathbf{6.5\times10^{-1}}$
Alternative 6C						
WTP	3.2×10^{2}	6.0×10^{-1}	1.1×10^{2}	5.2×10^{-1}	2.1×10^{2}	6.5×10^{-1}
STTS-East	2.6×10^{-2}	4.7×10^{-5}	9.0×10^{-3}	4.1×10^{-5}	1.7×10^{-2}	5.1×10^{-5}
STTS-West	2.5×10^{-2}	4.2×10^{-5}	7.5×10^{-3}	3.3×10^{-5}	1.7×10^{-2}	4.8×10^{-5}
Total	$\mathbf{3.2\times10^{2}}$	$\mathbf{6.0\times10^{-1}}$	$\mathbf{1.1\times10^{2}}$	$\mathbf{5.2\times10^{-1}}$	$\mathbf{2.1\times10^{2}}$	$\mathbf{6.5\times10^{-1}}$

[a] Includes all individuals, regardless of race, who identified themselves as Hispanic or Latino.

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Table J–18 compares average individual doses to low-income and non-low-income populations under each Tank Closure alternative to examine the potential for disproportionately high and adverse impacts. There are no appreciable differences between the average dose to a low-income individual and a non-low-income individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on low-income populations surrounding each facility site.

Table J–18. Tank Closure Alternatives – Total, Low-Income, and Non-Low-Income Population and Average Individual Doses in Year of Maximum Impact

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Low-Income Population Dose (person-rem)	Low-Income Individual Average Dose (millirem)	Non-Low-Income Population Dose (person-rem)	Non-Low-Income Individual Average Dose (millirem)
Alternative 1						
WTP	0	0	0	0	0	0
STTS-East	4.0×10^{-1}	7.2×10^{-4}	7.0×10^{-2}	6.5×10^{-4}	3.3×10^{-1}	7.4×10^{-4}
STTS-West	3.9×10^{-1}	6.6×10^{-4}	6.3×10^{-2}	5.7×10^{-4}	3.3×10^{-1}	6.8×10^{-4}
Total	$\mathbf{7.8\times10^{-1}}$	$\mathbf{1.4\times10^{-3}}$	$\mathbf{1.3\times10^{-1}}$	$\mathbf{1.2\times10^{-3}}$	$\mathbf{6.5\times10^{-1}}$	$\mathbf{1.4\times10^{-3}}$
Alternative 2A						
WTP	2.8×10^{2}	5.1×10^{-1}	4.7×10^{1}	4.4×10^{-1}	2.3×10^{2}	5.3×10^{-1}
STTS-East	6.4×10^{-8}	1.2×10^{-10}	1.1×10^{-8}	1.0×10^{-10}	5.3×10^{-8}	1.2×10^{-10}
STTS-West	0	0	0	0	0	0
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{4.7\times10^{1}}$	$\mathbf{4.4\times10^{-1}}$	$\mathbf{2.3\times10^{2}}$	$\mathbf{5.3\times10^{-1}}$
Alternative 2B						
WTP	3.3×10^{2}	6.1×10^{-1}	5.7×10^{1}	5.3×10^{-1}	2.7×10^{2}	6.3×10^{-1}
STTS-East	2.6×10^{-2}	4.7×10^{-5}	4.4×10^{-3}	4.1×10^{-5}	2.1×10^{-2}	4.8×10^{-5}
STTS-West	2.5×10^{-2}	4.2×10^{-5}	3.8×10^{-3}	3.4×10^{-5}	2.1×10^{-2}	4.4×10^{-5}
Total	$\mathbf{3.3\times10^{2}}$	$\mathbf{6.1\times10^{-1}}$	$\mathbf{5.7\times10^{1}}$	$\mathbf{5.3\times10^{-1}}$	$\mathbf{2.7\times10^{2}}$	$\mathbf{6.3\times10^{-1}}$
Alternative 3A						
WTP	2.8×10^{2}	5.1×10^{-1}	4.7×10^{1}	4.4×10^{-1}	2.3×10^{2}	5.3×10^{-1}
STTS-East	1.0	1.8×10^{-3}	1.8×10^{-1}	1.7×10^{-3}	8.2×10^{-1}	1.9×10^{-3}
STTS-West	9.0×10^{-1}	1.5×10^{-3}	1.5×10^{-1}	1.4×10^{-3}	7.5×10^{-1}	1.6×10^{-3}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{4.8\times10^{1}}$	$\mathbf{4.5\times10^{-1}}$	$\mathbf{2.3\times10^{2}}$	$\mathbf{5.3\times10^{-1}}$
Alternative 3B						
WTP	2.8×10^{2}	5.1×10^{-1}	4.7×10^{1}	4.4×10^{-1}	2.3×10^{2}	5.3×10^{-1}
STTS-East	4.1×10^{-5}	7.4×10^{-8}	7.1×10^{-6}	6.6×10^{-8}	3.3×10^{-5}	7.6×10^{-8}
STTS-West	7.4×10^{-4}	1.2×10^{-6}	1.1×10^{-4}	1.0×10^{-6}	6.2×10^{-4}	1.3×10^{-6}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{4.7\times10^{1}}$	$\mathbf{4.4\times10^{-1}}$	$\mathbf{2.3\times10^{2}}$	$\mathbf{5.2\times10^{-1}}$
Alternative 3C						
WTP	2.8×10^{2}	5.1×10^{-1}	4.7×10^{1}	4.4×10^{-1}	2.3×10^{2}	5.3×10^{-1}
STTS-East	1.1	2.1×10^{-3}	2.0×10^{-1}	1.9×10^{-3}	9.3×10^{-1}	2.1×10^{-3}
STTS-West	1.0	1.7×10^{-3}	1.7×10^{-1}	1.5×10^{-3}	8.5×10^{-1}	1.8×10^{-3}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{4.8\times10^{1}}$	$\mathbf{4.5\times10^{-1}}$	$\mathbf{2.3\times10^{2}}$	$\mathbf{5.3\times10^{-1}}$
Alternative 4						
WTP	2.8×10^{2}	5.1×10^{-1}	4.7×10^{1}	4.4×10^{-1}	2.3×10^{2}	5.3×10^{-1}
STTS-East	4.8×10^{-3}	8.9×10^{-6}	8.3×10^{-4}	7.8×10^{-6}	4.0×10^{-3}	9.1×10^{-6}
STTS-West	4.9×10^{-3}	8.2×10^{-6}	7.4×10^{-4}	6.6×10^{-6}	4.1×10^{-3}	8.6×10^{-6}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{4.7\times10^{1}}$	$\mathbf{4.4\times10^{-1}}$	$\mathbf{2.3\times10^{2}}$	$\mathbf{5.3\times10^{-1}}$

Table J–18. Tank Closure Alternatives – Total, Low-Income, and Non-Low-Income Population and Average Individual Doses in Year of Maximum Impact *(continued)*

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Low-Income Population Dose (person-rem)	Low-Income Individual Average Dose (millirem)	Non-Low-Income Population Dose (person-rem)	Non-Low-Income Individual Average Dose (millirem)
Alternative 5						
WTP	2.8×10^{2}	5.1×10^{-1}	4.7×10^{1}	4.5×10^{-1}	2.3×10^{2}	5.3×10^{-1}
STTS-East	1.9×10^{-5}	3.5×10^{-8}	3.4×10^{-6}	3.2×10^{-8}	1.6×10^{-5}	3.6×10^{-8}
STTS-West	1.1	1.9×10^{-3}	1.9×10^{-1}	1.7×10^{-3}	9.4×10^{-1}	2.0×10^{-3}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{4.8\times10^{1}}$	$\mathbf{4.5\times10^{-1}}$	$\mathbf{2.3\times10^{2}}$	$\mathbf{5.3\times10^{-1}}$
Alternative 6A, Base Case						
WTP	2.8×10^{2}	5.1×10^{-1}	4.7×10^{1}	4.4×10^{-1}	2.3×10^{2}	5.3×10^{-1}
STTS-East	4.1×10^{-2}	7.6×10^{-5}	7.1×10^{-3}	6.7×10^{-5}	3.4×10^{-2}	7.8×10^{-5}
STTS-West	3.9×10^{-2}	6.7×10^{-5}	6.0×10^{-3}	5.4×10^{-5}	3.3×10^{-2}	7.0×10^{-5}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{4.7\times10^{1}}$	$\mathbf{4.4\times10^{-1}}$	$\mathbf{2.3\times10^{2}}$	$\mathbf{5.3\times10^{-1}}$
Alternative 6A, Option Case						
WTP	2.8×10^{2}	5.1×10^{-1}	4.7×10^{1}	4.4×10^{-1}	2.3×10^{2}	5.3×10^{-1}
STTS-East	5.2×10^{-2}	9.4×10^{-5}	8.9×10^{-3}	8.3×10^{-5}	4.3×10^{-2}	9.7×10^{-5}
STTS-West	5.0×10^{-2}	8.4×10^{-5}	7.6×10^{-3}	6.8×10^{-5}	4.2×10^{-2}	8.8×10^{-5}
Total	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.1\times10^{-1}}$	$\mathbf{4.7\times10^{1}}$	$\mathbf{4.4\times10^{-1}}$	$\mathbf{2.3\times10^{2}}$	$\mathbf{5.3\times10^{-1}}$
Alternative 6B, Base Case						
WTP	3.2×10^{2}	6.0×10^{-1}	5.5×10^{1}	5.2×10^{-1}	2.7×10^{2}	6.1×10^{-1}
STTS-East	5.0×10^{-1}	9.2×10^{-4}	8.7×10^{-2}	8.1×10^{-4}	4.2×10^{-1}	9.5×10^{-4}
STTS-West	4.7×10^{-1}	7.9×10^{-4}	7.1×10^{-2}	6.4×10^{-4}	3.9×10^{-1}	8.2×10^{-4}
Total	$\mathbf{3.2\times10^{2}}$	$\mathbf{6.0\times10^{-1}}$	$\mathbf{5.5\times10^{1}}$	$\mathbf{5.2\times10^{-1}}$	$\mathbf{2.7\times10^{2}}$	$\mathbf{6.2\times10^{-1}}$
Alternative 6B, Option Case						
WTP	3.2×10^{2}	6.0×10^{-1}	5.5×10^{1}	5.2×10^{-1}	2.7×10^{2}	6.1×10^{-1}
STTS-East	6.5×10^{-1}	1.2×10^{-3}	1.1×10^{-1}	1.0×10^{-3}	5.3×10^{-1}	1.2×10^{-3}
STTS-West	5.7×10^{-1}	9.6×10^{-4}	8.7×10^{-2}	7.8×10^{-4}	4.8×10^{-1}	1.0×10^{-3}
Total	$\mathbf{3.2\times10^{2}}$	$\mathbf{6.0\times10^{-1}}$	$\mathbf{5.6\times10^{1}}$	$\mathbf{5.2\times10^{-1}}$	$\mathbf{2.7\times10^{2}}$	$\mathbf{6.2\times10^{-1}}$
Alternative 6C						
WTP	3.2×10^{2}	6.0×10^{-1}	5.5×10^{1}	5.2×10^{-1}	2.7×10^{2}	6.1×10^{-1}
STTS-East	2.6×10^{-2}	4.7×10^{-5}	4.4×10^{-3}	4.1×10^{-5}	2.1×10^{-2}	4.8×10^{-5}
STTS-West	2.5×10^{-2}	4.2×10^{-5}	3.8×10^{-3}	3.4×10^{-5}	2.1×10^{-2}	4.4×10^{-5}
Total	$\mathbf{3.2\times10^{2}}$	$\mathbf{6.0\times10^{-1}}$	$\mathbf{5.5\times10^{1}}$	$\mathbf{5.2\times10^{-1}}$	$\mathbf{2.7\times10^{2}}$	$\mathbf{6.1\times10^{-1}}$

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Table J–19 compares the average individual doses to minority and nonminority populations under each Tank Closure alternative over the lifetime of the project to examine the potential for disproportionately high and adverse impacts. There are no appreciable differences between the average dose to a minority individual and a nonminority individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on minority populations surrounding each facility site.

Table J–19. Tank Closure Alternatives – Total, Minority, and Nonminority Population and Average Individual Doses over the Life of the Project

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Minority Population Dose (person-rem)	Minority Individual Average Dose (millirem)	Nonminority Population Dose (person-rem)	Nonminority Individual Average Dose (millirem)
Alternative 1						
WTP	0	0	0	0	0	0
STTS-East	3.7×10^{1}	6.8×10^{-2}	1.6×10^{1}	6.3×10^{-2}	2.1×10^{1}	7.3×10^{-2}
STTS-West	3.7×10^{1}	6.2×10^{-2}	1.5×10^{1}	5.5×10^{-2}	2.2×10^{1}	6.8×10^{-2}
Total	$\mathbf{7.4\times10^{1}}$	$\mathbf{1.3\times10^{-1}}$	$\mathbf{3.1\times10^{1}}$	$\mathbf{1.2\times10^{-1}}$	$\mathbf{4.3\times10^{1}}$	$\mathbf{1.4\times10^{-1}}$
Alternative 2A						
WTP	1.6×10^{3}	3.0	6.9×10^{2}	2.7	9.4×10^{2}	3.2
STTS-East	3.9×10^{1}	7.2×10^{-2}	1.7×10^{1}	6.6×10^{-2}	2.2×10^{1}	7.7×10^{-2}
STTS-West	3.9×10^{1}	6.5×10^{-2}	1.5×10^{1}	5.8×10^{-2}	2.3×10^{1}	7.1×10^{-2}
Total	$\mathbf{1.7\times10^{3}}$	**3.1**	$\mathbf{7.2\times10^{2}}$	**2.9**	$\mathbf{9.8\times10^{2}}$	**3.4**
Alternative 2B						
WTP	1.6×10^{3}	3.0	7.0×10^{2}	2.8	9.5×10^{2}	3.3
STTS-East	9.3×10^{-1}	1.7×10^{-3}	3.8×10^{-1}	1.5×10^{-3}	5.4×10^{-1}	1.9×10^{-3}
STTS-West	9.1×10^{-1}	1.5×10^{-3}	3.3×10^{-1}	1.3×10^{-3}	5.7×10^{-1}	1.8×10^{-3}
Total	$\mathbf{1.6\times10^{3}}$	**3.0**	$\mathbf{7.0\times10^{2}}$	**2.8**	$\mathbf{9.5\times10^{2}}$	**3.3**
Alternative 3A						
WTP	1.2×10^{3}	2.2	4.9×10^{2}	2.0	6.8×10^{2}	2.3
STTS-East	2.2×10^{2}	4.1×10^{-1}	9.6×10^{1}	3.8×10^{-1}	1.3×10^{2}	4.3×10^{-1}
STTS-West	2.0×10^{2}	3.4×10^{-1}	8.3×10^{1}	3.1×10^{-1}	1.2×10^{2}	3.7×10^{-1}
Total	$\mathbf{1.6\times10^{3}}$	**2.9**	$\mathbf{6.7\times10^{2}}$	**2.6**	$\mathbf{9.2\times10^{2}}$	**3.1**
Alternative 3B						
WTP	1.2×10^{3}	2.2	4.9×10^{2}	2.0	6.8×10^{2}	2.3
STTS-East	1.1	1.9×10^{-3}	4.4×10^{-1}	1.7×10^{-3}	6.2×10^{-1}	2.1×10^{-3}
STTS-West	9.8×10^{-1}	1.7×10^{-3}	3.6×10^{-1}	1.4×10^{-3}	6.2×10^{-1}	1.9×10^{-3}
Total	$\mathbf{1.2\times10^{3}}$	**2.2**	$\mathbf{4.9\times10^{2}}$	**2.0**	$\mathbf{6.8\times10^{2}}$	**2.3**
Alternative 3C						
WTP	1.2×10^{3}	2.2	4.9×10^{2}	2.0	6.8×10^{2}	2.3
STTS-East	2.5×10^{2}	4.6×10^{-1}	1.1×10^{2}	4.3×10^{-1}	1.4×10^{2}	4.9×10^{-1}
STTS-West	2.3×10^{2}	3.9×10^{-1}	9.2×10^{1}	3.5×10^{-1}	1.4×10^{2}	4.2×10^{-1}
Total	$\mathbf{1.7\times10^{3}}$	**3.0**	$\mathbf{6.9\times10^{2}}$	**2.7**	$\mathbf{9.6\times10^{2}}$	**3.2**
Alternative 4						
WTP	1.2×10^{3}	2.2	5.0×10^{2}	2.0	6.8×10^{2}	2.4
STTS-East	2.2	3.9×10^{-3}	8.9×10^{-1}	3.5×10^{-3}	1.3	4.3×10^{-3}
STTS-West	2.0×10^{2}	3.5×10^{-1}	8.4×10^{1}	3.2×10^{-1}	1.2×10^{2}	3.7×10^{-1}
Total	$\mathbf{1.4\times10^{3}}$	**2.5**	$\mathbf{5.8\times10^{2}}$	**2.3**	$\mathbf{8.0\times10^{2}}$	**2.7**
Alternative 5						
WTP	1.2×10^{3}	2.3	5.2×10^{2}	2.1	7.1×10^{2}	2.5
STTS-East	8.8×10^{-1}	1.6×10^{-3}	3.6×10^{-1}	1.4×10^{-3}	5.1×10^{-1}	1.8×10^{-3}
STTS-West	1.8×10^{2}	3.1×10^{-1}	7.5×10^{1}	2.9×10^{-1}	1.1×10^{2}	3.3×10^{-1}
Total	$\mathbf{1.4\times10^{3}}$	**2.6**	$\mathbf{5.9\times10^{2}}$	**2.3**	$\mathbf{8.2\times10^{2}}$	**2.8**

Table J–19. Tank Closure Alternatives – Total, Minority, and Nonminority Population and Average Individual Doses over the Life of the Project *(continued)*

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Minority Population Dose (person-rem)	Minority Individual Average Dose (millirem)	Nonminority Population Dose (person-rem)	Nonminority Individual Average Dose (millirem)
Alternative 6A, Base Case						
WTP	1.7×10^{3}	3.1	7.2×10^{2}	2.9	9.8×10^{2}	3.4
STTS-East	3.6×10^{1}	6.6×10^{-2}	1.5×10^{1}	5.9×10^{-2}	2.1×10^{1}	7.2×10^{-2}
STTS-West	5.5×10^{-1}	9.3×10^{-4}	2.0×10^{-1}	7.6×10^{-4}	3.5×10^{-1}	1.1×10^{-3}
Total	**1.7×10^{3}**	**3.2**	**7.3×10^{2}**	**2.9**	**1.0×10^{3}**	**3.4**
Alternative 6A, Option Case						
WTP	1.7×10^{3}	3.1	7.1×10^{2}	2.8	9.8×10^{2}	3.4
STTS-East	4.5×10^{1}	8.2×10^{-2}	1.9×10^{1}	7.4×10^{-2}	2.6×10^{1}	9.0×10^{-2}
STTS-West	4.5×10^{1}	7.7×10^{-2}	1.7×10^{1}	6.3×10^{-2}	2.9×10^{1}	8.8×10^{-2}
Total	**1.8×10^{3}**	**3.3**	**7.5×10^{2}**	**3.0**	**1.0×10^{3}**	**3.6**
Alternative 6B, Base Case						
WTP	1.6×10^{3}	3.0	6.9×10^{2}	2.7	9.4×10^{2}	3.2
STTS-East	3.3×10^{1}	6.1×10^{-2}	1.4×10^{1}	5.4×10^{-2}	1.9×10^{1}	6.6×10^{-2}
STTS-West	3.4×10^{1}	5.7×10^{-2}	1.2×10^{1}	4.7×10^{-2}	2.1×10^{1}	6.5×10^{-2}
Total	**1.7×10^{3}**	**3.1**	**7.2×10^{2}**	**2.8**	**9.8×10^{2}**	**3.4**
Alternative 6B, Option Case						
WTP	1.6×10^{3}	3.0	6.9×10^{2}	2.7	9.5×10^{2}	3.3
STTS-East	4.2×10^{1}	7.7×10^{-2}	1.7×10^{1}	6.9×10^{-2}	2.5×10^{1}	8.4×10^{-2}
STTS-West	4.2×10^{1}	7.2×10^{-2}	1.6×10^{1}	5.9×10^{-2}	2.7×10^{1}	8.2×10^{-2}
Total	**1.7×10^{3}**	**3.2**	**7.2×10^{2}**	**2.8**	**1.0×10^{3}**	**3.4**
Alternative 6C						
WTP	1.6×10^{3}	3.0	6.9×10^{2}	2.7	9.4×10^{2}	3.2
STTS-East	9.3×10^{-1}	1.7×10^{-3}	3.8×10^{-1}	1.5×10^{-3}	5.4×10^{-1}	1.9×10^{-3}
STTS-West	9.1×10^{-1}	1.5×10^{-3}	3.3×10^{-1}	1.3×10^{-3}	5.7×10^{-1}	1.8×10^{-3}
Total	**1.6×10^{3}**	**3.0**	**6.9×10^{2}**	**2.7**	**9.4×10^{2}**	**3.2**

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Table J–20 compares the average individual doses to American Indian and non–American Indian populations under each Tank Closure alternative over the lifetime of the project to examine the potential for disproportionately high and adverse impacts. There are no appreciable differences between the average dose to an American Indian individual and a non–American Indian individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on American Indian populations surrounding each facility site.

Table J–20. Tank Closure Alternatives – Total, American Indian, and Non–American Indian Population and Average Individual Doses over the Life of the Project

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	American Indian Population Dose (person-rem)	American Indian Individual Average Dose (millirem)	Non–American Indian Population Dose (person-rem)	Non–American Indian Individual Average Dose (millirem)
Alternative 1						
WTP	0	0	0	0	0	0
STTS-East	3.7×10^{1}	6.8×10^{-2}	4.7×10^{-1}	4.3×10^{-2}	3.7×10^{1}	6.8×10^{-2}
STTS-West	3.7×10^{1}	6.2×10^{-2}	4.9×10^{-1}	4.1×10^{-2}	3.6×10^{1}	6.3×10^{-2}
Total	$\mathbf{7.4\times10^{1}}$	$\mathbf{1.3\times10^{-1}}$	$\mathbf{9.6\times10^{-1}}$	$\mathbf{8.4\times10^{-2}}$	$\mathbf{7.3\times10^{1}}$	$\mathbf{1.3\times10^{-1}}$
Alternative 2A						
WTP	1.6×10^{3}	3.0	1.9×10^{1}	1.7	1.6×10^{3}	3.0
STTS-East	3.9×10^{1}	7.2×10^{-2}	4.9×10^{-1}	4.5×10^{-2}	3.9×10^{1}	7.2×10^{-2}
STTS-West	3.9×10^{1}	6.5×10^{-2}	5.1×10^{-1}	4.3×10^{-2}	3.8×10^{1}	6.6×10^{-2}
Total	$\mathbf{1.7\times10^{3}}$	**3.1**	$\mathbf{2.0\times10^{1}}$	**1.8**	$\mathbf{1.7\times10^{3}}$	**3.2**
Alternative 2B						
WTP	1.6×10^{3}	3.0	1.9×10^{1}	1.7	1.6×10^{3}	3.1
STTS-East	9.3×10^{-1}	1.7×10^{-3}	9.2×10^{-3}	8.5×10^{-4}	9.2×10^{-1}	1.7×10^{-3}
STTS-West	9.1×10^{-1}	1.5×10^{-3}	9.7×10^{-3}	8.1×10^{-4}	9.0×10^{-1}	1.6×10^{-3}
Total	$\mathbf{1.6\times10^{3}}$	**3.0**	$\mathbf{1.9\times10^{1}}$	**1.7**	$\mathbf{1.6\times10^{3}}$	**3.1**
Alternative 3A						
WTP	1.2×10^{3}	2.2	1.2×10^{1}	1.2	1.2×10^{3}	2.2
STTS-East	2.2×10^{2}	4.1×10^{-1}	3.0	2.8×10^{-1}	2.2×10^{2}	4.1×10^{-1}
STTS-West	2.0×10^{2}	3.4×10^{-1}	2.9	2.4×10^{-1}	2.0×10^{2}	3.4×10^{-1}
Total	$\mathbf{1.6\times10^{3}}$	**2.9**	$\mathbf{1.8\times10^{1}}$	**1.7**	$\mathbf{1.6\times10^{3}}$	**2.9**
Alternative 3B						
WTP	1.2×10^{3}	2.2	1.2×10^{1}	1.2	1.2×10^{3}	2.2
STTS-East	1.1	1.9×10^{-3}	1.0×10^{-2}	9.7×10^{-4}	1.0	1.9×10^{-3}
STTS-West	9.8×10^{-1}	1.7×10^{-3}	1.0×10^{-2}	8.8×10^{-4}	9.7×10^{-1}	1.7×10^{-3}
Total	$\mathbf{1.2\times10^{3}}$	**2.2**	$\mathbf{1.2\times10^{1}}$	**1.2**	$\mathbf{1.2\times10^{3}}$	**2.2**
Alternative 3C						
WTP	1.2×10^{3}	2.2	1.2×10^{1}	1.2	1.2×10^{3}	2.2
STTS-East	2.5×10^{2}	4.6×10^{-1}	3.3	3.0×10^{-1}	2.5×10^{2}	4.7×10^{-1}
STTS-West	2.3×10^{2}	3.9×10^{-1}	3.2	2.6×10^{-1}	2.2×10^{2}	3.9×10^{-1}
Total	$\mathbf{1.7\times10^{3}}$	**3.0**	$\mathbf{1.9\times10^{1}}$	**1.7**	$\mathbf{1.6\times10^{3}}$	**3.0**
Alternative 4						
WTP	1.2×10^{3}	2.2	1.3×10^{1}	1.2	1.2×10^{3}	2.2
STTS-East	2.2	3.9×10^{-3}	2.1×10^{-2}	2.0×10^{-3}	2.1	4.0×10^{-3}
STTS-West	2.0×10^{2}	3.5×10^{-1}	2.9	2.4×10^{-1}	2.0×10^{2}	3.5×10^{-1}
Total	$\mathbf{1.4\times10^{3}}$	**2.5**	$\mathbf{1.5\times10^{1}}$	**1.4**	$\mathbf{1.4\times10^{3}}$	**2.5**
Alternative 5						
WTP	1.2×10^{3}	2.3	1.3×10^{1}	1.3	1.2×10^{3}	2.3
STTS-East	8.8×10^{-1}	1.6×10^{-3}	8.7×10^{-3}	8.0×10^{-4}	8.7×10^{-1}	1.6×10^{-3}
STTS-West	1.8×10^{2}	3.1×10^{-1}	2.6	2.2×10^{-1}	1.8×10^{2}	3.1×10^{-1}
Total	$\mathbf{1.4\times10^{3}}$	**2.6**	$\mathbf{1.6\times10^{1}}$	**1.5**	$\mathbf{1.4\times10^{3}}$	**2.6**

Table J–20. Tank Closure Alternatives – Total, American Indian, and Non–American Indian Population and Average Individual Doses over the Life of the Project *(continued)*

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	American Indian Population Dose (person-rem)	American Indian Individual Average Dose (millirem)	Non–American Indian Population Dose (person-rem)	Non–American Indian Individual Average Dose (millirem)
Alternative 6A, Base Case						
WTP	1.7×10^{3}	3.1	1.9×10^{1}	1.8	1.7×10^{3}	3.2
STTS-East	3.6×10^{1}	6.6×10^{-2}	3.6×10^{-1}	3.4×10^{-2}	3.6×10^{1}	6.6×10^{-2}
STTS-West	5.5×10^{-1}	9.3×10^{-4}	5.9×10^{-3}	5.0×10^{-4}	5.4×10^{-1}	9.4×10^{-4}
Total	$\mathbf{1.7\times10^{3}}$	**3.2**	$\mathbf{2.0\times10^{1}}$	**1.8**	$\mathbf{1.7\times10^{3}}$	**3.2**
Alternative 6A, Option Case						
WTP	1.7×10^{3}	3.1	1.9×10^{1}	1.8	1.7×10^{3}	3.2
STTS-East	4.5×10^{1}	8.2×10^{-2}	4.6×10^{-1}	4.2×10^{-2}	4.5×10^{1}	8.3×10^{-2}
STTS-West	4.5×10^{1}	7.7×10^{-2}	5.0×10^{-1}	4.2×10^{-2}	4.5×10^{1}	7.8×10^{-2}
Total	$\mathbf{1.8\times10^{3}}$	**3.3**	$\mathbf{2.0\times10^{1}}$	**1.9**	$\mathbf{1.8\times10^{3}}$	**3.3**
Alternative 6B, Base Case						
WTP	1.6×10^{3}	3.0	1.9×10^{1}	1.7	1.6×10^{3}	3.0
STTS-East	3.3×10^{1}	6.1×10^{-2}	3.4×10^{-1}	3.1×10^{-2}	3.3×10^{1}	6.1×10^{-2}
STTS-West	3.4×10^{1}	5.7×10^{-2}	3.7×10^{-1}	3.1×10^{-2}	3.3×10^{1}	5.7×10^{-2}
Total	$\mathbf{1.7\times10^{3}}$	**3.1**	$\mathbf{1.9\times10^{1}}$	**1.8**	$\mathbf{1.7\times10^{3}}$	**3.2**
Alternative 6B, Option Case						
WTP	1.6×10^{3}	3.0	1.9×10^{1}	1.7	1.6×10^{3}	3.0
STTS-East	4.2×10^{1}	7.7×10^{-2}	4.3×10^{-1}	4.0×10^{-2}	4.2×10^{1}	7.8×10^{-2}
STTS-West	4.2×10^{1}	7.2×10^{-2}	4.7×10^{-1}	3.9×10^{-2}	4.2×10^{1}	7.3×10^{-2}
Total	$\mathbf{1.7\times10^{3}}$	**3.2**	$\mathbf{1.9\times10^{1}}$	**1.8**	$\mathbf{1.7\times10^{3}}$	**3.2**
Alternative 6C						
WTP	1.6×10^{3}	3.0	1.9×10^{1}	1.7	1.6×10^{3}	3.0
STTS-East	9.3×10^{-1}	1.7×10^{-3}	9.2×10^{-3}	8.5×10^{-4}	9.2×10^{-1}	1.7×10^{-3}
STTS-West	9.1×10^{-1}	1.5×10^{-3}	9.7×10^{-3}	8.1×10^{-4}	9.0×10^{-1}	1.6×10^{-3}
Total	$\mathbf{1.6\times10^{3}}$	**3.0**	$\mathbf{1.9\times10^{1}}$	**1.7**	$\mathbf{1.6\times10^{3}}$	**3.0**

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Table J–21 compares the average individual doses to Hispanic and non-Hispanic populations under each Tank Closure alternative over the lifetime of the project to examine the potential for disproportionately high and adverse impacts. There are no appreciable differences between the average dose to a Hispanic individual and a non-Hispanic individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on Hispanic populations surrounding each facility site.

Table J–21. Tank Closure Alternatives – Total, Hispanic, and Non-Hispanic Population and Average Individual Doses over the Life of the Project

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Hispanic Population Dose[a] (person-rem)	Hispanic Individual Average Dose[a] (millirem)	Non-Hispanic Population Dose (person-rem)	Non-Hispanic Individual Average Dose (millirem)
Alternative 1						
WTP	0	0	0	0	0	0
STTS-East	3.7×10^{1}	6.8×10^{-2}	1.4×10^{1}	6.2×10^{-2}	2.4×10^{1}	7.2×10^{-2}
STTS-West	3.7×10^{1}	6.2×10^{-2}	1.2×10^{1}	5.4×10^{-2}	2.4×10^{1}	6.7×10^{-2}
Total	**7.4×10^{1}**	**1.3×10^{-1}**	**2.6×10^{1}**	**1.2×10^{-1}**	**4.8×10^{1}**	**1.4×10^{-1}**
Alternative 2A						
WTP	1.6×10^{3}	3.0	5.9×10^{2}	2.7	1.0×10^{3}	3.2
STTS-East	3.9×10^{1}	7.2×10^{-2}	1.4×10^{1}	6.5×10^{-2}	2.5×10^{1}	7.6×10^{-2}
STTS-West	3.9×10^{1}	6.5×10^{-2}	1.3×10^{1}	5.7×10^{-2}	2.6×10^{1}	7.1×10^{-2}
Total	**1.7×10^{3}**	**3.1**	**6.1×10^{2}**	**2.8**	**1.1×10^{3}**	**3.4**
Alternative 2B						
WTP	1.6×10^{3}	3.0	5.9×10^{2}	2.7	1.1×10^{3}	3.3
STTS-East	9.3×10^{-1}	1.7×10^{-3}	3.3×10^{-1}	1.5×10^{-3}	6.0×10^{-1}	1.8×10^{-3}
STTS-West	9.1×10^{-1}	1.5×10^{-3}	2.7×10^{-1}	1.2×10^{-3}	6.3×10^{-1}	1.8×10^{-3}
Total	**1.6×10^{3}**	**3.0**	**5.9×10^{2}**	**2.7**	**1.1×10^{3}**	**3.3**
Alternative 3A						
WTP	1.2×10^{3}	2.2	4.2×10^{2}	1.9	7.5×10^{2}	2.3
STTS-East	2.2×10^{2}	4.1×10^{-1}	8.3×10^{1}	3.8×10^{-1}	1.4×10^{2}	4.3×10^{-1}
STTS-West	2.0×10^{2}	3.4×10^{-1}	7.0×10^{1}	3.1×10^{-1}	1.3×10^{2}	3.6×10^{-1}
Total	**1.6×10^{3}**	**2.9**	**5.7×10^{2}**	**2.6**	**1.0×10^{3}**	**3.1**
Alternative 3B						
WTP	1.2×10^{3}	2.2	4.2×10^{2}	1.9	7.5×10^{2}	2.3
STTS-East	1.1	1.9×10^{-3}	3.7×10^{-1}	1.7×10^{-3}	6.8×10^{-1}	2.1×10^{-3}
STTS-West	9.8×10^{-1}	1.7×10^{-3}	3.0×10^{-1}	1.3×10^{-3}	6.9×10^{-1}	1.9×10^{-3}
Total	**1.2×10^{3}**	**2.2**	**4.2×10^{2}**	**1.9**	**7.5×10^{2}**	**2.3**
Alternative 3C						
WTP	1.2×10^{3}	2.2	4.2×10^{2}	1.9	7.5×10^{2}	2.3
STTS-East	2.5×10^{2}	4.6×10^{-1}	9.4×10^{1}	4.3×10^{-1}	1.6×10^{2}	4.9×10^{-1}
STTS-West	2.3×10^{2}	3.9×10^{-1}	7.8×10^{1}	3.4×10^{-1}	1.5×10^{2}	4.1×10^{-1}
Total	**1.7×10^{3}**	**3.0**	**5.9×10^{2}**	**2.7**	**1.1×10^{3}**	**3.2**
Alternative 4						
WTP	1.2×10^{3}	2.2	4.2×10^{2}	1.9	7.6×10^{2}	2.3
STTS-East	2.2	3.9×10^{-3}	7.6×10^{-1}	3.4×10^{-3}	1.4	4.3×10^{-3}
STTS-West	2.0×10^{2}	3.5×10^{-1}	7.1×10^{1}	3.1×10^{-1}	1.3×10^{2}	3.7×10^{-1}
Total	**1.4×10^{3}**	**2.5**	**4.9×10^{2}**	**2.2**	**8.9×10^{2}**	**2.7**
Alternative 5						
WTP	1.2×10^{3}	2.3	4.4×10^{2}	2.0	7.9×10^{2}	2.4
STTS-East	8.8×10^{-1}	1.6×10^{-3}	3.1×10^{-1}	1.4×10^{-3}	5.7×10^{-1}	1.7×10^{-3}
STTS-West	1.8×10^{2}	3.1×10^{-1}	6.4×10^{1}	2.8×10^{-1}	1.2×10^{2}	3.3×10^{-1}
Total	**1.4×10^{3}**	**2.6**	**5.0×10^{2}**	**2.3**	**9.1×10^{2}**	**2.8**

Table J–21. Tank Closure Alternatives – Total, Hispanic, and Non-Hispanic Population and Average Individual Doses over the Life of the Project *(continued)*

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Hispanic Population Dose[a] (person-rem)	Hispanic Individual Average Dose[a] (millirem)	Non-Hispanic Population Dose (person-rem)	Non-Hispanic Individual Average Dose (millirem)
Alternative 6A, Base Case						
WTP	1.7×10^{3}	3.1	6.1×10^{2}	2.8	1.1×10^{3}	3.4
STTS-East	3.6×10^{1}	6.6×10^{-2}	1.3×10^{1}	5.8×10^{-2}	2.3×10^{1}	7.1×10^{-2}
STTS-West	5.5×10^{-1}	9.3×10^{-4}	1.7×10^{-1}	7.3×10^{-4}	3.8×10^{-1}	1.1×10^{-3}
Total	$\mathbf{1.7\times10^{3}}$	**3.2**	$\mathbf{6.2\times10^{2}}$	**2.8**	$\mathbf{1.1\times10^{3}}$	**3.4**
Alternative 6A, Option Case						
WTP	1.7×10^{3}	3.1	6.1×10^{2}	2.8	1.1×10^{3}	3.4
STTS-East	4.5×10^{1}	8.2×10^{-2}	1.6×10^{1}	7.2×10^{-2}	2.9×10^{1}	8.9×10^{-2}
STTS-West	4.5×10^{1}	7.7×10^{-2}	1.4×10^{1}	6.1×10^{-2}	3.2×10^{1}	8.7×10^{-2}
Total	$\mathbf{1.8\times10^{3}}$	**3.3**	$\mathbf{6.4\times10^{2}}$	**2.9**	$\mathbf{1.1\times10^{3}}$	**3.5**
Alternative 6B, Base Case						
WTP	1.6×10^{3}	3.0	5.9×10^{2}	2.7	1.0×10^{3}	3.2
STTS-East	3.3×10^{1}	6.1×10^{-2}	1.2×10^{1}	5.3×10^{-2}	2.1×10^{1}	6.5×10^{-2}
STTS-West	3.4×10^{1}	5.7×10^{-2}	1.0×10^{1}	4.5×10^{-2}	2.3×10^{1}	6.5×10^{-2}
Total	$\mathbf{1.7\times10^{3}}$	**3.1**	$\mathbf{6.1\times10^{2}}$	**2.8**	$\mathbf{1.1\times10^{3}}$	**3.4**
Alternative 6B, Option Case						
WTP	1.6×10^{3}	3.0	5.9×10^{2}	2.7	1.0×10^{3}	3.2
STTS-East	4.2×10^{1}	7.7×10^{-2}	1.5×10^{1}	6.7×10^{-2}	2.7×10^{1}	8.3×10^{-2}
STTS-West	4.2×10^{1}	7.2×10^{-2}	1.3×10^{1}	5.7×10^{-2}	2.9×10^{1}	8.1×10^{-2}
Total	$\mathbf{1.7\times10^{3}}$	**3.2**	$\mathbf{6.1\times10^{2}}$	**2.8**	$\mathbf{1.1\times10^{3}}$	**3.4**
Alternative 6C						
WTP	1.6×10^{3}	3.0	5.9×10^{2}	2.7	1.0×10^{3}	3.2
STTS-East	9.3×10^{-1}	1.7×10^{-3}	3.3×10^{-1}	1.5×10^{-3}	6.0×10^{-1}	1.8×10^{-3}
STTS-West	9.1×10^{-1}	1.5×10^{-3}	2.7×10^{-1}	1.2×10^{-3}	6.3×10^{-1}	1.8×10^{-3}
Total	$\mathbf{1.6\times10^{3}}$	**3.0**	$\mathbf{5.9\times10^{2}}$	**2.7**	$\mathbf{1.0\times10^{3}}$	**3.2**

[a] Includes all individuals, regardless of race, who identified themselves as Hispanic or Latino.

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Table J–22 compares average individual doses to low-income and non-low-income populations under each Tank Closure alternative over the lifetime of the project to examine the potential for disproportionately high and adverse impacts. There are no appreciable differences between the average dose to a low-income individual and a non-low-income individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on low-income populations surrounding each facility site.

Table J–22. Tank Closure Alternatives – Total, Low-Income, and Non-Low-Income Population and Average Individual Doses over the Life of the Project

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Low-Income Population Dose (person-rem)	Low-Income Individual Average Dose (millirem)	Non-Low-Income Population Dose (person-rem)	Non-Low-Income Individual Average Dose (millirem)
Alternative 1						
WTP	0	0	0	0	0	0
STTS-East	3.7×10^{1}	6.8×10^{-2}	6.6	6.2×10^{-2}	3.1×10^{1}	7.0×10^{-2}
STTS-West	3.7×10^{1}	6.2×10^{-2}	6.0	5.4×10^{-2}	3.1×10^{1}	6.4×10^{-2}
Total	**7.4×10^{1}**	**1.3×10^{-1}**	**1.3×10^{1}**	**1.2×10^{-1}**	**6.1×10^{1}**	**1.3×10^{-1}**
Alternative 2A						
WTP	1.6×10^{3}	3.0	2.8×10^{2}	2.6	1.3×10^{3}	3.1
STTS-East	3.9×10^{1}	7.2×10^{-2}	6.9	6.5×10^{-2}	3.2×10^{1}	7.3×10^{-2}
STTS-West	3.9×10^{1}	6.5×10^{-2}	6.3	5.7×10^{-2}	3.2×10^{1}	6.8×10^{-2}
Total	**1.7×10^{3}**	**3.1**	**3.0×10^{2}**	**2.8**	**1.4×10^{3}**	**3.2**
Alternative 2B						
WTP	1.6×10^{3}	3.0	2.8×10^{2}	2.7	1.4×10^{3}	3.1
STTS-East	9.3×10^{-1}	1.7×10^{-3}	1.6×10^{-1}	1.5×10^{-3}	7.7×10^{-1}	1.7×10^{-3}
STTS-West	9.1×10^{-1}	1.5×10^{-3}	1.4×10^{-1}	1.2×10^{-3}	7.7×10^{-1}	1.6×10^{-3}
Total	**1.6×10^{3}**	**3.0**	**2.9×10^{2}**	**2.7**	**1.4×10^{3}**	**3.1**
Alternative 3A						
WTP	1.2×10^{3}	2.2	2.0×10^{2}	1.9	9.7×10^{2}	2.2
STTS-East	2.2×10^{2}	4.1×10^{-1}	4.0×10^{1}	3.7×10^{-1}	1.8×10^{2}	4.2×10^{-1}
STTS-West	2.0×10^{2}	3.4×10^{-1}	3.4×10^{1}	3.0×10^{-1}	1.7×10^{2}	3.5×10^{-1}
Total	**1.6×10^{3}**	**2.9**	**2.7×10^{2}**	**2.6**	**1.3×10^{3}**	**3.0**
Alternative 3B						
WTP	1.2×10^{3}	2.2	2.0×10^{2}	1.9	9.7×10^{2}	2.2
STTS-East	1.1	1.9×10^{-3}	1.8×10^{-1}	1.7×10^{-3}	8.7×10^{-1}	2.0×10^{-3}
STTS-West	9.8×10^{-1}	1.7×10^{-3}	1.5×10^{-1}	1.3×10^{-3}	8.3×10^{-1}	1.7×10^{-3}
Total	**1.2×10^{3}**	**2.2**	**2.1×10^{2}**	**1.9**	**9.7×10^{2}**	**2.2**
Alternative 3C						
WTP	1.2×10^{3}	2.2	2.0×10^{2}	1.9	9.7×10^{2}	2.2
STTS-East	2.5×10^{2}	4.6×10^{-1}	4.5×10^{1}	4.2×10^{-1}	2.1×10^{2}	4.7×10^{-1}
STTS-West	2.3×10^{2}	3.9×10^{-1}	3.8×10^{1}	3.4×10^{-1}	1.9×10^{2}	4.0×10^{-1}
Total	**1.7×10^{3}**	**3.0**	**2.8×10^{2}**	**2.6**	**1.4×10^{3}**	**3.1**
Alternative 4						
WTP	1.2×10^{3}	2.2	2.0×10^{2}	1.9	9.8×10^{2}	2.2
STTS-East	2.2	3.9×10^{-3}	3.7×10^{-1}	3.5×10^{-3}	1.8	4.1×10^{-3}
STTS-West	2.0×10^{2}	3.5×10^{-1}	3.4×10^{1}	3.1×10^{-1}	1.7×10^{2}	3.6×10^{-1}
Total	**1.4×10^{3}**	**2.5**	**2.4×10^{2}**	**2.2**	**1.1×10^{3}**	**2.6**
Alternative 5						
WTP	1.2×10^{3}	2.3	2.1×10^{2}	2.0	1.0×10^{3}	2.3
STTS-East	8.8×10^{-1}	1.6×10^{-3}	1.5×10^{-1}	1.4×10^{-3}	7.3×10^{-1}	1.7×10^{-3}
STTS-West	1.8×10^{2}	3.1×10^{-1}	3.1×10^{1}	2.8×10^{-1}	1.5×10^{2}	3.2×10^{-1}
Total	**1.4×10^{3}**	**2.6**	**2.4×10^{2}**	**2.3**	**1.2×10^{3}**	**2.7**

Table J–22. Tank Closure Alternatives – Total, Low-Income, and Non-Low-Income Population and Average Individual Doses over the Life of the Project *(continued)*

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Low-Income Population Dose (person-rem)	Low-Income Individual Average Dose (millirem)	Non-Low-Income Population Dose (person-rem)	Non-Low-Income Individual Average Dose (millirem)
Alternative 6A, Base Case						
WTP	1.7×10^{3}	3.1	2.9×10^{2}	2.8	1.4×10^{3}	3.2
STTS-East	3.6×10^{1}	6.6×10^{-2}	6.2	5.8×10^{-2}	3.0×10^{1}	6.8×10^{-2}
STTS-West	5.5×10^{-1}	9.3×10^{-4}	8.4×10^{-2}	7.5×10^{-4}	4.7×10^{-1}	9.7×10^{-4}
Total	**1.7×10^{3}**	**3.2**	**3.0×10^{2}**	**2.8**	**1.4×10^{3}**	**3.3**
Alternative 6A, Option Case						
WTP	1.7×10^{3}	3.1	2.9×10^{2}	2.8	1.4×10^{3}	3.2
STTS-East	4.5×10^{1}	8.2×10^{-2}	7.8	7.3×10^{-2}	3.7×10^{1}	8.5×10^{-2}
STTS-West	4.5×10^{1}	7.7×10^{-2}	6.9	6.2×10^{-2}	3.8×10^{1}	8.0×10^{-2}
Total	**1.8×10^{3}**	**3.3**	**3.1×10^{2}**	**2.9**	**1.5×10^{3}**	**3.4**
Alternative 6B, Base Case						
WTP	1.6×10^{3}	3.0	2.8×10^{2}	2.7	1.3×10^{3}	3.1
STTS-East	3.3×10^{1}	6.1×10^{-2}	5.7	5.3×10^{-2}	2.7×10^{1}	6.2×10^{-2}
STTS-West	3.4×10^{1}	5.7×10^{-2}	5.1	4.6×10^{-2}	2.8×10^{1}	6.0×10^{-2}
Total	**1.7×10^{3}**	**3.1**	**2.9×10^{2}**	**2.8**	**1.4×10^{3}**	**3.2**
Alternative 6B, Option Case						
WTP	1.6×10^{3}	3.0	2.8×10^{2}	2.7	1.3×10^{3}	3.1
STTS-East	4.2×10^{1}	7.7×10^{-2}	7.3	6.8×10^{-2}	3.5×10^{1}	7.9×10^{-2}
STTS-West	4.2×10^{1}	7.2×10^{-2}	6.5	5.8×10^{-2}	3.6×10^{1}	7.5×10^{-2}
Total	**1.7×10^{3}**	**3.2**	**3.0×10^{2}**	**2.8**	**1.4×10^{3}**	**3.2**
Alternative 6C						
WTP	1.6×10^{3}	3.0	2.8×10^{2}	2.7	1.3×10^{3}	3.1
STTS-East	9.3×10^{-1}	1.7×10^{-3}	1.6×10^{-1}	1.5×10^{-3}	7.7×10^{-1}	1.7×10^{-3}
STTS-West	9.1×10^{-1}	1.5×10^{-3}	1.4×10^{-1}	1.2×10^{-3}	7.7×10^{-1}	1.6×10^{-3}
Total	**1.6×10^{3}**	**3.0**	**2.8×10^{2}**	**2.7**	**1.4×10^{3}**	**3.1**

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

As discussed in Appendix K, Section K.2.1.1.1.1, normal operations would result in impacts on a maximally exposed individual (MEI) southeast of the 200 Areas under all tank closure alternatives except Alternative 1, under which the MEI would be northeast of the 200 Areas. Several regional tribes have expressed concerns regarding the potential for the proposed alternatives to impact the health of tribal members and their communities. These concerns are further elaborated in Appendix W, "American Indian Tribal Perspectives and Scenarios." To explore potential American Indian environmental justice concerns associated with normal operations, impacts on a hypothetical individual residing at the boundary of the Yakama Reservation were evaluated, similar to the MEI for the general population. Table J–23 presents the maximum annual dose and cancer fatality risk to an MEI located there.

The results of this analysis show that the probability of an individual at this location developing an LCF from radionuclide releases during normal operations would essentially be zero. In addition, the maximum annual dose to an MEI residing at the reservation boundary would be the equivalent of less than one-sixth the maximum annual dose to an MEI at the Hanford boundary under all alternatives.

Table J–23. Tank Closure Alternatives – Maximum Annual Dose and Risk to the Maximally Exposed Individual Located at the Boundary of the Yakama Reservation

Alternative	WTP	STTS-East	STTS-West	Total	Risk[a]
	Dose (millirem)				
1	0	2.82×10^{-3}	3.15×10^{-3}	5.98×10^{-3}	3.59×10^{-9}
2A	1.23	8.35×10^{-10}	0	1.23	7.41×10^{-7}
2B	1.45	3.52×10^{-4}	3.95×10^{-4}	1.45	8.72×10^{-7}
3A	1.23	3.39×10^{-3}	3.86×10^{-3}	1.24	7.45×10^{-7}
3B	1.23	4.19×10^{-7}	1.11×10^{-5}	1.23	7.41×10^{-7}
3C	1.23	5.41×10^{-3}	5.85×10^{-3}	1.25	7.48×10^{-7}
4	1.23	7.42×10^{-5}	8.67×10^{-5}	1.24	7.41×10^{-7}
5	1.24	2.01×10^{-7}	4.88×10^{-3}	1.25	7.47×10^{-7}
6A, Base	1.23	5.49×10^{-4}	6.01×10^{-4}	1.24	7.42×10^{-7}
6A, Option	1.23	6.70×10^{-4}	7.42×10^{-4}	1.24	7.42×10^{-7}
6B, Base	1.41	7.12×10^{-3}	7.38×10^{-3}	1.42	8.53×10^{-7}
6B, Option	1.41	9.03×10^{-3}	8.79×10^{-3}	1.43	8.55×10^{-7}
6C	1.41	3.53×10^{-4}	3.96×10^{-4}	1.41	8.45×10^{-7}

[a] Cancer risk is the probability of developing a latent cancer fatality, which is estimated by multiplying the dose by the risk factor of 0.0006 latent cancer fatalities per rem (DOE 2003).

Key: Base=Base Case; Option=Option Case; STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Table J–24 presents the dose and cancer fatality risk over the lifetime of the project to an MEI located at the boundary of the Yakama Reservation. The duration of exposure under several alternatives would far exceed the life expectancy of any person. Therefore, the doses presented in Table J–24 are conservative and the actual dose received by the hypothetical MEI at this location over his or her lifetime would likely be much lower.

Table J–24. Tank Closure Alternatives – Dose and Risk to the Maximally Exposed Individual Located at the Boundary of the Yakama Reservation over the Life of the Project

Alternative	Duration of Exposure (years)	WTP	STTS-East	STTS-West	Total	Risk[a]
		Dose (millirem)				
1	102	0	2.50×10^{-1}	2.79×10^{-1}	5.29×10^{-1}	3.17×10^{-7}
2A	188	6.34	2.78×10^{-1}	3.11×10^{-1}	6.93	4.16×10^{-6}
2B	40	6.43	1.28×10^{-2}	1.44×10^{-2}	6.46	3.88×10^{-6}
3A	37	4.89	7.66×10^{-1}	8.71×10^{-1}	6.53	3.92×10^{-6}
3B	37	4.89	1.45×10^{-2}	1.55×10^{-2}	4.92	2.95×10^{-6}
3C	37	4.89	1.22	1.31	7.42	4.45×10^{-6}
4	40	4.93	3.26×10^{-2}	9.04×10^{-1}	5.86	3.52×10^{-6}
5	31	5.02	1.21×10^{-2}	8.02×10^{-1}	5.83	3.50×10^{-6}
6A, Base	163	6.65	4.90×10^{-1}	9.61×10^{-3}	7.15	4.29×10^{-6}
6A, Option	163	6.65	6.05×10^{-1}	7.04×10^{-1}	7.96	4.77×10^{-6}
6B, Base	95	6.35	4.51×10^{-1}	5.26×10^{-1}	7.32	4.39×10^{-6}
6B, Option	95	6.35	5.63×10^{-1}	6.55×10^{-1}	7.56	4.54×10^{-6}
6C	40	6.35	1.28×10^{-2}	1.44×10^{-2}	6.37	3.82×10^{-6}

[a] Cancer risk is the probability of developing a latent cancer fatality, which is estimated by multiplying the dose by the risk factor of 0.0006 latent cancer fatalities per rem (DOE 2003).

Key: Base=Base Case; Option=Option Case; STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

The results of this analysis show that the probability of an individual at this location developing an LCF from radionuclide releases during normal operations would essentially be zero. In addition, the dose to an MEI residing at the reservation boundary over the life of the project would be the equivalent of less than one-sixth the dose to an MEI at the Hanford boundary under all alternatives.

In addition, a scenario was analyzed for an individual living at or near the Hanford boundary who subsists predominantly on the consumption of homegrown produce, animal products from a family farm, and foodstuffs harvested from the wild (e.g., fruits, vegetables, fish, and game) to determine a maximum potential dose. For this scenario, the hypothetical individual was assumed to live at the same location as the MEI analyzed for the general public and could represent a member of a minority group who lives a subsistence lifestyle. This individual was assumed to get all of his or her food from the sources listed above. It was further conservatively assumed that all food came from an environment that was radioactively contaminated from air deposition. Irrigation water for crops and livestock and drinking water was assumed to come from radioactively contaminated surface waters. In contrast, the general population MEI was assumed to consume only a portion of his or her diet from regional food contaminated by radioactive emissions. Table J–25 presents comparative data on the food consumption rates for the subsistence consumer and the general population MEI.

Table J–25. Comparative Food Consumption Rates for the Subsistence Consumer and the General Population Maximally Exposed Individual

Ingestion Exposure Pathway	General Population MEI[a] (kilograms per year except as noted)	Subsistence Consumer (kilograms per year except as noted)	Reference
Leafy vegetable	65	65	Beyeler et al. 1999; DOE and Ecology 1996
Other vegetable	120	120	DOE 1995; DOE and Ecology 1996
Fruit	120	120	DOE 1995; DOE and Ecology 1996
Grain	90	90	Beyeler et al. 1999
Meat/game	27.8	154	DOE 1995; DOE and Ecology 1996
Poultry	28.5	28.5	Beyeler et al. 1999
Eggs	19	19	Beyeler et al. 1999
Fish	0	62	EPA 1997
Dairy	110 liters	219 liters	DOE 1995; DOE and Ecology 1996
Surface water	0	730 liters	DOE 1995

[a] From Appendix K of this *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington.* The general population MEI is assumed to consume no surface water or fish.

Note: To convert kilograms to pounds, multiply by 2.2046; liters to gallons, by 0.26417.

Key: MEI=maximally exposed individual.

For purposes of analysis and comparison, the dose to this subsistence consumer was analyzed for increased exposure to radioactive materials as a result of increased consumption of contaminated foodstuffs and milk, as well as the consumption of contaminated drinking water under Tank Closure Alternative 2B. This alternative resulted in the highest dose to the general population MEI of 10 millirem in the year of maximum impact. This dose would only be applicable to the one year in which cesium and strontium capsules are processed. The dose to an individual practicing a subsistence lifestyle exposed to the same releases as the general population MEI for the whole year could increase to as much as 26 millirem. The dose to the subsistence consumer would not result in a total effective dose greater than

the DOE limit of 100 millirem per year from all radiation sources and all pathways (DOE Order 458.1). The subsistence consumer scenario is conservative due to the large amount of fish in the diet, the assumption that the fish was raised in the area, the assumption that surface water is used for drinking and irrigation, and the assumption that this individual remains at the point of greatest impact along the site boundary for the entire year. In reality, the dose to an individual practicing a subsistence lifestyle would likely be much lower. Considering that both the MEI and the subsistence consumer would also be receiving a dose in excess of 311 millirem per year from natural background radiation, there would be no appreciable differences between these two doses. The alternatives analyzed in this EIS would therefore not pose a disproportionately high and adverse impact on an individual with a subsistence diet.

Appendix K, Section K.3.4, discusses the radiological and chemical consequences of facility accidents under each Tank Closure alternative. Examination of the risks under each alternative shows that there would be essentially no LCFs per year for the offsite population, including minority and low-income populations, from radioactive emissions. Hazardous chemical impacts are not expected to affect offsite populations. Therefore, these alternatives would not pose disproportionately high and adverse impacts on the minority and low-income populations.

J.5.7.1.2 FFTF Decommissioning Alternatives

Table J–26 compares average individual doses to minority and nonminority populations under each FFTF Decommissioning alternative to examine the potential for disproportionately high and adverse impacts. The Idaho Option for disposition of remote-handled special components (RH-SCs) and disposition of bulk sodium under Alternative 2 or 3 would result in the average dose to a minority individual slightly exceeding the average dose to a nonminority individual. However, the values show that there are no appreciable differences between average doses (4.8×10^{-7} millirem or less). Therefore, these alternatives would not pose disproportionately high and adverse impacts on minority populations surrounding each facility site.

Table J–26. FFTF Decommissioning Alternatives – Total, Minority, and Nonminority Population and Average Individual Doses in Year of Maximum Impact

Alternative	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Minority Population Dose (person-rem)	Minority Individual Average Dose (millirem)	Nonminority Population Dose (person-rem)	Nonminority Individual Average Dose (millirem)
No Action						
1	2.7×10^{-4}	6.1×10^{-7}	1.0×10^{-4}	5.2×10^{-7}	1.7×10^{-4}	6.8×10^{-7}
Facility Disposition						
2	6.7×10^{-7}	1.5×10^{-9}	2.5×10^{-7}	1.3×10^{-9}	4.3×10^{-7}	1.7×10^{-9}
3	0	0	0	0	0	0
Disposition of Remote-Handled Special Components – Hanford Option						
2 or 3	1.3×10^{-4}	2.1×10^{-7}	4.6×10^{-5}	1.7×10^{-7}	8.0×10^{-5}	2.5×10^{-7}
Disposition of Remote-Handled Special Components – Idaho Option						
2 or 3	3.2×10^{-5}	2.1×10^{-7}	6.3×10^{-6}	2.2×10^{-7}	2.6×10^{-5}	2.1×10^{-7}
Disposition of Bulk Sodium – Hanford Reuse Option						
2 or 3	9.9×10^{-3}	2.2×10^{-5}	3.7×10^{-3}	1.9×10^{-5}	6.2×10^{-3}	2.5×10^{-5}
Disposition of Bulk Sodium – Idaho Reuse Option						
2 or 3	1.1×10^{-3}	4.2×10^{-6}	1.8×10^{-4}	4.6×10^{-6}	8.7×10^{-4}	4.1×10^{-6}

Key: FFTF=Fast Flux Test Facility.

Table J–27 compares average individual doses to American Indian and non–American Indian populations under each FFTF Decommissioning alternative to examine the potential for disproportionately high and adverse impacts. There are no appreciable differences between the average dose to an American Indian individual and a non–American Indian individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on American Indian populations surrounding each facility site.

Table J–27. FFTF Decommissioning Alternatives – Total, American Indian, and Non–American Indian Population and Average Individual Doses in Year of Maximum Impact

Alternative	Total Population Dose (person-rem)	Individual Average Dose (millirem)	American Indian Population Dose (person-rem)	American Indian Individual Average Dose (millirem)	Non–American Indian Population Dose (person-rem)	Non–American Indian Individual Average Dose (millirem)
No Action						
1	2.7×10^{-4}	6.1×10^{-7}	2.6×10^{-6}	4.0×10^{-7}	2.7×10^{-4}	6.1×10^{-7}
Facility Disposition						
2	6.7×10^{-7}	1.5×10^{-9}	6.0×10^{-9}	9.3×10^{-10}	6.7×10^{-7}	1.5×10^{-9}
3	0	0	0	0	0	0
Disposition of Remote-Handled Special Components – Hanford Option						
2 or 3	1.3×10^{-4}	2.1×10^{-7}	1.3×10^{-6}	1.1×10^{-7}	1.2×10^{-4}	2.2×10^{-7}
Disposition of Remote-Handled Special Components – Idaho Option						
2 or 3	3.2×10^{-5}	2.1×10^{-7}	7.0×10^{-7}	1.7×10^{-7}	3.1×10^{-5}	2.1×10^{-7}
Disposition of Bulk Sodium – Hanford Reuse Option						
2 or 3	9.9×10^{-3}	2.2×10^{-5}	9.1×10^{-5}	1.4×10^{-5}	9.8×10^{-3}	2.2×10^{-5}
Disposition of Bulk Sodium – Idaho Reuse Option						
2 or 3	1.1×10^{-3}	4.2×10^{-6}	2.3×10^{-5}	3.9×10^{-6}	1.0×10^{-3}	4.2×10^{-6}

Key: FFTF=Fast Flux Test Facility.

Table J–28 compares average individual doses to Hispanic and non-Hispanic populations under each FFTF Decommissioning alternative to examine the potential for disproportionately high and adverse impacts. The Idaho Option for disposition of RH-SCs and the Idaho Reuse Option for disposition of bulk sodium under Alternative 2 or 3 would result in the average dose to a Hispanic individual slightly exceeding the average dose to a non-Hispanic individual. However, the values show that there are no appreciable differences between average doses (7.3×10^{-7} millirem or less). Therefore, these alternatives would not pose disproportionately high and adverse impacts on Hispanic or Latino populations surrounding each facility site.

Table J–28. FFTF Decommissioning Alternatives – Total, Hispanic, and Non-Hispanic Population and Average Individual Doses in Year of Maximum Impact

Alternative	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Hispanic Population Dose[a] (person-rem)	Hispanic Individual Average Dose[a] (millirem)	Non-Hispanic Population Dose (person-rem)	Non-Hispanic Individual Average Dose (millirem)
No Action						
1	2.7×10^{-4}	6.1×10^{-7}	8.5×10^{-5}	4.9×10^{-7}	1.9×10^{-4}	6.8×10^{-7}
Facility Disposition						
2	6.7×10^{-7}	1.5×10^{-9}	2.0×10^{-7}	1.2×10^{-9}	4.7×10^{-7}	1.7×10^{-9}
3	0	0	0	0	0	0
Disposition of Remote-Handled Special Components – Hanford Option						
2 or 3	1.3×10^{-4}	2.1×10^{-7}	3.8×10^{-5}	1.7×10^{-7}	8.8×10^{-5}	2.4×10^{-7}
Disposition of Remote-Handled Special Components – Idaho Option						
2 or 3	3.2×10^{-5}	2.1×10^{-7}	4.9×10^{-6}	2.3×10^{-7}	2.7×10^{-5}	2.1×10^{-7}
Disposition of Bulk Sodium – Hanford Reuse Option						
2 or 3	9.9×10^{-3}	2.2×10^{-5}	3.0×10^{-3}	1.8×10^{-5}	6.8×10^{-3}	2.5×10^{-5}
Disposition of Bulk Sodium – Idaho Reuse Option						
2 or 3	1.1×10^{-3}	4.2×10^{-6}	1.3×10^{-4}	4.9×10^{-6}	9.2×10^{-4}	4.1×10^{-6}

[a] Includes all individuals, regardless of race, who identified themselves as Hispanic or Latino.
Key: FFTF=Fast Flux Test Facility.

Table J–29 compares average individual doses to low-income and non-low-income populations under each FFTF Decommissioning alternative to examine the potential for disproportionately high and adverse impacts. The Idaho Reuse Option for disposition of bulk sodium under Alternative 2 or 3 would result in the average dose to a low-income individual slightly exceeding the average dose to a non-low-income individual; however, there are no appreciable differences in average individual doses under any of the alternatives (6.1×10^{-8} millirem). Therefore, these alternatives would not pose disproportionately high and adverse impacts on low-income populations surrounding each facility site.

Table J–29. FFTF Decommissioning Alternatives – Total, Low-Income, and Non-Low-Income Population and Average Individual Doses in Year of Maximum Impact

Alternative	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Low-Income Population Dose (person-rem)	Low-Income Individual Average Dose (millirem)	Non-Low-Income Population Dose (person-rem)	Non-Low-Income Individual Average Dose (millirem)
No Action						
1	2.7×10^{-4}	6.1×10^{-7}	4.3×10^{-5}	5.4×10^{-7}	2.3×10^{-4}	6.2×10^{-7}
Facility Disposition						
2	6.7×10^{-7}	1.5×10^{-9}	1.1×10^{-7}	1.3×10^{-9}	5.7×10^{-7}	1.6×10^{-9}
3	0	0	0	0	0	0
Disposition of Remote-Handled Special Components – Hanford Option						
2 or 3	1.3×10^{-4}	2.1×10^{-7}	1.9×10^{-5}	1.7×10^{-7}	1.1×10^{-4}	2.2×10^{-7}
Disposition of Remote-Handled Special Components – Idaho Option						
2 or 3	3.2×10^{-5}	2.1×10^{-7}	4.0×10^{-6}	2.1×10^{-7}	2.8×10^{-5}	2.1×10^{-7}
Disposition of Bulk Sodium – Hanford Reuse Option						
2 or 3	9.9×10^{-3}	2.2×10^{-5}	1.6×10^{-3}	2.0×10^{-5}	8.3×10^{-3}	2.3×10^{-5}
Disposition of Bulk Sodium – Idaho Reuse Option						
2 or 3	1.1×10^{-3}	4.2×10^{-6}	1.5×10^{-4}	4.3×10^{-6}	9.0×10^{-4}	4.2×10^{-6}

Key: FFTF=Fast Flux Test Facility.

Table J–30 compares average individual doses to minority and nonminority populations under each FFTF Decommissioning alternative over the lifetime of the project to examine the potential for disproportionately high and adverse impacts. The Idaho Option for disposition of RH-SCs and the Idaho Reuse Option for disposition of bulk sodium under Alternative 2 or 3 would result in the average dose to a minority individual slightly exceeding the average dose to a nonminority individual. However, the values show that there are no appreciable differences between average doses (9.6×10^{-7} millirem or less). Therefore, these alternatives would not pose disproportionately high and adverse impacts on minority populations surrounding each facility site.

Table J–30. FFTF Decommissioning Alternatives – Total, Minority, and Nonminority Population and Average Individual Doses over the Life of the Project

Alternative	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Minority Population Dose (person-rem)	Minority Individual Average Dose (millirem)	Nonminority Population Dose person-rem)	Nonminority Individual Average Dose (millirem)
No Action						
1	2.7×10^{-2}	6.1×10^{-5}	1.0×10^{-2}	5.2×10^{-5}	1.7×10^{-2}	6.8×10^{-5}
Facility Disposition						
2	6.7×10^{-7}	1.5×10^{-9}	2.5×10^{-7}	1.3×10^{-9}	4.3×10^{-7}	1.7×10^{-9}
3	0	0	0	0	0	0
Disposition of Remote-Handled Special Components – Hanford Option						
2 or 3	1.9×10^{-4}	3.2×10^{-7}	6.9×10^{-5}	2.6×10^{-7}	1.2×10^{-4}	3.7×10^{-7}
Disposition of Remote-Handled Special Components – Idaho Option						
2 or 3	4.8×10^{-5}	3.2×10^{-7}	9.5×10^{-6}	3.3×10^{-7}	3.9×10^{-5}	3.1×10^{-7}
Disposition of Bulk Sodium – Hanford Reuse Option						
2 or 3	2.2×10^{-2}	4.9×10^{-5}	8.1×10^{-3}	4.1×10^{-5}	1.4×10^{-2}	5.5×10^{-5}
Disposition of Bulk Sodium – Idaho Reuse Option						
2 or 3	2.1×10^{-3}	8.4×10^{-6}	3.6×10^{-4}	9.2×10^{-6}	1.7×10^{-3}	8.3×10^{-6}

Key: FFTF=Fast Flux Test Facility.

Table J–31 compares average individual doses to American Indian and non–American Indian populations under each FFTF Decommissioning alternative over the lifetime of the project to examine the potential for disproportionately high and adverse impacts. There are no appreciable differences between the average dose to an American Indian individual and a non–American Indian individual. Therefore, these alternatives would not pose disproportionately high and adverse impacts on American Indian populations surrounding each facility site.

Table J–31. FFTF Decommissioning Alternatives – Total, American Indian, and Non–American Indian Population and Average Individual Doses over the Life of the Project

Alternative	Total Population Dose (person-rem)	Individual Average Dose (millirem)	American Indian Population Dose (person-rem)	American Indian Individual Average Dose (millirem)	Non–American Indian Population Dose (person-rem)	Non–American Indian Individual Average Dose (millirem)
No Action						
1	2.7×10^{-2}	6.1×10^{-5}	2.6×10^{-4}	4.0×10^{-5}	2.7×10^{-2}	6.1×10^{-5}
Facility Disposition						
2	6.7×10^{-7}	1.5×10^{-9}	6.0×10^{-9}	9.3×10^{-10}	6.7×10^{-7}	1.5×10^{-9}
3	0	0	0	0	0	0
Disposition of Remote-Handled Special Components – Hanford Option						
2 or 3	1.9×10^{-4}	3.2×10^{-7}	2.0×10^{-6}	1.7×10^{-7}	1.9×10^{-4}	3.2×10^{-7}
Disposition of Remote-Handled Special Components – Idaho Option						
2 or 3	4.8×10^{-5}	3.2×10^{-7}	1.1×10^{-6}	2.6×10^{-7}	4.7×10^{-5}	3.2×10^{-7}
Disposition of Bulk Sodium – Hanford Reuse Option						
2 or 3	2.2×10^{-2}	4.9×10^{-5}	2.0×10^{-4}	3.1×10^{-5}	2.2×10^{-2}	4.9×10^{-5}
Disposition of Bulk Sodium – Idaho Reuse Option						
2 or 3	2.1×10^{-3}	8.4×10^{-6}	4.5×10^{-5}	7.8×10^{-6}	2.1×10^{-3}	8.4×10^{-6}

Key: FFTF=Fast Flux Test Facility.

Table J–32 compares average individual doses to Hispanic and non-Hispanic populations under each FFTF Decommissioning alternative over the lifetime of the project to examine the potential for disproportionately high and adverse impacts. The Idaho Option for disposition of RH-SCs and the Idaho Reuse Option for disposition of bulk sodium under Alternative 2 or 3 would result in the average dose to a Hispanic individual slightly exceeding the average dose to a non-Hispanic individual. However, the values show that there are no appreciable differences between average doses (1.5×10^{-6} millirem or less). Therefore, these alternatives would not pose disproportionately high and adverse impacts on Hispanic or Latino populations surrounding each facility site.

Table J–32. FFTF Decommissioning Alternatives – Total, Hispanic, and Non-Hispanic Population and Average Individual Doses over the Life of the Project

Alternative	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Hispanic Population Dose[a] (person-rem)	Hispanic Individual Average Dose[a] (millirem)	Non-Hispanic Population Dose (person-rem)	Non-Hispanic Individual Average Dose (millirem)
No Action						
1	2.7×10^{-2}	6.1×10^{-5}	8.5×10^{-3}	4.9×10^{-5}	1.9×10^{-2}	6.8×10^{-5}
Facility Disposition						
2	6.7×10^{-7}	1.5×10^{-9}	2.0×10^{-7}	1.2×10^{-9}	4.7×10^{-7}	1.7×10^{-9}
3	0	0	0	0	0	0
Disposition of Remote-Handled Special Components – Hanford Option						
2 or 3	1.9×10^{-4}	3.2×10^{-7}	5.7×10^{-5}	2.5×10^{-7}	1.3×10^{-4}	3.6×10^{-7}
Disposition of Remote-Handled Special Components – Idaho Option						
2 or 3	4.8×10^{-5}	3.2×10^{-7}	7.4×10^{-6}	3.5×10^{-7}	4.1×10^{-5}	3.1×10^{-7}
Disposition of Bulk Sodium – Hanford Reuse Option						
2 or 3	2.2×10^{-2}	4.9×10^{-5}	6.7×10^{-3}	3.9×10^{-5}	1.5×10^{-2}	5.5×10^{-5}
Disposition of Bulk Sodium – Idaho Reuse Option						
2 or 3	2.1×10^{-3}	8.4×10^{-6}	2.7×10^{-4}	9.7×10^{-6}	1.8×10^{-3}	8.2×10^{-6}

[a] Includes all individuals, regardless of race, who identified themselves as Hispanic or Latino.

Key: FFTF=Fast Flux Test Facility.

Table J–33 compares average individual doses to low-income and non-low-income populations under each FFTF Decommissioning alternative over the lifetime of the project to examine the potential for disproportionately high and adverse impacts. The Idaho Reuse Option for disposition of bulk sodium under Alternative 2 or 3 would result in the average dose to a low-income individual slightly exceeding the average dose to a non-low-income individual. However, the values show that there are no appreciable differences between average doses (1.2×10^{-7} millirem). Therefore, these alternatives would not pose disproportionately high and adverse impacts on low-income populations surrounding each facility site.

Table J–33. FFTF Decommissioning Alternatives – Total, Low-Income, and Non-Low-Income Population and Average Individual Doses over the Life of the Project

Alternative	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Low-Income Population Dose (person-rem)	Low-Income Individual Average Dose (millirem)	Non-Low-Income Population Dose (person-rem)	Non-Low-Income Individual Average Dose (millirem)
No Action						
1	2.7×10^{-2}	6.1×10^{-5}	4.3×10^{-3}	5.4×10^{-5}	2.3×10^{-2}	6.2×10^{-5}
Facility Disposition						
2	6.7×10^{-7}	1.5×10^{-9}	1.1×10^{-7}	1.3×10^{-9}	5.7×10^{-7}	1.6×10^{-9}
3	0	0	0	0	0	0
Disposition of Remote-Handled Special Components – Hanford Option						
2 or 3	1.9×10^{-4}	3.2×10^{-7}	2.9×10^{-5}	2.6×10^{-7}	1.6×10^{-4}	3.3×10^{-7}
Disposition of Remote-Handled Special Components – Idaho Option						
2 or 3	4.8×10^{-5}	3.2×10^{-7}	5.9×10^{-6}	3.2×10^{-7}	4.2×10^{-5}	3.2×10^{-7}
Disposition of Bulk Sodium – Hanford Reuse Option						
2 or 3	2.2×10^{-2}	4.9×10^{-5}	3.5×10^{-3}	4.3×10^{-5}	1.8×10^{-2}	5.0×10^{-5}
Disposition of Bulk Sodium – Idaho Reuse Option						
2 or 3	2.1×10^{-3}	8.4×10^{-6}	3.1×10^{-4}	8.5×10^{-6}	1.8×10^{-3}	8.4×10^{-6}

Key: FFTF=Fast Flux Test Facility.

Appendix K, Section K.2.2.1.1, discusses the approach used to model the FFTF Decommissioning alternatives. The same MEIs modeled under the Tank Closure alternatives are used for emissions from the 200 Area. An offsite MEI was identified for emissions from the 400 Area. This MEI is located to the southeast, across the river from the 300 Area. Similar to the Tank Closure alternatives, an MEI at the boundary of the Yakama Reservation is analyzed to explore potential environmental justice concerns surrounding Hanford. Some FFTF Decommissioning alternatives include options to process materials at the INL's MFC and INTEC. One offsite MEI is identified to be southwest of the MFC to explore impacts of bulk sodium disposition and another to be south of INTEC to explore impacts of the disposition of RH-SCs. Several regional tribes have expressed concerns regarding the potential for the proposed alternatives to impact the health of tribal members and their communities. These concerns are further elaborated in Appendix W, "American Indian Tribal Perspectives and Scenarios." To explore potential American Indian environmental justice concerns associated with normal operations under these alternatives, impacts on a hypothetical individual residing at the boundary of the Fort Hall Reservation were evaluated, similar to the MEI for the general population.

Table J–34 presents the maximum annual dose and cancer fatality risk to an MEI located at the appropriate reservation boundary. The results of this analysis show that the probability of such an individual developing an LCF from radionuclide releases during normal operations would essentially be zero. In addition, the maximum annual dose to an MEI residing at a reservation boundary would be less than approximately one-fifth that to an MEI at each respective site boundary under all FFTF Decommissioning alternatives.

Table J–34. FFTF Decommissioning Alternatives – Maximum Annual Dose and Risk to a Maximally Exposed Individual Located at the Appropriate Reservation Boundary

Alternative	Yakama Reservation					Fort Hall Reservation			
	Facility Disposition	Disposition of Bulk Sodium	Disposition of RH-SCs	Hanford Site Total	Cancer Risk[a]	Disposition of Bulk Sodium	Disposition of RH-SCs	INL Total	Cancer Risk[a]
	Dose (millirem)								
1	1.0×10^{-6}	0	0	1.0×10^{-6}	6.1×10^{-13}	0	0	0	0
2 Hanford Site	3.2×10^{-9}	2.6×10^{-5}	1.3×10^{-6}	2.8×10^{-5}	1.7×10^{-11}	0	0	0	0
2 INL	3.2×10^{-9}	0	0	3.2×10^{-9}	1.9×10^{-15}	3.6×10^{-5}	3.6×10^{-7}	3.7×10^{-5}	2.2×10^{-11}
3 Hanford Site	0	2.6×10^{-5}	1.3×10^{-6}	2.8×10^{-5}	1.7×10^{-11}	0	0	0	0
3 INL	0	0	0	0	0	3.6×10^{-5}	3.6×10^{-7}	3.7×10^{-5}	2.2×10^{-11}

[a] Cancer risk is the probability of developing a latent cancer fatality, which is estimated by multiplying the dose by the risk factor of 0.0006 latent cancer fatalities per rem (DOE 2003).

Key: FFTF=Fast Flux Test Facility; INL=Idaho National Laboratory; RH-SC=remote-handled special component.

Table J–35 presents the dose and cancer fatality risk over the lifetime of the project to an MEI located at the appropriate reservation boundary. The results of this analysis show that the probability of such an individual developing an LCF from radionuclide releases during normal operations would essentially be zero. In addition, the dose to an MEI residing at a reservation boundary over the life of the project would be less than approximately one-fifth that to an MEI at each respective site boundary over the life of the project.

Table J–35. FFTF Decommissioning Alternatives – Dose and Risk to a Maximally Exposed Individual Located at the Appropriate Reservation Boundary over the Life of the Project

Alternative	Duration of Exposure (years)	Yakama Reservation					Fort Hall Reservation			
		Facility Disposition	Disposition of Bulk Sodium	Disposition of RH-SCs	Hanford Site Total	Cancer Risk[a]	Disposition of Bulk Sodium	Disposition of RH-SCs	INL Total	Cancer Risk[a]
		Dose (millirem)								
1	100	7.1×10^{-5}	0	0	7.1×10^{-5}	4.3×10^{-11}	0	0	0	0
2 Hanford Site	3	3.2×10^{-9}	5.8×10^{-5}	2.0×10^{-6}	6.0×10^{-5}	3.6×10^{-11}	0	0	0	0
2 INL	4	3.2×10^{-9}	0	0	3.2×10^{-9}	1.9×10^{-15}	7.2×10^{-5}	5.4×10^{-7}	7.3×10^{-5}	4.4×10^{-11}
3 Hanford Site	3	0	5.8×10^{-5}	2.0×10^{-6}	6.0×10^{-5}	3.6×10^{-11}	0	0	0	0
3 INL	4	0	0	0	0	0	7.2×10^{-5}	5.4×10^{-7}	7.3×10^{-5}	4.4×10^{-11}

[a] Cancer risk is the probability of developing a latent cancer fatality, which is estimated by multiplying the dose by the risk factor of 0.0006 latent cancer fatalities per rem (DOE 2003).

Key: FFTF=Fast Flux Test Facility; INL=Idaho National Laboratory; RH-SC=remote-handled special component.

Appendix K, Section K.3.5, discusses the radiological and chemical consequences of facility accidents under each FFTF Decommissioning alternative. Examination of the risks under each alternative shows that there would be essentially no LCFs per year for the offsite population, including minority and low-income populations, due to radioactive emissions. The most severe chemical impacts would be the result of a Hanford sodium storage tank failure scenario, which could result in a hazardous plume slightly exceeding the site boundary to the east of the 400 Area; however, it is not be expected to reach the far side of the Columbia River. The potentially affected area is located in Franklin County, Washington, census tract 206.01, block group 2. This block group has not been identified to contain minority or low-income populations. Therefore, these alternatives would not pose disproportionately high and adverse impacts on minority or low-income populations.

J.5.7.1.3 Waste Management Alternatives

Table J–36 compares average individual doses to minority and nonminority populations under each Waste Management alternative to examine the potential for disproportionately high and adverse impacts. These impacts would be the same regardless of disposal group. There are no appreciable differences between the average dose to a minority individual and a nonminority individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on minority populations surrounding each facility site.

Table J–36. Waste Management Alternatives – Total, Minority, and Nonminority Population and Average Individual Doses in Year of Maximum Impact

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Minority Population Dose (person-rem)	Minority Individual Average Dose (millirem)	Nonminority Population Dose (person-rem)	Nonminority Individual Average Dose (millirem)
Alternative 1						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
Alternative 2						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	2.0×10^{-6}	3.4×10^{-9}	7.5×10^{-7}	2.8×10^{-9}	1.3×10^{-6}	3.9×10^{-9}
Total	$\mathbf{2.0\times10^{-6}}$	$\mathbf{3.4\times10^{-9}}$	$\mathbf{7.5\times10^{-7}}$	$\mathbf{2.8\times10^{-9}}$	$\mathbf{1.3\times10^{-6}}$	$\mathbf{3.9\times10^{-9}}$
Alternative 3						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	2.0×10^{-6}	3.4×10^{-9}	7.5×10^{-7}	2.8×10^{-9}	1.3×10^{-6}	3.9×10^{-9}
Total	$\mathbf{2.0\times10^{-6}}$	$\mathbf{3.4\times10^{-9}}$	$\mathbf{7.5\times10^{-7}}$	$\mathbf{2.8\times10^{-9}}$	$\mathbf{1.3\times10^{-6}}$	$\mathbf{3.9\times10^{-9}}$

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Table J–37 compares average individual doses to American Indian and non–American Indian populations under each Waste Management alternative to examine the potential for disproportionately high and adverse impacts. These impacts would be the same regardless of disposal group. There are no appreciable differences between the average dose to an American Indian individual and a non–American Indian individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on American Indian populations surrounding each facility site.

Table J–37. Waste Management Alternatives – Total, American Indian, and Non–American Indian Population and Average Individual Doses in Year of Maximum Impact

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	American Indian Population Dose (person-rem)	American Indian Individual Average Dose (millirem)	Non–American Indian Population Dose (person-rem)	Non–American Indian Individual Average Dose (millirem)
Alternative 1						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
Alternative 2						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	2.0×10^{-6}	3.4×10^{-9}	2.2×10^{-8}	1.8×10^{-9}	2.0×10^{-6}	3.5×10^{-9}
Total	$\mathbf{2.0\times10^{-6}}$	$\mathbf{3.4\times10^{-9}}$	$\mathbf{2.2\times10^{-8}}$	$\mathbf{1.8\times10^{-9}}$	$\mathbf{2.0\times10^{-6}}$	$\mathbf{3.5\times10^{-9}}$
Alternative 3						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	2.0×10^{-6}	3.4×10^{-9}	2.2×10^{-8}	1.8×10^{-9}	2.0×10^{-6}	3.5×10^{-9}
Total	$\mathbf{2.0\times10^{-6}}$	$\mathbf{3.4\times10^{-9}}$	$\mathbf{2.2\times10^{-8}}$	$\mathbf{1.8\times10^{-9}}$	$\mathbf{2.0\times10^{-6}}$	$\mathbf{3.5\times10^{-9}}$

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Table J–38 compares average individual doses to Hispanic and non-Hispanic populations under each Waste Management alternative to examine the potential for disproportionately high and adverse impacts. These impacts would be the same regardless of disposal group. There are no appreciable differences between the average dose to a Hispanic individual and a non-Hispanic individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on Hispanic or Latino populations surrounding each facility site.

Table J–38. Waste Management Alternatives – Total, Hispanic, and Non-Hispanic Population and Average Individual Doses in Year of Maximum Impact

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Hispanic Population Dose[a] (person-rem)	Hispanic Individual Average Dose[a] (millirem)	Non-Hispanic Population Dose (person-rem)	Non-Hispanic Individual Average Dose (millirem)
Alternative 1						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
Alternative 2						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	2.0×10^{-6}	3.4×10^{-9}	6.2×10^{-7}	2.7×10^{-9}	1.4×10^{-6}	3.9×10^{-9}
Total	$\mathbf{2.0\times10^{-6}}$	$\mathbf{3.4\times10^{-9}}$	$\mathbf{6.2\times10^{-7}}$	$\mathbf{2.7\times10^{-9}}$	$\mathbf{1.4\times10^{-6}}$	$\mathbf{3.9\times10^{-9}}$

Table J–38. Waste Management Alternatives – Total, Hispanic, and Non-Hispanic Population and Average Individual Doses in Year of Maximum Impact *(continued)*

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Hispanic Population Dose[a] (person-rem)	Hispanic Individual Average Dose[a] (millirem)	Non-Hispanic Population Dose (person-rem)	Non-Hispanic Individual Average Dose (millirem)
Alternative 3						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	2.0×10^{-6}	3.4×10^{-9}	6.2×10^{-7}	2.7×10^{-9}	1.4×10^{-6}	3.9×10^{-9}
Total	$\mathbf{2.0\times10^{-6}}$	$\mathbf{3.4\times10^{-9}}$	$\mathbf{6.2\times10^{-7}}$	$\mathbf{2.7\times10^{-9}}$	$\mathbf{1.4\times10^{-6}}$	$\mathbf{3.9\times10^{-9}}$

[a] Includes all individuals, regardless of race, who identified themselves as Hispanic or Latino.

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Table J–39 compares average individual doses to low-income and non-low-income populations under each Waste Management alternative to examine the potential for disproportionately high and adverse impacts. These impacts would be the same regardless of disposal group. There are no appreciable differences between the average dose to a low-income individual and a non-low-income individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on low-income populations surrounding each facility site.

Table J–39. Waste Management Alternatives – Total, Low-Income, and Non-Low-Income Population and Average Individual Doses in Year of Maximum Impact

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Low-Income Population Dose (person-rem)	Low-Income Individual Average Dose (millirem)	Non-Low-Income Population Dose (person-rem)	Non-Low-Income Individual Average Dose (millirem)
Alternative 1						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
Alternative 2						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0.	0	0
STTS-West	2.0×10^{-6}	3.4×10^{-9}	3.1×10^{-7}	2.8×10^{-9}	1.7×10^{-6}	3.6×10^{-9}
Total	$\mathbf{2.0\times10^{-6}}$	$\mathbf{3.4\times10^{-9}}$	$\mathbf{3.1\times10^{-7}}$	$\mathbf{2.8\times10^{-9}}$	$\mathbf{1.7\times10^{-6}}$	$\mathbf{3.6\times10^{-9}}$
Alternative 3						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	2.0×10^{-6}	3.4×10^{-9}	3.1×10^{-7}	2.8×10^{-9}	1.7×10^{-6}	3.6×10^{-9}
Total	$\mathbf{2.0\times10^{-6}}$	$\mathbf{3.4\times10^{-9}}$	$\mathbf{3.1\times10^{-7}}$	$\mathbf{2.8\times10^{-9}}$	$\mathbf{1.7\times10^{-6}}$	$\mathbf{3.6\times10^{-9}}$

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Table J–40 compares the average individual doses to minority and nonminority populations under each Waste Management alternative over the lifetime of the project to examine the potential for disproportionately high and adverse impacts. These impacts would be the same regardless of disposal group. There are no appreciable differences between the average dose to a minority individual and a nonminority individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on minority populations surrounding each facility site.

Table J–40. Waste Management Alternatives – Total, Minority, and Nonminority Population and Average Individual Doses over the Life of the Project

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Minority Population Dose (person-rem)	Minority Individual Average Dose (millirem)	Nonminority Population Dose (person-rem)	Nonminority Individual Average Dose (millirem)
Alternative 1						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
Alternative 2						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	7.7×10^{-5}	1.3×10^{-7}	2.8×10^{-5}	1.1×10^{-7}	4.9×10^{-5}	1.5×10^{-7}
Total	$\mathbf{7.7\times10^{-5}}$	$\mathbf{1.3\times10^{-7}}$	$\mathbf{2.8\times10^{-5}}$	$\mathbf{1.1\times10^{-7}}$	$\mathbf{4.9\times10^{-5}}$	$\mathbf{1.5\times10^{-7}}$
Alternative 3						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	7.7×10^{-5}	1.3×10^{-7}	2.8×10^{-5}	1.1×10^{-7}	4.9×10^{-5}	1.5×10^{-7}
Total	$\mathbf{7.7\times10^{-5}}$	$\mathbf{1.3\times10^{-7}}$	$\mathbf{2.8\times10^{-5}}$	$\mathbf{1.1\times10^{-7}}$	$\mathbf{4.9\times10^{-5}}$	$\mathbf{1.5\times10^{-7}}$

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Table J–41 compares the average individual doses to American Indian and non–American Indian populations under each Waste Management alternative over the lifetime of the project to examine the potential for disproportionately high and adverse impacts. These impacts would be the same regardless of disposal group. There are no appreciable differences between the average dose to an American Indian individual and a non–American Indian individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on American Indian populations surrounding each facility site.

Table J–41. Waste Management Alternatives – Total, American Indian, and Non–American Indian Population and Average Individual Doses over the Life of the Project

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	American Indian Population Dose (person-rem)	American Indian Individual Average Dose (millirem)	Non–American Indian Population Dose (person-rem)	Non–American Indian Individual Average Dose (millirem)
Alternative 1						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**

Table J–41. Waste Management Alternatives – Total, American Indian, and Non–American Indian Population and Average Individual Doses over the Life of the Project *(continued)*

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	American Indian Population Dose (person-rem)	American Indian Individual Average Dose (millirem)	Non–American Indian Population Dose (person-rem)	Non–American Indian Individual Average Dose (millirem)
Alternative 2						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	7.7×10^{-5}	1.3×10^{-7}	8.3×10^{-7}	7.0×10^{-8}	7.6×10^{-5}	1.3×10^{-7}
Total	$\mathbf{7.7\times10^{-5}}$	$\mathbf{1.3\times10^{-7}}$	$\mathbf{8.3\times10^{-7}}$	$\mathbf{7.0\times10^{-8}}$	$\mathbf{7.6\times10^{-5}}$	$\mathbf{1.3\times10^{-7}}$
Alternative 3						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0.	0	0
STTS-West	7.7×10^{-5}	1.3×10^{-7}	8.3×10^{-7}	7.0×10^{-8}	7.6×10^{-5}	1.3×10^{-7}
Total	$\mathbf{7.7\times10^{-5}}$	$\mathbf{1.3\times10^{-7}}$	$\mathbf{8.3\times10^{-7}}$	$\mathbf{7.0\times10^{-8}}$	$\mathbf{7.6\times10^{-5}}$	$\mathbf{1.3\times10^{-7}}$

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Table J–42 compares the average individual doses to Hispanic and non-Hispanic populations under each Waste Management alternative over the lifetime of the project to examine the potential for disproportionately high and adverse impacts. These impacts would be the same regardless of the disposal groups. There are no appreciable differences between the average dose to a Hispanic individual and a non-Hispanic individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on American Indian populations surrounding each facility site.

Table J–42. Waste Management Alternatives – Total, Hispanic, and Non-Hispanic Population and Average Individual Doses over the Life of the Project

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Hispanic Population Dose[a] (person-rem)	Hispanic Individual Average Dose[a] (millirem)	Non-Hispanic Population Dose (person-rem)	Non-Hispanic Individual Average Dose (millirem)
Alternative 1						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
Alternative 2						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	7.7×10^{-5}	1.3×10^{-7}	2.4×10^{-5}	1.0×10^{-7}	5.3×10^{-5}	1.5×10^{-7}
Total	$\mathbf{7.7\times10^{-5}}$	$\mathbf{1.3\times10^{-7}}$	$\mathbf{2.4\times10^{-5}}$	$\mathbf{1.0\times10^{-7}}$	$\mathbf{5.3\times10^{-5}}$	$\mathbf{1.5\times10^{-7}}$
Alternative 3						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	7.7×10^{-5}	1.3×10^{-7}	2.4×10^{-5}	1.0×10^{-7}	5.3×10^{-5}	1.5×10^{-7}
Total	$\mathbf{7.7\times10^{-5}}$	$\mathbf{1.3\times10^{-7}}$	$\mathbf{2.4\times10^{-5}}$	$\mathbf{1.0\times10^{-7}}$	$\mathbf{5.3\times10^{-5}}$	$\mathbf{1.5\times10^{-7}}$

[a] Includes all individuals, regardless of race, who identified themselves as Hispanic or Latino.

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Table J–43 compares the average individual doses to low-income and non-low-income populations under each Waste Management alternative over the lifetime of the project to examine the potential for disproportionately high and adverse impacts. These impacts would be the same regardless of disposal group. There are no appreciable differences between the average dose to a low-income individual and a non-low-income individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on low-income populations surrounding each facility site.

Table J–43. Waste Management Alternatives – Total, Low-Income, and Non-Low-Income Population and Average Individual Doses over the Life of the Project

Facility Site	Total Population Dose (person-rem)	Individual Average Dose (millirem)	Low-Income Population Dose (person-rem)	Low-Income Individual Average Dose (millirem)	Non-Low-Income Population Dose (person-rem)	Non-Low-Income Individual Average Dose (millirem)
Alternative 1						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	0	0	0	0	0	0
Total	**0**	**0**	**0**	**0**	**0**	**0**
Alternative 2						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	7.7×10^{-5}	1.3×10^{-7}	1.2×10^{-5}	1.1×10^{-7}	6.5×10^{-5}	1.4×10^{-7}
Total	$\mathbf{7.7\times10^{-5}}$	$\mathbf{1.3\times10^{-7}}$	$\mathbf{1.2\times10^{-5}}$	$\mathbf{1.1\times10^{-7}}$	$\mathbf{6.5\times10^{-5}}$	$\mathbf{1.4\times10^{-7}}$
Alternative 3						
WTP	0	0	0	0	0	0
STTS-East	0	0	0	0	0	0
STTS-West	7.7×10^{-5}	1.3×10^{-7}	1.2×10^{-5}	1.1×10^{-7}	6.5×10^{-5}	1.4×10^{-7}
Total	$\mathbf{7.7\times10^{-5}}$	$\mathbf{1.3\times10^{-7}}$	$\mathbf{1.2\times10^{-5}}$	$\mathbf{1.1\times10^{-7}}$	$\mathbf{6.5\times10^{-5}}$	$\mathbf{1.4\times10^{-7}}$

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Table J–44 presents the maximum annual dose and cancer fatality risk to an MEI located at the boundary of the Yakama Reservation. The results of this analysis show that the probability of an individual at this location developing an LCF from radionuclide releases during normal operations would essentially be zero. In addition, the maximum annual dose to an MEI residing at the reservation boundary would be approximately one-fourth that to an MEI at the Hanford boundary under all Waste Management alternatives.

Table J–44. Waste Management Alternatives – Maximum Annual Dose and Risk to the Maximally Exposed Individual at the Boundary of the Yakama Reservation

Alternative	WTP	STTS-East	STTS-West	Total	Risk[a]
	Dose (millirem)				
1	0	0	0	0	0
2	0	0	3.2×10^{-8}	3.2×10^{-8}	1.9×10^{-14}
3	0	0	3.2×10^{-8}	3.2×10^{-8}	1.9×10^{-14}

[a] Cancer risk is the probability of developing a latent cancer fatality, which is estimated by multiplying the dose by the risk factor of 0.0006 latent cancer fatalities per rem (DOE 2003).

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Table J–45 presents the dose and cancer fatality risk over the lifetime of the project to an MEI located at the boundary of the Yakama Reservation. The results of this analysis show that the probability of an individual at this location developing an LCF from radionuclide releases during normal operations would essentially be zero. In addition, the dose to an MEI residing at the reservation boundary over the life of the project would be approximately one-fourth that to an MEI at the Hanford boundary over the life of the project under all Waste Management alternatives.

Table J–45. Waste Management Alternatives – Dose and Risk to the Maximally Exposed Individual Located at the Boundary of the Yakama Reservation over the Life of the Project

Alternative	Duration of Exposure (years)	WTP	STTS-East	STTS-West	Total	Risk[a]
		Dose (millirem)				
1	0[b]	0	0	0	0	0
2	39	0	0	1.2×10^{-6}	1.2×10^{-6}	7.3×10^{-10}
3	39	0	0	1.2×10^{-6}	1.2×10^{-6}	7.3×10^{-10}

[a] Cancer risk is the probability of developing a latent cancer fatality, which is estimated by multiplying the dose by the risk factor of 0.0006 latent cancer fatalities per rem (DOE 2003).

[b] There would be no incremental radioactive air releases above current facility operations reported as part of the baseline in the affected environment section of this *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington.*

Key: STTS-East=200-East Area Supplemental Treatment Technology Site; STTS-West=200-West Area Supplemental Treatment Technology Site; WTP=Waste Treatment Plant.

Appendix K, Section K.3.6, discusses the radiological and chemical consequences of facility accidents under each Waste Management alternative. Examination of the risks under each alternative shows that there would be essentially no LCFs per year for the offsite population, including minority and low-income populations due to radioactive emissions. Potential risks from hazardous chemical impacts from reasonably foreseeable accidents would be encompassed by those discussed in Section J.5.7.1.2 under the FFTF Decommissioning alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on minority or low-income populations.

J.5.7.2 Air Quality

Air quality impacts were not analyzed separately for each subset population because the results would be similar to those for radiological impacts (see Section J.5.7.1); because there were no disproportionately high and adverse health or environmental impacts on minority, American Indian, Hispanic, or low-income populations due to radioactive air releases during normal operations, the same would be true for nonradioactive air emissions.

J.5.7.3 Groundwater Resources: Long-Term Human Health Impacts

Appendix Q, Section Q.3, evaluated groundwater impacts and associated potential long-term human health effects for each Tank Closure, FFTF Decommissioning, and Waste Management alternative. Receptors analyzed with a potential for environmental justice concerns include a resident farmer, an American Indian resident farmer, and an American Indian hunter-gatherer. The hypothetical resident farmer and American Indian resident farmer were both assumed to use either groundwater or surface water, but not both, for drinking water ingestion and crop irrigation, depending on the location of the receptors. While only a portion of the food consumed by the resident farmer was assumed to come from crops and animal products exposed to contaminated groundwater, all of the food consumed by the American Indian resident farmer was assumed to be exposed to contaminated groundwater. The American Indian hunter-gatherer was assumed to have a subsistence consumption pattern that differs from that of the American Indian resident farmer. The American Indian hunter-gatherer would not cultivate crops but rather would gather food from indigenous plants and harvest fish from the

Columbia River; thus, this receptor is assumed to be exposed to a combination of surface water and groundwater. Given these assumptions, the two American Indian receptors would be most at risk from contaminated groundwater. These receptors were used to develop exposure scenarios at several on- and offsite locations identified in Appendix O, Section O.2.4, and Appendix Q, Section Q.2.2. Due to dependence on surface water, the American Indian hunter-gatherer receptor is only reported at the Columbia River nearshore location.

J.5.7.3.1 Tank Closure Alternatives

Results of the analysis of groundwater contamination under the Tank Closure alternatives for the American Indian receptors are presented in Appendix Q, Tables Q–22 through Q–241. Long-term human health impacts of tank closure proposed actions would be greatest under Tank Closure Alternative 1. Radionuclide releases under this alternative would result in doses at the A, B, and S Barriers and the Core Zone Boundary that would exceed regulatory limits for the resident farmer and the American Indian resident farmer. None of the hypothetical receptors at the Columbia River nearshore or surface-water locations, including the American Indian hunter-gatherer, would be exposed to a dose in excess of regulatory limits. Chemical releases under this alternative would result in exceedance of the Hazard Index for chromium and nitrate at the A, B, S, T, and U Barriers and the Core Zone Boundary for the resident farmer and the American Indian resident farmer, as well as exceedance of the Hazard Index for nitrate at the Columbia River nearshore location for those same receptors. The American Indian hunter-gatherer at the Columbia River nearshore location would be exposed to a collective Hazard Index in excess of regulatory limits from acetonitrile, chromium, nitrate, and uranium releases. None of the receptors at the Columbia River surface-water location would experience a Hazard Index in excess of regulatory limits from chemical releases. The analysis determined that the greatest impact of any alternative on long-term human health would 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). It is unlikely, therefore, that any of the Tank Closure alternatives would pose a disproportionately high and adverse long-term human health risk to the American Indian population at offsite locations. 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 the non–American Indian receptors at the same locations, but to a lesser extent.

J.5.7.3.2 FFTF Decommissioning Alternatives

Results of the analysis of groundwater contamination under the FFTF Decommissioning alternatives for the American Indian receptors are presented in Appendix Q, Tables Q–246 through Q–251. Long-term human health impacts of FFTF decommissioning proposed 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 boundary. 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.

J.5.7.3.3 Waste Management Alternatives

Results of the analysis of groundwater contamination under the Waste Management alternatives for the American Indian receptors are presented in Appendix Q, Tables Q–253 through Q–391. Long-term human health impacts of waste management proposed actions would be greatest under Waste Management Alternative 3, Disposal Group 1, Subgroup 1-C. Radionuclide releases under this alternative would result in doses at the 200-West Area Integrated Disposal Facility (IDF-West) barrier exceeding regulatory limits for the resident farmer and the American Indian resident farmer. None of the hypothetical receptors at the 200-East Area Integrated Disposal Facility (IDF-East) barrier, the Core Zone Boundary, the River Protection Project Disposal Facility (RPPDF) barrier, the Columbia River nearshore, or the Columbia River surface-water location, including the American Indian hunter-gatherer, would be exposed to a dose in excess of regulatory limits. Chemical releases under this alternative would result in exceedance of the Hazard Index for chromium at the IDF-East barrier for the resident farmer and the American Indian resident farmer, and at the Core Zone Boundary for the American Indian resident farmer. Exceedances of the Hazard Index for nitrate occur at the IDF-East barrier, the Core Zone Boundary, and the Columbia River nearshore for the resident farmer and the American Indian resident farmer. None of the hypothetical receptors at the RPPDF barrier or the Columbia River surface-water location would be exposed to a Hazard Index in excess of regulatory limits. The analysis determined that the greatest impact of any alternative on long-term human health would 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 IDF-West barrier, IDF-East barrier, 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). It is unlikely, therefore, that any of the Waste Management alternatives would pose a disproportionately high and adverse long-term human health risk to the American Indian population. The greatest risk would be to the American Indian resident farmer at the IDF-West barrier. During the year of peak dose, this receptor would receive a radiation dose of 131 millirem. 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 identified at the Core Zone Boundary and the Columbia River nearshore. The adverse impacts would also be applicable to non–American Indian receptors at the same locations, but to a lesser extent.

J.6 REFERENCES

Beyeler, W.E., W.A. Hareland, F.A. Durán, T.J. Brown, E. Kalinina, D.P. Gallegos, and P.A. Davis, 1999, *Residual Radioactive Contamination from Decommissioning, Parameter Analysis, Draft Report for Comment*, NUREG/CR-5512, Vol. 3, U.S. Nuclear Regulatory Commission, Washington, D.C., October.

Census (U.S. Census Bureau), 2011a, *2010 Decennial Census Summary File 1*, Table P5 – Hispanic or Latino Origin by Race (Universe – Total Population), accessed through http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml, August 25.

Census (U.S. Census Bureau), 2011b, *American Community Survey, Puerto Rico Community Survey, 2010 Subject Definitions*.

Census (U.S. Census Bureau), 2011c, *2006–2010 American Community Survey 5-Year Estimates*, Table C17002 – Ratio of Income to Poverty Level in the Past 12 Months – Universe: Population for Whom Poverty Status is Determined, accessed through http://www2.census.gov/acs2010_5yr/summaryfile/, December 8.

Census (U.S. Census Bureau), 2011d, *American Community Survey, Data and Documentation, Geography*, accessed through http://www.census.gov/acs/www/data_documentation/geography/, December 27.

Census (U.S. Census Bureau), 2011e, *2010 National Geographic Tallies*, accessed through http://www.census.gov/geo/www/2010census/geo_tallies/national_geo_tallies.html, September 29.

CEQ (Council on Environmental Quality), 1997, *Environmental Justice Guidance Under the National Environmental Policy Act*, Executive Office of the President, Washington, D.C., December 10.

DeNavas-Walt, C., B.D. Proctor, and J.C. Smith, 2011, *Income, Poverty, and Health Insurance Coverage in the United States: 2010*, Current Population Reports, Consumer Income, Series P60-239, U.S. Census Bureau, Washington, D.C., September.

DOE (U.S. Department of Energy), 1995, *Hanford Site Risk Assessment Methodology*, DOE/RL-91-45, Rev. 3, Richland Operations Office, Richland, Washington, May.

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), 2003, *Estimating Radiation Risk from Total Effective Dose Equivalent (TEDE)*, ISCORS Technical Report No. 1, DOE/EH-412/0015/0802, Rev. 1, Office of Environmental Policy and Guidance, Washington, D.C., January.

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.

EPA (U.S. Environmental Protection Agency), 1997, *Exposure Factors Handbook*, Vol. II, *Food Ingestion Factors*, EPA/600/P-95/002Fa, b and c, Office of Research and Development, National Center for Environmental Assessment, Washington, D.C., August.

EPA (U.S. Environmental Protection Agency), 1998, *Final Guidance for Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analyses*, accessed through http://www.epa.gov/compliance/resources/policies/ej/ej_guidance_nepa_epa0498.pdf, April.

Humes, K.R., N.A. Jones, and R.R. Ramirez, 2011, *Overview of Race and Hispanic Origin: 2010*, 2010 Census Briefs, C2010BR-02, U.S. Census Bureau, Washington, D.C., March.

OMB (U.S. Office of Management and Budget), 2000, *Guidance on Aggregation and Allocation of Data on Race for Use in Civil Rights Monitoring and Enforcement*, OMB Bulletin No. 00-02, accessed through http://www.whitehouse.gov/omb/bulletins/b00-02.html, March 9.

Executive Orders

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, February 11, 1994.

Federal Register

62 FR 58782, Office of Management and Budget, 1997, "Revisions to the Standards for the Classification of Federal Data on Race and Ethnicity," October 30.

69 FR 52040, U.S. Nuclear Regulatory Commission, 2004, "Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions," August 24.

U.S. Department of Energy Orders

DOE Order 458.1, *Radiation Protection of the Public and the Environment*, Change 2, June 6, 2011.

APPENDIX K
SHORT-TERM HUMAN HEALTH RISK ANALYSIS

This appendix presents the methodologies and assumptions used for estimating potential impacts on, and risks to, individuals and the general public from exposure to releases of radioactive and hazardous chemical materials during normal operations and as a result of hypothetical accidents. It also presents the methodology that was used to assess industrial safety. This information is intended to support the public and occupational health and safety assessments described in Chapter 4 of this *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*. Section K.1 presents background information on the nature and hazards of radiation and chemicals. Section K.2 presents the methodology used in the assessment of normal radiological impacts, followed by the results of the radiological impact analyses. Section K.3 presents the assumptions and methodologies used in the assessment of facility accidents, followed by presentation of the impacts of accidental radioactive material and hazardous chemical releases. Section K.3 also presents the results of an analysis of intentional destructive acts. Section K.4 discusses the method used for assessment of industrial safety.

K.1 BACKGROUND

K.1.1 Radiation

Radiological exposure and its consequences are topics of interest to the general public. For this reason, this *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)* provides the reader with the following information regarding the nature of radiation, the consequences of exposure to radiation, and the basic concepts used to evaluate the health effects resulting from radiological exposure.

Radiation is energy and/or mass transferred in the form of particles or waves. Globally, human beings are exposed constantly to radiation from cosmic sources (outer space); terrestrial sources, such as the Earth's rocks and soils; and radionuclides that are naturally present in the human body. This radiation contributes to the natural background radiation that always surrounds us. Manmade sources of radiation also exist, including medical and dental x-rays, household smoke detectors, and materials released from nuclear and coal-fired power plants.

All matter in the universe is composed of atoms. Radiation comes from the activity of tiny particles within an atom. An atom consists of a positively charged nucleus (the central part of an atom) and a number of negatively charged electron particles that orbit the nucleus. There are two types of particles in the nucleus: neutrons, which are electrically neutral, and protons, which are positively charged. Atoms with different numbers of protons are known as elements. There are more than 100 natural and manmade elements. An element has equal numbers of electrons and protons. When atoms of an element differ in their number of neutrons, they are called isotopes of that element. All elements have three or more isotopes, some or all of which could be unstable (i.e., change over time).

Unstable isotopes undergo spontaneous change, known as radioactive disintegration or radioactive decay. The process of continuously undergoing spontaneous disintegration is called radioactivity. The radioactivity of a material decreases with time. The time it takes a material to lose half of its original radioactivity is its half-life. An isotope's half-life is a measure of its decay rate. For example, an isotope with a half-life of 8 days will lose one-half of its radioactivity in that amount of time. In 8 more days, one-half of the remaining radioactivity will be lost, and so on. Each radioactive element has a characteristic half-life. The half-lives of various radioactive elements vary from millionths of a second to trillions of years.

As unstable isotopes change into more-stable forms, they emit energy and/or particles (mass). A particle may be an alpha particle (a helium nucleus), a beta particle (an electron), or a neutron, with various levels of kinetic energy. Sometimes these particles are emitted in conjunction with gamma rays. The particles and gamma rays are referred to as "ionizing radiation." Ionizing radiation means that the particles and

gamma rays can ionize, or electrically charge, an atom by stripping off one or more of its electrons. Even though gamma rays and neutrons do not carry an electrical charge, they can ionize atoms by ejecting electrons as they pass through an element, indirectly causing ionization. Ionizing radiation can change the chemical composition of many things, including living tissue (organs), which can affect the way they function.

When a radioactive isotope of an element emits a particle, it changes to an entirely different element or isotope, one that may or may not be radioactive. Eventually, a stable element is formed. This transformation, which may take several steps, is known as a decay chain. For example, radium, a member of the radioactive decay chain of uranium-238, has a half-life of 1,600 years. It emits an alpha particle and becomes radon, a radioactive gas with a half-life of only 3.8 days. Radon decays first to polonium, then through a series of further decay steps to bismuth, and ultimately to a stable isotope of lead. The characteristics of various forms of ionizing radiation are briefly described below.

- *Alpha* (α) particles – Alpha particles are the heaviest type of ionizing radiation. They can travel only a few centimeters in air. Alpha particles lose their energy almost as soon as they collide with anything. They can be stopped easily by a sheet of paper or by the skin's surface.

- *Beta* (β) particles – Beta particles are much (7,300 times) lighter than alpha particles. They can travel a longer distance than alpha particles in the air. A high-energy beta particle can travel a few meters in the air. Beta particles can pass through a sheet of paper, but may be stopped by a thin sheet of aluminum foil or glass.

- *Gamma* (γ) rays – Gamma rays (and x-rays), unlike alpha or beta particles, are a form of electromagnetic radiation, which is similar to, but more energetic than, visible light. Gamma rays travel at the speed of light. Gamma radiation is very penetrating and requires a large mass, such as a thick wall of concrete, lead, or steel, to stop it.

- *Neutrons* (n) – Neutrons are particles that contribute to radiological exposure both directly and indirectly. The most prolific source of neutrons is a nuclear reactor. Indirect radiological exposure occurs when gamma rays and alpha particles are emitted following neutron capture in matter. A neutron has about one-quarter the mass of an alpha particle. It will travel in the air until it is absorbed by another element.

K.1.1.1 Radiological Measurement Units

During the early days of radiological experimentation, there was no precise measurement unit for radiation. Therefore, various units were used to identify the amount, type, and intensity of radiation. Amounts of radiation are measured in curies and its effects can be measured in units of radiation absorbed dose (rad), roentgen equivalent man (rem), or person-rem. These units are defined as follows.

- *Curie* – The curie, named after the scientists Marie and Pierre Curie, describes the "intensity" or activity of a sample of radioactive material. The rate of decay of 1 gram of radium was the basis of this unit of measure. Because the measured decay rate kept changing slightly as measurement techniques became more accurate, 1 curie was subsequently defined as exactly 37 billion disintegrations (decays) per second.

- *Rad* – The rad is a measure of the physical absorption of radiation. The total energy absorbed per unit quantity of tissue is referred to as the "absorbed dose" (or simply "dose"). As sunlight heats pavement by giving up an amount of energy to it, radiation similarly gives up energy to objects in its path. One rad is equal to the deposition by ionizing radiation of 0.01 joules of energy per kilogram of absorbing material (a joule is a metric unit of energy, equivalent to 1 watt-second).

- *Rem* – The rem is a measure of both "equivalent dose" and "effective dose." (The rem is also a measure of "dose equivalent" and "effective dose equivalent" [see the text box below]. For convenience of discussion, the terms equivalent dose and effective dose are used in the following discussion, but the same concepts apply to both sets of terms.) The equivalent dose in rem equals the absorbed dose in rad in a tissue multiplied by the appropriate radiation weighting factor (a measure of the biological effectiveness of a given type of radiation). The effective dose is the sum, over all tissues, of the equivalent dose to each individual tissue times a tissue-specific weighting factor that represents the contribution of that tissue to the total risk that would result from uniform irradiation of the whole body. The rem is used to measure the effects of radiation on the body similar to the way degrees Celsius or Fahrenheit (°C or °F) are used to measure the effects of sunlight heating pavement. Thus, 1 rem from one type of radiation is presumed to have the same biological effects as 1 rem from any other kind of radiation. This allows comparison of the biological effects of different types of radiation. One-thousandth of a rem is called a millirem.

- *Person-rem* – The person-rem is a measure of collective radiation dose, i.e., the sum of the individual effective doses received by members of a population or group.

Measurements of Radiation Doses

Effective Dose and ***Effective Dose Equivalent*** are very similar calculated dosimetric quantities that express the severity and probability of deleterious effects on a human regardless of whether or not the whole body is irradiated uniformly. The two quantities represent the total health detriment to an individual, as calculated in accordance with the two different bodies of guidance from the International Commission on Radiological Protection (ICRP-26 and ICRP-60). Both terms are currently in wide use for environmental and safety assessment purposes.

	ICRP-60 (1990)	ICRP-26 (1977)
Term	***Equivalent Dose***	***Dose Equivalent***
How calculated	Based on average absorbed dose over the tissue	Based on absorbed dose at a point in the tissue
Term	***Effective Dose***	***Effective Dose Equivalent***
How calculated	Sum of tissue *equivalent doses* multiplied by their applicable tissue weighting factors	Sum of tissue *dose equivalents* multiplied by their applicable tissue weighting factors
Apply to	Federal Guidance Report 13 (FGR-13) dose factors	FGR-11 dose factors
In this EIS	Used for doses from operations emissions, transportation, and long-term impact analyses	Used for doses from accident analyses

The units of measure for radiation in the International System of Units are becquerels (used to measure source intensity [activity]), grays (used to measure absorbed dose), and sieverts (used to measure equivalent and effective doses).

Equivalent Radiation Units in the International System of Units

Traditional Unit	International System Unit
1 curie	3.7×10^{10} becquerels (Bq)
1 rad	0.01 grays (Gy)
1 rem	0.01 sieverts (Sv)

An individual may be exposed to ionizing radiation externally (from a radioactive source outside the body) or internally (from ingesting or inhaling radioactive material). The external dose is delivered only during the actual time of exposure to the external radioactive source, while an internal dose continues to be delivered as long as radioactive material is in the body. The dose from internal

exposure is typically calculated over 50 years following the initial exposure. Both radioactive decay and elimination of the radionuclide by ordinary metabolic processes decrease the dose rate with the passage of time.

Doses reported in this appendix are the sum of the effective dose due to penetrating radiation from sources external to the body and the committed effective dose from internal deposition of radioactive material. The committed effective dose is an estimate of the radiation dose to a person resulting from inhalation or ingestion of radioactive material that takes into account the radiation sensitivities of different organs and the time (up to 50 years) a particular substance stays in the body (further discussed in Section K.1.1.3).

K.1.1.2 Sources of Radiation

The average American receives a total dose of approximately 620 millirem per year from all sources of radiation, both natural and manmade (see Table K–1); approximately 311 millirem per year of this total are from ubiquitous, primarily natural, sources (NCRP 2009). The sources of radiation can be divided into six different categories: (1) cosmic radiation, (2) external terrestrial radiation, (3) internal radiation, (4) medical diagnosis and therapy, (5) consumer products, and (6) other sources. These categories are discussed in the following paragraphs.

Table K–1. Natural and Manmade Sources of Radiological Exposure to Individuals Unrelated to the Hanford Site

Source	Effective Dose (millirem per year)[a]
Natural	**311**
Cosmic radiation	33
External terrestrial radiation	21
Internal radiation (other than radon)	29
Radon isotopes and their progeny	228
Medical	**300**
Computed tomography	147
Fluoroscopy and other radiography	76
Nuclear medicine	77
Consumer (e.g., products, air travel)	**13**
Other (e.g., industrial, security, research, occupational)	**<1**
Total (rounded)	**620**

[a] Averages for an individual in the U.S. population.
Source: NCRP 2009.

Cosmic radiation. Cosmic radiation is ionizing radiation resulting from the energetic charged particles from space that continuously hit the Earth's atmosphere. These particles, as well as the secondary particles and photons they create, constitute cosmic radiation. Because the atmosphere provides some shielding against cosmic radiation, the intensity of this radiation increases with the altitude above sea level. The average dose to a person in the United States from this source is approximately 33 millirem per year.

External terrestrial radiation. External terrestrial radiation is the radiation emitted from the radioactive materials in the Earth's rocks and soils. The dose from this source varies because of variations in the composition of rocks and soil. The average individual dose from external terrestrial radiation is approximately 21 millirem per year.

Internal radiation. Internal radiation results from inhalation or ingestion of natural radioactive material. Natural radionuclides in the body include isotopes of uranium, thorium, radium, radon, polonium, bismuth, potassium, rubidium, and carbon. The major contributors to the annual effective dose for internal radioactivity are the short-lived decay products of radon, which contribute approximately 228 millirem per year. The average dose from other internal radionuclides is approximately 29 millirem per year.

Medical diagnosis and therapy. Radiation is an important tool for the diagnosis and treatment of medical conditions and illnesses. Diagnostic x-rays result in an average dose of 223 millirem per year, including computed tomography (147 millirem per year) and fluoroscopy and other radiography (76 millirem per year). Nuclear medical procedures result in an average dose of 77 millirem per year.[1] The average dose from medical exposures is 300 millirem per year.

Consumer products. Consumer products also contain sources of ionizing radiation. In some products, such as smoke detectors and airport x-ray machines, the radioactive source is essential to the product's operation. In other products, such as televisions and tobacco, the user is incidentally exposed to radiation as the products function. The average dose from consumer products is approximately 13 millirem per year.

Other sources. There are a few additional sources of radiation that contribute minor doses to individuals in the United States. The dose from nuclear fuel cycle facilities (e.g., uranium mines, mills, and fuel processing plants) and nuclear power plants has been estimated to be less than 1 millirem per year. Radioactive fallout from atmospheric atomic bomb tests, emissions from certain mineral extraction facilities, and transportation of radioactive materials contribute less than 1 millirem per year to the average dose to an individual. Air travel also contributes less than 1 millirem per year to the average dose.

K.1.1.3 Exposure Pathways

As stated earlier, an individual may be exposed to ionizing radiation both externally and internally. The different routes that could lead to radiological exposure are called exposure pathways. Each type of exposure and its associated exposure pathways are discussed separately in the following paragraphs.

External exposure. External exposure results from radioactive sources outside the body. Possible external exposure pathways include exposure to a cloud of radiation passing over a receptor (an exposed individual) either standing on ground that is contaminated with radioactivity or swimming or boating in contaminated water. If the receptor departs from the source of radiation, the exposure will decrease or end.

Internal exposure. Internal exposure results from radioactive material entering the human body, most often through inhalation of contaminated air, ingestion of contaminated food or water, or absorption through the skin. In contrast to external exposure, once radioactive material enters the body, it remains there for a period of time that varies depending on its biological half-life (the time required for a radioactive material taken in by a living organism to be reduced to half the initial quantity by a combination of biological elimination processes and radioactive decay). The equivalent dose to each organ of the body is typically calculated for a period of 50 years following the intake. The total equivalent dose to an organ over a period of time is called the committed equivalent dose. The sum, over all tissues, of the committed equivalent doses delivered to each individual tissue times a tissue-specific weighting factor is called the committed effective dose.

[1] Exposures from nuclear diagnostic and medical procedures vary over a wide range. The reported values are average annual doses in the U.S. population (NCRP 2009).

K.1.1.4 Radiation Protection Guides

Various organizations have issued radiation protection guides. The responsibilities of the main radiation safety organizations, particularly those that affect policies in the United States, are summarized below.

International Commission on Radiological Protection (ICRP). The ICRP is responsible for providing guidance in matters of radiation safety. The operating policy of this organization is to prepare recommendations that address basic principles of radiation protection, leaving to the various national protection committees the responsibility to prepare detailed technical regulations, recommendations, or codes of practice that are best suited to the needs of their countries.

National Council on Radiation Protection and Measurements. In the United States, this council is the national organization responsible for adapting and providing detailed technical guidelines to implement ICRP recommendations. The council consists of technical experts who are specialists in radiation protection and scientists who are experts in disciplines that form the basis for radiation protection.

National Research Council/National Academy of Sciences. The National Research Council, which functions under the auspices of the National Academy of Sciences, integrates the broad science and technology community with the Academy's mission to further knowledge and advise the Federal Government. The National Research Council's Committee on the Biological Effects of Ionizing Radiation (BEIR Committee) prepares reports to advise the Federal Government on the health consequences of radiological exposure.

U.S. Environmental Protection Agency (EPA). EPA has published a series of documents under the title *Radiation Protection Guidance to Federal Agencies*. This guidance is used as a regulatory benchmark by a number of Federal agencies, including the U.S. Department of Energy (DOE), for the purpose of limiting public and occupational workforce exposures to the greatest extent possible.

U.S. Nuclear Regulatory Commission (NRC). NRC regulates source materials, special nuclear materials, and byproduct materials used by commercial entities, such as nuclear power plants, either directly or through state agreements. NRC has promulgated "Standards for Protection Against Radiation" (10 CFR 20), which apply to commercial uses of the materials listed above.

U.S. Department of Energy (DOE). DOE establishes requirements for radiation protection at DOE sites in regulations and orders. Requirements for worker protection are included in "Occupational Radiation Protection" (10 CFR 835). Radiation protection of the public and environment is addressed in *Radiation Protection of the Public and the Environment* (DOE Order 458.1).

K.1.1.5 Radiological Exposure Limits

Radiological exposure limits for members of the public and radiation workers are derived from ICRP recommendations. EPA uses National Council on Radiation Protection and Measurements and ICRP recommendations to set specific annual exposure limits (usually lower than those specified by the ICRP) in its radiation protection guidance to Federal agencies. Each regulatory organization then establishes its own set of radiation standards. The various exposure limits set by DOE and EPA for radiation workers and members of the public are given in Table K–2.

Table K–2. Radiation Exposure Limits for Members of the Public and Radiation Workers (millirem per year)

Guidance Criteria (Organization)	Public Exposure Limits at the Site Boundary	Worker Exposure Limits
10 CFR 835 (DOE)	–	5,000[a]
10 CFR 835.1002 (DOE)	–	1,000[b]
DOE Order 458.1 (DOE)[c]	100 (all pathways)	–
40 CFR 61, Subpart H (EPA)[d]	10 (all air pathways)	–
40 CFR 141 (EPA)[d]	4 (drinking water pathway)	–

[a] Although this measurement is a limit (or level) that is enforced by DOE, worker doses must be managed in accordance with ALARA principles. Refer to footnote b.

[b] This measurement is a control level. DOE established this level to assist in achieving its goal of maintaining radiation doses ALARA. DOE recommends that facilities adopt a more limiting 500-millirem-per-year Administrative Control Level (DOE Standard 1098-2008). Facility operators must make reasonable attempts to maintain individual worker doses below these levels.

[c] Consistent with 10 CFR 20.

[d] DOE Order 458.1 invokes, by reference, the requirements of 40 CFR 61, Subpart H, and 40 CFR 141 for the air pathway and drinking water, respectively.

Key: ALARA=as low as is reasonably achievable; CFR=Code of Federal Regulations; DOE=U.S. Department of Energy; EPA=U.S. Environmental Protection Agency.

K.1.1.6 Human Health Effects due to Exposure to Radiation

To provide the background for discussions of impacts, this section explains the basic concepts used in the evaluation of radiological effects. Radiation can cause a variety of damaging health effects in humans. The most significant effects are induced cancer fatalities, called latent cancer fatalities (LCFs) because the onset of cancer may take many years to develop after the radiation dose is received. In this *TC & WM EIS*, LCFs are used to measure the estimated risk due to radiological exposure.

Cancer is a group of diseases characterized by the uncontrolled growth and spread of abnormal cells. Cancer is caused by both external factors (tobacco, infectious organisms, chemicals, and radiation) and internal factors (inherited mutations, hormones, immune conditions, and mutations that occur from metabolism). For the U.S. population of about 310 million, the American Cancer Society estimated that, in 2010, about 1,529,560 new cancer cases would be diagnosed and about 569,490 cancer deaths would occur. Approximately one-third of U.S. cancer deaths are estimated to be caused by tobacco use and about one-third are related to obesity, physical inactivity, and poor nutrition. The average U.S. resident has about 4 chances in 10 of developing an invasive cancer over his or her lifetime (44 percent probability for males, 38 percent for females). Nearly 25 percent of all deaths in the United States are due to cancer. Cancer incidence and death rates for the State of Washington tend to be near the national averages. The 2002 through 2006 combined (male plus female) cancer incidence rate for the State of Washington was about 4 percent higher than the U.S. average, and the combined death rate was about 3 percent lower than the U.S. average (ACS 2010).

The National Research Council's BEIR Committee has prepared a series of reports to advise the Federal Government on the health consequences of radiological exposure. Based on its 1990 report, *Health Effects of Exposure to Low Levels of Ionizing Radiation, BEIR V* (National Research Council 1990), the former Committee on Interagency Radiation Research and Policy Coordination recommended LCF risk factors of 0.0005 per rem for the public and 0.0004 per rem for working-age populations (CIRRPC 1992). In 2002, the Interagency Steering Committee on Radiation Standards (ISCORS) recommended that Federal agencies use conversion factors of 0.0006 fatal cancers per rem for mortality and 0.0008 cancers per rem for morbidity when making qualitative or semiquantitative estimates of risk from radiological exposure to members of the general public. No separate values were recommended for workers. The

DOE Office of Environmental and Policy Guidance subsequently recommended that DOE personnel and contractors use the risk factors recommended by ISCORS, stating that, for most purposes, the value for the general population (0.0006 fatal cancers per rem) could be used for both workers and members of the public in National Environmental Policy Act (NEPA) analyses (DOE 2003).

Recent publications by both the BEIR Committee and the ICRP support the continued use of the ISCORS-recommended risk values. *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2* (National Research Council 2006) reported fatal cancer risk factors of 0.00048 per rem for males and 0.00066 per rem for females in a population with an age distribution similar to that of the entire U.S. population (average value of 0.00057 per rem for a population with equal numbers of males and females). ICRP Publication 103 (Valentin 2007) recommends nominal cancer risk coefficients of 0.00041 and 0.00055 per rem for adults and the general population, respectively, and estimates the risk from heritable effects (those that can affect a subsequent generation) to be about 3 to 4 percent of the nominal fatal cancer risk (see Table K–3).

Table K–3. Nominal Health Risk Estimators Associated with Exposure to Ionizing Radiation[a]

Exposed Population	Cancer[b]	Genetic Effects	Total
Worker (adult)[c]	0.00041	0.00001	0.00042
Whole	0.00055	0.00002	0.00057

[a] Risk per rem (individual dose) or person-rem (population dose). For individual doses equal to or greater than 20 rem, the health risk estimators are multiplied by 2.

[b] Risk of all cancers, adjusted for lethality and quality-of-life impacts.

[c] Ages 18–64 years.

Source: Valentin 2007:Table A.4.4.

Accordingly, a risk factor of 0.0006 LCFs per rem was used in this *TC & WM EIS* to estimate risk to workers and members of the public due to radiation doses from normal operations and accidents. For high individual doses (greater than or equal to 20 rem), this health risk factor was multiplied by 2 (NCRP 1993), resulting in a factor of 0.0012 LCFs per rem.

Using the risk factors discussed above, a calculated dose can be used to provide an estimate of the risk of an LCF. For example, if each member of a population of 100,000 people were exposed to a one-time dose of 100 millirem (0.1 rem), the collective dose would be 10,000 person-rem (100,000 persons times 0.1 rem). Using the risk factor of 0.0006 LCFs per person-rem, this collective dose is expected to cause 6 additional LCFs in this population (10,000 person-rem times 0.0006 LCFs per person-rem).

Calculations of the number of LCFs sometimes do not yield whole numbers, and may yield a number less than 1. For example, if each individual of a population of 100,000 people were to receive an annual dose of 1 millirem (0.001 rem), the collective dose would be 100 person-rem, and the corresponding risk of an LCF would be 0.06 (100,000 persons times 0.001 rem times 0.0006 LCFs per person-rem). A fractional result should be interpreted as a statistical estimate. That is, 0.06 is the average number of LCFs expected if many groups of 100,000 people were to experience the same radiological exposure situation. For most groups, no LCFs would occur; in a few groups, 1 LCF would occur; in a very small number of groups, 2 or more LCFs would occur. The average number of LCFs over all of the groups would be 0.06 (just like the average of 0, 0, 0, and 1 is 1 divided by 4, or 0.25). In the preceding example, the most likely outcome for any single group would be 0 LCFs. In this *TC & WM EIS*, LCFs calculated for a population are presented as both the rounded whole number, representing the most likely outcome for that population, and the calculated statistical estimate of risk, which is presented in parentheses.

The numerical estimates of LCFs presented in this *TC & WM EIS* were obtained using a linear extrapolation from the nominal risk estimated for lifetime total cancer mortality resulting from a dose of

0.1 grays (10 rad). Other methods of extrapolation to the low-dose region could yield higher or lower numerical estimates of LCFs. Studies of human populations exposed to low doses are inadequate to demonstrate the actual level of risk. There is scientific uncertainty about cancer risk in the low-dose region below the range of epidemiologic observation. However, a comprehensive review of available biological and biophysical data supports a "linear no-threshold" risk model in which the risk of cancer proceeds in a linear fashion at lower doses without a threshold and the smallest dose has the potential to cause a small increase in risk to humans (National Research Council 2006).

K.1.2 Chemicals

The reprocessing of nuclear fuels, the manufacture of nuclear materials, and the processing of fuel cycle waste entail the use of chemicals. Some of the more hazardous chemicals could pose risks to human health, even to the point of being fatal, if they are accidentally released to the environment or if they come into contact with workers in an occupational setting. The risks from exposure are of two general types: carcinogenic (cancer-inducing) effects and toxic, noncarcinogenic (non-cancer-causing) effects. In addition, the presence of some chemicals may pose a physical hazard to humans, such as chemical burns of the skin or internal organs, explosions or thermal hazards, displacement of oxygen, or runaway chemical reactions that cause high-energy release events.

K.1.2.1 Toxic or Hazardous Chemicals

Nearly every chemical that exists can be detrimental to human health under specific exposure conditions. A large number, both carcinogenic and noncarcinogenic, are specifically addressed in Occupational Safety and Health Administration (OSHA) regulations. The exposure limit or guideline for any given substance depends on the basic toxic or hazardous properties of the material, its physical properties (solid, liquid, gas, or vapor), the circumstances of exposure (inhalation, consumption of water or food, or contact with soil or contaminated surfaces), and whether the exposure occurs at a low rate during normal operations or at a high rate as a result of an accident. Occupational exposure limitations and other controls for specific toxic or hazardous chemicals are provided in various sections of the "Occupational Safety and Health Standards" (29 CFR 1910). Acute exposure concentration guidelines for more than 3,000 chemicals have been developed by DOE and others for use in hazard analysis and emergency planning and response (DOE 2008).

K.1.2.2 Chemical Usage

Chemical usage categories include process chemicals and nonprocess chemicals that support and maintain waste management operations. Process chemicals are those required in the direct processing of waste. The specific chemicals used depend upon the specific processes chosen. The waste being processed, with its various chemical constituents, also falls into the category of process chemicals. Nonprocess chemicals that support and maintain waste management operations are typically cleaning fluids and lubricants.

K.1.2.3 Exposure Pathways

To cause toxic effects on human biological systems, chemicals must make contact with or be introduced into the body. There are three general means of entry into the body: inhalation, ingestion, and dermal (skin) contact. The effects through a particular pathway will depend essentially on the properties of the toxic chemical, its concentration in one or more environmental media (air, water, and soil), and human behavior. Exposure may be dominated by contact with chemicals in a single medium or may reflect concurrent contacts with multiple media.

K.1.2.4 Chemical Exposure Limits and Criteria

Exposure to chemicals in occupational settings is limited to levels within applicable OSHA Permissible Exposure Limits (29 CFR 1910) or the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (ACGIH 2011). Exposures are typically maintained below the levels specified in these references by either engineered controls or the use of protective equipment.

The flammable and explosive hazards associated with chemicals are typically controlled through standards promulgated by OSHA (29 CFR 1910.106). These standards address the chemical storage and labeling, as well as the information required to be provided to the worker, as in Material Safety Data Sheets.

For accidental airborne releases of hazardous chemicals into the environment, DOE has specified criteria to be used as indicators of human health impacts resulting from acute exposures (DOE Guide 151.1-2). For each specific hazardous chemical of concern, criteria are drawn from one of the following systems (listed in order of preference): the Acute Exposure Guideline Levels (AEGLs) promulgated by EPA, the Emergency Response Planning Guidelines (ERPGs) published by the American Industrial Hygiene Association, and the Temporary Emergency Exposure Limits (TEELs) developed by DOE. The system of AEGLs includes values for five exposure periods, ranging from 10 minutes to 8 hours. However, the ERPG and TEEL systems provide values only for exposures of 1 hour. To allow the systems to be used together, DOE has specified that the 1-hour (60-minute) AEGL values are to be used. For the chemicals addressed by each system, three exposure levels (i.e., thresholds), expressed in terms of airborne concentrations, have been developed. Although the specific definitions vary slightly between the systems, the levels of human health impact associated with exposure for 1 hour to each airborne concentration level can be paraphrased as follows: exposures of up to 1 hour at or below level 1 may result in mild, transient, adverse health effects; exposures of up to 1 hour above level 1 and up to level 2 should not result in irreversible or other serious health effects or symptoms that could impair a person's ability to take protective action; exposures of up to 1 hour above level 2 and up to level 3 should not result in an experience or development of life-threatening health effects; and exposures of up to 1 hour above level 3 could result in life-threatening health effects or death. DOE has specified that level 2 is the threshold above which unacceptable human health effects may be experienced. At concentrations above level 2, action should be taken to avoid, reduce, or mitigate human exposure. Level 3 has been identified as the threshold above which severe human health effects are expected.

K.1.2.5 Health Effects of Hazardous Chemical Exposure

Various chemicals invoke different types of damage to human biological systems. The harm may vary according to the sensitivity of each individual person exposed. Hazardous chemical releases from routine operations generally are expected to result in concentrations below levels that would cause acute toxic health effects. Acute toxic health effects generally result from short-term exposure to relatively high concentrations of the toxic contaminant, such as those resulting from accidental releases. Long-term exposure to lower concentrations can produce adverse chronic health effects, both carcinogenic and noncarcinogenic. Excess incidences of cancer are the endpoint of carcinogenic effects. However, a spectrum of chemical-specific noncancer health effects (e.g., headaches, skin irritation, neurotoxicity, immunotoxicity, reproductive and genetic toxicity, liver/kidney toxicity, and developmental toxicity) could be observed due to exposure to noncarcinogenic compounds.

K.1.2.6 Hazardous Chemical Impact Assessment

Illness, injury, and death resulting from industrial accidents in occupational settings (i.e., routine operations) are assessed in Section K.4 and the industrial safety sections of Chapter 4 (see Sections 4.1.15, 4.2.15, 4.3.15, and 4.4.13) and are summarized in Chapter 2 (see Sections 2.8.1.15,

2.8.2.15, and 2.8.3.15). These industrial safety impacts are included in the general industry incident rates. The remainder of this discussion pertains to the assessment of impacts on populations other than direct facility workers. The results of these assessments for each alternative may be found in Chapter 4, Sections 4.1.11, 4.2.11, and 4.3.11, Public and Occupational Health and Safety—Facility Accidents, and Chapter 5, Sections 5.1.2, 5.2.2, and 5.3.2, Human Health Impacts. Additional information is also provided in Appendix G, "Air Quality Analysis"; Appendix P, "Ecological Resources and Risk Analysis"; and Section K.3, Accident Analysis, of this appendix.

The exposure assessment for accidents evaluated how chemicals could travel to a receptor, how these chemicals could come into contact with a receptor's body, and whether the chemicals present in the environmental medium were likely to cause significant adverse effects. Activities evaluated in this environmental impact statement (EIS) that involve significant quantities of chemicals would be conducted in the 400 Area or the 200 Areas, far from any agricultural activities or body of water that might represent a significant human exposure pathway. The airborne exposure pathway was therefore determined to be the most important one for chemical exposure. The health impact of each accident scenario was estimated by calculating the concentration of the chemical in air at several receptor locations and comparing the concentration with accepted exposure standards for the chemical.

To determine long-term impacts (see Appendix Q), noncancer health effects were estimated by comparing the annual concentrations of contaminants with the reference concentrations published in the EPA's *Integrated Risk Information System* (http://www.epa.gov/iris). The potential toxic effects on an individual from exposure to a toxic chemical were evaluated by dividing the estimated inhalation concentration of that chemical by its reference concentration value to obtain a noncancer Hazard Quotient (EPA 1989). For exposure to multiple compounds, Hazard Quotients were calculated for each toxic chemical and then summed to generate a Hazard Index, as shown in the following equation:

$$HI = \sum_i \frac{CA_i}{RfC_i}$$

where:

HI	=	Hazard Index
CA_i	=	concentration of the chemical i in the air, micrograms per cubic meter
RfC_i	=	reference concentration for chemical i, micrograms per cubic meter

The Hazard Index is the estimate of the total noncancer toxicity impact. According to the EPA risk assessment guidelines, if the Hazard Index value is less than or equal to 1, the exposure is unlikely to produce adverse toxic effects. However, if it exceeds 1, adverse toxic effects may result from exposure to the considered chemicals.

The risks from exposure to carcinogenic chemicals were evaluated using chemical-specific unit risk factors, which are estimates of the maximum lifetime probability of an individual developing cancer from exposure to the chemical and the chemical concentration in the air. The unit risk factors for carcinogenic chemicals were taken from EPA's *Integrated Risk Information System* database. Therefore, for carcinogenic chemicals, the risk was estimated by the following equation (EPA 1989):

$$\text{Risk} = 1 - e^{(-CA \times URF)}$$

where:

e	=	~2.718
CA	=	contaminant concentration in the air, micrograms per cubic meter
URF	=	unit risk factor for inhalation specific to the contaminant obtained from the Integrated Risk Information System, cancers per micrograms per cubic meter

As the value in the parentheses is generally small (less than 0.01), the equation is simplified to:

$$\text{Risk} = CA \times URF$$

where:

CA	=	contaminant concentration in the air, micrograms per cubic meter
URF	=	unit risk factor for inhalation specific to the contaminant obtained from the Integrated Risk Information System, cancers per micrograms per cubic meter

K.2 NORMAL OPERATIONS

This section describes the methodology used to evaluate the impacts of radioactive emissions from tank closure, Fast Flux Test Facility (FFTF) decommissioning, and waste management activities on the public and workers. Dose assessments were performed for members of the general public near the Hanford Site (Hanford) (and Idaho National Laboratory [INL] for selected FFTF decommissioning options) to estimate the incremental doses and related risks that would be associated with the alternatives addressed in this *TC & WM EIS*. Incremental doses for members of the public were calculated using the GENII-2 [Hanford Environmental Radiation Dosimetry Software System, Generation II, Version 2] computer code (Napier 2007), for the following receptors:

- *Population* – The general public living within 80 kilometers (50 miles) of the facilities.
- *Maximally exposed individual (MEI)* – The MEI is a hypothetical individual member of the public located at a position near the site boundary who would experience the highest impacts during normal operations.
- *Onsite MEI* – The onsite MEI is a member of the public who works at Hanford but is not associated with DOE facilities or operations. The Columbia Generating Station, the Laser Interferometer Gravitational-Wave Observatory (LIGO), and the US Ecology Commercial Low-Level Radioactive Waste Disposal Site (US Ecology) were the three worksites considered. This receptor would only be exposed during a normal work shift.

Impacts were also evaluated for two classes of workers: (1) radiation workers, involved workers who might be exposed to radiation while performing activities associated with the alternatives; and (2) noninvolved workers, onsite workers who may be incidentally exposed as a result of the actions taken to implement a project, but who are not directly involved in the project. Radiological impacts were determined for both radiation workers and noninvolved workers. Impacts on noninvolved workers were calculated with the GENII-2 computer code.

K.2.1 Tank Closure Alternatives

K.2.1.1 Impacts on the Public During Normal Operations

This section describes the methodology used to evaluate the impacts of radioactive emissions from waste treatment and tank closure activities on the population near Hanford. Later sections of this appendix

address any differences in the methodology as it was applied to radiological impacts analysis for FFTF decommissioning and waste management.

K.2.1.1.1 Approach

Under normal operations, radionuclide releases would occur during activities associated with tank farm operations, including waste retrieval, pretreatment and treatment, and tank farm closure. Small amounts of radioactivity from normal operations may be released in liquid effluents. The liquid effluents would be routed to the Treated Effluent Disposal Facility or the Liquid Effluent Retention Facility/Effluent Treatment Facility, which are existing, state-permitted facilities. Effluents are sampled prior to release and treated, as necessary, using best available technologies to ensure they meet state discharge limits. Based on a previous environmental assessment (DOE 1992), discharges from these facilities were determined to be of no significant impact and therefore are not expected to make a distinguishable difference in the calculated doses to members of the public.

For purposes of evaluating the impacts of radioactive air emissions, the activities and facilities associated with each Tank Closure alternative are treated as originating from one of three locations: the Waste Treatment Plant (WTP), the 200-East Area, or the 200-West Area. Releases modeled as originating from the WTP included those from the vitrification and pretreatment facilities. All other activities and facilities in the 200-East Area were modeled as if they were located at the 200-East Area Supplemental Treatment Technology Site (STTS-East) in the southeast corner of the 200-East Area (see Figure K–1). This location has been identified for supplemental technologies (e.g., bulk vitrification, cast stone, or steam reforming) if they are deployed in the 200-East Area. This location was selected because the emissions of the supplemental technologies would be substantially higher for most radionuclides than those associated with other project-related, 200-East Area activities, such as normal tank farm operations or waste retrieval. Similarly, emissions from the 200-West Area were modeled as if they arose from the 200-West Area STTS (STTS-West) in the southeast corner of the 200-West Area (see Figure K–1), the site for deployment of supplemental technologies in the 200-West Area. Although tank farms are located at a number of positions within the 200-East and 200-West Areas (all tank farms are within 2.6 kilometers [1.6 miles] of STTS-East and -West), the simplifying assumption that radioactive emissions other than those from the WTP would come from these STTSs added a level of conservatism to the analysis because the STTSs would be located closer to the principal receptors in the predominant downwind direction, the population centers of Richland, Pasco, and Kennewick, and closer to the MEI, located eastward.

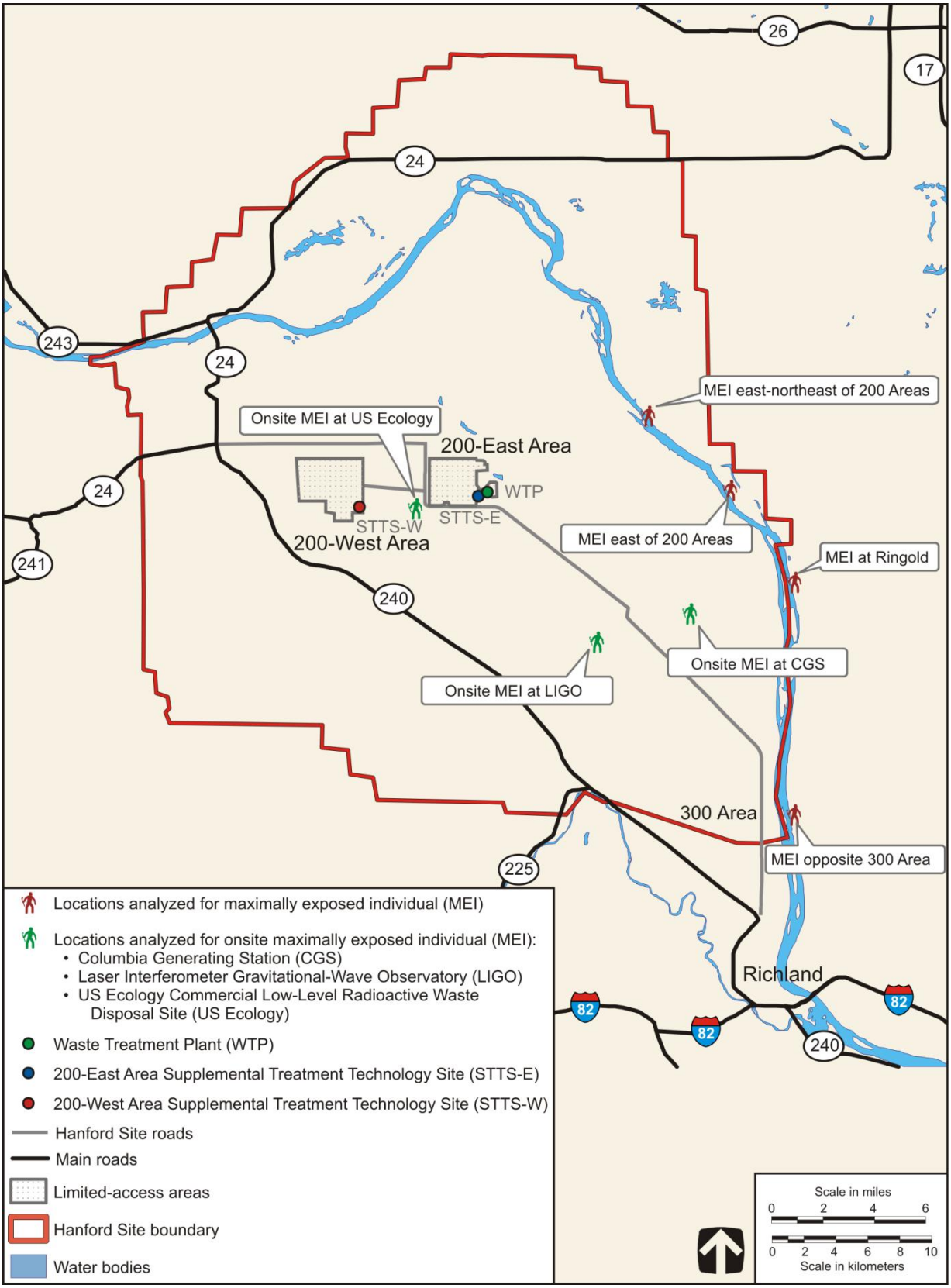

Figure K–1. Locations Assumed to Be Sources of Radioactive Air Emissions and Possible Locations of the Maximally Exposed Individual

The activities associated with each of these emission source locations are summarized as follows:

WTP:

- High-level radioactive waste (HLW) vitrification
- Low-activity waste (LAW) vitrification
- Cesium and strontium de-encapsulation and processing
- Waste pretreatment
- Sulfate removal

STTS-East:

- Tank farm operations
- Tank waste retrieval
- Tank farm facilities deactivation
- Bulk vitrification
- Cast stone
- Steam reforming
- Remote-handled transuranic (TRU) waste treatment
- Contact-handled TRU waste treatment
- Tank removal
- Soil removal

STTS-West:

- Tank farm operations
- Tank waste retrieval
- Tank farm facilities deactivation
- Bulk vitrification
- Cast stone
- Steam reforming
- Contact-handled TRU waste treatment
- Tank removal
- Soil removal

K.2.1.1.1.1 Exposure Scenarios

The analysis of radionuclide releases from normal operations evaluated the impacts on three public receptors: the general population living within 80 kilometers (50 miles) of the release locations, a hypothetical MEI, and an onsite MEI. The general population, the MEI, and the onsite MEI would receive external as well as internal doses from radionuclide releases.

The population living within 80 kilometers (50 miles) of the release locations would be exposed to atmospheric releases of radioactive materials that are carried by the wind. Therefore, the meteorological conditions at Hanford and the population distribution around the site would affect the dose received by the population. Details of the population distribution and the meteorological conditions are presented in Section K.2.1.1.3, Input Parameters. Members of the general population would receive an external exposure to radiation from the radioactive plume as it passes and from materials that are deposited on the ground. They would also receive an internal dose from the inhalation and ingestion of radionuclides. Members of the population would receive an internal dose through inhalation of contaminated air as the plume passes and inhalation of resuspended materials that are deposited on the ground. They were also assumed to receive an internal dose by consuming produce grown in a family garden and animal products

from regional livestock contaminated by deposition and uptake of radioactive materials. The assumed respiration rate and the amount of contaminated food consumed are discussed in Section K.2.1.1.3.

For the purpose of analyzing the impacts of radionuclide releases to the air from normal operations, the MEI was assumed to be an individual who lives near the Hanford boundary in the location that results in the maximum impact. The GENII-2 computer code (Napier 2007), which was used to project the impacts of radionuclide releases from normal operations, was also used to evaluate possible locations of the MEI. Using the joint frequency distribution of meteorological data for the Hanford 200 Areas, the assumed emission source locations (the WTP, STTS-East, and STTS-West), and the release inventories, MEI analyses were performed for multiple locations on the bank of the Columbia River opposite Hanford (see Figure K–1). These analyses showed that the MEI would be at one of the following locations: (1) a point about 11 kilometers (6.8 miles) east-northeast of the WTP, (2) a point about 13.1 kilometers (8.1 miles) east of the WTP, or (3) a point along the Ringold section of the Columbia River about 18.2 kilometers (11.3 miles) east-southeast of the WTP. A point across the river from the Hanford 300 Area, about 22 kilometers (13.7 miles) southeast of the WTP, was also considered but never yielded the maximum result. As the relative emissions from the three source locations change, the location of the MEI would also change. Although it is expected that the supplemental treatment technologies would have elevated releases (e.g., from stack emissions), no detailed design information for the associated facilities was available to use in the analysis. Therefore, it was assumed that the emissions from the supplemental treatment facilities at STTS-East and -West would be at ground level. Emissions modeled as arising from ground-level sources would not disperse as much as those from elevated release points. The difference between a ground-level release and release from a 10-meter (30-foot) height was found not to result in a large difference in exposure.

The MEI would be exposed in the same manner as the general population, that is, by external exposure to the plume and deposited radioactive materials and by internal exposure from inhalation of radioactive materials and ingestion of contaminated food. The MEI was assumed to consume a larger quantity of produce grown in a family garden.

The onsite MEI, a member of the public whose workday is spent at the Columbia Generating Station, LIGO, or US Ecology at Hanford, would receive an external dose from the plume and material deposited on the ground and an internal dose from inhalation of the plume and resuspended radioactive materials deposited on the ground.

K.2.1.1.2 Modeling

The radiological impacts of releases during normal operations of the facilities used to retrieve and treat tank waste and to deactivate and close tank farm facilities were calculated using the GENII-2 computer code (Napier 2007). Site-specific input data were used, including location, meteorology, population, and source terms. This section briefly describes GENII-2 and outlines the approach used for estimating impacts of normal operations.

K.2.1.1.2.1 Description of the GENII-2 Computer Code

The GENII-2 computer code, developed by Pacific Northwest National Laboratory, is an integrated system of computer models and modules that analyzes environmental contamination resulting from acute or chronic releases to, or initial contamination of, air, water, or soil. The GENII-2 computer code calculates radiation doses to individuals and populations. Its assumptions, technical approach, method, and quality assurance are well documented. The GENII-2 computer code has gone through an extensive quality assurance and quality control process, which included comparing results from model computations with those from manual calculations and performing internal and external peer reviews (Napier 2007).

Available release scenarios include acute and chronic releases to water or air (ground-level or elevated sources) and initial contamination of soil or surfaces. GENII-2 implements NRC models for surface-water doses that were developed using the LADTAP [Liquid Annual Doses to All Persons] computer code. Exposure pathways include direct exposure via water (swimming, boating, and fishing), as well as soil, air, inhalation, and ingestion. GENII, Version 1.485 (an earlier version), implemented dosimetry models recommended by the ICRP in Publications 26, 30, and 48. GENII-2 implements these models, as well as those of ICRP Publications 56 through 72 and the related risk factors published in Federal Guidance Report 13 (FGR-13) (Eckerman et al. 1999). Risk factors in the form of EPA-developed slope factors (a special subset of the FGR-13 values) are also included. These dosimetry and risk models are considered state of the art by the international radiation protection community and have been adopted by most national and international organizations as their standard dosimetry methodology (Napier 2007).

GENII-2 consists of four independent atmospheric models, one surface-water model, and three independent environmental accumulation models, as well as an exposure module and a dose/risk module. GENII-2 includes user interfaces for the models and modules (i.e., interactive, menu-driven programs to assist the user with scenario generation and data input), internal and external dose factor libraries, environmental dosimetry programs, and file-viewing routines. The FRAMES [Framework for Risk Analysis in Multimedia Environmental Systems] program serves as the interface for operating GENII-2. For maximum flexibility, the code has been divided into several interrelated, but separate, exposure and dose calculations (Napier 2007).

In preparing this *Final TC & WM EIS*, an updated version of the GENII computer code (GENII-2) was used to model the potential impacts from radioactive emissions; GENII Version 1.485 was used in preparing the *Draft TC & WM EIS*. In general, use of Version 2 of the code resulted in an increase in the calculated doses. A number of the components used in the computer code were updated, using more recent information.

A revised atmospheric dispersion module uses hourly meteorological data that can be input in a variety of formats, including the joint frequency distribution format used by the prior version of the model. The updated model accounts for variation in the mixing depth (the height to which the atmosphere is uniformly mixed) depending on the meteorological conditions; the prior version established a single mixing depth at 1,000 meters (3,300 feet). The current model also accounts for precipitation scavenging of radionuclides from the plume and reflects depletion of the plume as a result of deposition and scavenging.

A revised air-to-plant model accounts for deposition directly from the air module and can account for differences in deposition velocities depending on radionuclide characteristics. A significant change between the two versions of GENII was the set exposure pathway transfer factors (soil-to-plant and plant-to-animal) used. As discussed in the *GENII Version 2 Software Design Document* (Napier et al. 2004), a hierarchy of data sources was established, the first reference being the International Atomic Energy Agency Technical Report Series No. 364, *Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Temperate Environments*. The newer transfer factors are generally larger.

An option available in GENII-2, and used in evaluating potential impacts in this *Final TC & WM EIS*, is the use of updated internal dose conversion factors from FGR-13 (Eckerman et al. 1999). Compared with the previous Federal Guidance Report (FGR-11) (Eckerman, Wolburst, and Richardson 1988), some FGR-13 dose conversion factors went down and others went up; of the nuclides of interest in this EIS, the dose conversion factors for technetium-99, iodine-129, and cesium-137 went up.

K.2.1.1.3 Input Parameters

Site-specific and scenario-dependent data are used as input to the GENII-2 computer code. The following paragraphs describe the development of data that were used in the analyses of doses to the public, the onsite MEI, and noninvolved workers.

K.2.1.1.3.1 Meteorological Data

As employed for this analysis, the GENII-2 computer code uses a data set of the joint frequency distribution of windspeed, direction, and Pasquill atmospheric stability class as input to modeling the atmospheric transport of radioactive emissions. Tables K–4 and K–5 present the joint frequency distribution data for the Hanford 200 Areas at the 61-meter (200-foot) and 10-meter (30-foot) heights, respectively. These data represent the 10-year averages of data collected from 1997 through 2006 at the 200 Area Hanford Meteorological Station (Burk 2007). Wind rose representations of these data are included in Chapter 3, Section 3.2.4.1.

In the current *TC & WM EIS* analysis, the meteorological data from the 61-meter (200-foot) height were used in evaluating the impacts of releases from the WTP. This height is consistent with the current WTP design in which most emissions would be from a 61-meter (200-foot) height. The 10-meter (30-foot) height joint frequency data were used as input to model the transport of releases from STTS-East and -West.

Table K–4. Joint Frequency Distribution for the Hanford Site 200 Areas at a 61-Meter Height

Average Windspeed (meters per second)	Pasquill Atmospheric Stability Class	Percentage of Time Wind Blows from the Indicated Direction															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.78	A	0.11	0.12	0.14	0.12	0.12	0.1	0.08	0.07	0.07	0.04	0.05	0.04	0.04	0.06	0.07	0.08
	B	0.05	0.06	0.07	0.06	0.06	0.04	0.04	0.04	0.02	0.03	0.03	0.03	0.04	0.03	0.04	0.06
	C	0.05	0.06	0.06	0.04	0.04	0.05	0.05	0.03	0.03	0.03	0.01	0.02	0.02	0.02	0.03	0.05
	D	0.41	0.41	0.39	0.33	0.33	0.25	0.38	0.3	0.19	0.18	0.17	0.17	0.2	0.24	0.32	0.41
	E	0.21	0.18	0.17	0.18	0.2	0.2	0.33	0.23	0.18	0.15	0.16	0.15	0.18	0.22	0.23	0.25
	F	0.17	0.15	0.12	0.14	0.13	0.13	0.18	0.17	0.12	0.13	0.15	0.15	0.2	0.15	0.19	0.18
	G	0.05	0.06	0.05	0.06	0.06	0.05	0.08	0.08	0.08	0.07	0.06	0.06	0.09	0.11	0.1	0.08
2.5	A	0.58	0.64	0.5	0.47	0.62	0.4	0.5	0.46	0.27	0.24	0.24	0.16	0.18	0.24	0.48	0.77
	B	0.17	0.17	0.14	0.12	0.13	0.11	0.16	0.1	0.08	0.09	0.08	0.07	0.07	0.11	0.21	0.26
	C	0.14	0.12	0.1	0.09	0.08	0.09	0.12	0.08	0.06	0.05	0.06	0.04	0.04	0.07	0.14	0.19
	D	0.64	0.47	0.41	0.37	0.43	0.37	0.49	0.39	0.23	0.2	0.24	0.27	0.34	0.57	1.09	1
	E	0.32	0.27	0.19	0.2	0.26	0.26	0.37	0.33	0.19	0.17	0.27	0.34	0.57	0.81	0.91	0.55
	F	0.26	0.15	0.14	0.1	0.15	0.15	0.31	0.3	0.21	0.2	0.26	0.41	0.66	0.82	0.86	0.57
	G	0.07	0.05	0.05	0.05	0.05	0.06	0.07	0.12	0.08	0.1	0.17	0.22	0.33	0.33	0.29	0.16
4.5	A	0.29	0.3	0.2	0.1	0.14	0.09	0.08	0.07	0.09	0.18	0.28	0.3	0.14	0.26	0.74	0.44
	B	0.08	0.09	0.03	0.01	0.02	0.02	0.01	0.02	0.03	0.05	0.08	0.09	0.06	0.12	0.27	0.1
	C	0.07	0.04	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.03	0.05	0.06	0.04	0.09	0.21	0.08
	D	0.18	0.13	0.08	0.06	0.12	0.09	0.08	0.11	0.1	0.16	0.28	0.32	0.35	0.82	1.34	0.35
	E	0.14	0.1	0.11	0.09	0.15	0.13	0.09	0.2	0.1	0.16	0.31	0.53	1.06	1.85	1.5	0.35
	F	0.09	0.05	0.03	0.03	0.04	0.05	0.06	0.21	0.1	0.07	0.19	0.47	1.02	1.63	1.41	0.39
	G	0.02	0	0	0	0.01	0	0.01	0.05	0.03	0.03	0.07	0.17	0.38	0.47	0.47	0.15
7.0	A	0.08	0.14	0.08	0.02	0.02	0.01	0	0.01	0.03	0.09	0.27	0.34	0.1	0.23	0.52	0.1
	B	0.02	0.03	0.01	0	0	0	0	0.01	0.01	0.02	0.06	0.09	0.04	0.09	0.11	0.02
	C	0.01	0.01	0.01	0	0.01	0	0	0.01	0.01	0.01	0.05	0.06	0.02	0.06	0.09	0.01
	D	0.06	0.07	0.05	0.01	0.01	0	0.01	0.05	0.1	0.16	0.33	0.4	0.35	1	0.96	0.07
	E	0.04	0.06	0.03	0.01	0.02	0.01	0.02	0.1	0.11	0.16	0.41	0.77	0.98	2.58	1.56	0.11
	F	0.02	0.03	0.02	0.01	0.01	0	0.01	0.06	0.03	0.02	0.07	0.29	0.42	1.19	1.18	0.09
	G	0	0	0	0	0	0	0	0.03	0.01	0.01	0.01	0.05	0.08	0.17	0.63	0.05

Table K–4. Joint Frequency Distribution for the Hanford Site 200 Areas at a 61-Meter Height *(continued)*

Average Windspeed (meters per second)	Pasquill Atmospheric Stability Class	Percentage of Time Wind Blows from the Indicated Direction															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
9.6	A	0.01	0.02	0.03	0	0	0	0	0	0	0.04	0.17	0.2	0.05	0.12	0.35	0.02
	B	0	0.01	0.01	0	0	0	0	0	0	0.01	0.05	0.05	0.01	0.03	0.07	0
	C	0	0.01	0.01	0	0	0	0	0	0	0.01	0.03	0.03	0	0.02	0.06	0
	D	0.01	0.03	0.02	0	0	0	0	0.02	0.06	0.15	0.33	0.26	0.14	0.65	0.65	0.01
	E	0.01	0.03	0.04	0.01	0	0	0	0.05	0.13	0.17	0.36	0.34	0.21	1	0.91	0.01
	F	0	0	0	0	0	0	0	0	0.01	0.01	0.03	0.05	0.04	0.12	0.16	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02	0.08	0
12.5	A	0	0	0	0	0	0	0	0	0	0.01	0.11	0.09	0.02	0.04	0.18	0
	B	0	0	0	0	0	0	0	0	0	0	0.04	0.02	0.01	0.01	0.05	0
	C	0	0	0	0	0	0	0	0	0	0.01	0.02	0.02	0.01	0.01	0.04	0
	D	0	0	0.01	0	0	0	0	0.01	0.06	0.14	0.28	0.15	0.03	0.3	0.45	0
	E	0	0.01	0.01	0	0	0	0	0.02	0.05	0.12	0.18	0.11	0.03	0.3	0.26	0
	F	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.9	A	0	0	0	0	0	0	0	0	0	0.01	0.04	0.02	0.01	0	0.03	0
	B	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0	0.01	0
	C	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0	0.01	0
	D	0	0	0	0	0	0	0	0	0.01	0.08	0.11	0.03	0.01	0.02	0.04	0
	E	0	0	0	0	0	0	0	0	0	0.03	0.06	0.04	0.01	0.03	0.04	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.8	A	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0.02	0.02	0.02	0.01	0	0	0
	E	0	0	0	0	0	0	0	0	0	0.01	0.04	0.01	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: To convert meters to feet, multiply by 3.281; meters per second to miles per hour, by 2.237.
Source: Burk 2007.

Table K–5. Joint Frequency Distribution for the Hanford Site 200 Areas at a 10-Meter Height

Average Windspeed (meters per second)	Pasquill Atmospheric Stability Class	Percentage of Time Wind Blows from the Indicated Direction															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.78	A	0.29	0.31	0.34	0.27	0.28	0.25	0.19	0.17	0.13	0.12	0.12	0.1	0.1	0.13	0.17	0.22
	B	0.12	0.11	0.12	0.09	0.08	0.09	0.07	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.1
	C	0.09	0.09	0.1	0.05	0.06	0.07	0.06	0.05	0.04	0.03	0.03	0.03	0.03	0.03	0.04	0.06
	D	0.68	0.56	0.57	0.44	0.4	0.39	0.42	0.39	0.3	0.24	0.26	0.3	0.35	0.41	0.55	0.67
	E	0.36	0.29	0.27	0.24	0.27	0.32	0.47	0.4	0.35	0.34	0.48	0.53	0.55	0.52	0.57	0.46
	F	0.24	0.16	0.17	0.17	0.17	0.19	0.27	0.25	0.33	0.34	0.39	0.38	0.41	0.39	0.38	0.3
	G	0.09	0.07	0.1	0.09	0.08	0.08	0.11	0.1	0.1	0.11	0.1	0.1	0.13	0.13	0.14	0.11
2.5	A	0.72	0.53	0.42	0.36	0.46	0.47	0.45	0.28	0.24	0.24	0.32	0.25	0.2	0.29	0.66	0.78
	B	0.18	0.14	0.11	0.11	0.1	0.13	0.13	0.07	0.08	0.08	0.09	0.08	0.08	0.13	0.27	0.28
	C	0.16	0.11	0.09	0.08	0.07	0.1	0.1	0.08	0.04	0.04	0.07	0.06	0.05	0.09	0.21	0.22
	D	0.62	0.36	0.29	0.27	0.37	0.4	0.49	0.34	0.23	0.23	0.31	0.39	0.52	0.96	1.56	1.08
	E	0.25	0.15	0.13	0.14	0.23	0.31	0.38	0.38	0.33	0.32	0.63	1.13	2.04	2.26	1.69	0.56
	F	0.12	0.06	0.06	0.06	0.09	0.14	0.3	0.45	0.42	0.5	0.89	1.78	2.15	2.12	1.55	0.44
	G	0.04	0.02	0.02	0.03	0.03	0.03	0.08	0.19	0.2	0.24	0.37	0.75	0.62	0.69	0.59	0.11
4.5	A	0.21	0.22	0.16	0.06	0.08	0.04	0.02	0.04	0.05	0.14	0.27	0.4	0.2	0.35	0.76	0.27
	B	0.05	0.07	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.09	0.13	0.08	0.13	0.23	0.06
	C	0.03	0.03	0.01	0	0.01	0	0.01	0.01	0.01	0.02	0.06	0.08	0.04	0.09	0.18	0.04
	D	0.12	0.12	0.07	0.03	0.05	0.03	0.03	0.08	0.11	0.21	0.36	0.53	0.58	1.18	1.36	0.18
	E	0.05	0.05	0.04	0.02	0.02	0.01	0.04	0.12	0.15	0.19	0.46	0.91	1.24	2.28	1.57	0.11
	F	0	0	0	0.01	0.01	0	0.01	0.07	0.04	0.03	0.12	0.39	0.31	0.53	0.52	0.03
	G	0	0	0	0	0	0	0	0.02	0.01	0.01	0.04	0.2	0.04	0.17	0.21	0.01
7.0	A	0.02	0.06	0.05	0.01	0	0	0	0	0.01	0.05	0.25	0.37	0.09	0.2	0.5	0.07
	B	0	0.01	0.01	0	0	0	0	0	0.01	0.02	0.06	0.09	0.03	0.04	0.12	0.01
	C	0	0	0.01	0	0	0	0	0	0.01	0.01	0.04	0.06	0.02	0.04	0.09	0
	D	0.01	0.03	0.04	0.01	0	0	0	0.02	0.1	0.2	0.43	0.39	0.2	0.7	0.92	0.02
	E	0.01	0.03	0.03	0.01	0	0	0	0.05	0.14	0.21	0.39	0.29	0.17	0.57	0.76	0.01
	F	0	0	0	0	0	0	0	0	0.01	0	0.01	0.01	0.01	0.01	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table K–5. Joint Frequency Distribution for the Hanford Site 200 Areas at a 10-Meter Height *(continued)*

Average Windspeed (meters per second)	Pasquill Atmospheric Stability Class	Percentage of Time Wind Blows from the Indicated Direction															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
9.6	A	0	0	0	0	0	0	0	0	0	0.01	0.1	0.13	0.04	0.05	0.16	0
	B	0	0	0	0	0	0	0	0	0	0	0.04	0.03	0.01	0.01	0.04	0
	C	0	0	0	0	0	0	0	0	0	0	0.02	0.02	0.01	0.01	0.03	0
	D	0	0	0.01	0	0	0	0	0	0.04	0.11	0.22	0.13	0.03	0.1	0.23	0
	E	0	0	0.01	0	0	0	0	0.01	0.01	0.04	0.08	0.06	0.02	0.06	0.1	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.5	A	0	0	0	0	0	0	0	0	0	0.01	0.02	0.02	0	0	0.02	0
	B	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0.03	0.03	0.03	0.01	0.01	0	0
	E	0	0	0	0	0	0	0	0	0	0.01	0.02	0.01	0	0	0.01	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.9	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0
	E	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.8	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: To convert meters to feet, multiply by 3.281; meters per second to miles per hour, by 2.237.

Source: Burk 2007.

K.2.1.1.3.2 Population Data

The analysis considered the impacts on the populations residing within an 80-kilometer (50-mile) radius of the sources of emissions on the 200 Area plateau, the WTP, STTS-East, and STTS-West: 542,324; 546,746; and 589,668 people, respectively. The population data used in the analysis were taken from the 2010 decennial census (Census 2011). These data were used to provide a common basis for comparing impacts among the alternatives. Projections of future population growth were not made because the long duration of some alternatives would make such projections extremely speculative. Population distributions within 80 kilometers (50 miles) of the WTP, STTS-East, and STTS-West are shown in Figures K–2 through K–4 respectively. These figures illustrate the population distribution used in the calculations conducted with the GENII-2 computer code. Concentric circles shown in each figure are centered on the locations discussed above and have the following radii: 1.6 kilometers (1 mile), 3.2 kilometers (2 miles), 4.8 kilometers (3 miles), 6.4 kilometers (4 miles), 8.0 kilometers (5 miles), 16 kilometers (10 miles), 32 kilometers (20 miles), 48 kilometers (30 miles), 64 kilometers (40 miles), and 80 kilometers (50 miles). The population in each sector was calculated using data from the 2010 decennial census (Census 2011). All sectors located within 8.0 kilometers (5 miles) and many of the sectors located within 16 kilometers (10 miles) of the center points have zero populations because no one is allowed to reside on Hanford.

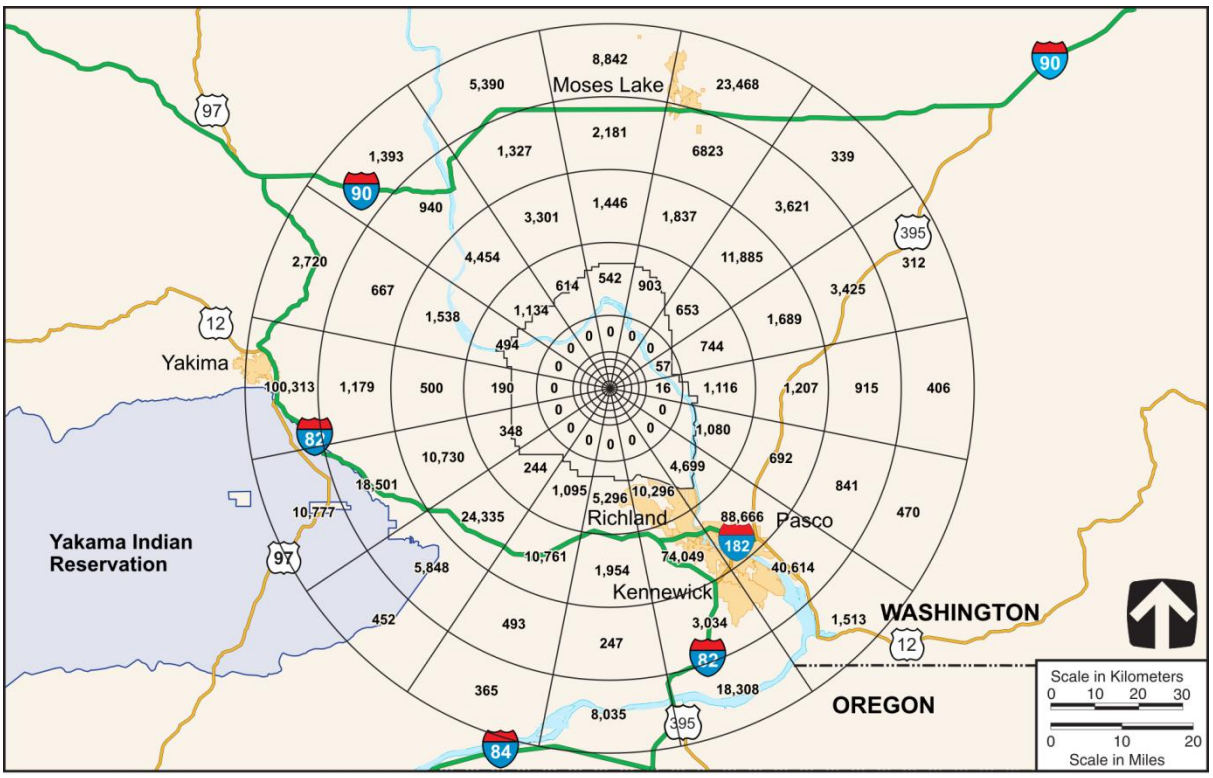

Figure K–2. Population Distribution Within 80 Kilometers (50 Miles) of the Waste Treatment Plant – Total Population: 542,324

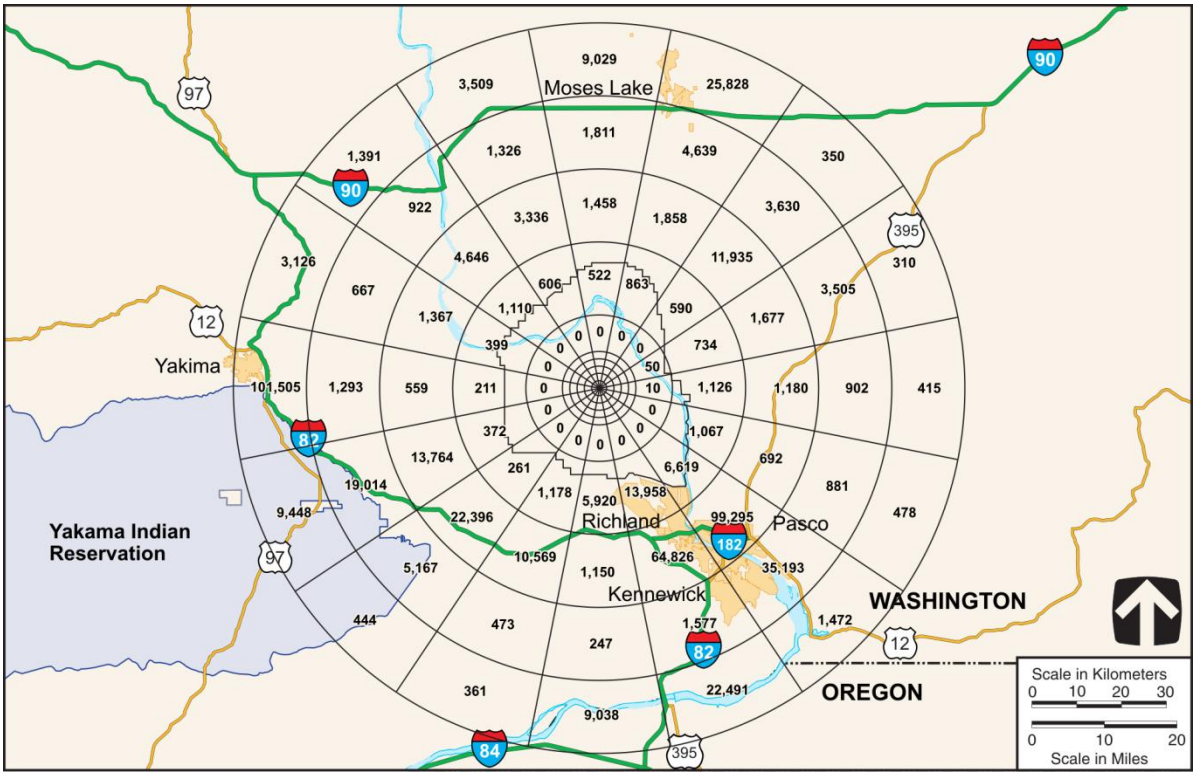

Figure K–3. Population Distribution Within 80 Kilometers (50 Miles) of the 200-East Area Supplemental Treatment Technology Site – Total Population: 546,746

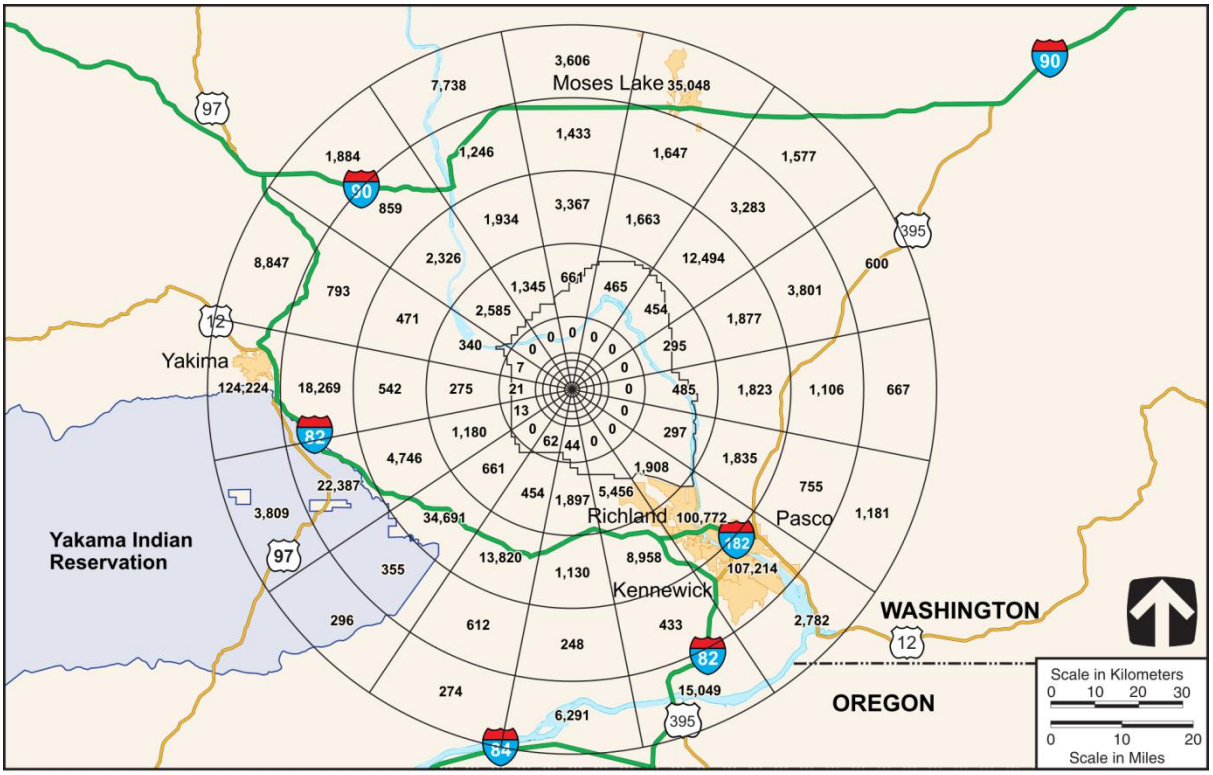

Figure K–4. Population Distribution Within 80 Kilometers (50 Miles) of the 200-West Area Supplemental Treatment Technology Site – Total Population: 589,668

K.2.1.1.3.3 Exposure Data

During normal operations of managing, retrieving, pretreating, and treating tank waste and deactivating and closing tanks and tank farm facilities, the general population would be exposed to atmospheric emissions. Exposure parameters for evaluating dose to the general population, the MEI, and the onsite MEI were primarily based on parameters from the *Hanford Site Risk Assessment Methodology (HSRAM)* (DOE 1995). As discussed below, the *HSRAM* parameters were modified, combined, or replaced where there was a reasonable basis for doing so. The parameters used for the general population, the MEI, and the onsite MEI are shown in Table K–6. Certain inputs to the GENII-2 computer code required the number of hours per year that an exposure could occur. A full year was defined as 8,760 hours.

Table K–6. Exposure Input Parameters for Members of the Public

Medium	Exposure Pathway	Rate	Reference
Population			
Air (plume)	External	8,760 hours per year	Napier et al. 1988
	Internal – inhalation	23 cubic meters per day	Beyeler et al. 1999
Soil	External	2,190 hours per year	Napier et al. 1988
	Internal – ingestion	120 milligrams per day	EPA 2000a
Food[a]	Internal – ingestion of:		
	Leafy vegetable	21 kilograms per year	Beyeler et al. 1999
	Other vegetable	29.2 kilograms per year	DOE 1995
	Fruit	15.3 kilograms per year	DOE 1995
	Grain	14 kilograms per year	Beyeler et al. 1999
	Meat	27.8 kilograms per year	DOE 1995
	Dairy	110 kilograms per year	DOE 1995
	Poultry	28.5 kilograms per year	Beyeler et al. 1999
	Eggs	19 kilograms per year	Beyeler et al. 1999
Maximally Exposed Individual			
Air (plume)	External	8,760 hours per year	Napier et al. 1988
	Internal – inhalation	23 cubic meters per day	Beyeler et al. 1999
Soil	External	4,380 hours per year	Napier et al. 1988
	Internal – ingestion	120 milligrams per day	EPA 2000a
Food[a]	Internal – ingestion of:		
	Leafy vegetable	65 kilograms per year	Beyeler et al. 1999, DOE and Ecology 1996
	Other vegetable	120 kilograms per year	DOE and Ecology 1996
	Fruit	120 kilograms per year	DOE and Ecology 1996
	Grain	90 kilograms per year	Beyeler et al. 1999
	Meat	27.8 kilograms per year	DOE and Ecology 1996
	Dairy	110 kilograms per year	DOE 1995
	Poultry	28.5 kilograms per year	Beyeler et al. 1999
	Eggs	19 kilograms per year	Beyeler et al. 1999

Table K–6. Exposure Input Parameters for Members of the Public *(continued)*

Medium	Exposure Pathway	Rate	Reference
Onsite Maximally Exposed Individual			
Air (plume)	External	2,080 hours per year	DOE 1995
	Internal – inhalation	2,080 hours per year	DOE 1995
Soil	External	988 hours per year	DOE 1995
	Internal – ingestion	50 milligrams per day	DOE 1995

[a] Food consumption rates represent the portion of the diet consisting of contaminated food.

Note: To convert cubic meters to cubic feet, multiply by 35.315; kilograms to pounds, by 2.2046; milligrams to ounces, by 0.0000350003527.

Members of the public would be exposed via two pathways to the passing plume. They would receive an external dose 24 hours per day from direct exposure to the passing plume. They also would receive an internal dose from breathing 23 cubic meters (810 cubic feet) of contaminated air per day. Respiration of resuspended radionuclides that have been deposited on the ground was also included in the dose from inhalation.

Radionuclides deposited on the ground represent another means of exposure because they may cause an external exposure to individuals near the contamination. In this analysis, it was assumed that an average member of the public would be exposed 25 percent of the time, 2,190 hours, during the entire year, and the MEI would be exposed 50 percent of the time, 4,380 hours per year. Soil could also be inadvertently ingested, resulting in an internal dose. The *HSRAM* assumes ingestion rates of 200 milligrams (0.0071 ounces) per day for children and 100 milligrams (0.0035 ounces) per day for adults. In this analysis, a single rate of 120 milligrams (0.0042 ounces) per day was used (EPA 2000a). This is the weighted average of the values in the *HSRAM*—ingestion of 200 milligrams (0.0071 ounces) per day over a 6-year period and ingestion of 100 milligrams (0.0035 ounces) per day over a 24-year period.

Exposure of members of the public was also assumed to occur as a result of a portion of their diet coming from fruits and vegetables grown in a family garden. These fruits and vegetables could become contaminated by the deposition of radioactive materials. When consumed, the radioactive materials would result in an internal dose. Consistent with the *HSRAM*, members of the general public were assumed to consume 15.3 kilograms (33.7 pounds) of fruit and 29.2 kilograms (64.4 pounds) of nonleafy vegetables per year that have become contaminated by deposition of radioactive material (DOE 1995). Additionally, individuals were assumed to consume 21 kilograms (46.3 pounds) per year of leafy vegetables and 14 kilograms (30.9 pounds) per year of grains that have become contaminated (Beyeler et al. 1999). The MEI was assumed to consume a larger portion of his or her diet from fruits and vegetables grown in a family garden. Annual consumption was assumed to be 120 kilograms (265 pounds) of fruit, 120 kilograms (265 pounds) of nonleafy vegetables, 65 kilograms (143 pounds) of leafy vegetables, and 90 kilograms (198 pounds) of grains (Beyeler et al. 1999; DOE and Ecology 1996).

Analysis of the radiological impact on members of the public was based on an assumption that a portion of their diet would come from animal products from livestock raised in the area. Consuming forage that has been contaminated through the deposition of radioactive material would expose the animals. A person was assumed to consume 27.8 kilograms (61.3 pounds) of meat per year, consisting of 27.4 kilograms (60.4 pounds) of beef and 0.4 kilograms (0.9 pounds) of venison (DOE 1995). The consumption rate of contaminated dairy products was assumed to be 110 kilograms (243 pounds) per year (DOE 1995). The entire annual intake of 28.5 kilograms (62.8 pounds) of poultry and 19 kilograms (41.9 pounds) of eggs was assumed to come from local sources (Beyeler et al. 1999). The MEI consumption of meat, poultry, eggs, and dairy products was assumed to be the same as consumption by the members of the public.

Exposure parameter values for the onsite MEI dose analysis are shown in Table K–6. The onsite MEI was assumed to be exposed during the workday. Exposure to the passing plume and inhalation were assumed to occur for a normal 40-hour work week, or about 2,080 hours per year. Exposure to deposited materials on the ground was assumed to occur for only a portion of this time, about 988 hours per year. Ingestion of resuspended soil would result in consumption of 50 milligrams (0.0018 ounces) per day.

K.2.1.1.3.4 Source Terms

Doses and risks to the public from the atmospheric release of radionuclides during normal operations were estimated for the year of maximum impact and for the life of the project for each Tank Closure alternative. The atmospheric releases were evaluated as arising from three locations: the WTP, STTS-East, and STTS-West. Therefore, six sets of source terms were developed for each Tank Closure alternative.

Radionuclides that would dominate the dose to the public through the air pathway were selected for detailed analysis. These were the radionuclides that are known to be the main contributors to the air pathway dose or that are of specific interest. To ensure that no major radionuclides were eliminated from the detailed analysis, a screening analysis was performed. In the screening analysis, it was assumed that one-millionth of the tank farms' Best-Basis Inventory (see Appendix D, Section D.1.1.2) would enter an air stream through a treatment system that would remove 99.95 percent of the particulates. Exceptions were hydrogen-3 (tritium), carbon-14, and iodine-129, all of which would likely be in a gaseous state, are easily volatilized, and are poorly captured in air treatment systems. In the screening analysis, the entire Best-Basis Inventory of these three radionuclides was assumed to be released. Inhalation dose conversion factors (Eckerman, Wolburst, and Richardson 1988) were multiplied by the released inventory to determine the radionuclides in the tank farm inventory of greatest potential impact.[2] Table K–7 lists the radionuclides considered in the detailed dose analysis. These radionuclides account for 99.99 percent of the dose estimated from the screening analysis. In a second screening analysis, it was assumed that the air treatment system removed 99 percent of the iodine-129. This assumption is consistent with the way iodine-129 releases from the WTP, Bulk Vitrification Facilities, Cast Stone Facilities, Contact-Handled Mixed TRU Waste Facility(ies), and Remote-Handled Mixed TRU Waste Facility were modeled in the dose analysis. This second screening also showed that the radionuclides selected for detailed analysis were responsible for 99.99 percent of the estimated dose. A sensitivity analysis was performed to determine the effect on the dose of the assumption that the treatment system would be effective in removing iodine. The dose to the population and the MEI over the duration of the project under Alternative 2B was calculated without reducing the iodine inventory. The dose without iodine removal is about 13 to 15 percent higher than the dose assuming some reduction in iodine.

Estimates of the release of radionuclides associated with the Tank Closure alternatives evaluated in this *TC & WM EIS* were derived from data packages that defined the various activities needed to execute the tank closure project. These data packages defined the resource and labor requirements, radioactive and nonradioactive air emissions, worker dose, waste generation, and scope and duration of activities, such as installing risers (access ports into the underground tanks), retrieving waste from tanks (determined by retrieval technology), processing waste, removing and filling tanks, and other closure activities. Various combinations of these activities form the Tank Closure alternatives.

[2] The screening was performed using dose conversion factors from Federal Guidance Report 11 (Eckerman, Wolburst, and Richardson 1988). In the more recent Federal Guidance Report 13 (Eckerman et al. 1999), the dose conversion factors changed (different amounts for different radionuclides). These changes do not affect the selection of radionuclides for analysis.

Table K–7. Radionuclides Included in Air Pathway Dose Analysis

Radionuclide	Symbol
Hydrogen-3 (tritium)	H-3
Carbon-14	C-14
Cobalt-60	Co-60
Strontium-90	Sr-90
Technetium-99	Tc-99
Iodine-129	I-129
Cesium-137	Cs-137
Uranium[a]	U
Plutonium-238	Pu-238
Plutonium-239 and -240	Pu-239, Pu-240
Plutonium-241	Pu-241
Americium-241	Am-241

[a] Uranium inventories include the isotopes uranium-233, uranium-234, uranium-235, and uranium-238.

The data package activities had to be scaled to correspond to the Tank Closure alternatives evaluated in this EIS. Scaling is proportionally adjusting the values in the data packages to account for differences in the assumptions or basis of each alternative. Scaling accounts for a number of differences, including the duration of an activity and the number of actions performed as part of an activity. For example, the amount of a radionuclide emitted from processing 99 percent of the tank waste would remain essentially the same for a given treatment technology under any of the alternatives, but the annual release might change depending on the number of years taken to process the waste under a specific alternative. Scaling was used to adjust the emissions to account for the number of years of operations for a particular alternative compared with the duration assumed in the data packages. Similarly, if a data package activity was developed based on the installation of 50 new risers, but the alternative requires 75 new risers, the resource requirements, emissions, and other data associated with the activity would be increased by 50 percent to scale the data to match the alternative. The scaled data are included in the scaled data sets (SAIC 2010a, 2010b, 2010c).

Estimated emissions for the treatment facilities (e.g., the Pretreatment Facility and WTP) presented in the scaled data sets (SAIC 2010a) were conservatively based on a reduction factor of 2,000 for particulate emissions. This factor represents the reduction associated with a single stage of high-efficiency particulate air (HEPA) filters. The air treatment equipment currently proposed for the WTP includes a number of other technologies that would further reduce emissions to the atmosphere, including, for example, scrubbers, high-efficiency mist eliminators, and a second stage of HEPA filters. The source terms from the treatment facilities were adjusted by a factor of 100 for particulates and iodine-129 to take credit equivalent to that provided by a second set of HEPA filters (for particulates) or caustic scrubbers and other treatments (for iodine). This adjustment still resulted in an overestimation of the radionuclides in the treatment facility air discharges because no credit was taken for other air treatment technologies that would be employed. No reduction factors were applied to tritium and carbon-14 emissions. They are treated as gaseous emissions that would not be abated by the air treatment technologies.

The source terms for the WTP and STTS-East and -West were based on the estimated annual emissions from the scaled data sets (SAIC 2010a). Then the radioactive emissions, or a portion thereof, were assigned to one of the three locations. Emissions associated with pretreatment or vitrification of tank waste, de-encapsulation and vitrification of cesium and strontium, or deactivation of the associated facilities were attributed to the WTP. Radioactive emissions from all other activities are divided between STTS-East and -West, based on the actions and facilities involved. For example, emissions from tank

waste retrieval via a particular technology were divided between the two locations based on the proportion of tanks in the 200-East and 200-West Areas on which the technology would be used. Similarly, emissions from supplemental treatment technologies such as bulk vitrification, cast stone, or steam reforming were assigned to the appropriate area to reflect the assumptions employed in developing a specific alternative.

The timeframe over which each activity would occur was determined for all of the activities associated with an alternative. The total annual emissions for each of the three locations were determined by summing the emissions from each activity that would be ongoing during a year. In most cases, the year of maximum impact was immediately apparent because the emissions from the WTP and supplemental treatment technologies would contribute most to variability in the release of radionuclides and these activities would operate simultaneously; when necessary to distinguish which year would result in the maximum impact, emissions from different years were evaluated. Tables K–8 through K–20 present the emissions for the year of maximum impact (based on the population and MEI doses in Tables K–21 through K–46) and the year in which those emissions would occur under each Tank Closure alternative.

Total emissions over the operational life of the project were also calculated for the WTP, the 200-East Area, and the 200-West Area for each Tank Closure alternative. The total emissions were calculated by summing the releases for each location across all the years of release. The results are also presented in Tables K–8 through K–20. For the life-of-project emissions, the time span presented in the tables reflects the portion of the project in which radioactive emissions were projected to occur. Except for Tank Closure Alternatives 6A and 6B, which include clean closure of all of the tank farms, each alternative would have an administrative control period or a postclosure care period. Under Tank Closure Alternatives 1 and 2A, which do not include any closure, life-of-project emissions would include those that occur over the administrative control period. The postclosure care periods were not included in the time span for the life-of-project emissions for the other Tank Closure alternatives because no radioactive emissions are expected to occur.

Table K–8. Tank Closure Alternative 1 Radioactive Airborne Emissions During Normal Operations (curies)

	Emissions over Life of Project (2006–2107)			Annual Emissions in Year of Maximum Impact (2008)[a]		
Radionuclides	**Waste Treatment Plant[b]**	**200-East Area STTS**	**200-West Area STTS**	**Waste Treatment Plant[b]**	**200-East Area STTS**	**200-West Area STTS**
Hydrogen-3 (tritium)	0	6.1×10^{4}	5.9×10^{4}	0	6.1×10^{2}	5.9×10^{2}
Carbon-14	0	0	0	0	0	0
Cobalt-60	0	2.9	2.8	0	2.9×10^{-2}	2.8×10^{-2}
Strontium-90	0	3.3×10^{-1}	3.2×10^{-1}	0	6.4×10^{-3}	6.2×10^{-3}
Technetium-99	0	0	0	0	0	0
Iodine-129	0	7.3×10^{-1}	7.1×10^{-1}	0	1.4×10^{-2}	1.3×10^{-2}
Cesium-137	0	4.0	3.9	0	7.9×10^{-2}	7.5×10^{-2}
Uranium	0	1.9	1.8	0	1.9×10^{-2}	1.8×10^{-2}
Plutonium-238	0	0	0	0	0	0
Plutonium-239, -240	0	6.5×10^{-8}	6.1×10^{-8}	0	1.7×10^{-9}	1.2×10^{-9}
Plutonium-241	0	0	0	0	0	0
Americium-241	0	5.0×10^{-8}	4.6×10^{-8}	0	1.5×10^{-9}	9.6×10^{-10}

[a] The year of maximum impact of 2008 is based on a 2006 start date (see Chapter 2).

[b] There would be no emissions from the Waste Treatment Plant because it would not operate under this alternative.

Key: STTS=Supplemental Treatment Technology Site.

Table K–9. Tank Closure Alternative 2A Radioactive Airborne Emissions During Normal Operations (curies)

Radionuclides	Emissions over Life of Project (2006–2193)			Annual Emissions in Year of Maximum Impact (2093)		
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Waste Treatment Plant	200-East Area STTS	200-West Area STTS[a]
Hydrogen-3 (tritium)	1.2×10^{4}	6.1×10^{4}	5.9×10^{4}	0	0	0
Carbon-14	3.1×10^{3}	0	0	0	0	0
Cobalt-60	4.0×10^{-2}	2.9	2.8	0	0	0
Strontium-90	4.0×10^{2}	6.0×10^{-1}	5.8×10^{-1}	1.0×10^{2}	0	0
Technetium-99	1.5×10^{-1}	0	0	0	0	0
Iodine-129	4.8×10^{-1}	1.3	1.3	0	0	0
Cesium-137	5.8×10^{2}	7.3	7.1	2.4×10^{2}	0	0
Uranium	4.7×10^{-3}	1.9	1.8	0	0	0
Plutonium-238	2.4×10^{-2}	1.2×10^{-7}	3.2×10^{-7}	0	0	0
Plutonium-239, -240	4.1×10^{-1}	1.6×10^{-5}	4.1×10^{-5}	0	1.0×10^{-9}	0
Plutonium-241	6.2×10^{-1}	0	0	0	0	0
Americium-241	7.2×10^{-1}	1.6×10^{-6}	3.5×10^{-6}	0	0	0

[a] In the year of maximum impact, there would be no project emissions from 200-West Area because all project activities would have been completed previously.

Key: STTS=Supplemental Treatment Technology Site.

Table K–10. Tank Closure Alternative 2B Radioactive Airborne Emissions During Normal Operations (curies)

Radionuclides	Emissions over Life of Project (2006–2045)			Annual Emissions in Year of Maximum Impact (2040)		
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Waste Treatment Plant	200-East Area STTS	200-West Area STTS
Hydrogen-3 (tritium)	1.2×10^{4}	0	0	4.6×10^{2}	0	0
Carbon-14	3.1×10^{3}	0	0	1.2×10^{2}	0	0
Cobalt-60	4.1×10^{-2}	0	0	1.6×10^{-3}	0	0
Strontium-90	4.2×10^{2}	1.2×10^{-1}	1.2×10^{-1}	1.2×10^{2}	3.2×10^{-3}	3.1×10^{-3}
Technetium-99	1.5×10^{-1}	0	0	5.7×10^{-3}	0	0
Iodine-129	4.8×10^{-1}	2.7×10^{-1}	2.6×10^{-1}	1.8×10^{-2}	7.0×10^{-3}	6.7×10^{-3}
Cesium-137	5.8×10^{2}	1.5	1.4	2.5×10^{2}	3.9×10^{-2}	3.8×10^{-2}
Uranium	4.7×10^{-3}	0	0	1.8×10^{-4}	0	0
Plutonium-238	2.4×10^{-2}	5.6×10^{-7}	7.6×10^{-7}	9.3×10^{-4}	1.5×10^{-7}	1.5×10^{-7}
Plutonium-239, -240	4.1×10^{-1}	7.2×10^{-5}	9.6×10^{-5}	1.6×10^{-2}	1.9×10^{-5}	1.9×10^{-5}
Plutonium-241	6.3×10^{-1}	0	0	2.4×10^{-2}	0	0
Americium-241	7.2×10^{-1}	5.9×10^{-6}	7.8×10^{-6}	2.8×10^{-2}	1.5×10^{-6}	1.5×10^{-6}

Key: STTS=Supplemental Treatment Technology Site.

Table K–11. Tank Closure Alternative 3A Radioactive Airborne Emissions During Normal Operations (curies)

Radionuclides	Emissions over Life of Project (2006–2042)			Annual Emissions in Year of Maximum Impact (2040)		
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Waste Treatment Plant	200-East Area STTS	200-West Area STTS
Hydrogen-3 (tritium)	3.5×10^{3}	4.6×10^{3}	3.9×10^{3}	0	2.1×10^{1}	1.8×10^{1}
Carbon-14	9.6×10^{2}	1.2×10^{3}	9.9×10^{2}	0	5.3	4.5
Cobalt-60	3.3×10^{-2}	3.5×10^{-3}	3.4×10^{-3}	0	1.6×10^{-5}	1.5×10^{-5}
Strontium-90	4.0×10^{2}	1.9×10^{-1}	2.4	1.0×10^{2}	2.1×10^{-5}	1.1×10^{-2}
Technetium-99	4.4×10^{-2}	5.7×10^{-2}	4.8×10^{-2}	0	2.6×10^{-4}	2.1×10^{-4}
Iodine-129	1.4×10^{-1}	4.2×10^{-1}	3.8×10^{-1}	0	8.3×10^{-4}	7.0×10^{-4}
Cesium-137	5.6×10^{2}	2.5	2.3×10^{1}	2.4×10^{2}	5.2×10^{-3}	1.0×10^{-1}
Uranium	4.3×10^{-3}	1.1×10^{-4}	1.5×10^{-4}	0	4.9×10^{-7}	6.8×10^{-7}
Plutonium-238	2.1×10^{-2}	6.8×10^{-5}	3.0×10^{-4}	0	7.5×10^{-10}	1.3×10^{-6}
Plutonium-239, -240	3.7×10^{-1}	8.0×10^{-4}	5.4×10^{-3}	0	1.4×10^{-8}	2.4×10^{-5}
Plutonium-241	5.6×10^{-1}	1.2×10^{-3}	8.0×10^{-3}	0	2.0×10^{-8}	3.6×10^{-5}
Americium-241	6.0×10^{-1}	2.4×10^{-3}	7.0×10^{-3}	0	3.6×10^{-8}	3.2×10^{-5}

Key: STTS=Supplemental Treatment Technology Site.

Table K–12. Tank Closure Alternative 3B Radioactive Airborne Emissions During Normal Operations (curies)

Radionuclides	Emissions over Life of Project (2006–2042)			Annual Emissions in Year of Maximum Impact (2040)		
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Waste Treatment Plant	200-East Area STTS	200-West Area STTS
Hydrogen-3 (tritium)	3.5×10^{3}	4.6×10^{-2}	3.9×10^{-2}	0	2.1×10^{-4}	1.8×10^{-4}
Carbon-14	9.6×10^{2}	1.2×10^{-2}	9.9×10^{-3}	0	5.3×10^{-5}	4.5×10^{-5}
Cobalt-60	3.3×10^{-2}	7.7×10^{-5}	6.7×10^{-5}	0	3.1×10^{-7}	3.0×10^{-7}
Strontium-90	4.0×10^{2}	1.9×10^{-1}	1.5×10^{-1}	1.0×10^{2}	4.1×10^{-7}	2.1×10^{-4}
Technetium-99	1.0×10^{-1}	4.6×10^{-5}	9.5×10^{-4}	0	5.1×10^{-8}	4.3×10^{-6}
Iodine-129	1.4×10^{-1}	2.4×10^{-1}	2.3×10^{-1}	0	8.3×10^{-9}	7.0×10^{-9}
Cesium-137	5.6×10^{2}	1.4	1.7	2.4×10^{2}	1.0×10^{-4}	2.0×10^{-3}
Uranium	4.3×10^{-3}	6.7×10^{-6}	3.4×10^{-6}	0	9.7×10^{-9}	1.4×10^{-8}
Plutonium-238	2.1×10^{-2}	6.9×10^{-5}	7.1×10^{-6}	0	1.5×10^{-11}	2.7×10^{-8}
Plutonium-239, -240	3.7×10^{-1}	8.2×10^{-4}	2.8×10^{-4}	0	1.3×10^{-9}	4.8×10^{-7}
Plutonium-241	5.6×10^{-1}	1.2×10^{-3}	1.7×10^{-4}	0	4.0×10^{-10}	7.2×10^{-7}
Americium-241	6.0×10^{-1}	2.4×10^{-3}	1.6×10^{-4}	0	7.3×10^{-10}	6.3×10^{-7}

Key: STTS=Supplemental Treatment Technology Site.

Table K–13. Tank Closure Alternative 3C Radioactive Airborne Emissions During Normal Operations (curies)

Radionuclides	Emissions over Life of Project (2006–2042)			Annual Emissions in Year of Maximum Impact (2040)		
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Waste Treatment Plant	200-East Area STTS	200-West Area STTS
Hydrogen-3 (tritium)	3.5×10^{3}	4.6×10^{3}	3.9×10^{3}	0	2.1×10^{1}	1.8×10^{1}
Carbon-14	9.6×10^{2}	1.2×10^{3}	9.9×10^{2}	0	5.3	4.5
Cobalt-60	3.3×10^{-2}	3.5×10^{-3}	3.4×10^{-3}	0	1.6×10^{-5}	1.5×10^{-5}
Strontium-90	4.0×10^{2}	1.9×10^{-1}	2.4	1.0×10^{2}	2.1×10^{-5}	1.1×10^{-2}
Technetium-99	1.0×10^{-1}	5.7×10^{-2}	4.8×10^{-2}	0	2.6×10^{-4}	2.1×10^{-4}
Iodine-129	1.4×10^{-1}	1.9×10^{1}	1.6×10^{1}	0	8.3×10^{-2}	7.0×10^{-2}
Cesium-137	5.6×10^{2}	2.5	2.3×10^{1}	2.4×10^{2}	5.2×10^{-3}	1.0×10^{-1}
Uranium	4.3×10^{-3}	1.1×10^{-4}	1.5×10^{-4}	0	4.9×10^{-7}	6.8×10^{-7}
Plutonium-238	2.1×10^{-2}	6.9×10^{-5}	3.0×10^{-4}	0	7.5×10^{-10}	1.3×10^{-6}
Plutonium-239, -240	3.7×10^{-1}	8.0×10^{-4}	5.4×10^{-3}	0	1.4×10^{-8}	2.4×10^{-5}
Plutonium-241	5.6×10^{-1}	1.2×10^{-3}	8.0×10^{-3}	0	2.0×10^{-8}	3.6×10^{-5}
Americium-241	6.0×10^{-1}	2.4×10^{-3}	7.0×10^{-3}	0	3.6×10^{-8}	3.2×10^{-5}

Key: STTS=Supplemental Treatment Technology Site.

Table K–14. Tank Closure Alternative 4 Radioactive Airborne Emissions During Normal Operations (curies)

Radionuclides	Emissions over Life of Project (2006–2045)			Annual Emissions in Year of Maximum Impact (2043)		
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Waste Treatment Plant	200-East Area STTS	200-West Area STTS
Hydrogen-3 (tritium)	3.6×10^{3}	4.8×10^{-2}	3.9×10^{3}	0	3.0×10^{-6}	3.0×10^{-6}
Carbon-14	9.7×10^{2}	1.2×10^{-2}	1.0×10^{3}	0	2.2×10^{-7}	2.2×10^{-7}
Cobalt-60	3.4×10^{-2}	2.0×10^{-4}	3.6×10^{-3}	0	2.1×10^{-7}	2.1×10^{-7}
Strontium-90	4.0×10^{2}	2.1	4.9	1.0×10^{2}	5.8×10^{-3}	5.8×10^{-3}
Technetium-99	4.4×10^{-2}	1.5×10^{-3}	4.8×10^{-2}	0	1.7×10^{-6}	1.7×10^{-6}
Iodine-129	1.4×10^{-1}	2.6×10^{-1}	4.1×10^{-1}	0	3.0×10^{-9}	3.0×10^{-9}
Cesium-137	5.6×10^{2}	2.4	2.4×10^{1}	2.4×10^{2}	4.1×10^{-3}	4.1×10^{-3}
Uranium	4.4×10^{-3}	5.2×10^{-5}	2.0×10^{-4}	0	2.3×10^{-7}	2.3×10^{-7}
Plutonium-238	2.1×10^{-2}	1.2×10^{-4}	3.6×10^{-4}	0	4.2×10^{-7}	4.2×10^{-7}
Plutonium-239, -240	3.7×10^{-1}	2.8×10^{-3}	8.0×10^{-3}	0	2.6×10^{-5}	2.6×10^{-5}
Plutonium-241	5.7×10^{-1}	2.1×10^{-3}	9.0×10^{-3}	0	4.4×10^{-6}	4.4×10^{-6}
Americium-241	6.1×10^{-1}	4.4×10^{-3}	9.8×10^{-3}	0	5.5×10^{-6}	5.5×10^{-6}

Key: STTS=Supplemental Treatment Technology Site.

Table K–15. Tank Closure Alternative 5 Radioactive Airborne Emissions During Normal Operations (curies)

Radionuclides	Emissions over Life of Project (2006–2036)			Annual Emissions in Year of Maximum Impact (2034)		
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Waste Treatment Plant	200-East Area STTS	200-West Area STTS
Hydrogen-3 (tritium)	5.8×10^{3}	1.6×10^{-2}	3.5×10^{3}	3.6	1.0×10^{-4}	2.2×10^{1}
Carbon-14	1.5×10^{3}	4.1×10^{-3}	9.0×10^{2}	9.1	2.5×10^{-5}	5.6
Cobalt-60	4.1×10^{-2}	3.1×10^{-5}	3.1×10^{-3}	5.4×10^{-5}	1.5×10^{-7}	1.9×10^{-5}
Strontium-90	3.8×10^{2}	1.6×10^{-1}	2.2	1.0×10^{2}	2.0×10^{-7}	1.3×10^{-2}
Technetium-99	2.1×10^{-1}	4.3×10^{-4}	4.3×10^{-2}	8.8×10^{-4}	2.4×10^{-6}	2.7×10^{-4}
Iodine-129	2.3×10^{-1}	2.0×10^{-1}	3.3×10^{-1}	1.4×10^{-6}	4.0×10^{-9}	8.8×10^{-4}
Cesium-137	5.4×10^{2}	1.1	2.3×10^{1}	2.4×10^{2}	4.9×10^{-5}	1.4×10^{-1}
Uranium	4.3×10^{-3}	4.8×10^{-6}	1.4×10^{-4}	1.7×10^{-6}	4.6×10^{-9}	8.6×10^{-7}
Plutonium-238	1.9×10^{-2}	6.2×10^{-5}	2.7×10^{-4}	2.6×10^{-9}	7.1×10^{-12}	1.7×10^{-6}
Plutonium-239, -240	3.4×10^{-1}	6.8×10^{-4}	4.9×10^{-3}	4.5×10^{-8}	1.1×10^{-9}	3.0×10^{-5}
Plutonium-241	5.1×10^{-1}	1.1×10^{-3}	7.3×10^{-3}	6.8×10^{-8}	1.9×10^{-10}	4.5×10^{-5}
Americium-241	5.5×10^{-1}	2.2×10^{-3}	6.4×10^{-3}	1.3×10^{-7}	3.5×10^{-10}	3.9×10^{-5}

Key: STTS=Supplemental Treatment Technology Site.

Table K–16. Tank Closure Alternative 6A, Base Case, Radioactive Airborne Emissions During Normal Operations (curies)

Radionuclides	Emissions over Life of Project (2006–2168)			Annual Emissions in Year of Maximum Impact (2163)		
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Waste Treatment Plant	200-East Area STTS	200-West Area STTS
Hydrogen-3 (tritium)	1.2×10^{4}	8.8×10^{1}	8.4×10^{-1}	0	1.1×10^{-1}	1.1×10^{-1}
Carbon-14	3.1×10^{3}	1.1×10^{1}	1.0×10^{-1}	0	1.4×10^{-2}	1.4×10^{-2}
Cobalt-60	4.1×10^{-2}	2.9×10^{-3}	7.8×10^{-5}	0	3.1×10^{-6}	3.1×10^{-6}
Strontium-90	4.3×10^{2}	2.5×10^{1}	7.1×10^{-1}	1.0×10^{2}	2.4×10^{-2}	2.4×10^{-2}
Technetium-99	1.5×10^{-1}	4.0×10^{-2}	3.8×10^{-4}	0	5.2×10^{-5}	5.2×10^{-5}
Iodine-129	4.8×10^{-1}	1.2	8.1×10^{-3}	0	2.0×10^{-4}	2.0×10^{-4}
Cesium-137	6.4×10^{2}	7.7×10^{1}	7.3×10^{-1}	2.4×10^{2}	9.2×10^{-2}	9.2×10^{-2}
Uranium	4.7×10^{-3}	2.5×10^{-3}	2.4×10^{-5}	0	3.2×10^{-6}	3.2×10^{-6}
Plutonium-238	2.4×10^{-2}	1.1×10^{-3}	1.1×10^{-5}	0	1.7×10^{-6}	1.4×10^{-6}
Plutonium-239, -240	4.1×10^{-1}	1.4×10^{-2}	6.5×10^{-4}	0	4.9×10^{-5}	1.2×10^{-5}
Plutonium-241	6.3×10^{-1}	1.1×10^{-2}	1.2×10^{-4}	0	1.5×10^{-5}	1.5×10^{-5}
Americium-241	7.3×10^{-1}	1.8×10^{-2}	9.0×10^{-4}	0	1.6×10^{-5}	1.4×10^{-5}

Key: STTS=Supplemental Treatment Technology Site.

Table K–17. Tank Closure Alternative 6A, Option Case, Radioactive Airborne Emissions During Normal Operations (curies)

Radionuclides	Emissions over Life of Project (2006–2168)			Annual Emissions in Year of Maximum Impact (2163)		
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Waste Treatment Plant	200-East Area STTS	200-West Area STTS
Hydrogen-3 (tritium)	1.2×10^{4}	1.5×10^{3}	1.5×10^{3}	0	1.9	1.9
Carbon-14	3.1×10^{3}	1.5×10^{1}	1.5×10^{1}	0	1.9×10^{-2}	1.9×10^{-2}
Cobalt-60	4.1×10^{-2}	5.3×10^{-3}	5.3×10^{-3}	0	5.8×10^{-6}	5.8×10^{-6}
Strontium-90	4.3×10^{2}	2.9×10^{1}	2.9×10^{1}	1.0×10^{2}	2.6×10^{-2}	2.6×10^{-2}
Technetium-99	1.5×10^{-1}	5.7×10^{-2}	5.7×10^{-2}	0	7.5×10^{-5}	7.5×10^{-5}
Iodine-129	4.8×10^{-1}	1.3	1.3	0	2.8×10^{-4}	2.8×10^{-4}
Cesium-137	6.4×10^{2}	7.9×10^{1}	7.9×10^{1}	2.4×10^{2}	9.5×10^{-2}	9.5×10^{-2}
Uranium	4.7×10^{-3}	3.2×10^{-3}	3.2×10^{-3}	0	4.2×10^{-6}	4.2×10^{-6}
Plutonium-238	2.4×10^{-2}	2.2×10^{-3}	2.2×10^{-3}	0	3.1×10^{-6}	2.8×10^{-6}
Plutonium-239, -240	4.1×10^{-1}	9.1×10^{-2}	9.1×10^{-2}	0	1.5×10^{-4}	1.1×10^{-4}
Plutonium-241	6.3×10^{-1}	6.6×10^{-2}	6.6×10^{-2}	0	8.6×10^{-5}	8.6×10^{-5}
Americium-241	7.3×10^{-1}	3.6×10^{-2}	3.6×10^{-2}	0	3.3×10^{-5}	3.0×10^{-5}

Key: STTS=Supplemental Treatment Technology Site.

Table K–18. Tank Closure Alternative 6B, Base Case, Radioactive Airborne Emissions During Normal Operations (curies)

Radionuclides	Emissions over Life of Project (2006–2100)			Annual Emissions in Year of Maximum Impact (2040)		
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Waste Treatment Plant	200-East Area STTS	200-West Area STTS
Hydrogen-3 (tritium)	1.2×10^{4}	8.8×10^{1}	8.8×10^{1}	4.6×10^{2}	1.1	1.1
Carbon-14	3.1×10^{3}	1.1×10^{1}	1.1×10^{1}	1.2×10^{2}	1.4×10^{-1}	1.4×10^{-1}
Cobalt-60	4.1×10^{-2}	2.9×10^{-3}	2.9×10^{-3}	1.6×10^{-3}	5.3×10^{-5}	4.3×10^{-5}
Strontium-90	4.1×10^{2}	2.4×10^{1}	2.4×10^{1}	1.1×10^{2}	4.6×10^{-1}	3.6×10^{-1}
Technetium-99	1.5×10^{-1}	4.0×10^{-2}	4.0×10^{-2}	5.7×10^{-3}	5.2×10^{-4}	5.2×10^{-4}
Iodine-129	4.8×10^{-1}	4.2×10^{-1}	4.1×10^{-1}	1.8×10^{-2}	9.0×10^{-3}	8.7×10^{-3}
Cesium-137	5.8×10^{2}	7.3×10^{1}	7.3×10^{1}	2.5×10^{2}	9.7×10^{-1}	9.6×10^{-1}
Uranium	4.7×10^{-3}	2.5×10^{-3}	2.5×10^{-3}	1.8×10^{-4}	3.2×10^{-5}	3.2×10^{-5}
Plutonium-238	2.4×10^{-2}	1.1×10^{-3}	1.1×10^{-3}	9.3×10^{-4}	1.4×10^{-5}	1.4×10^{-5}
Plutonium-239, -240	4.1×10^{-1}	1.4×10^{-2}	1.4×10^{-2}	1.6×10^{-2}	3.0×10^{-4}	2.1×10^{-4}
Plutonium-241	6.3×10^{-1}	1.1×10^{-2}	1.1×10^{-2}	2.4×10^{-2}	1.5×10^{-4}	1.5×10^{-4}
Americium-241	7.2×10^{-1}	1.8×10^{-2}	1.9×10^{-2}	2.8×10^{-2}	4.5×10^{-4}	3.0×10^{-4}

Key: STTS=Supplemental Treatment Technology Site.

Table K–19. Tank Closure Alternative 6B, Option Case, Radioactive Airborne Emissions During Normal Operations (curies)

Radionuclides	Emissions over Life of Project (2006–2100)			Annual Emissions in Year of Maximum Impact (2040)		
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Waste Treatment Plant	200-East Area STTS	200-West Area STTS
Hydrogen-3 (tritium)	1.2×10^{4}	1.5×10^{3}	1.5×10^{3}	4.6×10^{2}	1.9×10^{1}	1.9×10^{1}
Carbon-14	3.1×10^{3}	1.5×10^{1}	1.5×10^{1}	1.2×10^{2}	1.9×10^{-1}	1.9×10^{-1}
Cobalt-60	4.1×10^{-2}	5.3×10^{-3}	5.2×10^{-3}	1.6×10^{-3}	9.0×10^{-5}	6.9×10^{-5}
Strontium-90	4.1×10^{2}	2.8×10^{1}	2.8×10^{1}	1.1×10^{2}	5.7×10^{-1}	3.7×10^{-1}
Technetium-99	1.5×10^{-1}	5.7×10^{-2}	5.7×10^{-2}	5.7×10^{-3}	7.5×10^{-4}	7.5×10^{-4}
Iodine-129	4.8×10^{-1}	4.8×10^{-1}	4.7×10^{-1}	1.8×10^{-2}	9.8×10^{-3}	9.5×10^{-3}
Cesium-137	5.8×10^{2}	7.5×10^{1}	7.5×10^{1}	2.5×10^{2}	9.9×10^{-1}	9.9×10^{-1}
Uranium	4.7×10^{-3}	3.2×10^{-3}	3.2×10^{-3}	1.8×10^{-4}	4.2×10^{-5}	4.2×10^{-5}
Plutonium-238	2.4×10^{-2}	2.2×10^{-3}	2.2×10^{-3}	9.3×10^{-4}	2.8×10^{-5}	2.8×10^{-5}
Plutonium-239, -240	4.1×10^{-1}	9.1×10^{-2}	9.1×10^{-2}	1.6×10^{-2}	1.3×10^{-3}	1.2×10^{-3}
Plutonium-241	6.3×10^{-1}	6.6×10^{-2}	6.6×10^{-2}	2.4×10^{-2}	8.6×10^{-4}	8.3×10^{-4}
Americium-241	7.2×10^{-1}	3.5×10^{-2}	3.5×10^{-2}	2.8×10^{-2}	7.6×10^{-4}	4.7×10^{-4}

Key: STTS=Supplemental Treatment Technology Site.

Table K–20. Tank Closure Alternative 6C Radioactive Airborne Emissions During Normal Operations (curies)

Radionuclides	Emissions over Life of Project (2006–2045)			Annual Emissions in Year of Maximum Impact (2040)		
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Waste Treatment Plant	200-East Area STTS	200-West Area STTS
Hydrogen-3 (tritium)	1.2×10^{4}	0	0	4.6×10^{2}	0	0
Carbon-14	3.1×10^{3}	0	0	1.2×10^{2}	0	0
Cobalt-60	4.1×10^{-2}	0	0	1.6×10^{-3}	0	0
Strontium-90	4.1×10^{2}	1.2×10^{-1}	1.2×10^{-1}	1.1×10^{2}	3.2×10^{-3}	3.1×10^{-3}
Technetium-99	1.5×10^{-1}	0	0	5.7×10^{-3}	0	0
Iodine-129	4.8×10^{-1}	2.7×10^{-1}	2.6×10^{-1}	1.8×10^{-2}	7.0×10^{-3}	6.7×10^{-3}
Cesium-137	5.8×10^{2}	1.5	1.4	2.5×10^{2}	3.9×10^{-2}	3.8×10^{-2}
Uranium	4.7×10^{-3}	0	0	1.8×10^{-4}	0	0
Plutonium-238	2.4×10^{-2}	5.6×10^{-7}	7.6×10^{-7}	9.3×10^{-4}	1.5×10^{-7}	1.5×10^{-7}
Plutonium-239, -240	4.1×10^{-1}	7.2×10^{-5}	9.6×10^{-5}	1.6×10^{-2}	1.9×10^{-5}	1.9×10^{-5}
Plutonium-241	6.3×10^{-1}	0	0	2.4×10^{-2}	0	0
Americium-241	7.2×10^{-1}	5.9×10^{-6}	7.8×10^{-6}	2.8×10^{-2}	1.5×10^{-6}	1.5×10^{-6}

Key: STTS=Supplemental Treatment Technology Site.

K.2.1.1.4 Results

The results of the dose analyses are presented in this section. Tables K–21 through K–33 show the estimated doses to the population living within 80 kilometers (50 miles) of the 200 Areas over the life of the project and during the year of maximum impact under each Tank Closure alternative. Tables K–34

through K–46 show the estimated doses to the MEI over the life of the project and during the year of maximum impact under each Tank Closure alternative. The year of maximum impact was determined by considering the combined impacts on the population or the MEI from the three emission source locations: the WTP, STTS-East, and STTS-West. For purposes of comparison, the National Emission Standards for Hazardous Air Pollutants annual dose limit to an individual member of the public is 10 millirem (0.01 rem) per year for all emission sources from a DOE site (40 CFR 61, Subpart H). In those cases where projections indicated that doses could approach or exceed the 10 millirem per year, DOE would take action to ensure that emissions are controlled so that the total site impact remains below the dose standard.

For activities that occur over a number of years, an average emission was assumed for each year. This approach can result in the peak impact spanning a number of years rather than occurring in a single year. Under all Tank Closure alternatives except Alternative 1, the year in which cesium and strontium would be de-encapsulated and processed at the WTP would result in the largest annual impacts.

Note that some of the alternatives would take much longer than others to complete; this difference would affect the population dose. As a result of the duration of some of the alternatives, the exposed population could include multiple generations. The radionuclide inventories were not adjusted to account for the differences in the duration of the alternatives (radioactive decay over time would reduce the radioactivity of each radionuclide); however, the analyses still support a general comparison of the impacts on the offsite population and MEI.

Table K–21. Tank Closure Alternative 1 Impacts on the Population During Normal Operations

	Dose over Life of Project (person-rem)[a]				Dose in Year of Maximum Impact (person-rem per year)[a]			
Radionuclides	**Waste Treatment Plant[b]**	**200-East Area STTS**	**200-West Area STTS**	**Combined Sources**	**Waste Treatment Plant[b]**	**200-East Area STTS**	**200-West Area STTS**	**Combined Sources**
Hydrogen-3 (tritium)	0	2.7×10^{1}	2.7×10^{1}	5.4×10^{1}	0	2.7×10^{-1}	2.7×10^{-1}	5.4×10^{-1}
Carbon-14	0	0	0	0	0	0	0	0
Cobalt-60	0	4.3×10^{-1}	4.2×10^{-1}	8.5×10^{-1}	0	4.3×10^{-3}	4.2×10^{-3}	8.5×10^{-3}
Strontium-90	0	9.6×10^{-2}	9.3×10^{-2}	1.9×10^{-1}	0	1.9×10^{-3}	1.8×10^{-3}	3.7×10^{-3}
Technetium-99	0	0	0	0	0	0	0	0
Iodine-129	0	1.2	1.2	2.4	0	2.4×10^{-2}	2.3×10^{-2}	4.7×10^{-2}
Cesium-137	0	1.2	1.2	2.4	0	2.3×10^{-2}	2.3×10^{-2}	4.6×10^{-2}
Uranium	0	7.0	6.7	1.4×10^{1}	0	7.0×10^{-2}	6.7×10^{-2}	1.4×10^{-1}
Plutonium-238	0	0	0	0	0	0	0	0
Plutonium-239, -240	0	4.1×10^{-6}	3.8×10^{-6}	7.9×10^{-6}	0	1.1×10^{-7}	7.6×10^{-8}	1.9×10^{-7}
Plutonium-241	0	0	0	0	0	0	0	0
Americium-241	0	2.7×10^{-6}	2.4×10^{-6}	5.1×10^{-6}	0	7.8×10^{-8}	5.0×10^{-8}	1.3×10^{-7}
Total	**0**	**3.7×10^{1}**	**3.7×10^{1}**	**7.4×10^{1}**	**0**	**4.0×10^{-1}**	**3.9×10^{-1}**	**7.8×10^{-1}**
Number of latent cancer fatalities[c]				0 (4×10^{-2})				0 (5×10^{-4})

[a] The reported result is the collective dose for a population of approximately 560,000, the average of the populations of 542,324, 546,746, and 589,668 that live within 80 kilometers (50 miles) of the Waste Treatment Plant, 200-East Area STTS, and 200-West Area STTS, respectively. There is no regulatory standard for a population dose.

[b] There would be no emissions from the Waste Treatment Plant because it would not operate under this alternative.

[c] The integer indicates the number of excess latent cancer fatalities that would be expected in the population based on the risk factor of 0.0006 latent cancer fatalities per person-rem; the value in parentheses is the value calculated from the dose and risk factor.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–22. Tank Closure Alternative 2A Impacts on the Population During Normal Operations

Radionuclides	Dose over Life of Project (person-rem)[a]				Dose in Year of Maximum Impact (person-rem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS[b]	Combined Sources
Hydrogen-3 (tritium)	5.3	2.7×10^{1}	2.7×10^{1}	6.0×10^{1}	0	0	0	0
Carbon-14	5.8×10^{2}	0	0	5.8×10^{2}	0	0	0	0
Cobalt-60	1.7×10^{-2}	4.3×10^{-1}	4.2×10^{-1}	8.7×10^{-1}	0	0	0	0
Strontium-90	3.3×10^{2}	1.7×10^{-1}	1.7×10^{-1}	3.3×10^{2}	8.6×10^{1}	0	0	8.6×10^{1}
Technetium-99	1.1×10^{-2}	0	0	1.1×10^{-2}	0	0	0	0
Iodine-129	2.2	2.2	2.2	6.6	0	0	0	0
Cesium-137	4.6×10^{2}	2.2	2.1	4.7×10^{2}	1.9×10^{2}	0	0	1.9×10^{2}
Uranium	6.5×10^{-2}	7.0	6.7	1.4×10^{1}	0	0	0	0
Plutonium-238	5.3	7.2×10^{-6}	1.8×10^{-5}	5.3	0	0	0	0
Plutonium-239, -240	9.6×10^{1}	1.0×10^{-3}	2.6×10^{-3}	9.6×10^{1}	0	6.4×10^{-8}	0	6.4×10^{-8}
Plutonium-241	2.7	0	0	2.7	0	0	0	0
Americium-241	1.4×10^{2}	8.6×10^{-5}	1.8×10^{-4}	1.4×10^{2}	0	0	0	0
Total	**1.6×10^{3}**	**3.9×10^{1}**	**3.9×10^{1}**	**1.7×10^{3}**	**2.8×10^{2}**	**6.4×10^{-8}**	**0**	**2.8×10^{2}**
Number of latent cancer fatalities[c]				1 (1)				0 (2×10^{-1})

[a] The reported result is the collective dose for a population of approximately 560,000, the average of the populations of 542,324, 546,746, and 589,668 that live within 80 kilometers (50 miles) of the Waste Treatment Plant, 200-East Area STTS, and 200-West Area STTS, respectively. There is no regulatory standard for a population dose.

[b] In the year of maximum impact, there would be no project emissions from 200-West Area because all project activities would have been completed previously.

[c] The integer indicates the number of excess latent cancer fatalities that would be expected in the population based on the risk factor of 0.0006 latent cancer fatalities per person-rem; the value in parentheses is the value calculated from the dose and risk factor.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–23. Tank Closure Alternative 2B Impacts on the Population During Normal Operations

Radionuclides	Dose over Life of Project (person-rem)[a]				Dose in Year of Maximum Impact (person-rem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	5.4	0	0	5.4	2.0×10^{-1}	0	0	2.0×10^{-1}
Carbon-14	5.8×10^{2}	0	0	5.8×10^{2}	2.2×10^{1}	0	0	2.2×10^{1}
Cobalt-60	1.7×10^{-2}	0	0	1.7×10^{-2}	6.4×10^{-4}	0	0	6.4×10^{-4}
Strontium-90	3.5×10^{2}	3.5×10^{-2}	3.4×10^{-2}	3.5×10^{2}	1.0×10^{2}	9.4×10^{-4}	9.1×10^{-4}	1.0×10^{2}
Technetium-99	1.1×10^{-2}	0	0	1.1×10^{-2}	4.0×10^{-4}	0	0	4.0×10^{-4}
Iodine-129	2.2	4.5×10^{-1}	4.4×10^{-1}	3.1	8.3×10^{-2}	1.2×10^{-2}	1.1×10^{-2}	1.1×10^{-1}
Cesium-137	4.6×10^{2}	4.4×10^{-1}	4.3×10^{-1}	4.6×10^{2}	2.0×10^{2}	1.2×10^{-2}	1.1×10^{-2}	2.0×10^{2}
Uranium	6.5×10^{-2}	0	0	6.5×10^{-2}	2.5×10^{-3}	0	0	2.5×10^{-3}
Plutonium-238	5.3	3.3×10^{-5}	4.4×10^{-5}	5.3	2.0×10^{-1}	8.6×10^{-6}	8.5×10^{-6}	2.0×10^{-1}
Plutonium-239, -240	9.6×10^{1}	4.6×10^{-3}	6.1×10^{-3}	9.6×10^{1}	3.7	1.2×10^{-3}	1.2×10^{-3}	3.7
Plutonium-241	2.7	0	0	2.7	1.0×10^{-1}	0	0	1.0×10^{-1}

Table K–23. Tank Closure Alternative 2B Impacts on the Population During Normal Operations *(continued)*

Radionuclides	Dose over Life of Project (person-rem)[a]				Dose in Year of Maximum Impact (person-rem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Americium-241	1.4×10^{2}	3.1×10^{-4}	4.1×10^{-4}	1.4×10^{2}	5.4	7.8×10^{-5}	7.7×10^{-5}	5.4
Total	**1.6×10^{3}**	**9.3×10^{-1}**	**9.1×10^{-1}**	**1.6×10^{3}**	**3.3×10^{2}**	**2.6×10^{-2}**	**2.5×10^{-2}**	**3.3×10^{2}**
Number of latent cancer fatalities[b]				1 (1)				0 (2×10^{-1})

[a] The reported result is the collective dose for a population of approximately 560,000, the average of the populations of 542,324, 546,746, and 589,668 that live within 80 kilometers (50 miles) of the Waste Treatment Plant, 200-East Area STTS, and 200-West Area, respectively. There is no regulatory standard for a population dose.

[b] The integer indicates the number of excess latent cancer fatalities that would be expected in the population based on the risk factor of 0.0006 latent cancer fatalities per person-rem; the value in parentheses is the value calculated from the dose and risk factor.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–24. Tank Closure Alternative 3A Impacts on the Population During Normal Operations

Radionuclides	Dose over Life of Project (person-rem)[a]				Dose in Year of Maximum Impact (person-rem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	1.6	2.1	1.8	5.4	0	9.3×10^{-3}	8.1×10^{-3}	1.7×10^{-2}
Carbon-14	1.8×10^{2}	2.2×10^{2}	1.9×10^{2}	5.9×10^{2}	0	9.9×10^{-1}	8.6×10^{-1}	1.8
Cobalt-60	1.4×10^{-2}	5.1×10^{-4}	5.0×10^{-4}	1.5×10^{-2}	0	2.3×10^{-6}	2.3×10^{-6}	4.6×10^{-6}
Strontium-90	3.3×10^{2}	5.5×10^{-2}	7.1×10^{-1}	3.3×10^{2}	8.6×10^{1}	6.0×10^{-6}	3.1×10^{-3}	8.6×10^{1}
Technetium-99	3.1×10^{-3}	1.4×10^{-3}	1.2×10^{-3}	5.7×10^{-3}	0	6.3×10^{-6}	5.4×10^{-6}	1.2×10^{-5}
Iodine-129	6.4×10^{-1}	7.2×10^{-1}	6.6×10^{-1}	2.0	0	1.4×10^{-3}	1.2×10^{-3}	2.6×10^{-3}
Cesium-137	4.4×10^{2}	7.4×10^{-1}	7.0	4.5×10^{2}	1.9×10^{2}	1.5×10^{-3}	3.0×10^{-2}	1.9×10^{2}
Uranium	6.0×10^{-2}	4.2×10^{-4}	5.6×10^{-4}	6.1×10^{-2}	0	1.8×10^{-6}	2.5×10^{-6}	4.3×10^{-6}
Plutonium-238	4.6	4.0×10^{-3}	1.7×10^{-2}	4.6	0	4.4×10^{-8}	7.7×10^{-5}	7.7×10^{-5}
Plutonium-239, -240	8.8×10^{1}	5.1×10^{-2}	3.4×10^{-1}	8.8×10^{1}	0	8.8×10^{-7}	1.5×10^{-3}	1.5×10^{-3}
Plutonium-241	2.4	1.4×10^{-3}	9.1×10^{-3}	2.4	0	2.3×10^{-8}	4.1×10^{-5}	4.1×10^{-5}
Americium-241	1.2×10^{2}	1.3×10^{-1}	3.7×10^{-1}	1.2×10^{2}	0	1.9×10^{-6}	1.6×10^{-3}	1.6×10^{-3}
Total	**1.2×10^{3}**	**2.2×10^{2}**	**2.0×10^{2}**	**1.6×10^{3}**	**2.8×10^{2}**	**1.0**	**9.0×10^{-1}**	**2.8×10^{2}**
Number of latent cancer fatalities[b]				1 (1)				0 (2×10^{-1})

[a] The reported result is the collective dose for a population of approximately 560,000, the average of the populations of 542,324, 546,746, and 589,668 that live within 80 kilometers (50 miles) of the Waste Treatment Plant, 200-East Area STTS, and 200-West Area STTS, respectively. There is no regulatory standard for a population dose.

[b] The integer indicates the number of excess latent cancer fatalities that would be expected in the population based on the risk factor of 0.0006 latent cancer fatalities per person-rem; the value in parentheses is the value calculated from the dose and risk factor.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–25. Tank Closure Alternative 3B Impacts on the Population During Normal Operations

Radionuclides	Dose over Life of Project (person-rem)[a]				Dose in Year of Maximum Impact (person-rem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	1.6	2.1×10^{-5}	1.8×10^{-5}	1.6	0	9.3×10^{-8}	8.1×10^{-8}	1.7×10^{-7}
Carbon-14	1.8×10^{2}	2.2×10^{-3}	1.9×10^{-3}	1.8×10^{2}	0	9.9×10^{-6}	8.6×10^{-6}	1.8×10^{-5}
Cobalt-60	1.4×10^{-2}	1.1×10^{-5}	1.0×10^{-5}	1.4×10^{-2}	0	4.6×10^{-8}	4.5×10^{-8}	9.1×10^{-8}
Strontium-90	3.3×10^{2}	5.4×10^{-2}	4.5×10^{-2}	3.3×10^{2}	8.6×10^{1}	1.2×10^{-7}	6.2×10^{-5}	8.6×10^{1}
Technetium-99	7.1×10^{-3}	1.1×10^{-6}	2.4×10^{-5}	7.2×10^{-3}	0	1.3×10^{-9}	1.1×10^{-7}	1.1×10^{-7}
Iodine-129	6.4×10^{-1}	4.0×10^{-1}	3.9×10^{-1}	1.4	0	1.4×10^{-8}	1.2×10^{-8}	2.6×10^{-8}
Cesium-137	4.4×10^{2}	4.1×10^{-1}	5.2×10^{-1}	4.5×10^{2}	1.9×10^{2}	3.0×10^{-5}	6.0×10^{-4}	1.9×10^{2}
Uranium	6.0×10^{-2}	2.5×10^{-5}	1.3×10^{-5}	6.0×10^{-2}	0	3.6×10^{-8}	5.1×10^{-8}	8.7×10^{-8}
Plutonium-238	4.6	4.0×10^{-3}	4.1×10^{-4}	4.6	0	8.7×10^{-10}	1.5×10^{-6}	1.5×10^{-6}
Plutonium-239, -240	8.8×10^{1}	5.2×10^{-2}	1.8×10^{-2}	8.8×10^{1}	0	8.0×10^{-8}	3.0×10^{-5}	3.0×10^{-5}
Plutonium-241	2.4	1.3×10^{-3}	1.9×10^{-4}	2.4	0	4.5×10^{-10}	8.2×10^{-7}	8.2×10^{-7}
Americium-241	1.2×10^{2}	1.3×10^{-1}	8.1×10^{-3}	1.2×10^{2}	0	3.8×10^{-8}	3.3×10^{-5}	3.3×10^{-5}
Total	**1.2×10^{3}**	**1.1**	**9.8×10^{-1}**	**1.2×10^{3}**	**2.8×10^{2}**	**4.1×10^{-5}**	**7.4×10^{-4}**	**2.8×10^{2}**
Number of latent cancer fatalities[b]				1 (7×10^{-1})				0 (2×10^{-1})

[a] The reported result is the collective dose for a population of approximately 560,000, the average of the populations of 542,324, 546,746, and 589,668 that live within 80 kilometers (50 miles) of the Waste Treatment Plant, 200-East Area STTS, and 200-West Area STTS, respectively. There is no regulatory standard for a population dose.

[b] The integer indicates the number of excess latent cancer fatalities that would be expected in the population based on the risk factor of 0.0006 latent cancer fatalities per person-rem; the value in parentheses is the value calculated from the dose and risk factor.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–26. Tank Closure Alternative 3C Impacts on the Population During Normal Operations

Radionuclides	Dose over Life of Project (person-rem)[a]				Dose in Year of Maximum Impact (person-rem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	1.6	2.1	1.8	5.4	0	9.3×10^{-3}	8.1×10^{-3}	1.7×10^{-2}
Carbon-14	1.8×10^{2}	2.2×10^{2}	1.9×10^{2}	5.9×10^{2}	0	9.9×10^{-1}	8.6×10^{-1}	1.8
Cobalt-60	1.4×10^{-2}	5.1×10^{-4}	5.0×10^{-4}	1.5×10^{-2}	0	2.3×10^{-6}	2.3×10^{-6}	4.6×10^{-6}
Strontium-90	3.3×10^{2}	5.5×10^{-2}	7.1×10^{-1}	3.3×10^{2}	8.6×10^{1}	6.0×10^{-6}	3.1×10^{-3}	8.6×10^{1}
Technetium-99	7.1×10^{-3}	1.4×10^{-3}	1.2×10^{-3}	9.7×10^{-3}	0	6.3×10^{-6}	5.4×10^{-6}	1.2×10^{-5}
Iodine-129	6.4×10^{-1}	3.2×10^{1}	2.7×10^{1}	5.9×10^{1}	0	1.4×10^{-1}	1.2×10^{-1}	2.6×10^{-1}
Cesium-137	4.4×10^{2}	7.4×10^{-1}	7.0	4.5×10^{2}	1.9×10^{2}	1.5×10^{-3}	3.0×10^{-2}	1.9×10^{2}
Uranium	6.0×10^{-2}	4.2×10^{-4}	5.6×10^{-4}	6.1×10^{-2}	0	1.8×10^{-6}	2.5×10^{-6}	4.3×10^{-6}
Plutonium-238	4.6	4.0×10^{-3}	1.7×10^{-2}	4.6	0	4.4×10^{-8}	7.7×10^{-5}	7.7×10^{-5}
Plutonium-239, -240	8.8×10^{1}	5.1×10^{-2}	3.4×10^{-1}	8.8×10^{1}	0	8.8×10^{-7}	1.5×10^{-3}	1.5×10^{-3}
Plutonium-241	2.4	1.4×10^{-3}	9.1×10^{-3}	2.4	0	2.3×10^{-8}	4.1×10^{-5}	4.1×10^{-5}

Table K–26. Tank Closure Alternative 3C Impacts on the Population During Normal Operations *(continued)*

Radionuclides	Dose over Life of Project (person-rem)[a]				Dose in Year of Maximum Impact (person-rem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Americium-241	1.2×10^{2}	1.3×10^{-1}	3.7×10^{-1}	1.2×10^{2}	0	1.9×10^{-6}	1.6×10^{-3}	1.6×10^{-3}
Total	**1.2×10^{3}**	**2.5×10^{2}**	**2.3×10^{2}**	**1.7×10^{3}**	**2.8×10^{2}**	**1.1**	**1.0**	**2.8×10^{2}**
Number of latent cancer fatalities[b]				1 (1)				0 (2×10^{-1})

[a] The reported result is the collective dose for a population of approximately 560,000, the average of the populations of 542,324, 546,746, and 589,668 that live within 80 kilometers (50 miles) of the Waste Treatment Plant, 200-East Area STTS, and 200-West Area STTS, respectively. There is no regulatory standard for a population dose.

[b] The integer indicates the number of excess latent cancer fatalities that would be expected in the population based on the risk factor of 0.0006 latent cancer fatalities per person-rem; the value in parentheses is the value calculated from the dose and risk factor.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–27. Tank Closure Alternative 4 Impacts on the Population During Normal Operations

Radionuclides	Dose over Life of Project (person-rem)[a]				Dose in Year of Maximum Impact (person-rem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	1.6	2.1×10^{-5}	1.8	3.4	0	1.3×10^{-9}	1.4×10^{-9}	2.7×10^{-9}
Carbon-14	1.8×10^{2}	2.2×10^{-3}	1.9×10^{2}	3.7×10^{2}	0	4.0×10^{-8}	4.2×10^{-8}	8.2×10^{-8}
Cobalt-60	1.4×10^{-2}	2.9×10^{-5}	5.3×10^{-4}	1.4×10^{-2}	0	3.1×10^{-8}	3.2×10^{-8}	6.3×10^{-8}
Strontium-90	3.3×10^{2}	6.1×10^{-1}	1.4	3.4×10^{2}	8.6×10^{1}	1.7×10^{-3}	1.7×10^{-3}	8.6×10^{1}
Technetium-99	3.2×10^{-3}	3.8×10^{-5}	1.2×10^{-3}	4.4×10^{-3}	0	4.1×10^{-8}	4.1×10^{-8}	8.2×10^{-8}
Iodine-129	6.4×10^{-1}	4.4×10^{-1}	6.9×10^{-1}	1.8	0	5.0×10^{-9}	5.1×10^{-9}	1.0×10^{-8}
Cesium-137	4.5×10^{2}	6.9×10^{-1}	7.3	4.5×10^{2}	1.9×10^{2}	1.2×10^{-3}	1.2×10^{-3}	1.9×10^{2}
Uranium	6.0×10^{-2}	2.0×10^{-4}	7.4×10^{-4}	6.1×10^{-2}	0	8.5×10^{-7}	8.4×10^{-7}	1.7×10^{-6}
Plutonium-238	4.6	7.3×10^{-3}	2.1×10^{-2}	4.6	0	2.5×10^{-5}	2.4×10^{-5}	4.9×10^{-5}
Plutonium-239, -240	8.8×10^{1}	1.8×10^{-1}	5.0×10^{-1}	8.9×10^{1}	0	1.6×10^{-3}	1.6×10^{-3}	3.2×10^{-3}
Plutonium-241	2.4	2.4×10^{-3}	1.0×10^{-2}	2.4	0	5.1×10^{-6}	5.0×10^{-6}	1.0×10^{-5}
Americium-241	1.2×10^{2}	2.3×10^{-1}	5.1×10^{-1}	1.2×10^{2}	0	2.9×10^{-4}	2.9×10^{-4}	5.8×10^{-4}
Total	**1.2×10^{3}**	**2.2**	**2.0×10^{2}**	**1.4×10^{3}**	**2.8×10^{2}**	**4.8×10^{-3}**	**4.9×10^{-3}**	**2.8×10^{2}**
Number of latent cancer fatalities[b]				1 (8×10^{-1})				0 (2×10^{-1})

[a] The reported result is the collective dose for a population of approximately 560,000, the average of the populations of 542,324, 546,746, and 589,668 that live within 80 kilometers (50 miles) of the Waste Treatment Plant, 200-East Area STTS, and 200-West Area STTS, respectively. There is no regulatory standard for a population dose.

[b] The integer indicates the number of excess latent cancer fatalities that would be expected in the population based on the risk factor of 0.0006 latent cancer fatalities per person-rem; the value in parentheses is the value calculated from the dose and risk factor.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–28. Tank Closure Alternative 5 Impacts on the Population During Normal Operations

Radionuclides	Dose over Life of Project (person-rem)[a]				Dose in Year of Maximum Impact (person-rem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	2.6	7.2×10^{-6}	1.6	4.2	1.6×10^{-3}	4.4×10^{-8}	1.0×10^{-2}	1.2×10^{-2}
Carbon-14	2.9×10^{2}	7.7×10^{-4}	1.7×10^{2}	4.6×10^{2}	1.7	4.7×10^{-6}	1.1	2.8
Cobalt-60	1.7×10^{-2}	4.6×10^{-6}	4.6×10^{-4}	1.7×10^{-2}	2.2×10^{-5}	2.2×10^{-8}	2.8×10^{-6}	2.5×10^{-5}
Strontium-90	3.1×10^{2}	4.6×10^{-2}	6.5×10^{-1}	3.1×10^{2}	8.6×10^{1}	5.8×10^{-8}	3.8×10^{-3}	8.6×10^{1}
Technetium-99	1.5×10^{-2}	1.1×10^{-5}	1.1×10^{-3}	1.6×10^{-2}	6.3×10^{-5}	6.1×10^{-8}	6.7×10^{-6}	7.0×10^{-5}
Iodine-129	1.1	3.3×10^{-1}	5.7×10^{-1}	2.0	6.5×10^{-6}	6.7×10^{-9}	1.5×10^{-3}	1.5×10^{-3}
Cesium-137	4.3×10^{2}	3.3×10^{-1}	7.0	4.4×10^{2}	1.9×10^{2}	1.4×10^{-5}	4.1×10^{-2}	1.9×10^{2}
Uranium	5.9×10^{-2}	1.8×10^{-5}	5.1×10^{-4}	5.9×10^{-2}	2.3×10^{-5}	1.7×10^{-8}	3.2×10^{-6}	2.6×10^{-5}
Plutonium-238	4.2	3.6×10^{-3}	1.6×10^{-2}	4.2	5.6×10^{-7}	4.2×10^{-10}	9.7×10^{-5}	9.7×10^{-5}
Plutonium-239, -240	8.0×10^{1}	4.3×10^{-2}	3.1×10^{-1}	8.0×10^{1}	1.1×10^{-5}	7.1×10^{-8}	1.9×10^{-3}	1.9×10^{-3}
Plutonium-241	2.2	1.2×10^{-3}	8.3×10^{-3}	2.2	2.9×10^{-7}	2.2×10^{-10}	5.1×10^{-5}	5.1×10^{-5}
Americium-241	1.1×10^{2}	1.2×10^{-1}	3.3×10^{-1}	1.1×10^{2}	2.5×10^{-5}	1.8×10^{-8}	2.1×10^{-3}	2.1×10^{-3}
Total	**1.2×10^{3}**	**8.8×10^{-1}**	**1.8×10^{2}**	**1.4×10^{3}**	**2.8×10^{2}**	**1.9×10^{-5}**	**1.1**	**2.8×10^{2}**
Number of latent cancer fatalities[b]				1 (8×10^{-1})				0 (2×10^{-1})

[a] The reported result is the collective dose for a population of approximately 560,000, the average of the populations of 542,324, 546,746, and 589,668 that live within 80 kilometers (50 miles) of the Waste Treatment Plant, 200-East Area STTS, and 200-West Area STTS, respectively. There is no regulatory standard for a population dose.

[b] The integer indicates the number of excess latent cancer fatalities that would be expected in the population based on the risk factor of 0.0006 latent cancer fatalities per person-rem; the value in parentheses is the value calculated from the dose and risk factor.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–29. Tank Closure Alternative 6A, Base Case, Impacts on the Population During Normal Operations

Radionuclides	Dose over Life of Project (person-rem)[a]				Dose in Year of Maximum Impact (person-rem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	5.4	3.9×10^{-2}	3.9×10^{-4}	5.4	0	5.1×10^{-5}	5.2×10^{-5}	1.0×10^{-4}
Carbon-14	5.8×10^{2}	2.0	2.0×10^{-2}	5.8×10^{2}	0	2.6×10^{-3}	2.7×10^{-3}	5.3×10^{-3}
Cobalt-60	1.7×10^{-2}	4.3×10^{-4}	1.2×10^{-5}	1.7×10^{-2}	0	4.6×10^{-7}	4.6×10^{-7}	9.2×10^{-7}
Strontium-90	3.5×10^{2}	7.1	2.1×10^{-1}	3.6×10^{2}	8.6×10^{1}	7.1×10^{-3}	7.1×10^{-3}	8.6×10^{1}
Technetium-99	1.1×10^{-2}	9.8×10^{-4}	9.5×10^{-6}	1.2×10^{-2}	0	1.3×10^{-6}	1.3×10^{-6}	2.6×10^{-6}
Iodine-129	2.2	2.1	1.4×10^{-2}	4.3	0	3.4×10^{-4}	3.5×10^{-4}	6.9×10^{-4}
Cesium-137	5.1×10^{2}	2.3×10^{1}	2.2×10^{-1}	5.3×10^{2}	1.9×10^{2}	2.7×10^{-2}	2.8×10^{-2}	1.9×10^{2}
Uranium	6.5×10^{-2}	9.2×10^{-3}	8.7×10^{-5}	7.5×10^{-2}	0	1.2×10^{-5}	1.2×10^{-5}	2.4×10^{-5}
Plutonium-238	5.3	6.2×10^{-2}	6.5×10^{-4}	5.4	0	9.7×10^{-5}	7.9×10^{-5}	1.8×10^{-4}
Plutonium-239, -240	9.7×10^{1}	8.9×10^{-1}	4.1×10^{-2}	9.8×10^{1}	0	3.1×10^{-3}	7.4×10^{-4}	3.9×10^{-3}
Plutonium-241	2.7	1.3×10^{-2}	1.4×10^{-4}	2.7	0	1.7×10^{-5}	1.6×10^{-5}	3.3×10^{-5}

Table K–29. Tank Closure Alternative 6A, Base Case, Impacts on the Population During Normal Operations *(continued)*

Radionuclides	Dose over Life of Project (person-rem)[a]				Dose in Year of Maximum Impact (person-rem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Americium-241	1.4×10^{2}	9.7×10^{-1}	4.7×10^{-2}	1.4×10^{2}	0	8.7×10^{-4}	7.0×10^{-4}	1.6×10^{-3}
Total	$\mathbf{1.7\times10^{3}}$	$\mathbf{3.6\times10^{1}}$	$\mathbf{5.5\times10^{-1}}$	$\mathbf{1.7\times10^{3}}$	$\mathbf{2.8\times10^{2}}$	$\mathbf{4.1\times10^{-2}}$	$\mathbf{3.9\times10^{-2}}$	$\mathbf{2.8\times10^{2}}$
Number of latent cancer fatalities[b]				1 (1)				0 (2×10^{-1})

[a] The reported result is the collective dose for a population of approximately 560,000, the average of the populations of 542,324, 546,746, and 589,668 that live within 80 kilometers (50 miles) of the Waste Treatment Plant, 200-East Area STTS, and 200-West Area STTS, respectively. There is no regulatory standard for a population dose.

[b] The integer indicates the number of excess latent cancer fatalities that would be expected in the population based on the risk factor of 0.0006 latent cancer fatalities per person-rem; the value in parentheses is the value calculated from the dose and risk factor.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–30. Tank Closure Alternative 6A, Option Case, Impacts on the Population During Normal Operations

Radionuclides	Dose over Life of Project (person-rem)[a]				Dose in Year of Maximum Impact (person-rem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	5.4	6.5×10^{-1}	6.7×10^{-1}	6.7	0	8.4×10^{-4}	8.7×10^{-4}	1.7×10^{-3}
Carbon-14	5.8×10^{2}	2.7	2.8	5.9×10^{2}	0	3.5×10^{-3}	3.7×10^{-3}	7.2×10^{-3}
Cobalt-60	1.7×10^{-2}	7.8×10^{-4}	8.0×10^{-4}	1.8×10^{-2}	0	8.5×10^{-7}	8.6×10^{-7}	1.7×10^{-6}
Strontium-90	3.5×10^{2}	8.3	8.4	3.7×10^{2}	8.6×10^{1}	7.5×10^{-3}	7.6×10^{-3}	8.6×10^{1}
Technetium-99	1.1×10^{-2}	1.4×10^{-3}	1.4×10^{-3}	1.3×10^{-2}	0	1.8×10^{-6}	1.9×10^{-6}	3.7×10^{-6}
Iodine-129	2.2	2.2	2.2	6.5	0	4.7×10^{-4}	4.8×10^{-4}	9.5×10^{-4}
Cesium-137	5.1×10^{2}	2.3×10^{1}	2.4×10^{1}	5.5×10^{2}	1.9×10^{2}	2.8×10^{-2}	2.8×10^{-2}	1.9×10^{2}
Uranium	6.5×10^{-2}	1.2×10^{-2}	1.2×10^{-2}	8.9×10^{-2}	0	1.6×10^{-5}	1.6×10^{-5}	3.1×10^{-5}
Plutonium-238	5.3	1.3×10^{-1}	1.3×10^{-1}	5.6	0	1.8×10^{-4}	1.6×10^{-4}	3.5×10^{-4}
Plutonium-239, -240	9.7×10^{1}	5.8	5.7	1.1×10^{2}	0	9.3×10^{-3}	6.8×10^{-3}	1.6×10^{-2}
Plutonium-241	2.7	7.6×10^{-2}	7.5×10^{-2}	2.8	0	9.7×10^{-5}	9.7×10^{-5}	1.9×10^{-4}
Americium-241	1.4×10^{2}	1.9	1.9	1.5×10^{2}	0	1.8×10^{-3}	1.6×10^{-3}	3.3×10^{-3}
Total	$\mathbf{1.7\times10^{3}}$	$\mathbf{4.5\times10^{1}}$	$\mathbf{4.5\times10^{1}}$	$\mathbf{1.8\times10^{3}}$	$\mathbf{2.8\times10^{2}}$	$\mathbf{5.2\times10^{-2}}$	$\mathbf{5.0\times10^{-2}}$	$\mathbf{2.8\times10^{2}}$
Number of latent cancer fatalities[b]				1 (1)				0 (2×10^{-1})

[a] The reported result is the collective dose for a population of approximately 560,000, the average of the populations of 542,324, 546,746, and 589,668 that live within 80 kilometers (50 miles) of the Waste Treatment Plant, 200-East Area STTS, and 200-West Area STTS, respectively. There is no regulatory standard for a population dose.

[b] The integer indicates the number of excess latent cancer fatalities that would be expected in the population based on the risk factor of 0.0006 latent cancer fatalities per person-rem; the value in parentheses is the value calculated from the dose and risk factor.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–31. Tank Closure Alternative 6B, Base Case, Impacts on the Population During Normal Operations

Radionuclides	Dose over Life of Project (person-rem)[a]				Dose in Year of Maximum Impact (person-rem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	5.4	3.9×10^{-2}	4.0×10^{-2}	5.4	2.0×10^{-1}	5.1×10^{-4}	5.2×10^{-4}	2.1×10^{-1}
Carbon-14	5.8×10^{2}	2.0	2.1	5.8×10^{2}	2.2×10^{1}	2.6×10^{-2}	2.7×10^{-2}	2.2×10^{1}
Cobalt-60	1.7×10^{-2}	4.3×10^{-4}	4.4×10^{-4}	1.8×10^{-2}	6.4×10^{-4}	7.9×10^{-6}	6.4×10^{-6}	6.5×10^{-4}
Strontium-90	3.3×10^{2}	7.0	7.1	3.5×10^{2}	9.3×10^{1}	1.3×10^{-1}	1.0×10^{-1}	9.4×10^{1}
Technetium-99	1.1×10^{-2}	9.9×10^{-4}	9.9×10^{-4}	1.3×10^{-2}	4.0×10^{-4}	1.3×10^{-5}	1.3×10^{-5}	4.3×10^{-4}
Iodine-129	2.2	7.1×10^{-1}	7.0×10^{-1}	3.6	8.3×10^{-2}	1.5×10^{-2}	1.5×10^{-2}	1.1×10^{-1}
Cesium-137	4.6×10^{2}	2.1×10^{1}	2.2×10^{1}	5.1×10^{2}	2.0×10^{2}	2.8×10^{-1}	2.9×10^{-1}	2.0×10^{2}
Uranium	6.5×10^{-2}	9.2×10^{-3}	9.1×10^{-3}	8.3×10^{-2}	2.5×10^{-3}	1.2×10^{-4}	1.2×10^{-4}	2.7×10^{-3}
Plutonium-238	5.3	6.2×10^{-2}	6.1×10^{-2}	5.5	2.0×10^{-1}	8.0×10^{-4}	7.9×10^{-4}	2.0×10^{-1}
Plutonium-239, -240	9.6×10^{1}	8.9×10^{-1}	8.9×10^{-1}	9.8×10^{1}	3.7	1.9×10^{-2}	1.3×10^{-2}	3.7
Plutonium-241	2.7	1.3×10^{-2}	1.3×10^{-2}	2.7	1.0×10^{-1}	1.7×10^{-4}	1.7×10^{-4}	1.0×10^{-1}
Americium-241	1.4×10^{2}	9.7×10^{-1}	9.7×10^{-1}	1.4×10^{2}	5.4	2.4×10^{-2}	1.6×10^{-2}	5.5
Total	$\mathbf{1.6\times10^{3}}$	$\mathbf{3.3\times10^{1}}$	$\mathbf{3.4\times10^{1}}$	$\mathbf{1.7\times10^{3}}$	$\mathbf{3.2\times10^{2}}$	$\mathbf{5.0\times10^{-1}}$	$\mathbf{4.7\times10^{-1}}$	$\mathbf{3.2\times10^{2}}$
Number of latent cancer fatalities[b]				1 (1)				0 (2×10^{-1})

[a] The reported result is the collective dose for a population of approximately 560,000, the average of the populations of 542,324, 546,746, and 589,668 that live within 80 kilometers (50 miles) of the Waste Treatment Plant, 200-East Area STTS, and 200-West Area STTS, respectively. There is no regulatory standard for a population dose.

[b] The integer indicates the number of excess latent cancer fatalities that would be expected in the population based on the risk factor of 0.0006 latent cancer fatalities per person-rem; the value in parentheses is the value calculated from the dose and risk factor.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–32. Tank Closure Alternative 6B, Option Case, Impacts on the Population During Normal Operations

Radionuclides	Dose over Life of Project (person-rem)[a]				Dose in Year of Maximum Impact (person-rem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	5.4	6.5×10^{-1}	6.7×10^{-1}	6.7	2.0×10^{-1}	8.4×10^{-3}	8.7×10^{-3}	2.2×10^{-1}
Carbon-14	5.8×10^{2}	2.7	2.8	5.9×10^{2}	2.2×10^{1}	3.5×10^{-2}	3.7×10^{-2}	2.2×10^{1}
Cobalt-60	1.7×10^{-2}	7.8×10^{-4}	7.9×10^{-4}	1.8×10^{-2}	6.4×10^{-4}	1.3×10^{-5}	1.0×10^{-5}	6.6×10^{-4}
Strontium-90	3.3×10^{2}	8.1	8.1	3.5×10^{2}	9.3×10^{1}	1.6×10^{-1}	1.1×10^{-1}	9.4×10^{1}
Technetium-99	1.1×10^{-2}	1.4×10^{-3}	1.4×10^{-3}	1.3×10^{-2}	4.0×10^{-4}	1.9×10^{-5}	1.9×10^{-5}	4.4×10^{-4}
Iodine-129	2.2	8.1×10^{-1}	8.1×10^{-1}	3.8	8.3×10^{-2}	1.7×10^{-2}	1.6×10^{-2}	1.2×10^{-1}
Cesium-137	4.6×10^{2}	2.2×10^{1}	2.2×10^{1}	5.1×10^{2}	2.0×10^{2}	2.9×10^{-1}	2.9×10^{-1}	2.0×10^{2}
Uranium	6.5×10^{-2}	1.2×10^{-2}	1.2×10^{-2}	8.9×10^{-2}	2.5×10^{-3}	1.6×10^{-4}	1.6×10^{-4}	2.8×10^{-3}
Plutonium-238	5.3	1.3×10^{-1}	1.3×10^{-1}	5.6	2.0×10^{-1}	1.7×10^{-3}	1.6×10^{-3}	2.1×10^{-1}
Plutonium-239, -240	9.6×10^{1}	5.8	5.7	1.1×10^{2}	3.7	8.5×10^{-2}	7.4×10^{-2}	3.8
Plutonium-241	2.7	7.5×10^{-2}	7.5×10^{-2}	2.8	1.0×10^{-1}	9.9×10^{-4}	9.7×10^{-4}	1.0×10^{-1}

Table K–32. Tank Closure Alternative 6B, Option Case, Impacts on the Population During Normal Operations *(continued)*

Radionuclides	Dose over Life of Project (person-rem)[a]				Dose in Year of Maximum Impact (person-rem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Americium-241	1.4×10^{2}	1.9	1.8	1.5×10^{2}	5.4	4.0×10^{-2}	2.5×10^{-2}	5.5
Total	**1.6×10^{3}**	**4.2×10^{1}**	**4.2×10^{1}**	**1.7×10^{3}**	**3.2×10^{2}**	**6.5×10^{-1}**	**5.7×10^{-1}**	**3.2×10^{2}**
Number of latent cancer fatalities[b]				1 (1)				0 (2×10^{-1})

[a] The reported result is the collective dose for a population of approximately 560,000, the average of the populations of 542,324, 546,746, and 589,668 that live within 80 kilometers (50 miles) of the Waste Treatment Plant, 200-East Area STTS, and 200-West Area STTS, respectively. There is no regulatory standard for a population dose.

[b] The integer indicates the number of excess latent cancer fatalities that would be expected in the population based on the risk factor of 0.0006 latent cancer fatalities per person-rem; the value in parentheses is the value calculated from the dose and risk factor.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–33. Tank Closure Alternative 6C Impacts on the Population During Normal Operations

Radionuclides	Dose over Life of Project (person-rem)[a]				Dose in Year of Maximum Impact (person-rem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	5.4	0	0	5.4	2.0×10^{-1}	0	0	2.0×10^{-1}
Carbon-14	5.8×10^{2}	0	0	5.8×10^{2}	2.2×10^{1}	0	0	2.2×10^{1}
Cobalt-60	1.7×10^{-2}	0	0	1.7×10^{-2}	6.4×10^{-4}	0	0	6.4×10^{-4}
Strontium-90	3.3×10^{2}	3.5×10^{-2}	3.4×10^{-2}	3.3×10^{2}	9.3×10^{1}	9.4×10^{-4}	9.1×10^{-4}	9.3×10^{1}
Technetium-99	1.1×10^{-2}	0	0	1.1×10^{-2}	4.0×10^{-4}	0	0	4.0×10^{-4}
Iodine-129	2.2	4.5×10^{-1}	4.4×10^{-1}	3.1	8.3×10^{-2}	1.2×10^{-2}	1.2×10^{-2}	1.1×10^{-1}
Cesium-137	4.6×10^{2}	4.4×10^{-1}	4.3×10^{-1}	4.6×10^{2}	2.0×10^{2}	1.2×10^{-2}	1.1×10^{-2}	2.0×10^{2}
Uranium	6.5×10^{-2}	0	0	6.5×10^{-2}	2.5×10^{-3}	0	0	2.5×10^{-3}
Plutonium-238	5.3	3.3×10^{-5}	4.4×10^{-5}	5.3	2.0×10^{-1}	8.6×10^{-6}	8.5×10^{-6}	2.0×10^{-1}
Plutonium-239, -240	9.6×10^{1}	4.6×10^{-3}	6.1×10^{-3}	9.6×10^{1}	3.7	1.2×10^{-3}	1.2×10^{-3}	3.7
Plutonium-241	2.7	0	0	2.7	1.0×10^{-1}	0	0	1.0×10^{-1}
Americium-241	1.4×10^{2}	3.1×10^{-4}	4.1×10^{-4}	1.4×10^{2}	5.4	7.8×10^{-5}	7.7×10^{-5}	5.4
Total	**1.6×10^{3}**	**9.3×10^{-1}**	**9.1×10^{-1}**	**1.6×10^{3}**	**3.2×10^{2}**	**2.6×10^{-2}**	**2.5×10^{-2}**	**3.2×10^{2}**
Number of latent cancer fatalities[b]				1 (1)				0 (2×10^{-1})

[a] The reported result is the collective dose for a population of approximately 560,000, the average of the populations of 542,324, 546,746, and 589,668 that live within 80 kilometers (50 miles) of the Waste Treatment Plant, 200-East Area STTS, and 200-West Area STTS, respectively. There is no regulatory standard for a population dose.

[b] The integer indicates the number of excess latent cancer fatalities that would be expected in the population based on the risk factor of 0.0006 latent cancer fatalities per person-rem; the value in parentheses is the value calculated from the dose and risk factor.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–34. Tank Closure Alternative 1 Impacts on the Maximally Exposed Individual During Normal Operations

Radionuclides	Dose over Life of Project (millirem)[a]				Dose in Year of Maximum Impact (millirem per year)[b]			
	Waste Treatment Plant[c]	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant[c]	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	0	1.1	6.0×10^{-1}	1.7	0	1.1×10^{-2}	6.0×10^{-3}	1.7×10^{-2}
Carbon-14	0	0	0	0	0	0	0	0
Cobalt-60	0	1.7×10^{-2}	9.1×10^{-3}	2.6×10^{-2}	0	1.7×10^{-4}	9.1×10^{-5}	2.6×10^{-4}
Strontium-90	0	1.9×10^{-2}	1.0×10^{-2}	2.9×10^{-2}	0	3.6×10^{-4}	2.0×10^{-4}	5.6×10^{-4}
Technetium-99	0	0	0	0	0	0	0	0
Iodine-129	0	1.8×10^{-1}	9.7×10^{-2}	2.8×10^{-1}	0	3.4×10^{-3}	1.9×10^{-3}	5.3×10^{-3}
Cesium-137	0	1.5×10^{-1}	8.1×10^{-2}	2.3×10^{-1}	0	2.9×10^{-3}	1.6×10^{-3}	4.5×10^{-3}
Uranium	0	8.8×10^{-1}	5.0×10^{-1}	1.4	0	8.8×10^{-3}	5.0×10^{-3}	1.4×10^{-2}
Plutonium-238	0	0	0	0	0	0	0	0
Plutonium-239, -240	0	4.9×10^{-7}	2.7×10^{-7}	7.7×10^{-7}	0	1.3×10^{-8}	5.4×10^{-9}	1.9×10^{-8}
Plutonium-241	0	0	0	0	0	0	0	0
Americium-241	0	3.2×10^{-7}	1.7×10^{-7}	4.9×10^{-7}	0	9.4×10^{-9}	3.6×10^{-9}	1.3×10^{-8}
Total	**0**	**2.3**	**1.3**	**3.6**	**0**	**2.6×10^{-2}**	**1.5×10^{-2}**	**4.1×10^{-2}**
Lifetime risk of a latent cancer fatality				2×10^{-6}				2×10^{-8}

[a] Impacts are provided for comparison with other alternatives. The life-of-project dose would not be received by one individual person due to the duration of this alternative. The dose from 70 years of exposure at the average annual dose rate would be 2.5 millirem, with a corresponding lifetime risk of a latent cancer fatality of 1×10^{-6}.

[b] The regulatory limit for exposure of an individual to radioactive air emissions from U.S. Department of Energy facilities is an effective dose equivalent of 10 millirem per year (40 CFR 61, Subpart H).

[c] There would be no emissions from the Waste Treatment Plant because it would not operate under this alternative.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–35. Tank Closure Alternative 2A Impacts on the Maximally Exposed Individual During Normal Operations

Radionuclides	Dose over Life of Project (millirem)[a]				Dose in Year of Maximum Impact (millirem per year)[b]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS[c]	Combined Sources
Hydrogen-3 (tritium)	1.3×10^{-1}	9.2×10^{-1}	5.6×10^{-1}	1.6	0	0	0	0
Carbon-14	1.1×10^{1}	0	0	1.1×10^{1}	0	0	0	0
Cobalt-60	1.4×10^{-4}	1.4×10^{-2}	8.4×10^{-3}	2.3×10^{-2}	0	0	0	0
Strontium-90	1.3×10^{1}	2.9×10^{-2}	1.7×10^{-2}	1.3×10^{1}	3.4	0	0	3.4
Technetium-99	5.6×10^{-4}	0	0	5.6×10^{-4}	0	0	0	0
Iodine-129	6.8×10^{-2}	2.7×10^{-1}	1.6×10^{-1}	5.0×10^{-1}	0	0	0	0
Cesium-137	1.2×10^{1}	2.3×10^{-1}	1.3×10^{-1}	1.3×10^{1}	5.1	0	0	5.1
Uranium	1.4×10^{-3}	7.6×10^{-1}	4.6×10^{-1}	1.2	0	0	0	0
Plutonium-238	1.1×10^{-1}	7.5×10^{-7}	1.2×10^{-6}	1.1×10^{-1}	0	0	0	0
Plutonium-239, -240	2.0	1.1×10^{-4}	1.7×10^{-4}	2.0	0	6.6×10^{-9}	0	6.6×10^{-9}
Plutonium-241	5.5×10^{-2}	0	0	5.5×10^{-2}	0	0	0	0

Table K–35. Tank Closure Alternative 2A Impacts on the Maximally Exposed Individual During Normal Operations *(continued)*

Radionuclides	Dose over Life of Project (millirem)[a]				Dose in Year of Maximum Impact (millirem per year)[b]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS[c]	Combined Sources
Americium-241	2.9	8.9×10^{-6}	1.2×10^{-5}	2.9	0	0	0	0
Total	**4.2×10^{1}**	**2.2**	**1.3**	**4.6×10^{1}**	**8.5**	**6.6×10^{-9}**	**0**	**8.5**
Lifetime risk of a latent cancer fatality				3×10^{-5}				5×10^{-6}

[a] Impacts are provided for comparison with other alternatives. The life-of-project dose would not be received by one individual person due to the duration of this alternative. The dose from 70 years of exposure at the average annual dose rate would be 17 millirem, with a corresponding lifetime risk of a latent cancer fatality of 1×10^{-5}.

[b] The regulatory limit for exposure of an individual to radioactive air emissions from U.S. Department of Energy facilities is an effective dose equivalent of 10 millirem per year (40 CFR 61, Subpart H).

[c] In the year of maximum impact, there would be no project emissions from 200-West Area because all project activities would have been completed previously.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–36. Tank Closure Alternative 2B Impacts on the Maximally Exposed Individual During Normal Operations

Radionuclides	Dose over Life of Project (millirem)				Dose in Year of Maximum Impact (millirem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	1.3×10^{-1}	0	0	1.3×10^{-1}	5.1×10^{-3}	0	0	5.1×10^{-3}
Carbon-14	1.1×10^{1}	0	0	1.1×10^{1}	4.3×10^{-1}	0	0	4.3×10^{-1}
Cobalt-60	1.4×10^{-4}	0	0	1.4×10^{-4}	5.2×10^{-6}	0	0	5.2×10^{-6}
Strontium-90	1.4×10^{1}	5.9×10^{-3}	3.5×10^{-3}	1.4×10^{1}	4.1	1.6×10^{-4}	9.2×10^{-5}	4.1
Technetium-99	5.7×10^{-4}	0	0	5.7×10^{-4}	2.2×10^{-5}	0	0	2.2×10^{-5}
Iodine-129	6.8×10^{-2}	5.5×10^{-2}	3.2×10^{-2}	1.5×10^{-1}	2.6×10^{-3}	1.5×10^{-3}	8.5×10^{-4}	4.9×10^{-3}
Cesium-137	1.2×10^{1}	4.7×10^{-2}	2.7×10^{-2}	1.2×10^{1}	5.3	1.2×10^{-3}	7.2×10^{-4}	5.3
Uranium	1.4×10^{-3}	0	0	1.4×10^{-3}	5.3×10^{-5}	0	0	5.3×10^{-5}
Plutonium-238	1.1×10^{-1}	3.4×10^{-6}	2.9×10^{-6}	1.1×10^{-1}	4.2×10^{-3}	8.9×10^{-7}	5.6×10^{-7}	4.2×10^{-3}
Plutonium-239, -240	2.0	4.8×10^{-4}	4.0×10^{-4}	2.0	7.6×10^{-2}	1.2×10^{-4}	7.8×10^{-5}	7.6×10^{-2}
Plutonium-241	5.5×10^{-2}	0	0	5.5×10^{-2}	2.1×10^{-3}	0	0	2.1×10^{-3}
Americium-241	2.9	3.2×10^{-5}	2.7×10^{-5}	2.9	1.1×10^{-1}	8.1×10^{-6}	5.1×10^{-6}	1.1×10^{-1}
Total	**4.3×10^{1}**	**1.1×10^{-1}**	**6.3×10^{-2}**	**4.3×10^{1}**	**1.0×10^{1}**	**3.0×10^{-3}**	**1.7×10^{-3}**	**1.0×10^{1}**
Lifetime risk of a latent cancer fatality				3×10^{-5}				6×10^{-6}

[a] The regulatory limit for exposure of an individual to radioactive air emissions from U.S. Department of Energy facilities is an effective dose equivalent of 10 millirem per year (40 CFR 61, Subpart H).

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–37. Tank Closure Alternative 3A Impacts on the Maximally Exposed Individual During Normal Operations

Radionuclides	Dose over Life of Project (millirem)				Dose in Year of Maximum Impact (millirem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	3.9×10^{-2}	7.0×10^{-2}	3.7×10^{-2}	1.5×10^{-1}	0	3.1×10^{-4}	1.7×10^{-4}	4.8×10^{-4}
Carbon-14	3.5	5.8	3.1	1.2×10^{1}	0	2.6×10^{-2}	1.4×10^{-2}	4.0×10^{-2}
Cobalt-60	1.1×10^{-4}	1.7×10^{-5}	1.0×10^{-5}	1.4×10^{-4}	0	7.6×10^{-8}	4.5×10^{-8}	1.2×10^{-7}
Strontium-90	1.3×10^{1}	9.1×10^{-3}	7.2×10^{-2}	1.3×10^{1}	3.4	1.0×10^{-6}	3.1×10^{-4}	3.4
Technetium-99	1.7×10^{-4}	3.2×10^{-4}	1.6×10^{-4}	6.5×10^{-4}	0	1.4×10^{-6}	7.4×10^{-7}	2.2×10^{-6}
Iodine-129	2.0×10^{-2}	8.8×10^{-2}	4.8×10^{-2}	1.6×10^{-1}	0	1.7×10^{-4}	8.8×10^{-5}	2.6×10^{-4}
Cesium-137	1.2×10^{1}	7.9×10^{-2}	4.5×10^{-1}	1.2×10^{1}	5.1	1.6×10^{-4}	1.9×10^{-3}	5.1
Uranium	1.3×10^{-3}	4.5×10^{-5}	3.9×10^{-5}	1.4×10^{-3}	0	2.0×10^{-7}	1.7×10^{-7}	3.7×10^{-7}
Plutonium-238	9.4×10^{-2}	4.2×10^{-4}	1.1×10^{-3}	9.5×10^{-2}	0	4.5×10^{-9}	5.2×10^{-6}	5.1×10^{-6}
Plutonium-239, -240	1.8	5.3×10^{-3}	2.3×10^{-2}	1.8	0	9.2×10^{-8}	9.9×10^{-5}	9.7×10^{-5}
Plutonium-241	5.0×10^{-2}	1.4×10^{-4}	6.0×10^{-4}	5.0×10^{-2}	0	2.4×10^{-9}	2.7×10^{-6}	2.7×10^{-6}
Americium-241	2.4	1.3×10^{-2}	2.4×10^{-2}	2.5	0	2.0×10^{-7}	1.1×10^{-4}	1.1×10^{-4}
Total	**3.3×10^{1}**	**6.0**	**3.7**	**4.3×10^{1}**	**8.5**	**2.7×10^{-2}**	**1.6×10^{-2}**	**8.6**
Lifetime risk of a latent cancer fatality				3×10^{-5}				5×10^{-6}

[a] The regulatory limit for exposure of an individual to radioactive air emissions from U.S. Department of Energy facilities is an effective dose equivalent of 10 millirem per year (40 CFR 61, Subpart H).

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–38. Tank Closure Alternative 3B Impacts on the Maximally Exposed Individual During Normal Operations

Radionuclides	Dose over Life of Project (millirem)				Dose in Year of Maximum Impact (millirem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	3.9×10^{-2}	7.0×10^{-7}	3.7×10^{-7}	3.9×10^{-2}	0	3.1×10^{-9}	1.7×10^{-9}	4.8×10^{-9}
Carbon-14	3.5	5.8×10^{-5}	3.1×10^{-5}	3.5	0	2.6×10^{-7}	1.4×10^{-7}	4.0×10^{-7}
Cobalt-60	1.1×10^{-4}	3.7×10^{-7}	2.0×10^{-7}	1.1×10^{-4}	0	1.5×10^{-9}	9.1×10^{-10}	2.4×10^{-9}
Strontium-90	1.3×10^{1}	8.9×10^{-3}	4.6×10^{-3}	1.3×10^{1}	3.4	2.0×10^{-8}	6.2×10^{-6}	3.4
Technetium-99	3.8×10^{-4}	2.6×10^{-7}	3.3×10^{-6}	3.9×10^{-4}	0	2.9×10^{-10}	1.5×10^{-8}	1.5×10^{-8}
Iodine-129	2.0×10^{-2}	4.9×10^{-2}	2.9×10^{-2}	9.8×10^{-2}	0	1.7×10^{-9}	8.8×10^{-10}	2.6×10^{-9}
Cesium-137	1.2×10^{1}	4.3×10^{-2}	3.3×10^{-2}	1.2×10^{1}	5.1	3.2×10^{-6}	3.8×10^{-5}	5.1
Uranium	1.3×10^{-3}	2.7×10^{-6}	8.8×10^{-7}	1.3×10^{-3}	0	3.9×10^{-9}	3.5×10^{-9}	7.4×10^{-9}
Plutonium-238	9.4×10^{-2}	4.2×10^{-4}	2.7×10^{-5}	9.4×10^{-2}	0	9.1×10^{-11}	1.0×10^{-7}	1.0×10^{-7}
Plutonium-239, -240	1.8	5.4×10^{-3}	1.2×10^{-3}	1.8	0	8.3×10^{-9}	2.0×10^{-6}	2.0×10^{-6}
Plutonium-241	5.0×10^{-2}	1.4×10^{-4}	1.3×10^{-5}	5.0×10^{-2}	0	4.7×10^{-11}	5.4×10^{-8}	5.3×10^{-8}

Table K–38. Tank Closure Alternative 3B Impacts on the Maximally Exposed Individual During Normal Operations *(continued)*

Radionuclides	Dose over Life of Project (millirem)				Dose in Year of Maximum Impact (millirem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Americium-241	2.4	1.3×10^{-2}	5.4×10^{-4}	2.5	0	4.0×10^{-9}	2.2×10^{-6}	2.2×10^{-6}
Total	**3.3×10^{1}**	**1.2×10^{-1}**	**6.8×10^{-2}**	**3.3×10^{1}**	**8.5**	**3.5×10^{-6}**	**4.9×10^{-5}**	**8.5**
Lifetime risk of a latent cancer fatality				2×10^{-5}				5×10^{-6}

[a] The regulatory limit for exposure of an individual to radioactive air emissions from U.S. Department of Energy facilities is an effective dose equivalent of 10 millirem per year (40 CFR 61, Subpart H).

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–39. Tank Closure Alternative 3C Impacts on the Maximally Exposed Individual During Normal Operations

Radionuclides	Dose over Life of Project (millirem)				Dose in Year of Maximum Impact (millirem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	3.9×10^{-2}	7.0×10^{-2}	3.7×10^{-2}	1.5×10^{-1}	0	3.1×10^{-4}	1.7×10^{-4}	4.8×10^{-4}
Carbon-14	3.5	5.8	3.1	1.2×10^{1}	0	2.6×10^{-2}	1.4×10^{-2}	4.0×10^{-2}
Cobalt-60	1.1×10^{-4}	1.7×10^{-5}	1.0×10^{-6}	1.4×10^{-4}	0	7.6×10^{-8}	4.5×10^{-8}	1.2×10^{-7}
Strontium-90	1.3×10^{1}	9.1×10^{-3}	7.2×10^{-2}	1.3×10^{1}	3.4	1.0×10^{-6}	3.1×10^{-4}	3.4
Technetium-99	3.8×10^{-4}	3.2×10^{-4}	1.6×10^{-4}	8.6×10^{-4}	0	1.4×10^{-6}	7.4×10^{-7}	2.2×10^{-6}
Iodine-129	2.0×10^{-2}	3.9	2.0	5.9	0	1.7×10^{-2}	8.8×10^{-3}	2.6×10^{-2}
Cesium-137	1.2×10^{1}	7.9×10^{-2}	4.5×10^{-1}	1.2×10^{1}	5.1	1.6×10^{-4}	1.9×10^{-3}	5.1
Uranium	1.3×10^{-3}	4.5×10^{-5}	3.9×10^{-5}	1.4×10^{-3}	0	2.0×10^{-7}	1.7×10^{-7}	3.7×10^{-7}
Plutonium-238	9.4×10^{-2}	4.2×10^{-4}	1.1×10^{-3}	9.5×10^{-2}	0	4.5×10^{-9}	5.2×10^{-6}	5.1×10^{-6}
Plutonium-239, -240	1.8	5.3×10^{-3}	2.3×10^{-2}	1.8	0	9.2×10^{-8}	9.9×10^{-5}	9.7×10^{-5}
Plutonium-241	5.0×10^{-2}	1.4×10^{-4}	6.0×10^{-4}	5.0×10^{-2}	0	2.4×10^{-9}	2.7×10^{-6}	2.7×10^{-6}
Americium-241	2.4	1.3×10^{-2}	2.4×10^{-2}	2.5	0	2.0×10^{-7}	1.1×10^{-4}	1.1×10^{-4}
Total	**3.3×10^{1}**	**9.8**	**5.7**	**4.9×10^{1}**	**8.5**	**4.4×10^{-2}**	**2.5×10^{-2}**	**8.6**
Lifetime risk of a latent cancer fatality				3×10^{-5}				5×10^{-6}

[a] The regulatory limit for exposure of an individual to radioactive air emissions from U.S. Department of Energy facilities is an effective dose equivalent of 10 millirem per year (40 CFR 61, Subpart H).

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–40. Tank Closure Alternative 4 Impacts on the Maximally Exposed Individual During Normal Operations

Radionuclides	Dose over Life of Project (millirem)				Dose in Year of Maximum Impact (millirem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	4.0×10^{-2}	7.2×10^{-7}	3.7×10^{-2}	7.7×10^{-2}	0	4.6×10^{-11}	2.9×10^{-11}	7.4×10^{-11}
Carbon-14	3.5	5.9×10^{-5}	3.1	6.6	0	1.1×10^{-9}	6.7×10^{-10}	1.7×10^{-9}
Cobalt-60	1.1×10^{-4}	9.6×10^{-7}	1.1×10^{-5}	1.3×10^{-4}	0	1.0×10^{-9}	6.4×10^{-10}	1.7×10^{-9}
Strontium-90	1.3×10^{1}	1.0×10^{-1}	1.5×10^{-1}	1.4×10^{1}	3.4	2.8×10^{-4}	1.7×10^{-4}	3.4
Technetium-99	1.7×10^{-4}	8.5×10^{-6}	1.7×10^{-4}	3.4×10^{-4}	0	9.3×10^{-9}	5.7×10^{-9}	1.5×10^{-8}
Iodine-129	2.0×10^{-2}	5.4×10^{-2}	5.1×10^{-2}	1.2×10^{-1}	0	6.1×10^{-10}	3.7×10^{-10}	9.8×10^{-10}
Cesium-137	1.2×10^{1}	7.3×10^{-2}	4.7×10^{-1}	1.2×10^{1}	5.1	1.3×10^{-4}	7.9×10^{-5}	5.1
Uranium	1.3×10^{-3}	2.1×10^{-5}	5.1×10^{-5}	1.4×10^{-3}	0	9.2×10^{-8}	5.8×10^{-8}	1.5×10^{-7}
Plutonium-238	9.5×10^{-2}	7.6×10^{-4}	1.4×10^{-3}	9.7×10^{-2}	0	2.6×10^{-6}	1.6×10^{-6}	4.2×10^{-6}
Plutonium-239, -240	1.8	1.9×10^{-2}	3.3×10^{-2}	1.9	0	1.7×10^{-4}	1.1×10^{-4}	2.8×10^{-4}
Plutonium-241	5.0×10^{-2}	2.5×10^{-4}	6.8×10^{-4}	5.1×10^{-2}	0	5.3×10^{-7}	3.3×10^{-7}	8.6×10^{-7}
Americium-241	2.5	2.4×10^{-2}	3.4×10^{-2}	2.5	0	3.0×10^{-5}	1.9×10^{-5}	4.9×10^{-5}
Total	**3.3×10^{1}**	**2.7×10^{-1}**	**3.9**	**3.7×10^{1}**	**8.5**	**6.1×10^{-4}**	**3.8×10^{-4}**	**8.5**
Lifetime risk of a latent cancer fatality				2×10^{-5}				5×10^{-6}

[a] The regulatory limit for exposure of an individual to radioactive air emissions from U.S. Department of Energy facilities is an effective dose equivalent of 10 millirem per year (40 CFR 61, Subpart H).

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–41. Tank Closure Alternative 5 Impacts on the Maximally Exposed Individual During Normal Operations

Radionuclides	Dose over Life of Project (millirem)				Dose in Year of Maximum Impact (millirem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	6.5×10^{-2}	2.4×10^{-7}	3.4×10^{-2}	9.8×10^{-2}	4.0×10^{-5}	1.5×10^{-9}	2.1×10^{-4}	2.5×10^{-4}
Carbon-14	5.6	2.0×10^{-5}	2.8	8.3	3.3×10^{-2}	1.2×10^{-7}	1.7×10^{-2}	5.0×10^{-2}
Cobalt-60	1.4×10^{-4}	1.5×10^{-7}	9.2×10^{-6}	1.5×10^{-4}	1.8×10^{-7}	7.2×10^{-10}	5.7×10^{-8}	2.4×10^{-7}
Strontium-90	1.3×10^{1}	7.7×10^{-3}	6.6×10^{-2}	1.3×10^{1}	3.4	9.5×10^{-9}	3.9×10^{-4}	3.4
Technetium-99	8.2×10^{-4}	2.4×10^{-6}	1.5×10^{-4}	9.7×10^{-4}	3.4×10^{-6}	1.4×10^{-8}	9.2×10^{-7}	4.3×10^{-6}
Iodine-129	3.3×10^{-2}	4.1×10^{-2}	4.2×10^{-2}	1.1×10^{-1}	2.0×10^{-7}	8.3×10^{-10}	1.1×10^{-4}	1.1×10^{-4}
Cesium-137	1.2×10^{1}	3.6×10^{-2}	4.5×10^{-1}	1.2×10^{1}	5.1	1.5×10^{-6}	2.6×10^{-3}	5.1
Uranium	1.3×10^{-3}	2.0×10^{-6}	3.5×10^{-5}	1.3×10^{-3}	5.0×10^{-7}	1.9×10^{-9}	2.2×10^{-7}	7.1×10^{-7}
Plutonium-238	8.6×10^{-2}	3.8×10^{-4}	1.0×10^{-3}	8.7×10^{-2}	1.2×10^{-8}	4.3×10^{-11}	6.4×10^{-6}	6.3×10^{-6}
Plutonium-239, -240	1.6	4.5×10^{-3}	2.0×10^{-2}	1.7	2.2×10^{-7}	7.4×10^{-9}	1.2×10^{-4}	1.2×10^{-4}
Plutonium-241	4.5×10^{-2}	1.3×10^{-4}	5.5×10^{-4}	4.6×10^{-2}	6.0×10^{-9}	2.2×10^{-11}	3.4×10^{-6}	3.3×10^{-6}

Table K–41. Tank Closure Alternative 5 Impacts on the Maximally Exposed Individual During Normal Operations *(continued)*

Radionuclides	Dose over Life of Project (millirem)				Dose in Year of Maximum Impact (millirem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Americium-241	2.2	1.2×10^{-2}	2.2×10^{-2}	2.3	5.1×10^{-7}	1.9×10^{-9}	1.4×10^{-4}	1.4×10^{-4}
Total	**3.4×10^{1}**	**1.0×10^{-1}**	**3.4**	**3.7×10^{1}**	**8.6**	**1.7×10^{-6}**	**2.1×10^{-2}**	**8.6**
Lifetime risk of a latent cancer fatality				2×10^{-5}				5×10^{-6}

[a] The regulatory limit for exposure of an individual to radioactive air emissions from U.S. Department of Energy facilities is an effective dose equivalent of 10 millirem per year (40 CFR 61, Subpart H).

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–42. Tank Closure Alternative 6A, Base Case, Impacts on the Maximally Exposed Individual During Normal Operations

Radionuclides	Dose over Life of Project (millirem)[a]				Dose in Year of Maximum Impact (millirem per year)[b]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	1.3×10^{-1}	1.3×10^{-3}	8.0×10^{-6}	1.4×10^{-1}	0	1.7×10^{-6}	1.1×10^{-6}	2.8×10^{-6}
Carbon-14	1.1×10^{1}	5.3×10^{-2}	3.2×10^{-4}	1.1×10^{1}	0	6.9×10^{-5}	4.4×10^{-5}	1.1×10^{-4}
Cobalt-60	1.4×10^{-4}	1.4×10^{-5}	2.4×10^{-7}	1.5×10^{-4}	0	1.5×10^{-8}	9.2×10^{-9}	2.4×10^{-8}
Strontium-90	1.4×10^{1}	1.2	2.1×10^{-2}	1.5×10^{1}	3.4	1.2×10^{-3}	7.2×10^{-4}	3.4
Technetium-99	5.7×10^{-4}	2.2×10^{-4}	1.3×10^{-6}	7.9×10^{-4}	0	2.9×10^{-7}	1.8×10^{-7}	4.6×10^{-7}
Iodine-129	6.8×10^{-2}	2.6×10^{-1}	1.0×10^{-3}	3.3×10^{-1}	0	4.2×10^{-5}	2.6×10^{-5}	6.7×10^{-5}
Cesium-137	1.4×10^{1}	2.4	1.4×10^{-2}	1.6×10^{1}	5.1	2.9×10^{-3}	1.8×10^{-3}	5.1
Uranium	1.4×10^{-3}	1.0×10^{-3}	6.0×10^{-6}	2.4×10^{-3}	0	1.3×10^{-6}	8.2×10^{-7}	2.1×10^{-6}
Plutonium-238	1.1×10^{-1}	6.5×10^{-3}	4.3×10^{-5}	1.2×10^{-1}	0	1.0×10^{-5}	5.2×10^{-6}	1.5×10^{-5}
Plutonium-239, -240	2.0	9.3×10^{-2}	2.7×10^{-3}	2.1	0	3.3×10^{-4}	4.9×10^{-5}	3.7×10^{-4}
Plutonium-241	5.5×10^{-2}	1.3×10^{-3}	9.2×10^{-6}	5.7×10^{-2}	0	1.7×10^{-6}	1.1×10^{-6}	2.8×10^{-6}
Americium-241	3.0	1.0×10^{-1}	3.1×10^{-3}	3.1	0	9.0×10^{-5}	4.7×10^{-5}	1.4×10^{-4}
Total	**4.5×10^{1}**	**4.1**	**4.2×10^{-2}**	**4.9×10^{1}**	**8.5**	**4.6×10^{-3}**	**2.7×10^{-3}**	**8.6**
Lifetime risk of a latent cancer fatality				3×10^{-5}				5×10^{-6}

[a] Impacts are provided for comparison with other alternatives. The life-of-project dose would not be received by one individual person due to the duration of this alternative. The dose from 70 years of exposure at the average annual dose rate would be 21 millirem, with a corresponding lifetime risk of a latent cancer fatality of 1×10^{-5}.

[b] The regulatory limit for exposure of an individual to radioactive air emissions from U.S. Department of Energy facilities is an effective dose equivalent of 10 millirem per years on to other alternatives.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–43. Tank Closure Alternative 6A, Option Case, Impacts on the Maximally Exposed Individual During Normal Operations

Radionuclides	Dose over Life of Project (millirem)[a]				Dose in Year of Maximum Impact (millirem per year)[b]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	1.3×10^{-1}	2.2×10^{-2}	1.4×10^{-2}	1.7×10^{-1}	0	2.9×10^{-5}	1.8×10^{-5}	4.6×10^{-5}
Carbon-14	1.1×10^{1}	7.2×10^{-2}	4.5×10^{-2}	1.2×10^{1}	0	9.3×10^{-5}	5.9×10^{-5}	1.5×10^{-4}
Cobalt-60	1.4×10^{-4}	2.6×10^{-5}	1.6×10^{-5}	1.8×10^{-4}	0	2.8×10^{-8}	1.7×10^{-8}	4.5×10^{-8}
Strontium-90	1.4×10^{1}	1.4	8.5×10^{-1}	1.6×10^{1}	3.4	1.2×10^{-3}	7.7×10^{-4}	3.4
Technetium-99	5.7×10^{-4}	3.2×10^{-4}	2.0×10^{-4}	1.1×10^{-3}	0	4.2×10^{-7}	2.6×10^{-7}	6.7×10^{-7}
Iodine-129	6.8×10^{-2}	2.7×10^{-1}	1.6×10^{-1}	4.9×10^{-1}	0	5.8×10^{-5}	3.5×10^{-5}	9.3×10^{-5}
Cesium-137	1.4×10^{1}	2.5	1.5	1.8×10^{1}	5.1	2.9×10^{-3}	1.8×10^{-3}	5.1
Uranium	1.4×10^{-3}	1.3×10^{-3}	8.3×10^{-4}	3.5×10^{-3}	0	1.7×10^{-6}	1.1×10^{-6}	2.8×10^{-6}
Plutonium-238	1.1×10^{-1}	1.3×10^{-2}	8.4×10^{-3}	1.3×10^{-1}	0	1.9×10^{-5}	1.1×10^{-5}	3.0×10^{-5}
Plutonium-239, -240	2.0	6.0×10^{-1}	3.8×10^{-1}	3.0	0	9.6×10^{-4}	4.5×10^{-4}	1.4×10^{-3}
Plutonium-241	5.5×10^{-2}	7.9×10^{-3}	5.0×10^{-3}	6.8×10^{-2}	0	1.0×10^{-5}	6.4×10^{-6}	1.6×10^{-5}
Americium-241	3.0	2.0×10^{-1}	1.2×10^{-1}	3.3	0	1.8×10^{-4}	1.0×10^{-4}	2.9×10^{-4}
Total	**4.5×10^{1}**	**5.0**	**3.1**	**5.3×10^{1}**	**8.5**	**5.6×10^{-3}**	**3.3×10^{-3}**	**8.6**
Lifetime risk of a latent cancer fatality				3×10^{-5}				5×10^{-6}

[a] Impacts are provided for comparison with other alternatives. The life-of-project dose would not be received by one individual person due to the duration of this alternative. The dose from 70 years of exposure at the average annual dose rate would be 23 millirem, with a corresponding lifetime risk of a latent cancer fatality of 1×10^{-5}.

[b] The regulatory limit for exposure of an individual to radioactive air emissions from U.S. Department of Energy facilities is an effective dose equivalent of 10 millirem per year (40 CFR 61, Subpart H).

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–44. Tank Closure Alternative 6B, Base Case, Impacts on the Maximally Exposed Individual During Normal Operations

Radionuclides	Dose over Life of Project (millirem)[a]				Dose in Year of Maximum Impact (millirem per year)[b]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	1.3×10^{-1}	1.3×10^{-3}	8.4×10^{-4}	1.4×10^{-1}	5.1×10^{-3}	1.7×10^{-5}	1.1×10^{-5}	5.2×10^{-3}
Carbon-14	1.1×10^{1}	5.3×10^{-2}	3.4×10^{-2}	1.1×10^{1}	4.3×10^{-1}	6.9×10^{-4}	4.4×10^{-4}	4.3×10^{-1}
Cobalt-60	1.4×10^{-4}	1.4×10^{-5}	8.8×10^{-6}	1.6×10^{-4}	5.2×10^{-6}	2.6×10^{-7}	1.3×10^{-7}	5.6×10^{-6}
Strontium-90	1.3×10^{1}	1.2	7.2×10^{-1}	1.5×10^{1}	3.8	2.2×10^{-2}	1.1×10^{-2}	3.8
Technetium-99	5.7×10^{-4}	2.2×10^{-4}	1.4×10^{-4}	9.3×10^{-4}	2.2×10^{-5}	2.9×10^{-6}	1.8×10^{-6}	2.6×10^{-5}
Iodine-129	6.8×10^{-2}	8.8×10^{-2}	5.2×10^{-2}	2.1×10^{-1}	2.6×10^{-3}	1.9×10^{-3}	1.1×10^{-3}	5.5×10^{-3}
Cesium-137	1.2×10^{1}	2.3	1.4	1.6×10^{1}	5.3	3.0×10^{-2}	1.8×10^{-2}	5.3
Uranium	1.4×10^{-3}	1.0×10^{-3}	6.3×10^{-4}	3.0×10^{-3}	5.3×10^{-5}	1.3×10^{-5}	8.2×10^{-6}	7.4×10^{-5}
Plutonium-238	1.1×10^{-1}	6.4×10^{-3}	4.1×10^{-3}	1.2×10^{-1}	4.2×10^{-3}	8.4×10^{-5}	5.3×10^{-5}	4.3×10^{-3}
Plutonium-239, -240	2.0	9.2×10^{-2}	5.9×10^{-2}	2.1	7.6×10^{-2}	2.0×10^{-3}	8.9×10^{-4}	7.8×10^{-2}
Plutonium-241	5.5×10^{-2}	1.3×10^{-3}	8.5×10^{-4}	5.7×10^{-2}	2.1×10^{-3}	1.8×10^{-5}	1.1×10^{-5}	2.1×10^{-3}

Table K–44. Tank Closure Alternative 6B, Base Case, Impacts on the Maximally Exposed Individual During Normal Operations *(continued)*

Radionuclides	Dose over Life of Project (millirem)[a]				Dose in Year of Maximum Impact (millirem per year)[b]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Americium-241	2.9	1.0×10^{-1}	6.4×10^{-2}	3.1	1.1×10^{-1}	2.5×10^{-3}	1.0×10^{-3}	1.2×10^{-1}
Total	**4.2×10^{1}**	**3.8**	**2.3**	**4.9×10^{1}**	**9.7**	**6.0×10^{-2}**	**3.3×10^{-2}**	**9.8**
Lifetime risk of a latent cancer fatality				3×10^{-5}				6×10^{-6}

[a] Impacts are provided for comparison with other alternatives. The life-of-project dose would not be received by one individual person due to the duration of this alternative. The dose from 70 years of exposure at the average annual dose rate would be 36 millirem, with a corresponding lifetime risk of a latent cancer fatality of 2×10^{-5}.

[b] The regulatory limit for exposure of an individual to radioactive air emissions from U.S. Department of Energy facilities is an effective dose equivalent of 10 millirem per year (40 CFR 61, Subpart H).

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–45. Tank Closure Alternative 6B, Option Case, Impacts on the Maximally Exposed Individual During Normal Operations

Radionuclides	Dose over Life of Project (millirem)[a]				Dose in Year of Maximum Impact (millirem per year)[b]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	1.3×10^{-1}	2.2×10^{-2}	1.4×10^{-2}	1.7×10^{-1}	5.1×10^{-3}	2.9×10^{-4}	1.8×10^{-4}	5.6×10^{-3}
Carbon-14	1.1×10^{1}	7.2×10^{-2}	4.6×10^{-2}	1.1×10^{1}	4.3×10^{-1}	9.3×10^{-4}	5.9×10^{-4}	4.3×10^{-1}
Cobalt-60	1.4×10^{-4}	2.5×10^{-5}	1.6×10^{-5}	1.8×10^{-4}	5.2×10^{-6}	4.4×10^{-7}	2.1×10^{-7}	5.9×10^{-6}
Strontium-90	1.3×10^{1}	1.3	8.2×10^{-1}	1.6×10^{1}	3.8	2.7×10^{-2}	1.1×10^{-2}	3.8
Technetium-99	5.7×10^{-4}	3.2×10^{-4}	2.0×10^{-4}	1.1×10^{-3}	2.2×10^{-5}	4.2×10^{-6}	2.6×10^{-6}	2.8×10^{-5}
Iodine-129	6.8×10^{-2}	1.0×10^{-1}	5.9×10^{-2}	2.3×10^{-1}	2.6×10^{-3}	2.0×10^{-3}	1.2×10^{-3}	5.8×10^{-3}
Cesium-137	1.2×10^{1}	2.3	1.4	1.6×10^{1}	5.3	3.1×10^{-2}	1.9×10^{-2}	5.3
Uranium	1.4×10^{-3}	1.3×10^{-3}	8.3×10^{-4}	3.5×10^{-3}	5.3×10^{-5}	1.7×10^{-5}	1.1×10^{-5}	8.1×10^{-5}
Plutonium-238	1.1×10^{-1}	1.3×10^{-2}	8.4×10^{-3}	1.3×10^{-1}	4.2×10^{-3}	1.7×10^{-4}	1.1×10^{-4}	4.5×10^{-3}
Plutonium-239, -240	2.0	6.0×10^{-1}	3.8×10^{-1}	3.0	7.6×10^{-2}	8.9×10^{-3}	4.9×10^{-3}	8.9×10^{-2}
Plutonium-241	5.5×10^{-2}	7.9×10^{-3}	5.0×10^{-3}	6.8×10^{-2}	2.1×10^{-3}	1.0×10^{-4}	6.4×10^{-5}	2.3×10^{-3}
Americium-241	2.9	1.9×10^{-1}	1.2×10^{-1}	3.2	1.1×10^{-1}	4.2×10^{-3}	1.6×10^{-3}	1.2×10^{-1}
Total	**4.2×10^{1}**	**4.7**	**2.9**	**5.0×10^{1}**	**9.7**	**7.5×10^{-2}**	**3.9×10^{-2}**	**9.8**
Lifetime risk of a latent cancer fatality				3×10^{-5}				6×10^{-6}

[a] Impacts are provided for comparison with other alternatives. The life-of-project dose would not be received by one individual person due to the duration of this alternative. The dose from 70 years of exposure at the average annual dose rate would be 37 millirem, with a corresponding lifetime risk of a latent cancer fatality of 2×10^{-5}.

[b] The regulatory limit for exposure of an individual to radioactive air emissions from U.S. Department of Energy facilities is an effective dose equivalent of 10 millirem per year (40 CFR 61, Subpart H).

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

Table K–46. Tank Closure Alternative 6C Impacts on the Maximally Exposed Individual During Normal Operations

Radionuclides	Dose over Life of Project (millirem)				Dose in Year of Maximum Impact (millirem per year)[a]			
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources
Hydrogen-3 (tritium)	1.3×10^{-1}	0	0	1.3×10^{-1}	5.1×10^{-3}	0	0	5.1×10^{-3}
Carbon-14	1.1×10^{1}	0	0	1.1×10^{1}	4.3×10^{-1}	0	0	4.3×10^{-1}
Cobalt-60	1.4×10^{-4}	0	0	1.4×10^{-4}	5.2×10^{-6}	0	0	5.2×10^{-6}
Strontium-90	1.3×10^{1}	5.9×10^{-3}	3.5×10^{-3}	1.3×10^{1}	3.8	1.6×10^{-4}	9.2×10^{-5}	3.8
Technetium-99	5.7×10^{-4}	0	0	5.7×10^{-4}	2.2×10^{-5}	0	0	2.2×10^{-5}
Iodine-129	6.8×10^{-2}	5.5×10^{-2}	3.2×10^{-2}	1.5×10^{-1}	2.6×10^{-3}	1.5×10^{-3}	8.5×10^{-4}	4.9×10^{-3}
Cesium-137	1.2×10^{1}	4.7×10^{-2}	2.7×10^{-2}	1.2×10^{1}	5.3	1.2×10^{-3}	7.2×10^{-4}	5.3
Uranium	1.4×10^{-3}	0	0	1.4×10^{-3}	5.3×10^{-5}	0	0	5.3×10^{-5}
Plutonium-238	1.1×10^{-1}	3.4×10^{-6}	2.9×10^{-6}	1.1×10^{-1}	4.2×10^{-3}	8.9×10^{-7}	5.6×10^{-7}	4.2×10^{-3}
Plutonium-239, -240	2.0	4.8×10^{-4}	4.0×10^{-4}	2.0	7.6×10^{-2}	1.2×10^{-4}	7.8×10^{-5}	7.6×10^{-2}
Plutonium-241	5.5×10^{-2}	0	0	5.5×10^{-2}	2.1×10^{-3}	0	0	2.1×10^{-3}
Americium-241	2.9	3.2×10^{-5}	2.7×10^{-5}	2.9	1.1×10^{-1}	8.1×10^{-6}	5.1×10^{-6}	1.1×10^{-1}
Total	**4.2×10^{1}**	**1.1×10^{-1}**	**6.3×10^{-2}**	**4.3×10^{1}**	**9.7**	**3.0×10^{-3}**	**1.7×10^{-3}**	**9.7**
Lifetime risk of a latent cancer fatality				3×10^{-5}				6×10^{-6}

[a] The regulatory limit for exposure of an individual to radioactive air emissions from U.S. Department of Energy facilities is an effective dose equivalent of 10 millirem per year (40 CFR 61, Subpart H).

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: STTS=Supplemental Treatment Technology Site.

An onsite MEI would receive a dose from emissions from the WTP, STTS-East, and STTS-West. Table K–47 presents the doses from each source location, the sum of those doses, and the associated risk of an LCF for the life of the project under each Tank Closure alternative. These data are provided for comparison among the alternatives, recognizing that some of the alternatives (Alternatives 1; 2A; 6A, Base and Option Cases; and 6B, Base and Option Cases) would span multiple generations. Table K–48 presents the doses and associated risks for the year or years of projected maximum impact. The location of the onsite MEI was determined to be at US Ecology; impacts at this location would exceed those at the Columbia Generating Station or LIGO.

Table K–47. Tank Closure Alternatives – Impacts on the Onsite Maximally Exposed Individual over the Life of the Project During Normal Operations

Tank Closure Alternative	Dose (millirem)				Lifetime Risk of an LCF	Location
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources		
1[a]	0.0	9.2×10^{-1}	2.3	3.2	2×10^{-6}	US Ecology
2A[a]	9.1	9.4×10^{-1}	2.4	1.2×10^{1}	7×10^{-6}	US Ecology
2B	9.1	1.1×10^{-2}	2.8×10^{-2}	9.2	6×10^{-6}	US Ecology
3A	8.3	4.1×10^{-2}	6.5×10^{-1}	8.9	5×10^{-6}	US Ecology
3B	8.3	3.3×10^{-2}	3.9×10^{-2}	8.3	5×10^{-6}	US Ecology
3C	8.3	8.7×10^{-2}	7.5×10^{-1}	9.1	5×10^{-6}	US Ecology

Table K–47. Tank Closure Alternatives – Impacts on the Onsite Maximally Exposed Individual over the Life of the Project During Normal Operations *(continued)*

Tank Closure Alternative	Dose (millirem)				Lifetime Risk of an LCF	Location
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources		
4	8.3	7.9×10^{-2}	8.1×10^{-1}	9.2	6×10^{-6}	US Ecology
5	7.7	2.8×10^{-2}	6.2×10^{-1}	8.4	5×10^{-6}	US Ecology
6A, Base Case[a]	9.4	8.5×10^{-1}	5.2×10^{-2}	1.0×10^{1}	6×10^{-6}	US Ecology
6A, Option Case[a]	9.4	1.6	4.3	1.5×10^{1}	9×10^{-6}	US Ecology
6B, Base Case[a]	9.1	8.2×10^{-1}	2.2	1.2×10^{1}	7×10^{-6}	US Ecology
6B, Option Case[a]	9.1	1.6	4.1	1.5×10^{1}	9×10^{-6}	US Ecology
6C	9.1	1.1×10^{-2}	2.8×10^{-2}	9.1	5×10^{-6}	US Ecology

[a] The life-of-project dose would not be received by one individual person due to the duration of these alternatives. The dose and lifetime risk of an LCF from 40 years of exposure at the average annual dose rate would be as follows: Alternative 1 – 1.3 millirem, 8×10^{-7} LCF risk; Alternative 2A – 2.6 millirem, 2×10^{-6} LCF risk; Alternative 6A, Base Case – 2.6 millirem, 2×10^{-6} LCF risk; Alternative 6A, Option Case – 3.7 millirem, 2×10^{-6} LCF risk; Alternative 6B, Base Case – 5.1 millirem, 3×10^{-6} LCF risk; Alternative 6B, Option Case – 6.2 millirem, 4×10^{-6} LCF risk.

Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.

Key: LCF=latent cancer fatality; STTS=Supplemental Treatment Technology Site; US Ecology=US Ecology Commercial Low-Level Radioactive Waste Disposal Site.

Table K–48. Tank Closure Alternatives – Impacts on the Onsite Maximally Exposed Individual in the Year of Maximum Impact During Normal Operations

Tank Closure Alternative	Dose (millirem per year)[a]				Lifetime Risk of an LCF	Location
	Waste Treatment Plant	200-East Area STTS	200-West Area STTS	Combined Sources		
1	0.0	9.4×10^{-3}	2.4×10^{-2}	3.3×10^{-2}	2×10^{-8}	US Ecology
2A	1.4	7.8×10^{-9}	0	1.4	8×10^{-7}	US Ecology
2B	1.7	4.2×10^{-4}	1.1×10^{-3}	1.7	1×10^{-6}	US Ecology
3A	1.4	3.9×10^{-5}	2.8×10^{-3}	1.4	8×10^{-7}	US Ecology
3B	1.4	6.3×10^{-7}	5.6×10^{-5}	1.4	8×10^{-7}	US Ecology
3C	1.4	2.5×10^{-4}	3.3×10^{-3}	1.4	8×10^{-7}	US Ecology
4	1.4	3.0×10^{-4}	7.9×10^{-4}	1.4	8×10^{-7}	US Ecology
5	1.4	3.1×10^{-7}	3.7×10^{-3}	1.4	8×10^{-7}	US Ecology
6A, Base Case	1.4	1.2×10^{-3}	2.3×10^{-3}	1.4	8×10^{-7}	US Ecology
6A, Option Case	1.4	2.1×10^{-3}	4.7×10^{-3}	1.4	8×10^{-7}	US Ecology
6B, Base Case	1.6	1.4×10^{-2}	3.1×10^{-2}	1.7	1×10^{-6}	US Ecology
6B, Option Case	1.6	2.5×10^{-2}	5.5×10^{-2}	1.7	1×10^{-6}	US Ecology
6C	1.6	4.2×10^{-4}	1.1×10^{-3}	1.6	1×10^{-6}	US Ecology

[a] The regulatory limit for exposure of an individual to radioactive air emissions from U.S. Department of Energy facilities is an effective dose equivalent of 10 millirem per year (40 CFR 61, Subpart H).

Key: LCF=latent cancer fatality; STTS=Supplemental Treatment Technology Site; US Ecology=US Ecology Commercial Low-Level Radioactive Waste Disposal Site.

K.2.1.2 Impacts on Workers During Normal Operations

This section describes the methodologies used to evaluate the impacts of waste treatment and closure activities on Hanford workers. Two groups of workers were considered in the evaluation: project radiation workers who are engaged in waste treatment and closure activities and nearby, noninvolved workers. Different methodologies were used to determine the radiological impacts on these two receptors.

K.2.1.2.1 Project Radiation Workers

Project radiation workers are exposed to radiation through the performance of activities related to the retrieval and processing of tank waste and the deactivation and closure of tank farm facilities. External exposure to radiation is the principal cause of doses to radiation workers.

Doses to radiation workers under each Tank Closure alternative were estimated using data provided in the scaled data sets developed to support this *TC & WM EIS* (SAIC 2010a). The data sets present conservative estimates of expected worker doses for a range of activities that make up the Tank Closure alternatives. Those estimates were based on a number of factors, including dose rates and doses associated with current tank farm operations, engineering studies of related activities, and conservative engineering estimates for accomplishing particular scopes of work. Scaled data sets representing the Tank Closure alternatives included in this *TC & WM EIS* include scaled estimates of the radiation worker labor hours required to accomplish the activities that make up an alternative and the associated radiation doses.

Total doses associated with each Tank Closure alternative were estimated by summing the dose estimates for each activity that is a component of the alternative, resulting in the project dose estimates shown in Table K–49. These results are presumed to overestimate the dose that would likely be received by the worker population. A number of factors contributed to the conservatism. Conservative dose estimates were included in the original data packages to ensure that they represented the upper range of expected doses associated with performing the activities. Linear scaling of the resources, labor hours, and doses to develop the alternatives added to the conservatism because there was no recognition of economies of scale or changes in annual resource needs commensurate with changes in the duration of activities. For example, the annual labor requirements for operating a facility to process a given amount of material were the same whether the processing period would be 30 years or 80 years. Consequently, the conservatism in the project doses may be greater for alternatives with long operating periods. Through the application of administrative and engineering controls to maintain exposure as low as is reasonably achievable, actual total radiation worker doses from executing an alternative would likely be lower than the estimates.

Data from the scaled data sets were used to develop an estimate of the average annual dose per work year for each Tank Closure alternative. Doses to radiation workers were calculated based on a full-time-equivalent (FTE) worker, who was assumed to have a 2,080-hour work year for the purposes of this dose evaluation. The time and dose associated with the various activities that make up an alternative vary, resulting in comparatively low dose rates for some activities and high dose rates for others. In practice, DOE and its contractors would implement controls to limit the exposure of individual workers for all activities in accordance with regulations and guidance (10 CFR 835; DOE Standard 1098-2008). Therefore, the average FTE doses calculated for each alternative are not necessarily representative of the actual doses that would be received by individual workers. Rather, they represent an overestimation of the average dose that a worker would receive.

The average dose per FTE under an alternative was calculated by dividing the total radiation worker dose by the number of FTEs. The number of FTEs was determined by dividing the total radiation worker labor hours by 2,080 hours per work year. An average dose for an FTE radiation worker assumed to be

involved with the project for the duration of the project or an entire working career was also calculated for each alternative. The project dose to an individual was estimated by multiplying the average annual FTE dose by the lesser of the project duration or 40 years. The average dose per FTE and the average project dose are shown in Table K–49.

Table K–49. Tank Closure Alternatives – Radiation Worker Impacts and Labor Estimates

Alternative	Life-of-Project Collective Worker Impact		Life-of-Project Full-Time-Equivalent Radiation Worker Labor		Average Annual Impact per Full-Time-Equivalent Radiation Worker		Average Project Impact per Full-Time-Equivalent Radiation Worker[a]	
	Dose (person-rem)	LCFs[b]	Hours	Years	Dose (millirem/year)	LCFs[c]	Dose (millirem)	LCFs
1	2.8×10^{2}	0 (0.2)	4.07×10^{6}	2,000	1.4×10^{2}	9×10^{-5}	5.7×10^{3}	3×10^{-3}
2A	2.2×10^{4}	13	2.72×10^{8}	131,000	1.7×10^{2}	1×10^{-4}	6.9×10^{3}	4×10^{-3}
2B	1.1×10^{4}	7	1.40×10^{8}	67,100	1.6×10^{2}	1×10^{-4}	6.5×10^{3}	4×10^{-3}
3A	1.0×10^{4}	6	1.32×10^{8}	63,600	1.6×10^{2}	1×10^{-4}	6.1×10^{3}	4×10^{-3}
3B	9.8×10^{3}	6	1.28×10^{8}	61,500	1.6×10^{2}	1×10^{-4}	6.1×10^{3}	4×10^{-3}
3C	1.1×10^{4}	6	1.36×10^{8}	65,600	1.6×10^{2}	1×10^{-4}	6.1×10^{3}	4×10^{-3}
4	4.3×10^{4}	26	1.71×10^{8}	82,100	5.3×10^{2}	3×10^{-4}	2.1×10^{4}	1×10^{-2}
5	8.5×10^{3}	5	1.19×10^{8}	57,000	1.5×10^{2}	9×10^{-5}	5.1×10^{3}	3×10^{-3}
6A, Base Case	1.2×10^{5}	72	6.02×10^{8}	289,000	4.2×10^{2}	2×10^{-4}	1.7×10^{4}	1×10^{-2}
6A, Option Case	1.2×10^{5}	75	6.47×10^{8}	311,000	4.0×10^{2}	2×10^{-4}	1.6×10^{4}	1×10^{-2}
6B, Base Case	8.2×10^{4}	49	1.92×10^{8}	92,100	8.9×10^{2}	5×10^{-4}	3.6×10^{4}	2×10^{-2}
6B, Option Case	8.5×10^{4}	51	2.21×10^{8}	106,000	8.0×10^{2}	5×10^{-4}	3.2×10^{4}	2×10^{-2}
6C	1.1×10^{4}	7	1.40×10^{8}	67,100	1.6×10^{2}	1×10^{-4}	6.4×10^{3}	4×10^{-3}

[a] Full-time-equivalent radiation worker project dose and individual risk of an LCF from 40 years of occupational exposure.
[b] Increased number of LCFs for the worker population as a result of the radiation dose received under the alternative. If zero, the number in parentheses is the value calculated by multiplying the dose by the risk factor of 0.0006 LCFs per person-rem.
[c] The increased individual risk of an LCF from one year of occupational exposure.
Note: Sums and products presented in the table may differ from those calculated from table entries due to rounding.
Key: LCF=latent cancer fatality.

K.2.1.2.2 Noninvolved Workers

Doses were also estimated for a noninvolved worker, i.e., a person working at the site who is incidentally exposed due to the radioactive emissions associated with the Tank Closure alternatives. The GENII-2 computer code described in Section K.2.1.1.2 was used to estimate doses to noninvolved workers. The exposure parameters for a noninvolved worker were different from those used for an offsite member of the public. Because the worker was assumed to spend only a work shift at the site, exposure to and inhalation of the radioactive plume was assumed to occur only for a portion of the day. It was also assumed that a portion of the worker's job is performed outdoors, resulting in exposure to deposited material. The outdoor activity was assumed to result in ingestion of contaminated soil resuspended by wind or work activities. Unlike doses to members of the offsite population, there was no assumption that any portion of the exposure associated with work would result from consumption of radioactively contaminated fruits, vegetables, or animal products. Table K–50 shows the parameters used for the dose analysis of noninvolved workers.

Table K–50. Dose Assessment Parameters for Noninvolved Workers

Medium	Exposure Pathway	Rate	Reference
Air (plume)	Internal – inhalation	23 cubic meters per day	Beyeler et al. 1999
	Internal – inhalation	2,080 hours per year	DOE 1995
	External	2,080 hours per year	Consistent with inhalation exposure
Soil	External	988 hours per year	DOE 1995
	Internal – ingestion	50 milligrams per day	DOE 1995

Note: To convert cubic meters to cubic feet, multiply by 35.315; milligrams to ounces, by 0.00003527.

As discussed in Section K.2.1.1.1, for purposes of assessing the impacts of radioactive emissions, all emissions were assigned to one of three sources: the WTP, STTS-East, or STTS-West. Doses to a noninvolved worker were evaluated for a location in the 200-East Area and a location in the 200-West Area. The locations selected are near the assumed emission sources in facilities that are expected to be staffed on a daily basis. In the 200-East Area, the noninvolved worker was assumed to be at the 242-A Evaporator, about 0.8 kilometers (890 yards) west of the WTP and 1.1 kilometers (1,200 yards) north-northwest of STTS-East.

In the 200-West Area, two locations were considered for the noninvolved worker. The Environmental Restoration Disposal Facility (ERDF) was selected for detailed analysis after determining that the impact on a noninvolved worker located there would be higher than that on one located at the 222-S Laboratory. The ERDF is about 0.9 kilometers (1,000 yards) east of STTS-West, while the 222-S Laboratory is southwest of STTS-West.

Doses to a noninvolved worker at the 242-A Evaporator and ERDF under each Tank Closure alternative were determined for releases from STTS-East, the WTP, and STTS-West based on releases of 1 curie of each radionuclide identified in Table K–7. The doses to noninvolved workers were scaled based on the estimated releases from the WTP, STTS-East, and STTS-West under each Tank Closure alternative (see Tables K–8 through K–20) over the life of the project and during the years of maximum impact. The doses to noninvolved workers in the year(s) of maximum impact are presented in Table K–51. Although the emissions that would impact a noninvolved worker or an MEI would be the same, the year(s) of maximum impact for these receptors may be different. Emissions from the STTSs would have various sources, such as routine tank farm operations, tank waste retrieval activities, supplemental waste treatment, and tank closure, each of which would occur in a different time period during the project. The year(s) of maximum impact for a noninvolved worker at the ERDF would occur when the STTS-West emissions were largest. Similarly, the year(s) of maximum impact for a noninvolved worker at the 242-A Evaporator would be when emissions from the WTP, STTS-East, or both were largest. At a distance of more than 9.6 kilometers (6 miles), the MEI would be exposed to a combination of emissions from the WTP and STTS-East and -West; consequently, the combined impacts of all three emission sources could affect the year of maximum impact. However, the peak impacts on the MEI and noninvolved worker at the 242-A Evaporator would be dominated by the emissions from processing cesium and strontium at the WTP under all Tank Closure alternatives except Alternatives 1 and 2A. The alternatives have been conceptualized such that all of the cesium and strontium from capsules would be processed in a single year at the WTP, resulting in increased cesium and strontium emissions that year. Alternative 1 does not include cesium and strontium processing, and peak impacts under Alternative 2A would occur from continuing tank emissions during the period of administrative control and emissions occurring during deactivation of the WTP.

Table K–51. Tank Closure Alternatives – Impacts on Noninvolved Workers in the Year(s) of Maximum Impact During Normal Operations

Tank Closure Alternative	Noninvolved Worker at 242-A Evaporator		Noninvolved Worker at ERDF		Year(s) of Maximum Impact
	Total Dose (millirem per year)	Risk of a Latent Cancer Fatality	Total Dose (millirem per year)	Risk of a Latent Cancer Fatality	
1	9.7×10^{-2}	6×10^{-8}	2.7×10^{-1}	2×10^{-7}	2008[a]
2A	3.0	2×10^{-6}	9.0×10^{-1}	5×10^{-7}	2093
2B	3.4	2×10^{-6}	1.1	7×10^{-7}	2040
3A	3.0	2×10^{-6}	9.3×10^{-1}	6×10^{-7}	2040
3B	3.0	2×10^{-6}	9.0×10^{-1}	5×10^{-7}	2040
3C	3.0	2×10^{-6}	9.4×10^{-1}	6×10^{-7}	2040
4	3.0	2×10^{-6}	9.1×10^{-1}	5×10^{-7}	2043
5	3.0	2×10^{-6}	9.4×10^{-1}	6×10^{-7}	2034
6A, Base Case	3.0	2×10^{-6}	9.3×10^{-1}	6×10^{-7}	2163
6A, Option Case	3.0	2×10^{-6}	9.6×10^{-1}	6×10^{-7}	2163
6B, Base Case	3.5	2×10^{-6}	1.4	9×10^{-7}	2040
6B, Option Case	3.6	2×10^{-6}	1.7	1×10^{-6}	2040
6C	3.4	2×10^{-6}	1.1	7×10^{-7}	2040

[a] The year of maximum impact of 2008 is based on a 2006 start date (see Chapter 2).
Note: Total may not equal the sum of the contributions due to rounding.
Key: ERDF=Environmental Restoration Disposal Facility.

Doses to noninvolved workers from emissions over the entire duration of each Tank Closure alternative are shown in Table K–52. Note that these project doses are presented for comparison purposes only. The duration of some of the alternatives (in particular, Alternatives 1; 2A; 6A, Base and Option Cases; and 6B, Base and Option Cases) would make it impossible for a single worker to receive the dose from the project's total emissions.

Table K–52. Tank Closure Alternatives – Impacts on Noninvolved Workers over the Life of the Project During Normal Operations

Tank Closure Alternative	Noninvolved Worker at 242-A Evaporator		Noninvolved Worker at ERDF		Years of Project Emissions
	Total Dose (millirem)	Lifetime Risk of a Latent Cancer Fatality	Total Dose (millirem)	Lifetime Risk of a Latent Cancer Fatality	
1[a]	9.4	6×10^{-6}	2.7×10^{1}	2×10^{-5}	2006–2107
2A[a]	2.3×10^{1}	1×10^{-5}	3.4×10^{1}	2×10^{-5}	2006–2193
2B	1.4×10^{1}	8×10^{-6}	6.7	4×10^{-6}	2006–2045
3A	1.3×10^{1}	8×10^{-6}	1.3×10^{1}	8×10^{-6}	2006–2042
3B	1.3×10^{1}	8×10^{-6}	6.2	4×10^{-6}	2006–2042
3C	1.4×10^{1}	8×10^{-6}	1.4×10^{1}	9×10^{-6}	2006–2042
4	1.4×10^{1}	8×10^{-6}	1.5×10^{1}	9×10^{-6}	2006–2045
5	1.3×10^{1}	8×10^{-6}	1.2×10^{1}	7×10^{-6}	2006–2036
6A, Base Case[a]	2.2×10^{1}	1×10^{-5}	7.5	5×10^{-6}	2006–2168
6A, Option Case[a]	3.1×10^{1}	2×10^{-5}	5.5×10^{1}	3×10^{-5}	2006–2168

Table K–52. Tank Closure Alternatives – Impacts on Noninvolved Workers over the Life of the Project During Normal Operations *(continued)*

Tank Closure Alternative	Noninvolved Worker at 242-A Evaporator		Noninvolved Worker at ERDF		Years of Project Emissions
	Total Dose (millirem)	Lifetime Risk of a Latent Cancer Fatality	Total Dose (millirem)	Lifetime Risk of a Latent Cancer Fatality	
6B, Base Case[a]	2.2×10^{1}	1×10^{-5}	3.1×10^{1}	2×10^{-5}	2006–2100
6B, Option Case[a]	3.0×10^{1}	2×10^{-5}	5.4×10^{1}	3×10^{-5}	2006–2100
6C	1.4×10^{1}	8×10^{-6}	6.6	4×10^{-6}	2006–2045

[a] The life-of-project dose would not be received by one individual person due to the duration of these alternatives. The dose and lifetime risk of an LCF for the noninvolved worker with the larger impact from 40 years of exposure at the average annual dose rate would be the following: Alternative 1 – 10 millirem, 6×10^{-6} LCF risk; Alternative 2A – 7.1 millirem, 4×10^{-6} LCF risk; Alternative 6A, Base Case – 5.5 millirem, 3×10^{-6} LCF risk; Alternative 6A, Option Case – 14 millirem, 8×10^{-6} LCF risk; Alternative 6B, Base Case – 13 millirem, 8×10^{-6} LCF risk; Alternative 6B, Option Case – 23 millirem, 1×10^{-5} LCF risk.

Note: Total may not equal the sum of the contributions due to rounding.

Key: ERDF=Environmental Restoration Disposal Facility; LCF=latent cancer fatality.

K.2.1.2.3 Chemical Risks to Workers

Workers involved in performing activities associated with the storage, retrieval, and processing of tank waste and the closure of the tank farm facilities could be exposed to chemical vapors. Chemical exposure is a concern because the tanks are continuously vented to the atmosphere, and workers would need to access parts of the tank farm system to monitor or retrieve the waste. The primary route of chemical exposure to workers during routine operations was assumed to be inhalation.

Exposures to tank farm vapors have been reported by workers since 1987. Between July 1987 and May 1993, 19 vapor exposure events involving 34 workers were reported (Osborne et al. 1995). These workers reported musty and foul odors, including the smell of ammonia, emanating from several single-shell tanks (SSTs) (Osborne and Huckaby 1994). They also reported effects such as headaches, burning sensations in the nose and throat, nausea, and impaired pulmonary functioning (Osborne et al. 1995).

In 1992, DOE and Westinghouse Hanford Company, which operated the tank farms at that time, determined that the tank farm vapor emissions had not been adequately characterized and represented a potential health risk to workers in the immediate vicinity of the tanks. To address this potential health risk, workers in certain areas of the tank farms (e.g., within the buffer zone of tank 214-C-103) were required to use supplied-air respirators. The Tank Vapor Issue Resolution Program was established in 1992 to characterize waste tank headspace vapors and understand their impact if they migrated into the workers' breathing zones (Osborne and Huckaby 1994).

In 1993, the Defense Nuclear Facilities Safety Board issued Recommendation 93-5, which indicated the need for better characterization of tank waste and headspace gases to understand the hazards present. As a result, an extensive tank waste characterization program was initiated that included process history and waste transfer records analysis, solid- and liquid-phase sampling and analysis, and vapor sampling and analysis (Cash 2004).

Between 1992 and 1997, headspace gas samples were collected from 109 SSTs (Stock and Huckaby 2000), primarily from SSTs that had passive ventilation. Some headspace vapor samples were also taken from double-shell tanks; however, all double-shell tanks have active ventilation, which greatly diminishes vapors (Cash 2004). Over 1,200 chemical species were identified as a result of this sampling effort (Stock and Huckaby 2000). By the end of 1996, the potential for hazardous vapor exposure had been analyzed, and acceptable controls were put in place. Based on the results of tank sample analysis and extensive reviews by outside oversight committees, including the Worker Health and Safety Subpanel

of the DOE Tanks Advisory Panel, the vapor issue as known at that time was closed. Worker protection controls were implemented in the tank farms around those tanks known to contain larger amounts of noxious gases. The subpanel agreed that the implemented controls were adequate to protect the tank farm workers (Cash 2004).

Using sampling and monitoring data, a tank farm industrial hygiene program was implemented to prevent worker exposure to chemicals above occupational exposure limits. Among other actions designed to ensure worker protection, a tank farm health and safety plan was developed and implemented in 1993 and has been revised as necessary. The plan set action limits for organic chemical agents and ammonia that are below national occupational exposure limits. It further established case-by-case monitoring requirements based on the specific tank located near where the work is to be performed and the nature of the work activity (CH2M HILL 2003a).

From 1997 until 1999, waste-disturbing activities were minimal. Interim stabilization of the SSTs resumed in 1999 under an enforceable consent decree with the State of Washington (Consent Decree No. CT-99-5076-EPS). This waste-disturbing activity increased during late 2001 and early 2002, and several negative evaluation reports were made by tank farm workers with concerns about odors in and around specific tank farms (Cash 2004).

In early 2002, workers were asked to report all smells or odors, and procedures were developed that required a medical evaluation of any worker exhibiting symptoms due to vapor exposure (CH2M HILL 2004a). In 2002, 19 workers reported vapor smells and received medical evaluations. Between January 1, 2003, and September 30, 2003, 40 workers reported vapor smells and received medical evaluations (CH2M HILL 2003a). Efforts to understand and address this increase were made in 2002 and were made the subject of a project in September 2003 to accelerate progress on resolving vapor issues (CH2M HILL 2004b).

A September 2003 report by the Government Accountability Project (GAP) (GAP 2003) stated that there had been an increase in the number of workers reporting deleterious effects of exposure to the chemical vapors in tank farms. The report was generally critical of the quality and adequacy of the exposure monitoring program and alleged that workers were sick and injured as a result of being exposed to vapors from HLW tanks and other toxic and carcinogenic substances. The GAP report and subsequent GAP statements also alleged that there were instances of improper medical record-keeping, including falsification of records and collusion to undermine worker compensation claims. Further, the GAP alleged that there had been instances in which injuries and illnesses had not been properly reported.

In February 2004, the Secretary of Energy directed the DOE Office of Independent Oversight and Performance Assurance (OA) to evaluate the GAP report allegations and assess past practices and current operations to determine whether additional actions were needed to ensure a safe work environment at Hanford. OA conducted an investigation of selected aspects of worker safety and health systems at Hanford from February through April 2004. The OA team consisted of 23 experts from various disciplines, including occupational medicine, industrial hygiene, radiation protection, nuclear engineering, waste management, environmental protection, chemistry, maintenance, operations, and management systems.

The April 2004 OA report (DOE 2004a) identified 18 individual findings, including deficiencies or weaknesses related to the following:

- Hazards analysis, exposure control, and exposure assessment
- Engineering practices and operational controls that threaten tank integrity and control of vapor emissions

- Processes for defining and investigating vapor exposure issues and managing corrective actions
- Classification and reporting of injury and illness cases
- DOE oversight and coordination of contractor industrial hygiene and occupational medicine programs

In its report, the OA team observed that there were no known instances of tank farm worker vapor exposures that exceeded regulatory limits. However, the team concluded that longstanding deficiencies in the characterization of tank farm vapors and the industrial hygiene program were such that the site could not adequately ensure that all exposures were below regulatory limits. Furthermore, to ensure that the vapor exposure issues would be fully addressed, OA reported that improvements were needed in various management systems, including engineering processes, industrial hygiene programs, integrated safety management implementation, communications, contractor feedback systems, and DOE Office of River Protection (ORP) line management oversight. The OA team identified an overarching weakness in that the strategy for protecting workers from vapors was not adequately defined and documented at a level that could be translated into a set of engineered controls, administrative controls, and personal protective equipment.

At the time of the assessment, the OA team determined that the contractor had adopted an "as low as is reasonably achievable" approach as the starting point for addressing this weakness, but had not yet characterized tank vapors (i.e., the chemicals of concern and conditions under which they are likely to be released) or established a technically sound industrial hygiene program that would provide for adequate sampling and monitoring of breathing zones and personnel air. The OA report also concluded that the Richland Operations Office had not established the necessary interfaces between prime contractors and the occupational medicine program to ensure the integration of occupational medicine program services as required by DOE directives and contractor requirements. Data on OSHA-recordable accidents and in the Computerized Accident/Incident Reporting System (CAIRS) (see Section K.4) were found not to be as reliable as they should have been. Also, the CAIRS database was not being updated in a timely manner to reflect new information or the discovery of errors or omissions.

On the positive side, the OA report stated that the interim actions instituted by ORP and the contractor, which included respiratory protection for most work performed in tank farms, provided assurance that most of the immediate concerns were being addressed. Ongoing and planned actions regarding tank characterization, sampling, and personnel monitoring were seen as providing a good framework for developing longer-term solutions. The OA team found Hanford Environmental Health Foundation clinical practices and protocols to be consistent with standard occupational medical practices. The OA team found no substantiation of any of the health-related GAP allegations except for isolated instances of incomplete treatment information being provided to contractor record-keeping case managers. Although the need for some improvements was noted, OA concluded that the number and type of discrepancies identified in their investigation did not negate the overall usefulness of injury and illness metrics as a tool for monitoring safety performance and focusing attention on problem areas or trends. No indication of significant or pervasive underreporting of injuries and illnesses was noted, and most injury and illness events were found to be appropriately categorized. No egregious examples of misreporting were identified. This finding was consistent with a later Office of the Inspector General report of an independent review, which noted that the medical files were in good order (Friedman 2004).

Due to the increase in vapor exposure reports, mandatory respiratory protection for workers within the tank farm boundaries was implemented in March 2004 (Aromi 2004). In April 2004, a requirement for supplied-air respirators was implemented because of concerns about the amount of nitrous oxide in the tank vapors and the effectiveness of air-purifying respirators. Other actions taken to address vapor exposure issues included the following:

- Personal sampling devices were put into use to characterize tank farm worker breathing-zone vapor concentrations to better understand the exposure potential for various tasks. As of June 3, 2004, a total of 326 personal breathing-zone samples had been collected (124 for volatile organic compounds, 88 for ammonia, and 114 for nitrous oxide). Preliminary analysis of 79 of the nitrous oxide samples showed typical breathing-zone concentrations of less than 1 part per million (ppm) compared with the 50 ppm Threshold Limit Value established by ACGIH. Of the 29 ammonia samples for which analysis was complete, 17 showed less than detectable levels, while 12 showed levels ranging from 0.04 to 0.24 ppm, less than 1 percent of the 25 ppm Threshold Limit Value for ammonia.

- To better understand nitrous oxide emissions from tanks, samples were obtained from the breather filter openings for all 149 SSTs. Results of the sample analyses are provided in *Results of Nitrous Oxide Monitoring Equipment Tests and Badge Monitoring Non-personnel Area Tests Within Hanford Single Shell Tank Farms* and are summarized as follows (Schofield 2004):

  - Results from 62 samples taken from 10 selected tanks believed to have high nitrous oxide concentrations in the tank headspace showed that the 24-hour time-weighted average concentrations at a distance of 0.9 to 1.5 meters (3 to 5 feet) from the breather filters were all below 1.0 ppm. Results from an additional 25 samples showed no 24-hour time-weighted average concentrations above 1.0 ppm at a distance of 46 centimeters (18 inches) from the breather filters on 5 selected tanks with high nitrous oxide concentrations in the tank headspace.

  - Results for 12- and 24-hour samples taken directly from the tank breather filter outlets showed, out of 343 samples, only 30 with time-weighted average concentrations above 1 ppm and 6 above 10 ppm. The highest value was 38 ppm, and the remaining 307 samples were less than 1.0 ppm.

- Tank headspace gas and vapor samples were obtained, and the 16 SSTs in the C tank farm were the first to be sampled. Data from these samples were used to monitor changes in vapor chemistry over time and determine appropriate protective measures (CH2M HILL 2004c).

- Other actions taken included installation of active ventilation systems, stack extensions to raise vapors above the worker breathing zone, and enhanced worker training (CH2M HILL 2004c).

An April 2005 assessment of the tank farms industrial hygiene program by ORP concluded that the program complied with applicable DOE and OSHA regulations and standards and was effective in protecting tank farm workers from industrial hazards (Schepens 2005). The assessment also sampled 57 of the 101 corrective actions arising from the April 2004 OA report (DOE 2004a) and verified adequate implementation for all 57. The assessment noted that the contractor had a plan to implement engineering controls in the tank farms to elevate exhaust points, and, in some cases, provide exhaust fans to minimize worker exposure. A number of key actions, including some engineering controls, had already been implemented, and all workers entering areas where they might be exposed to tank vapors were being required to use respiratory protection. It was also noted that the use of respiratory protection introduced several new hazards. From January 1, 2004, to March 30, 2005, about 33 percent of workplace injuries (mainly muscle strains, slips, and trips and falls) could be directly related to the use of a self-contained

breathing apparatus (SCBA), which caused reduced visibility. Respiratory tract irritation from breathing the very dry air supplied by SCBAs was also noted (Schepens 2005).

On July 27, 2007, about 320 liters (85 gallons) of tank waste were spilled during a transfer from tank 241-S-102; the resulting *Type A Accident Investigation Report* identified several worker chemical exposure issues associated with the spill (DOE 2007a). A number of workers identified odors, experienced symptoms, or expressed concerns about their potential exposure to chemicals from the spill. Two individuals approached the spill location about 10 minutes after the leak and may have been exposed to tank vapors. One person noticed a strong odor and later reported symptoms, while the other, only a few feet away, did not. Others who reported symptoms were outside the tank farm fence, at least 40 meters (130 feet) from the leak location. Workers were sheltered for an extended time in a very warm mobile office building without ventilation, which may have contributed to the stress, concern, and symptoms (headaches) reported by some. There was no industrial hygiene sampling or monitoring for a chemical vapor release for more than 13 hours following the spill. However, any chemical vapors would have dissipated quickly and would have been difficult to measure quantitatively under the best of circumstances. Dispersion modeling conducted in the days following the spill indicated that, even in the maximum reasonably foreseeable case scenario with conservative assumptions, only individuals inside the S tank farm fence would have been subjected to chemical concentrations at or above the applicable occupational exposure limit. The accident investigation report concluded that the contractor needed to better integrate industrial hygiene into its response to abnormal events that may involve chemical releases. It was also concluded that the Hanford fire department needed to improve the performance of its emergency medical technicians in the areas of documentation of patient encounters and communications with the site occupational medical services provider. The need for more-frequent review of patient records by physicians and enhanced documentation of patient encounters was also identified (DOE 2007a).

Estimates of worker exposure to chemicals and the resulting health effects are highly dependent on modeling assumptions. If a worker were assumed to be very close to the chemical emission point, the predicted consequences might vary from zero to extreme (severe, irreversible health effects), depending on the assumed duration of the release and exposure and the location of the worker with respect to the emission point and wind direction. Therefore, no attempt was made to estimate involved worker exposure to chemical releases associated with routine operations. Through compliance with applicable requirements and the scrutiny provided by internal and external review of chemical exposure issues, it is expected that involved worker exposure would be maintained below the thresholds identified by OSHA and ACGIH.

Because a noninvolved worker was assumed to be some distance away, it is possible to model exposures using average meteorological conditions at the site. Impacts on a noninvolved worker from carcinogenic and noncarcinogenic chemicals, ammonia, benzene, 1,3-butadiene, formaldehyde, mercury, toluene, and xylene were modeled. The modeling and risk assessment approach is described in Appendix G. The resulting toxic chemical concentrations and associated Hazard Quotients and risks are presented in Chapter 4, Section 4.1.4, for each Tank Closure alternative. The Hazard Index (the sum of the individual Hazard Quotients for all noncarcinogenic toxic chemicals) would be less than 1 under all alternatives, indicating that concentrations would be below a level requiring action to protect the noninvolved worker. The risk of cancer from exposure to the carcinogenic chemicals (benzene, 1,3-butadiene, and formaldehyde) would be on the order of 1 in 100,000 or less under all Tank Closure alternatives.

K.2.2 FFTF Decommissioning Alternatives

K.2.2.1 Impacts on the Public During Normal Operations

The methodology employed to evaluate impacts on the public and workers from decommissioning FFTF is similar to that discussed in Section K.2.1 for evaluating impacts of tank closure activities. Under FFTF Decommissioning Alternative 1: No Action, current impacts that are part of the Hanford baseline as presented in Chapter 3 would continue. The following sections address differences in scenarios and assumptions affecting human health impacts due to radioactive emissions under FFTF Decommissioning Alternative 2: Entombment and FFTF Decommissioning Alternative 3: Removal. Unless noted otherwise, assumptions described in Section K.2.1 also apply to the FFTF decommissioning radiological impacts analysis.

K.2.2.1.1 Approach

FFTF Decommissioning alternatives comprise three activities: (1) facility disposition (decommissioning of FFTF and auxiliary buildings), (2) disposition of remote-handled special components (RH-SCs), and (3) disposition of contaminated bulk sodium. Disposition of RH-SCs and bulk sodium would occur either at Hanford or at INL; therefore, the three activities were evaluated separately.

Under normal operations, radionuclide releases could occur from any of the activities listed above. Deactivation activities were previously 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 2006). Based on the environmental assessment, DOE found no significant impact on the offsite population. The impact on an MEI was estimated to be 0.00026 millirem (an LCF risk of essentially zero) per year, assuming all of the tritium contamination was released to the environment (DOE 2006:4-2). Impacts of deactivation activities would be the same under all FFTF Decommissioning alternatives and were not included in the alternatives' dose estimates.

Impacts were evaluated for the same public receptors as the Tank Closure alternatives (described in the introduction to Section K.2): the offsite population, an MEI, and an onsite MEI. Impacts on an MEI due to FFTF emissions were evaluated for the dominant downwind directions; the MEI was identified as being about 9.1 kilometers (5.6 miles) to the southeast, across the river from the 300 Area. Ground-level radioactive emissions were assumed for facility disposition activities or disposition of bulk sodium in a new facility at Hanford. This conservative assumption resulted in overestimation of the impacts. Emissions associated with the potential treatment of RH-SCs at Hanford would emanate from the 200-West Area near the T Plant complex. The same source location assumed for the 200-West Area tank closure emissions was assumed for the RH-SC emissions, i.e., STTS-West. This assumption resulted in conservative estimates of the impacts on members of the public.

FFTF Decommissioning Alternatives 2 and 3 include options for processing RH-SCs, bulk sodium, or both at INL. The RH-SCs would be processed in a facility at the Idaho Nuclear Technology Engineering Center (INTEC); the bulk sodium would be processed in a facility in the Materials and Fuels Complex (MFC). For INTEC, the MEI would be about 13.4 kilometers (8.3 miles) south of the facility. For the MFC, the MEI would be about 5.2 kilometers (3.2 miles) south-southeast of the facility. A release height of 61 meters (200 feet) was assumed for INTEC based on the tall stack at this facility, the release height for the MFC stack is 7.3 meters (24 feet).

K.2.2.1.2 Modeling

The GENII-2 computer code was used to evaluate impacts on the offsite populations of Hanford and INL.

K.2.2.1.3 Input Parameters

Input parameters for the GENII-2 computer code included items that are a function of the location of the action being taken. For FFTF Decommissioning alternatives, the input parameters that were different than those used in evaluating Tank Closure alternatives were the meteorological data, population data, and radioactive source terms.

K.2.2.1.3.1 Meteorological Data

FFTF Decommissioning alternatives could include activities that occur at FFTF (the Hanford 400 Area), the Hanford 200-West Area, the INL INTEC, or the INL MFC. Meteorological data for evaluating offsite impacts of activities that would occur in the Hanford 200-West Area were the same as those used in evaluating emissions from STTS-West for the Tank Closure alternatives (see Table K–5). Meteorological data for activities that would occur at FFTF (facility disposition or disposition of bulk sodium) are presented in Table K–53. These data represent 10-year averages of data collected from 1997 through 2006 at the 10-meter (30-foot) height at the FFTF Meteorological Station (Burk 2007). Wind rose representations of these data are included in Chapter 3, Section 3.2.4. Meteorological data for activities occurring at the INL INTEC and MFC are presented in Tables K–54 and K–55, respectively. These data are based on meteorological data collected from 2002 through 2006 at the 10-meter (30-foot) height at the meteorological stations near the facilities.

Table K–53. Joint Frequency Distribution for the Hanford Site 400 Area (Fast Flux Test Facility) at a 10-Meter Height

Average Windspeed (meters per second)	Pasquill Atmospheric Stability Class	Percentage of Time Wind Blows from the Indicated Direction															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.78	A	0.13	0.14	0.12	0.11	0.13	0.17	0.13	0.11	0.11	0.08	0.08	0.06	0.06	0.05	0.06	0.1
	B	0.04	0.05	0.07	0.04	0.05	0.05	0.07	0.05	0.05	0.04	0.03	0.02	0.03	0.03	0.02	0.04
	C	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.02	0.03	0.03	0.02	0.03
	D	0.27	0.29	0.24	0.22	0.25	0.26	0.3	0.26	0.26	0.25	0.23	0.21	0.21	0.25	0.33	0.27
	E	0.27	0.22	0.21	0.21	0.21	0.2	0.25	0.3	0.36	0.35	0.35	0.33	0.36	0.35	0.41	0.3
	F	0.29	0.21	0.18	0.13	0.15	0.14	0.21	0.24	0.3	0.3	0.3	0.26	0.29	0.27	0.32	0.27
	G	0.09	0.08	0.06	0.06	0.05	0.06	0.07	0.08	0.1	0.12	0.1	0.09	0.1	0.11	0.09	0.11
2.5	A	0.43	0.49	0.41	0.34	0.4	0.48	0.57	0.55	0.64	0.43	0.22	0.14	0.15	0.13	0.18	0.28
	B	0.18	0.16	0.12	0.07	0.09	0.1	0.19	0.17	0.19	0.13	0.08	0.04	0.04	0.05	0.07	0.14
	C	0.14	0.12	0.07	0.06	0.08	0.09	0.15	0.1	0.15	0.1	0.03	0.03	0.02	0.04	0.07	0.11
	D	0.68	0.67	0.45	0.31	0.28	0.33	0.7	0.82	0.89	0.63	0.4	0.22	0.25	0.38	0.78	0.87
	E	0.66	0.55	0.37	0.21	0.19	0.27	0.63	1.03	1.18	1.19	0.62	0.46	0.47	0.66	1.08	0.95
	F	0.57	0.54	0.31	0.15	0.1	0.16	0.47	0.88	1.08	0.94	0.52	0.28	0.21	0.31	0.75	0.72
	G	0.28	0.24	0.13	0.04	0.03	0.05	0.14	0.31	0.32	0.27	0.17	0.08	0.06	0.12	0.31	0.31
4.5	A	0.4	0.46	0.24	0.07	0.09	0.12	0.21	0.25	0.83	0.74	0.28	0.17	0.16	0.13	0.19	0.27
	B	0.14	0.11	0.03	0.02	0.02	0.02	0.06	0.09	0.22	0.27	0.09	0.07	0.04	0.05	0.08	0.12
	C	0.08	0.07	0.03	0.01	0.01	0.01	0.04	0.05	0.15	0.19	0.05	0.03	0.04	0.03	0.05	0.09
	D	0.4	0.27	0.1	0.06	0.05	0.08	0.3	0.56	0.87	1.02	0.39	0.24	0.18	0.4	0.97	0.83
	E	0.23	0.18	0.1	0.03	0.01	0.03	0.36	0.98	0.99	1.19	0.54	0.28	0.27	0.57	1.43	0.96
	F	0.17	0.14	0.07	0.01	0.01	0.01	0.27	1.13	0.87	0.77	0.24	0.05	0.04	0.07	0.61	0.68
	G	0.06	0.06	0.03	0	0	0	0.13	0.46	0.27	0.17	0.04	0.01	0	0.01	0.23	0.29
7.0	A	0.1	0.16	0.06	0.01	0	0.01	0.02	0.02	0.23	0.66	0.4	0.19	0.12	0.12	0.19	0.09
	B	0.02	0.02	0.01	0	0	0	0.01	0.01	0.04	0.16	0.11	0.05	0.02	0.02	0.06	0.05
	C	0.02	0.01	0.01	0	0	0	0.01	0.01	0.04	0.15	0.08	0.05	0.02	0.01	0.05	0.02
	D	0.07	0.07	0.03	0.01	0	0	0.03	0.07	0.28	0.84	0.49	0.23	0.16	0.29	0.75	0.21
	E	0.04	0.05	0.03	0	0	0	0.05	0.1	0.31	0.77	0.56	0.18	0.12	0.3	0.67	0.1
	F	0.01	0.01	0.01	0	0	0	0.01	0.07	0.13	0.26	0.08	0.01	0.01	0.01	0.05	0.02
	G	0	0	0	0	0	0	0.01	0.09	0.05	0.07	0.04	0.01	0	0	0.01	0.01

Table K–53. Joint Frequency Distribution for the Hanford Site 400 Area (Fast Flux Test Facility) at a 10-Meter Height *(continued)*

Average Windspeed (meters per second)	Pasquill Atmospheric Stability Class	Percentage of Time Wind Blows from the Indicated Direction															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
9.6	A	0	0.01	0.01	0.01	0	0	0	0	0.02	0.12	0.16	0.13	0.08	0.03	0.1	0.02
	B	0	0	0	0	0	0	0	0	0.01	0.02	0.06	0.03	0.02	0.01	0.02	0
	C	0	0	0	0	0	0	0	0	0	0.03	0.04	0.02	0.01	0	0.03	0
	D	0.01	0.02	0.02	0	0	0	0	0.01	0.04	0.23	0.27	0.12	0.06	0.08	0.23	0.02
	E	0.01	0.04	0.03	0	0	0	0.01	0.01	0.03	0.2	0.26	0.07	0.03	0.06	0.12	0.01
	F	0	0	0	0	0	0	0	0	0	0.02	0.02	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0.01	0.02	0	0	0	0	0
12.5	A	0	0	0	0	0	0	0	0	0	0.01	0.05	0.05	0.03	0	0.02	0
	B	0	0	0	0	0	0	0	0	0	0.01	0.03	0.01	0	0	0.01	0
	C	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0	0.01	0
	D	0	0	0.01	0	0	0	0	0	0	0.06	0.14	0.05	0.02	0.01	0.04	0
	E	0	0	0.01	0	0	0	0	0	0	0.05	0.08	0.03	0.01	0.01	0.02	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15.9	A	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0.02	0.04	0.01	0.01	0	0	0
	E	0	0	0	0	0	0	0	0	0	0.01	0.02	0.01	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18.8	A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0	0	0	0
	E	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: To convert meters to feet, multiply by 3.281; meters per second to miles per hour, by 2.237.
Source: Burk 2007.

Table K–54. Joint Frequency Distribution for the Idaho National Laboratory Idaho Nuclear Technology and Engineering Center at a 10-Meter Height

Average Windspeed (meters per second)	Pasquill Atmospheric Stability Class	Percentage of Time Wind Blows from the Indicated Direction															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.98	A	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0
	B	0	0	0	0	0	0	0	0	0	0.01	0.01	0	0	0	0	0
	C	0	0	0	0	0	0	0.01	0.01	0.01	0.01	0	0	0	0	0	0
	D	0.16	0.28	0.28	0.15	0.12	0.07	0.09	0.07	0.10	0.10	0.09	0.11	0.09	0.07	0.07	0.08
	E	0.63	0.44	0.33	0.17	0.13	0.09	0.10	0.09	0.17	0.14	0.23	0.21	0.20	0.21	0.32	0.40
	F	0.38	0.25	0.23	0.07	0.09	0.07	0.06	0.09	0.15	0.20	0.24	0.21	0.26	0.24	0.28	0.33
	G	0.47	0.32	0.23	0.14	0.13	0.06	0.11	0.11	0.24	0.39	0.65	0.55	0.38	0.27	0.3	0.32
2.5	A	0	0	0.01	0.02	0.02	0.01	0.03	0.03	0.09	0.17	0.22	0.06	0.01	0	0	0
	B	0	0.01	0.05	0.04	0.04	0.04	0.06	0.09	0.20	0.25	0.24	0.15	0.02	0.01	0	0.01
	C	0.02	0.03	0.22	0.13	0.10	0.06	0.09	0.15	0.18	0.22	0.29	0.16	0.06	0.01	0.01	0.01
	D	0.56	1.80	1.80	0.61	0.27	0.21	0.23	0.27	0.39	0.42	0.57	0.44	0.32	0.18	0.15	0.20
	E	1.09	1.45	0.85	0.27	0.16	0.13	0.16	0.30	0.47	0.64	0.80	0.57	0.30	0.24	0.23	0.33
	F	1.09	1.12	0.63	0.23	0.15	0.11	0.18	0.23	0.43	0.53	0.72	0.65	0.44	0.24	0.24	0.33
	G	0.94	1.33	0.95	0.41	0.14	0.08	0.15	0.30	0.66	1.39	2.04	1.5	0.61	0.24	0.23	0.31
4.5	A	0.01	0.02	0.13	0.05	0	0.01	0.02	0.05	0.16	0.39	0.84	0.27	0.02	0	0	0
	B	0.02	0.06	0.25	0.08	0.02	0.01	0.02	0.04	0.09	0.20	0.31	0.18	0.03	0.01	0	0.01
	C	0.03	0.17	0.36	0.06	0.01	0.01	0.01	0.07	0.06	0.11	0.23	0.12	0.03	0.02	0.02	0.02
	D	0.22	0.97	1.11	0.15	0.06	0.04	0.07	0.16	0.23	0.44	0.85	0.41	0.17	0.06	0.08	0.09
	E	0.33	0.68	0.52	0.17	0.08	0.03	0.08	0.16	0.36	0.78	1.40	0.94	0.28	0.06	0.10	0.16
	F	0.21	0.49	0.42	0.20	0.04	0.03	0.03	0.10	0.24	0.43	0.87	0.64	0.16	0.04	0.03	0.05
	G	0.16	0.52	0.64	0.35	0.04	0.01	0.02	0.14	0.15	0.45	1.36	1.03	0.19	0.03	0.01	0.01
6.9	A	0.05	0.07	0.16	0.01	0	0	0	0.01	0.06	0.22	1.37	0.41	0.07	0.01	0	0
	B	0.04	0.05	0.09	0.01	0	0	0	0.01	0.03	0.11	0.35	0.13	0.02	0.01	0	0
	C	0.03	0.06	0.09	0.01	0	0	0	0.02	0.02	0.04	0.35	0.14	0.02	0.01	0	0.01
	D	0.18	0.20	0.24	0.09	0.01	0	0.03	0.04	0.16	0.38	1.21	0.62	0.13	0.04	0.02	0.10
	E	0.37	0.21	0.30	0.10	0	0	0.02	0.07	0.13	0.50	1.48	0.80	0.16	0.04	0.02	0.13
	F	0.02	0.04	0.10	0.03	0	0	0	0	0.01	0.10	0.40	0.22	0.03	0.01	0	0
	G	0.02	0.02	0.04	0.02	0	0	0	0	0	0.03	0.25	0.16	0	0	0	0

Table K–54. Joint Frequency Distribution for the Idaho National Laboratory Idaho Nuclear Technology and Engineering Center at a 10-Meter Height *(continued)*

Average Windspeed (meters per second)	Pasquill Atmospheric Stability Class	Percentage of Time Wind Blows from the Indicated Direction															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
9.5	A	0.01	0.05	0.05	0	0	0	0	0	0.05	0.07	1.17	0.52	0.02	0.01	0	0
	B	0	0.03	0.02	0	0	0	0	0	0.01	0.01	0.23	0.14	0.01	0	0	0.01
	C	0	0.02	0.01	0	0	0	0	0	0.01	0.03	0.21	0.10	0.01	0.01	0	0.01
	D	0.03	0.06	0.09	0.02	0	0	0	0	0.04	0.16	0.84	0.48	0.04	0.01	0	0.04
	E	0.06	0.06	0.08	0.03	0	0	0	0.01	0.01	0.12	0.68	0.28	0.05	0	0.01	0.02
	F	0.01	0	0	0	0	0	0	0	0	0.01	0.06	0.01	0.01	0	0	0.01
	G	0	0	0	0	0	0	0	0	0	0	0.02	0	0	0	0	0
10.7	A	0	0.02	0.02	0	0	0	0	0	0	0.01	0.82	0.72	0	0	0	0
	B	0	0	0.01	0	0	0	0	0	0	0.01	0.12	0.13	0	0	0	0
	C	0	0.01	0	0	0	0	0	0	0	0.01	0.07	0.10	0	0	0	0
	D	0	0.02	0.01	0	0	0	0	0	0.03	0.03	0.31	0.26	0.02	0	0	0.01
	E	0	0	0.01	0	0	0	0	0	0	0.03	0.20	0.07	0.01	0	0	0
	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: To convert meters to feet, multiply by 3.281; meters per second to miles per hour, by 2.237.

Table K–55. Joint Frequency Distribution for the Idaho National Laboratory Materials and Fuels Complex at a 10-Meter Height

Average Windspeed (meters per second)	Pasquill Atmospheric Stability Class	Percentage of Time Wind Blows from the Indicated Direction															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.98	A	0.02	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0.01
	B	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0.02
	C	0.04	0.02	0.02	0	0.01	0.01	0	0	0	0	0	0.01	0.03	0.06	0.08	0.04
	D	0.17	0.17	0.16	0.08	0.07	0.05	0.05	0.03	0.03	0.07	0.10	0.09	0.12	0.13	0.19	0.19
	E	0.4	0.43	0.38	0.27	0.15	0.12	0.10	0.15	0.17	0.20	0.17	0.19	0.12	0.12	0.19	0.26
	F	0.28	0.30	0.44	0.45	0.31	0.21	0.25	0.44	0.55	0.43	0.29	0.15	0.14	0.15	0.15	0.20
	G	0.15	0.25	0.45	0.63	0.67	0.34	0.30	0.45	0.54	0.31	0.20	0.12	0.07	0.06	0.08	0.13
2.5	A	0.15	0.21	0.25	0.13	0.07	0.05	0.03	0.03	0.01	0.03	0.05	0.04	0.07	0.05	0.06	0.07
	B	0.10	0.15	0.11	0.05	0.04	0.03	0.03	0.04	0.05	0.05	0.06	0.07	0.10	0.06	0.06	0.09
	C	0.30	0.43	0.31	0.12	0.07	0.04	0.05	0.08	0.14	0.18	0.28	0.32	0.22	0.14	0.15	0.26
	D	0.49	1.14	0.71	0.20	0.10	0.05	0.11	0.17	0.26	0.47	0.62	0.55	0.33	0.26	0.28	0.32
	E	0.59	1.12	1.01	0.42	0.17	0.10	0.14	0.28	0.44	0.50	0.56	0.44	0.26	0.20	0.23	0.31
	F	0.37	0.72	1.08	0.91	0.37	0.18	0.22	0.60	0.95	0.72	0.51	0.31	0.22	0.14	0.17	0.27
	G	0.19	0.44	1.12	1.49	0.72	0.20	0.21	0.62	1.36	1.06	0.49	0.19	0.05	0.04	0.06	0.09
4.5	A	0.03	0.17	0.28	0.11	0.03	0.02	0.01	0.02	0.05	0.07	0.06	0.03	0.02	0.01	0.02	0.01
	B	0.05	0.06	0.15	0.03	0.01	0	0.01	0.04	0.06	0.20	0.15	0.09	0.03	0.01	0.01	0
	C	0.06	0.23	0.28	0.07	0.03	0.02	0.02	0.08	0.25	0.56	0.62	0.25	0.10	0.06	0.03	0.02
	D	0.16	0.52	0.50	0.13	0.07	0.05	0.05	0.23	0.46	0.85	1.11	0.59	0.23	0.15	0.16	0.13
	E	0.32	0.46	0.37	0.18	0.08	0.06	0.07	0.34	0.64	0.83	0.89	0.41	0.12	0.12	0.15	0.20
	F	0.18	0.39	0.44	0.38	0.14	0.10	0.10	0.59	0.59	0.80	0.65	0.18	0.03	0.02	0.06	0.12
	G	0.02	0.07	0.31	0.73	0.39	0.08	0.22	1.64	0.84	0.69	0.40	0.06	0.01	0.01	0	0
6.9	A	0.02	0.09	0.13	0.02	0	0	0.01	0.02	0.10	0.17	0.12	0.02	0	0	0	0.01
	B	0	0.04	0.06	0.01	0	0	0	0.01	0.12	0.25	0.28	0.07	0.01	0.02	0.01	0
	C	0.03	0.06	0.13	0.02	0	0	0	0.03	0.22	0.52	0.81	0.26	0.03	0.02	0.03	0.04
	D	0.16	0.22	0.25	0.07	0.03	0.01	0.02	0.14	0.52	0.96	1.35	0.67	0.09	0.06	0.07	0.12
	E	0.20	0.29	0.33	0.10	0.02	0	0.01	0.12	0.57	1.13	1.28	0.32	0.04	0.03	0.05	0.09
	F	0.01	0.07	0.08	0.04	0.01	0.01	0	0.09	0.18	0.43	0.25	0.03	0	0	0	0.01
	G	0	0	0.03	0.04	0.01	0.01	0	0.20	0.03	0.08	0.04	0.01	0	0	0	0

Table K–55. Joint Frequency Distribution for the Idaho National Laboratory Materials and Fuels Complex at a 10-Meter Height *(continued)*

Average Windspeed (meters per second)	Pasquill Atmospheric Stability Class	Percentage of Time Wind Blows from the Indicated Direction															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
9.5	A	0.01	0.04	0.02	0.01	0.01	0	0	0	0.06	0.11	0.29	0.03	0	0	0	0
	B	0	0.02	0.01	0	0	0	0	0	0.04	0.09	0.33	0.04	0	0	0	0
	C	0.04	0.06	0.03	0.01	0	0	0	0	0.07	0.18	0.68	0.25	0.01	0	0	0
	D	0.12	0.12	0.08	0.02	0	0	0	0.01	0.16	0.52	1.08	0.40	0.02	0.01	0	0.02
	E	0.10	0.09	0.06	0.02	0	0	0.01	0.01	0.18	0.61	0.69	0.18	0	0	0	0.01
	F	0	0	0	0	0	0	0	0	0.01	0.06	0.03	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0
10.7	A	0	0.06	0	0	0	0	0	0	0.01	0.01	0.09	0.04	0	0	0	0
	B	0.01	0	0	0	0	0	0	0	0.01	0.01	0.16	0.07	0	0	0	0
	C	0	0.02	0.01	0	0	0	0	0	0.01	0.01	0.36	0.20	0	0	0	0
	D	0.04	0.06	0	0	0	0	0	0	0.04	0.14	0.66	0.31	0.01	0	0	0
	E	0.01	0	0	0	0	0	0	0	0.08	0.23	0.38	0.11	0	0	0	0
	F	0	0	0	0	0	0	0	0	0.01	0.01	0.02	0	0	0	0	0
	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: To convert meters to feet, multiply by 3.281; meters per second to miles per hour, by 2.237.

K.2.2.1.3.2 Population Data

The potentially exposed offsite population used for analysis depends on where an activity would occur. The population potentially exposed to emissions from disposition of FFTF and the auxiliary buildings would be within an 80-kilometer (50-mile) radius centered on the 400 Area. The population data represent results of the 2010 decennial census (Census 2011). Under the Hanford Reuse Option of processing the bulk sodium at Hanford, the same population would be used because the Sodium Reaction Facility would be located in the 400 Area. The distribution of the 80-kilometer (50-mile) population around the 400 Area is shown in Figure K–5.

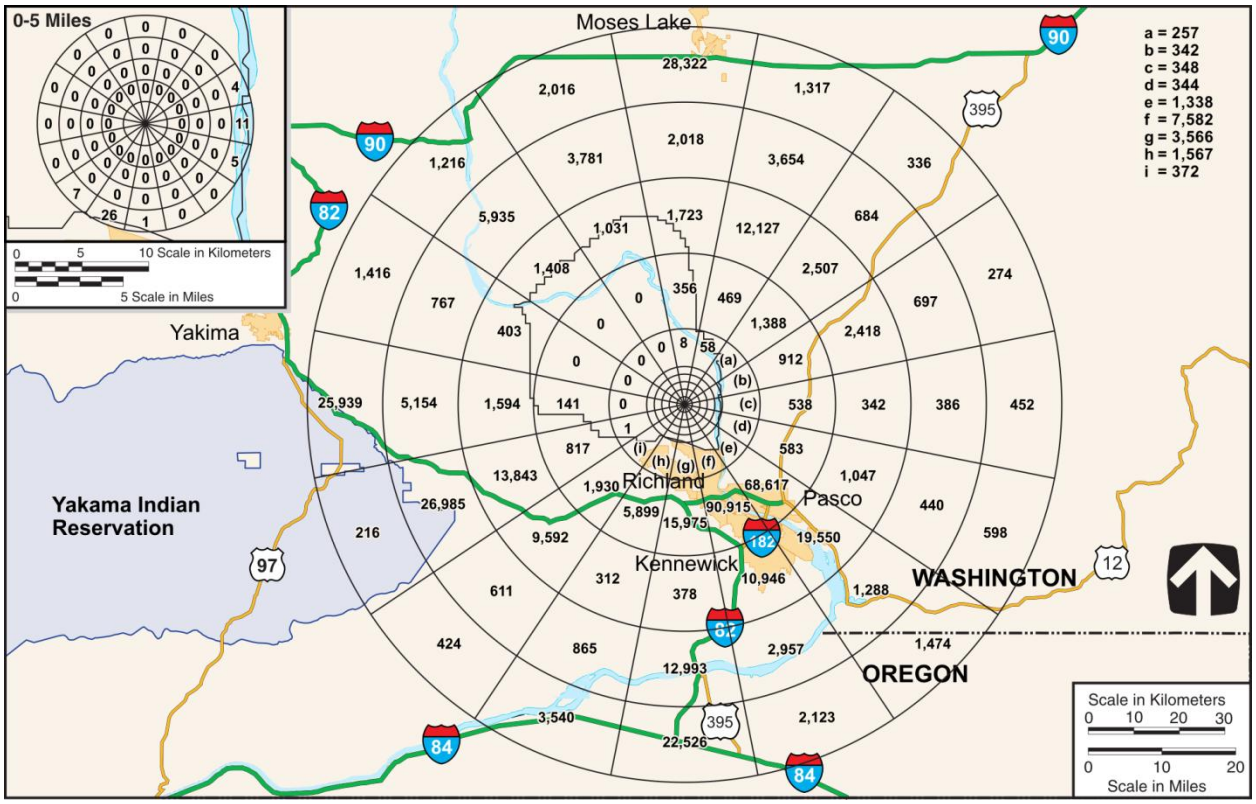

Figure K–5. Population Distribution Within 80 Kilometers (50 Miles) of the Fast Flux Test Facility – Total Population: 445,002

The Hanford Option for processing the RH-SCs would be to construct a facility adjacent to the T Plant in the 200-West Area. The same population distribution used for evaluating impacts of tank closure activities that would occur in the 200-West Area was used for evaluating impacts from processing RH-SCs (see Figure K–4). The center of the 80-kilometer (50-mile) region of influence, STTS-West in the southeast corner of 200-West Area, is closer than the T Plant to population centers in the dominant downwind directions, which contributed a degree of conservatism to the analysis.

FFTF Decommissioning Alternatives 2 and 3 include options for processing RH-SCs and bulk sodium in facilities at INL (the Idaho Option for disposition of RH-SCs at INTEC and the Idaho Reuse Option for disposition of bulk sodium at the MFC). The 80-kilometer (50-mile) population distributions used for analysis of impacts from these activities are shown in Figures K–6 and K–7.

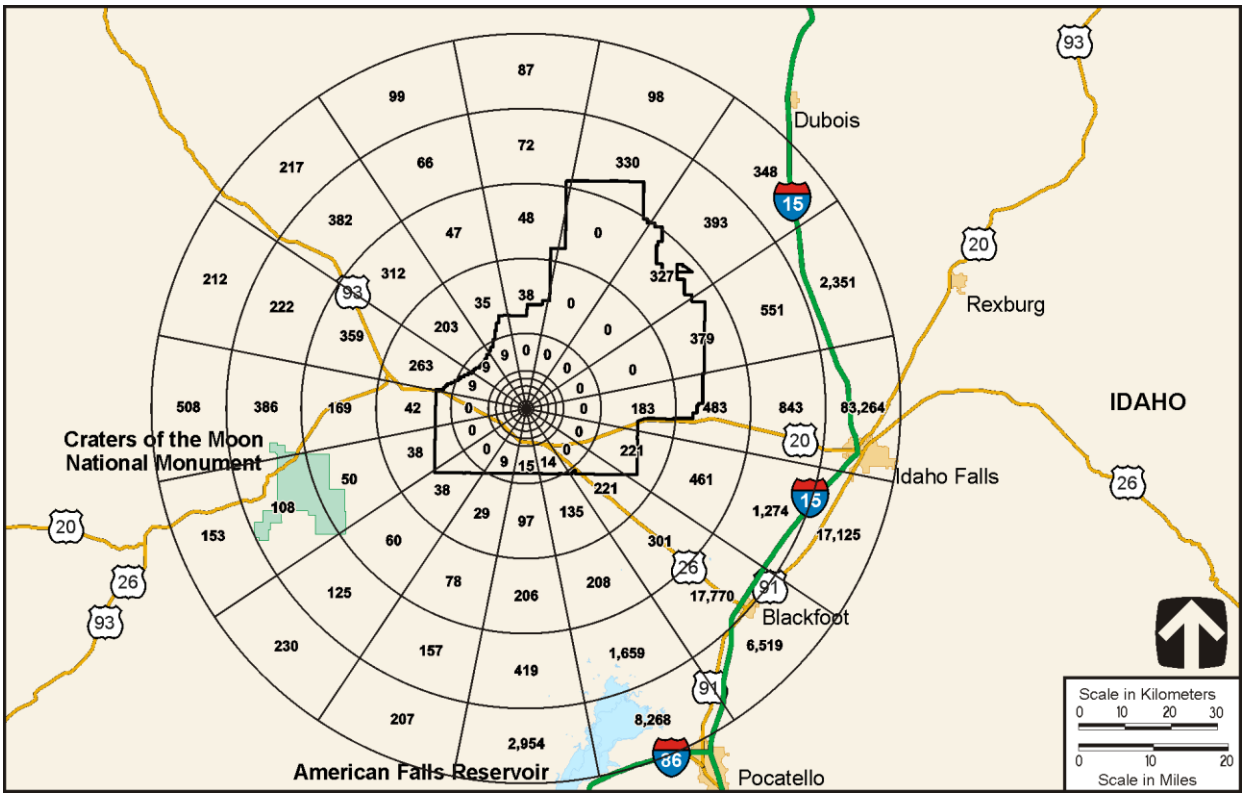

Figure K–6. Population Distribution Within 80 Kilometers (50 Miles) of the Idaho National Laboratory Idaho Nuclear Technology Engineering Center – Total Population: 152,493

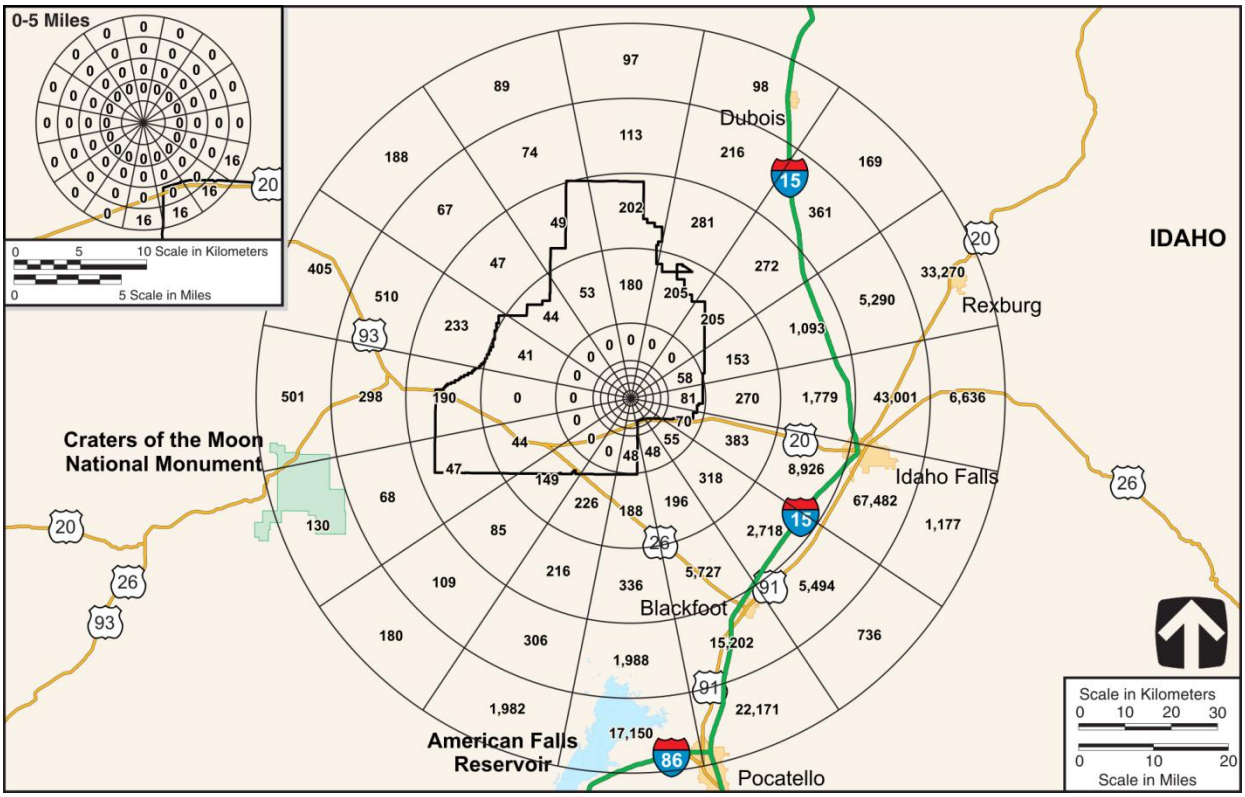

Figure K–7. Population Distribution Within 80 Kilometers (50 Miles) of the Idaho National Laboratory Materials and Fuels Complex – Total Population: 250,838

K.2.2.1.3.3 Source Terms

Radioactive emissions could be associated with each of the three activities that make up FFTF decommissioning. Emissions could result from activities to dispose of FFTF and the auxiliary buildings. FFTF Decommissioning Alternative 2 would require filling vessels and rooms that would remain in place prior to being covered by a barrier. Filling the voids could dislodge radioactive contaminants that would then be pushed out of the vessels and rooms as grout replaces the air in the voids. Under FFTF Decommissioning Alternative 3, the demolition practices employed, such as crimping or capping pipes and vessels, would control contamination such that negligible offsite emissions are expected.

Emissions from disposition of RH-SCs could occur at Hanford or INL, depending on which option is selected; the emissions would be the same regardless of location. Disposition of bulk sodium could occur at Hanford or INL. The total project emissions would be slightly higher under the Hanford Reuse Option because decommissioning the Sodium Reaction Facility is an additional activity. Deactivation of the Sodium Processing Facility (SPF) at INL was assumed not to be required because use of the facility would continue to support other activities.

The source terms for decommissioning actions, the treatment of the RH-SCs, and the processing of bulk sodium were based on the emissions presented in the scaled data set for FFTF decommissioning (SAIC 2010b). Table K–56 presents the source terms from radioactive emissions assumed for each of the activities: facility disposition, disposition of RH-SCs, and disposition of bulk sodium. Emissions associated with the No Action Alternative were assumed to be comparable to recent estimated emissions from FFTF. Annual emissions were assumed to be 3.7×10^{-1} curies of tritium, 7.2×10^{-6} curies of cesium-137, and 1.2×10^{-6} curies of plutonium-239. The cesium-137 and plutonium-239 estimates were based on an assumption that detected beta and alpha activity were attributable to these isotopes, respectively (Poston et al. 2007:10.11). These emissions were assumed to continue for 100 years.

Table K–56. FFTF Decommissioning Alternatives 2 and 3 – Radioactive Emissions During Normal Operations

Radionuclides	Emissions Over Life of Project		Annual Emissions in Year(s) of Maximum Impact	
	Curies	Year(s)	Curies	Year(s)
Facility Disposition[a]				
Cesium-137	1.5×10^{-6}	2017	1.5×10^{-6}	2017
Disposition of Remote-Handled Special Components – Hanford or Idaho Option				
Sodium-22	6.0×10^{-4}	2017–2018	4.0×10^{-4}	2017
Cesium-137	2.6×10^{-4}		1.7×10^{-4}	
Disposition of Bulk Sodium – Hanford Reuse Option				
Hydrogen-3 (tritium)	1.3×10^{1}	2017–2019	5.7	2017–2018
Sodium-22	5.7×10^{-2}		2.6×10^{-2}	
Cesium-137	7.3×10^{-4}		3.3×10^{-4}	
Uranium	2.1×10^{-7}		9.5×10^{-8}	
Disposition of Bulk Sodium – Idaho Reuse Option				
Tritium	1.1×10^{1}	2015–2016	5.7	2015–2016
Sodium-22	5.2×10^{-2}		2.6×10^{-2}	
Cesium-137	6.6×10^{-4}		3.3×10^{-4}	
Uranium	1.9×10^{-7}		9.5×10^{-8}	

[a] Emissions apply to Alternative 2 only.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory.

K.2.2.1.4 Results

The radiological impacts on the public due to the FFTF Decommissioning alternatives and options are presented in Table K–57 for the population, in Table K–58 for an MEI, and in Table K–59 for an onsite MEI at Hanford. Impacts of FFTF Decommissioning Alternatives 2 and 3 would include the impacts of facility disposition, disposition of RH-SCs, and disposition of bulk sodium. Based on the calculated collective population dose, no LCFs are expected as a result of any of the alternatives or options; all calculated LCF values are much less than 1. The incremental risk of an LCF to an MEI would be extremely small in all cases; the largest risk over the life of the project would be about 2×10^{-10}, or less than 1 in a billion.

The incremental risk to an onsite MEI located at LIGO for activities at FFTF and US Ecology for disposition of RH-SCs in the 200-West Area would be extremely small. Due to the shorter exposure time (a daily work shift) and typical wind direction, the onsite MEI dose from activities at FFTF would be smaller than the dose to the MEI located off site.

Table K–57. FFTF Decommissioning Alternatives – Impacts on the Population During Normal Operations

Radionuclides	Life of Project		Year(s) of Maximum Impact	
	Dose (person-rem)	**LCFs[a]**	**Dose (person-rem per year)**	**LCFs[a]**
Alternative 1, No Action				
Hydrogen-3 (tritium)	1.5×10^{-2}		1.5×10^{-4}	
Cesium-137	3.3×10^{-4}		3.3×10^{-6}	
Plutonium-239	1.2×10^{-2}		1.2×10^{-4}	
Total	**2.7×10^{-2}**	**0 (2×10^{-5})**	**2.7×10^{-4}**	**0 (2×10^{-7})**
Alternative 2, Facility Disposition				
Cesium-137	6.7×10^{-7}	0 (4×10^{-10})	6.7×10^{-7}	0 (4×10^{-10})
Alternative 3, Facility Disposition				
–	–	–	–	–
Alternative 2 or 3, Disposition of Remote-Handled Special Components – Hanford Option				
Sodium-22	1.1×10^{-4}		7.5×10^{-5}	
Cesium-137	7.6×10^{-5}		5.1×10^{-5}	
Total	**1.9×10^{-4}**	**0 (1×10^{-7})**	**1.3×10^{-4}**	**0 (8×10^{-8})**
Alternative 2 or 3, Disposition of Remote-Handled Special Components – Idaho Option				
Sodium-22	2.9×10^{-5}		1.9×10^{-5}	
Cesium-137	1.9×10^{-5}		1.3×10^{-5}	
Total	**4.8×10^{-5}**	**0 (3×10^{-8})**	**3.2×10^{-5}**	**0 (2×10^{-8})**

Table K–57. FFTF Decommissioning Alternatives – Impacts on the Population During Normal Operations *(continued)*

Radionuclides	Life of Project		Year(s) of Maximum Impact	
	Dose (person-rem)	LCFs[a]	Dose (person-rem per year)	LCFs[a]
Alternative 2 or 3, Disposition of Bulk Sodium – Hanford Reuse Option				
Tritium	5.1×10^{-3}		2.3×10^{-3}	
Sodium-22	1.6×10^{-2}		7.4×10^{-3}	
Cesium-137	3.3×10^{-4}		1.5×10^{-4}	
Uranium	1.2×10^{-6}		5.4×10^{-7}	
Total	**2.2×10^{-2}**	**0 (1×10^{-5})**	**9.9×10^{-3}**	**0 (6×10^{-6})**
Alternative 2 or 3, Disposition of Bulk Sodium – Idaho Reuse Option				
Tritium	7.2×10^{-4}		3.6×10^{-4}	
Sodium-22	1.4×10^{-3}		6.8×10^{-4}	
Cesium-137	2.8×10^{-5}		1.4×10^{-5}	
Uranium	9.7×10^{-8}		4.8×10^{-8}	
Total	**2.1×10^{-3}**	**0 (1×10^{-6})**	**1.1×10^{-3}**	**0 (6×10^{-7})**

[a] The integer indicates the number of excess latent cancer fatalities that would be expected in the population based on the risk factor of 0.0006 latent cancer fatalities per person-rem; the value in parentheses is the value calculated from the dose and risk factor.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; LCF=latent cancer fatality.

Table K–58. FFTF Decommissioning Alternatives – Impacts on the Maximally Exposed Individual During Normal Operations

Radionuclides	Life of Project		Year(s) of Maximum Impact		Direction	Distance (kilometers)
	Dose (millirem)	Lifetime Risk of an LCF	Dose (millirem per year)	Risk of an LCF		
Alternative 1, No Action[a]						
Hydrogen-3 (tritium)	6.7×10^{-4}		6.7×10^{-6}		SE	9.1
Cesium-137	2.8×10^{-5}		2.8×10^{-7}			
Plutonium-239	9.6×10^{-4}		9.6×10^{-6}			
Total	**1.7×10^{-3}**	**1×10^{-9}**	**1.7×10^{-5}**	**1×10^{-11}**		
Alternative 2, Facility Disposition						
Cesium-137	5.8×10^{-8}	3×10^{-14}	5.8×10^{-8}	3×10^{-14}	SE	9.1
Alternative 3, Facility Disposition						
–	–	–	–	–	–	–
Alternative 2 or 3, Disposition of Remote-Handled Special Components – Hanford Option						
Sodium-22	4.3×10^{-6}		3.5×10^{-6}		ENE	18.2
Cesium-137	5.3×10^{-6}		4.4×10^{-6}			
Total	**9.6×10^{-6}**	**6×10^{-12}**	**7.8×10^{-6}**	**5×10^{-12}**		

Table K–58. FFTF Decommissioning Alternatives – Impacts on the Maximally Exposed Individual During Normal Operations *(continued)*

Radionuclides	Life of Project		Year(s) of Maximum Impact		Direction	Distance (kilometers)
	Dose (millirem)	Lifetime Risk of an LCF	Dose (millirem per year)	Risk of an LCF		
Alternative 2 or 3, Disposition of Remote-Handled Special Components – Idaho Option						
Sodium-22	3.0×10^{-6}		2.0×10^{-6}		S	13.4
Cesium-137	3.7×10^{-6}		2.5×10^{-6}			
Total	$\mathbf{6.7\times10^{-6}}$	$\mathbf{4\times10^{-12}}$	$\mathbf{4.4\times10^{-6}}$	$\mathbf{3\times10^{-12}}$		
Alternative 2 or 3, Disposition of Bulk Sodium – Hanford Reuse Option						
Tritium	2.3×10^{-4}		1.0×10^{-4}		SE	9.1
Sodium-22	7.6×10^{-4}		3.5×10^{-4}			
Cesium-137	2.8×10^{-5}		1.3×10^{-5}			
Uranium	1.0×10^{-7}		4.7×10^{-8}			
Total	$\mathbf{1.0\times10^{-3}}$	$\mathbf{6\times10^{-10}}$	$\mathbf{4.6\times10^{-4}}$	$\mathbf{3\times10^{-10}}$		
Alternative 2 or 3, Disposition of Bulk Sodium – Idaho Reuse Option						
Tritium	1.7×10^{-4}		8.4×10^{-5}		SSE	5.2
Sodium-22	5.5×10^{-4}		2.7×10^{-4}			
Cesium-137	2.0×10^{-5}		1.0×10^{-5}			
Uranium	7.6×10^{-8}		3.8×10^{-8}			
Total	$\mathbf{7.4\times10^{-4}}$	$\mathbf{4\times10^{-10}}$	$\mathbf{3.7\times10^{-4}}$	$\mathbf{2\times10^{-10}}$		

[a] The life-of-project dose would not be received by one individual person due to the duration of this alternative (100 years). The dose and lifetime risk of an LCF from 70 years of exposure at the average annual dose rate would be 1.2×10^{-3} millirem, with a corresponding lifetime risk of an LCF of 7×10^{-10}.

Note: To convert kilometers to miles, multiply by 0.6214.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; LCF=latent cancer fatality.

Table K–59. FFTF Decommissioning Alternatives – Impacts on the Hanford Onsite Maximally Exposed Individual During Normal Operations

Radionuclides	Life of Project		Year(s) of Maximum Impact		Location
	Dose (millirem)	Lifetime Risk of an LCF	Dose (millirem per year)	Risk of an LCF	
Alternative 1, No Action[a]					
Hydrogen-3 (tritium)	1.2×10^{-8}		1.2×10^{-10}		CGS
Cesium-137	4.9×10^{-6}		4.9×10^{-8}		
Plutonium-239	1.1×10^{-3}		1.1×10^{-5}		
Total	$\mathbf{1.1\times10^{-3}}$	$\mathbf{6\times10^{-10}}$	$\mathbf{1.1\times10^{-5}}$	$\mathbf{6\times10^{-12}}$	
Alternative 2, Facility Disposition					
Cesium-137	1.0×10^{-8}	6×10^{-15}	1.0×10^{-8}	6×10^{-15}	CGS
Alternative 3, Facility Disposition					
–	–	–	–	–	–
Alternative 2 or 3, Disposition of Remote-Handled Special Components – Hanford Option					
Sodium-22	2.3×10^{-5}		1.5×10^{-5}		US Ecology
Cesium-137	3.9×10^{-6}		2.6×10^{-6}		

Table K–59. FFTF Decommissioning Alternatives – Impacts on the Hanford Onsite Maximally Exposed Individual During Normal Operations *(continued)*

Radionuclides	Life of Project		Year(s) of Maximum Impact		Location
	Dose (millirem)	Lifetime Risk of an LCF	Dose (millirem per year)	Risk of an LCF	
Total	**2.7×10^{-5}**	**2×10^{-11}**	**1.8×10^{-5}**	**1×10^{-11}**	
Alternative 2 or 3, Disposition of Bulk Sodium – Hanford Reuse Option					
Tritium	4.1×10^{-9}		1.9×10^{-9}		LIGO
Sodium-22	9.7×10^{-4}		4.4×10^{-4}		
Cesium-137	5.0×10^{-6}		2.3×10^{-6}		
Uranium	1.1×10^{-7}		4.8×10^{-8}		
Total	**9.8×10^{-4}**	**6×10^{-10}**	**4.4×10^{-4}**	**3×10^{-10}**	

[a] The life-of-project dose would not be received by one individual person due to the duration of this alternative (100 years). The dose and lifetime risk of an LCF from 40 years of exposure at the average annual dose rate would be 4.2×10^{-4} millirem, with a corresponding lifetime risk of an LCF of 3×10^{-10}.

Key: CGS=Columbia Generating Station; FFTF=Fast Flux Test Facility; Hanford=Hanford Site; LCF=latent cancer fatality; LIGO=Laser Interferometer Gravitational-Wave Observatory; US Ecology=US Ecology Commercial Low-Level Radioactive Waste Disposal Site.

K.2.2.2 Impacts on Workers During Normal Operations

K.2.2.2.1 Project Radiation Workers

Workers would receive radiation doses from deactivation activities that were previously 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 2006). The collective dose to the worker population from deactivation activities would be 576 person-rem (DOE 2006:4-2); no (0.3) LCFs would be expected as a result of this dose. This dose would be incurred regardless of which FFTF Decommissioning alternative is selected.

Worker doses would result from maintaining administrative controls (under FFTF Decommissioning Alternative 1) or from facility disposition, disposition of RH-SCs, and disposition of bulk sodium (under FFTF Decommissioning Alternatives 2 and 3). Table K–60 presents the worker doses that would be received from these activities.

Table K–60. FFTF Decommissioning Alternatives – Radiation Worker Impacts and Labor Estimates

Alternative	Life of Project Collective Worker Impact		Life of Project Full-Time Equivalent Radiation Worker Labor		Average Annual Impact per Full-Time-Equivalent Radiation Worker		Activity Duration
	Dose (person-rem)	LCFs[a]	Hours	Years	Dose (millirem per year)	Risk of an LCF	Years
1	**No Action**						
	1	0 (6×10^{-4})	4.16×10^{4}	20	50	3×10^{-5}	2008–2107
2	**Facility Disposition**						
	0.37	0 (2×10^{-4})	7.68×10^{3}	4	100	6×10^{-5}	2017
3	**Facility Disposition**						
	6.3	0 (4×10^{-3})	1.31×10^{5}	63	100	6×10^{-5}	2013–2014

Table K–60. FFTF Decommissioning Alternatives – Radiation Worker Impacts and Labor Estimates *(continued)*

Alternative	Life of Project Collective Worker Impact		Life of Project Full-Time Equivalent Radiation Worker Labor		Average Annual Impact per Full-Time-Equivalent Radiation Worker		Activity Duration
	Dose (person-rem)	LCFs[a]	Hours	Years	Dose (millirem per year)	Risk of an LCF	Years
2 or 3	**Disposition of Remote-Handled Special Components – Hanford or Idaho Option**						
	1.2	0 (7×10^{-4})	1.25×10^{5}	60	20	1×10^{-5}	2017–2018
	Disposition of Bulk Sodium – Hanford Reuse Option						
	3.7	0 (2×10^{-3})	1.96×10^{5}	94	39	2×10^{-5}	2017–2019
2 or 3	**Disposition of Bulk Sodium – Idaho Reuse Option**						
	3.6	0 (2×10^{-3})	1.90×10^{5}	92	39	2×10^{-5}	2014–2016

[a] Increased number of LCFs for the worker population as a result of the radiation dose received under the alternative. If zero, the number in parentheses is the value calculated by multiplying the dose by the risk factor of 0.0006 LCFs per person-rem.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; LCF=latent cancer fatality.

Source: SAIC 2010b.

K.2.2.2.2 Noninvolved Workers

For the FFTF Decommissioning alternatives, the noninvolved worker that would be potentially affected by either facility disposition or disposition of bulk sodium was assumed to be located in the 300 Area, which is about 9.3 kilometers (5.8 miles) southeast of FFTF. For emissions from the T Plant in the 200-West Area that would result from disposition of RH-SCs at Hanford, the noninvolved worker was assumed to be located at a distance of 100 meters (110 yards) to the east-northeast. For emissions occurring at the INL MFC, the noninvolved worker was assumed to be located at the Experimental Breeder Reactor II (EBR-II) in the MFC, approximately 100 meters (110 yards) away. At INTEC, the noninvolved worker was also assumed to be 100 meters (110 yards) away. Table K–61 presents the doses and risks calculated for a noninvolved worker for facility disposition, disposition of bulk sodium, and disposition of RH-SCs. In all cases, the doses would be small.

Table K–61. FFTF Decommissioning Alternatives – Impacts on the Noninvolved Worker During Normal Operations

Alternative	Noninvolved Worker Location	Life of Project		Year of Maximum Impact	
		Dose (millirem)	Lifetime Risk of an LCF	Dose (millirem)	Risk of an LCF
No Action					
1[a]	300 Area	6.4×10^{-4}	4×10^{-10}	6.4×10^{-6}	4×10^{-12}
Facility Disposition					
2	300 Area	5.9×10^{-9}	4×10^{-15}	5.9×10^{-9}	4×10^{-15}
3	300 Area	–	–	–	–
Disposition of Remote-Handled Special Components – Hanford Option					
2 or 3	100 meters east-northeast	1.6×10^{-2}	1×10^{-8}	1.1×10^{-2}	6×10^{-9}
Disposition of Remote-Handled Special Components – Idaho Option					
2 or 3	100 meters northeast	4.3×10^{-7}	3×10^{-13}	2.9×10^{-7}	2×10^{-13}

Table K–61. FFTF Decommissioning Alternatives – Impacts on the Noninvolved Worker During Normal Operations *(continued)*

Alternative	Noninvolved Worker Location	Life of Project		Year of Maximum Impact	
		Dose (millirem)	Lifetime Risk of an LCF	Dose (millirem)	Risk of an LCF
Disposition of Bulk Sodium – Hanford Reuse Option					
2 or 3	300 Area	5.6×10^{-4}	3×10^{-10}	2.5×10^{-4}	2×10^{-10}
Disposition of Bulk Sodium – Idaho Reuse Option					
2 or 3	EBR-II	1.4×10^{-1}	8×10^{-8}	6.9×10^{-2}	4×10^{-8}

[a] The life-of-project dose would not be received by one individual person due to the duration of this alternative (100 years). The dose and lifetime risk of an LCF from 40 years of exposure at the average annual dose rate would be 2.6×10^{-4} millirem, with a corresponding lifetime risk of an LCF of 2×10^{-10}.

Key: EBR-II=Experimental Breeder Reactor II; FFTF=Fast Flux Test Facility; Hanford=Hanford Site; Idaho=Idaho National Laboratory; LCF=latent cancer fatality.

K.2.3 Waste Management Alternatives

K.2.3.1 Impacts on the Public During Normal Operations

The methodology employed to evaluate the impacts of the Waste Management alternatives on the public and workers was similar to that discussed in Section K.2.1 for evaluating the impacts of Tank Closure alternatives. Under Waste Management Alternative 1: No Action, currently approved operation of waste treatment facilities would continue; no impacts above those that are part of the current Hanford baseline would result. The scope of the expanded waste treatment activities is the same under Waste Management Alternatives 2 and 3; emissions from the expanded waste treatment activities could result in radiological impacts on the public and are addressed in this section. Differences between Waste Management Alternatives 2 and 3 are in the proposed locations and sizes of waste disposal facilities. As the facilities would receive packaged waste, their normal operations are not expected to contribute to current offsite doses.

Unless noted otherwise, assumptions in Section K.2.1 also apply to the waste management radiological impacts analysis. The following sections address differences in scenarios and assumptions affecting human health impacts due to radioactive emissions from waste management.

K.2.3.1.1 Approach

Waste Management alternatives include treatment, storage, and disposal activities. Existing emissions from the Waste Receiving and Processing Facility (WRAP) and from waste treatment at the T Plant complex would continue under Waste Management Alternative 1. Under Waste Management Alternatives 2 and 3, additional treatment capacity would be added at WRAP and the T Plant complex and additional waste volumes would be processed. These facilities would be located in the 200-West Area. For purposes of evaluating radiological impacts on the public, emissions from waste treatment activities were modeled as originating from a single location, the STTS-West in the southeast corner of 200-West Area, which was the same location used for modeling emissions from the 200-West Area under the Tank Closure and FFTF Decommissioning alternatives.

Waste storage capacity at the Central Waste Complex (CWC) would be expanded under Waste Management Alternatives 2 and 3. Under Waste Management Alternative 2, waste disposal would occur in the 200-East Area Integrated Disposal Facility (IDF-East) and the proposed River Protection Project Disposal Facility (RPPDF) to be located between the 200-East and 200-West Areas. Under Waste Management Alternative 3, in addition to IDF-East and the RPPDF, a 200-West Area Integrated Disposal Facility (IDF-West) would be used for waste disposal. Stored waste and waste placed in the disposal

facilities would be in packages or large roll-on, roll-off containers; therefore, no radioactive emissions with the potential to cause offsite impacts are expected from waste storage and disposal.

K.2.3.1.2 Modeling

The GENII-2 computer code was used to evaluate impacts on the offsite populations of Hanford.

K.2.3.1.3 Input Parameters

The waste treatment facilities would be in the 200-West Area, so many of the GENII-2 input parameters would be the same as those used in modeling impacts from 200-West Area tank closure activities. Common input parameters include meteorological data (see Table K–5) and population distribution (see Figure K–4). The same pathway and exposure assumptions used in the tank closure analysis were used for evaluating waste management impacts (see Section K.2.1.1.3.3).

K.2.3.1.3.1 Source Terms

The emissions of the proposed waste treatment facilities were estimated based on emissions from current treatment facilities. Isotopic data reported in the *Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 2006* (Rokkan et al. 2007) for operation of WRAP and Buildings 2706-T and 2706-TA were used where available. If no specific alpha-emitting isotopes were reported, the reported gross alpha emissions were used and assumed to be plutonium-239. In the absence of specific beta-emitting isotopes, the reported gross beta emissions were used and assumed to be strontium-90. Assuming the emissions are plutonium-239 and strontium-90 yields conservative estimates of health impacts. Emissions for the duration of the waste treatment activities and for the years of maximum impact are presented in Table K–62.

Table K–62. Waste Management Alternative 2 or 3 Radioactive Emissions During Normal Operations

Radionuclides	Emissions over Life of Project		Annual Emissions in Years of Maximum Impact	
	Curies	Years	Curies	Years
Strontium-90	7.4×10^{-6}	2013–2051	2.0×10^{-7}	2019–2051
Plutonium-239	9.2×10^{-7}		2.4×10^{-8}	
Americium-241	3.2×10^{-7}		8.8×10^{-9}	

K.2.3.1.4 Results

The radiological impacts of Waste Management Alternative 1 on members of the public are accounted for in analyses of the impacts of ongoing Hanford waste management operations. The impacts of Waste Management Alternatives 2 and 3 would be the same because there are no differences in waste treatment activities between the alternatives. Estimated impacts on the offsite population are presented in Table K–63. Impacts on an MEI assumed to be on the far bank of the Columbia River to the east-northeast are presented in Table K–64. Impacts on an onsite MEI assumed to be at US Ecology, to the east of the 200-West Area, are presented in Table K–65. Impacts at this location would exceed those at the Columbia Generating Station or LIGO because it is closer to the emission source.

Table K–63. Waste Management Alternatives 2 or 3 Impacts on the Population During Normal Operations

Radionuclides	Life of Project		Years of Maximum Impact	
	Dose (person-rem)	LCFs[a]	Dose (person-rem)	LCFs[a]
Strontium-90	2.2×10^{-6}		5.9×10^{-8}	
Plutonium-239	5.8×10^{-5}		1.5×10^{-6}	
Americium-241	1.7×10^{-5}		4.6×10^{-7}	
Total	**7.7×10^{-5}**	**0 (5×10^{-8})**	**2.0×10^{-6}**	**0 (1×10^{-9})**

[a] The integer indicates the number of excess latent cancer fatalities that would be expected in the population based on the risk factor of 0.0006 latent cancer fatalities per person-rem; the value in parentheses is the value calculated from the dose and risk factor.

Key: LCF=latent cancer fatality.

Table K–64. Waste Management Alternatives 2 or 3 Impacts on the Maximally Exposed Individual During Normal Operations

Radionuclides	Life of Project		Years of Maximum Impact		Direction	Distance (kilometers)
	Dose (millirem)	Lifetime Risk of an LCF	Dose (millirem per year)	Risk of an LCF		
Strontium-90	2.4×10^{-7}		6.5×10^{-9}		ENE	18.2
Plutonium-239	4.2×10^{-6}		1.1×10^{-7}			
Americium-241	1.2×10^{-6}		3.3×10^{-8}			
Total	**5.6×10^{-6}**	**3×10^{-12}**	**1.5×10^{-7}**	**9×10^{-14}**		

Note: To convert kilometers to miles, multiply by 0.6214.

Key: LCF=latent cancer fatality.

Table K–65. Waste Management Alternatives 2 or 3 Impacts on the Onsite Maximally Exposed Individual During Normal Operations

Radionuclides	Onsite Maximally Exposed Individual Doses and Risks				
	Life of Project		Years of Maximum Impact		Location
	Dose (millirem)	Lifetime Risk of an LCF	Dose (millirem per year)	Risk of an LCF	
Strontium-90	1.2×10^{-7}		3.4×10^{-9}		US Ecology
Plutonium-239	1.9×10^{-5}		4.9×10^{-7}		
Americium-241	5.5×10^{-6}		1.5×10^{-7}		
Total	**2.5×10^{-5}**	**1×10^{-11}**	**6.4×10^{-7}**	**4×10^{-13}**	

Note: To convert kilometers to miles, multiply by 0.6214.

Key: LCF=latent cancer fatality; US Ecology=US Ecology Commercial Low-Level Radioactive Waste Disposal Site.

K.2.3.2 Impacts on Workers During Normal Operations

K.2.3.2.1 Project Radiation Workers

Impacts on workers would result from waste treatment and storage activities and from waste disposal operations. Under Waste Management Alternative 1, the impacts of currently operating treatment, storage, and disposal facilities would continue through 2035. Under Waste Management Alternatives 2

and 3, additional worker exposure would occur due to expanded treatment and storage operations beginning in 2013 and continuing through 2051. Waste Management Alternatives 2 and 3 include the same treatment and storage activities, so the worker dose would be the same under both alternatives. Radiation worker doses received from disposal operations would be comparable regardless of the Waste Management alternative, but the worker dose would be affected by the duration of disposal operations, which would depend on the disposal group selected. Disposal groups are based on which Tank Closure alternative is selected (see Chapter 2, Sections 2.5.4.2 and 2.5.4.3). Table K–66 shows the projected worker radiation doses for the Waste Management alternatives and the various disposal groups.

Table K–66. Waste Management Alternatives – Radiation Worker Impacts and Labor Estimates During Normal Operations

Alternative	Life-of-Project Collective Worker Impact		Life-of-Project Full-Time-Equivalent Radiation Worker Labor		Average Annual Impact per Full-Time-Equivalent Radiation Worker		Activity Duration
	Dose (person-rem)	LCFs[a]	Hours	Years	Dose (millirem per year)	Risk of an LCF	Years
1	**Treatment, Storage, and Disposal Operations**						
	37	0 (2×10^{-2})	3.87×10^{5}	186	200	1×10^{-4}	2007–2035
2 or 3	**Treatment and Storage Operations**						
	3.0×10^{3}	2	3.13×10^{7}	15,054	200	1×10^{-4}	2013–2051
2	**Disposal Operations**						
	Disposal Group 1 (for Tank Closure Alternatives 2B, 3A, 3B, 3C, 4, 5, and 6C)						
	360	0 (2×10^{-1})	3.76×10^{6}	1,806	200	1×10^{-4}	2007–2050
	Disposal Group 2 (for Tank Closure Alternatives 2A and 6B)						
	3.6×10^{3}	2	3.69×10^{7}	17,720	200	1×10^{-4}	2007–2100
	Disposal Group 3 (for Tank Closure Alternative 6A)						
	6.4×10^{3}	4	6.67×10^{7}	32,061	200	1×10^{-4}	2007–2165
3	**Disposal Operations**						
	Disposal Group 1 (for Tank Closure Alternatives 2B, 3A, 3B, 3C, 4, 5, and 6C)						
	360	0 (2×10^{-1})	3.75×10^{6}	1,803	200	1×10^{-4}	2007–2050
	Disposal Group 2 (for Tank Closure Alternatives 2A and 6B)						
	3.5×10^{3}	2	3.67×10^{7}	17,666	200	1×10^{-4}	2007–2100
	Disposal Group 3 (for Tank Closure Alternative 6A)						
	6.4×10^{3}	4	6.64×10^{7}	31,928	200	1×10^{-4}	2007–2165

[a] Increased number of LCFs for the worker population as a result of the radiation dose received under the alternative. If zero, the number in parentheses is the value calculated by multiplying the dose by the risk factor of 0.0006 LCFs per person-rem.

Key: LCF=latent cancer fatality.

Source: SAIC 2010c.

K.2.3.2.2 Noninvolved Workers

Radioactive emissions from waste treatment activities could potentially impact noninvolved workers. Waste disposal operations are not expected to result in emissions during normal operations because the waste would be received and disposed of in packages. Under Waste Management Alternative 1: No Action, no additional impacts beyond those included in the baseline would occur. Differences between Waste Management Alternatives 2 and 3 are due to locations and operations of disposal facilities; therefore, the impacts on a noninvolved worker, which are based on treatment facility emissions, would be the same under Waste Management Alternatives 2 and 3.

Emissions from waste management facilities were treated as coming from a single source for purposes of evaluating potential impacts on a noninvolved worker. Additionally, a conservative assumption was made that the emission source would be at ground level. A noninvolved worker was assumed to be about 100 meters (110 yards) from the emission source. The maximum annual dose to a noninvolved worker would be 3.9×10^{-4} millirem; the increased risk of an LCF from this dose would be less than 1 in 4 billion. Emissions from waste management treatment activities would occur from 2013 through 2051. If the same noninvolved worker were exposed over the duration of the waste treatment activities, the worker would receive a dose of 1.5×10^{-2} millirem; this dose corresponds to an increased lifetime risk of an LCF of 9×10^{-9}, about 1 in 100 million.

K.3 ACCIDENT ANALYSIS

K.3.1 Introduction

Accident analyses for the *TC & WM EIS* alternatives were performed to estimate the impacts on workers and the public from reasonably foreseeable accidents. The analyses were performed in accordance with NEPA guidelines, including the process for the selection of accidents, definition of accident scenarios, and estimation of potential impacts. The sections that follow describe the methodology and assumptions used, as well as the accident selection process, selected accident scenarios, and consequences and risks of the accidents evaluated. The accident scenario descriptions are intended to give the informed reader a general understanding of how the accident source terms were developed and how the releases from one event might compare with those of another.

K.3.2 Overview of Methodology and Assumptions

K.3.2.1 Modeling and Analysis of Airborne Radionuclide Releases

The radiological impacts of airborne releases from accidents at the facilities involved in the *TC & WM EIS* alternatives were calculated using the MACCS [MELCOR Accident Consequence Code System] computer code, Version 1.13.1 (MACCS2). A detailed description of the MACCS model is provided in *MELCOR Accident Consequence Code System (MACCS)* (NRC 1990). The enhancements incorporated in MACCS2 are described in the *Code Manual for MACCS2*, Vol. 1, *User's Guide* (Chanin and Young 1997). This section presents the MACCS2 data specific to the accident analyses.

MACCS2 description. The MACCS2 computer code is used to estimate the radiation doses and health effects that could result from postulated accidental releases of radioactive materials to the atmosphere. The specific release characteristics can consist of up to four Gaussian plumes that are often referred to simply as "plumes"; these specifications are designated a "source term."

The radioactive materials released are modeled as being dispersed in the atmosphere while being transported by the prevailing wind. During transport, whether or not there is precipitation, particulate material can be modeled as being deposited on the ground. If contamination levels exceed a user-specified criterion, mitigating actions can be triggered to limit radiological exposures.

Two aspects of the code's structure are fundamental to understanding its calculations: (1) the calculations are divided into modules and phases, and (2) the region surrounding the facility is divided into a polar coordinate grid. These concepts are described in the following paragraphs.

MACCS2 is divided into three primary modules: ATMOS, EARLY, and CHRONC. Three phases of exposure are defined as emergency, intermediate, and long-term. The relationship among the code's three modules and three phases of exposure are summarized below.

The ATMOS module performs all of the calculations pertaining to atmospheric transport, dispersion, and deposition, as well as the radioactive decay that occurs before release and while the material is in the atmosphere. It uses a Gaussian plume model with Pasquill-Gifford dispersion parameters. The phenomena treated include building wake effects, buoyant plume rise, plume dispersion during transport, wet and dry deposition, and radioactive decay and ingrowth. The results of the calculations are stored for use by EARLY and CHRONC. In addition to the air and ground concentrations, ATMOS stores information on wind direction, arrival and departure times, and plume dimensions.

The EARLY module models the period immediately following a radionuclide release. This period is commonly referred to as the emergency phase. The emergency phase begins at each successive downwind distance point when the first plume of the release arrives. The duration of the emergency phase is specified by the user; it can range from 1 to 7 days. The exposure pathways considered during this period are direct external exposure to radioactive material in the plume (cloud shine), exposure from inhalation of radionuclides in the cloud (cloud inhalation), exposure to radioactive material deposited on the ground (ground shine), inhalation of resuspended material (resuspension inhalation), and skin dose from material deposited on the skin. Mitigating actions that can be specified for the emergency phase include evacuation, sheltering, and dose-dependent relocation.

The CHRONC module performs all of the calculations pertaining to the intermediate and long-term phases. CHRONC calculates the individual health effects that result from both direct exposure to contaminated ground and inhalation of resuspended materials, as well as indirect health effects caused by the consumption of contaminated food and water by individuals who could reside both on and off the computational grid.

The intermediate phase begins at each successive downwind distance point upon conclusion of the emergency phase. The user can configure the calculations with an intermediate phase up to 1 year long. Alternatively, the user can configure the calculations with no intermediate phase, so that the long-term phase begins immediately upon conclusion of the emergency phase.

Intermediate-phase models are implemented on the assumption that the radioactive plume has passed and the only exposure sources (ground shine and resuspension inhalation) are from material deposited on the ground. It is for this reason that MACCS2 requires that the total duration of a radionuclide release be limited to 4 days. Potential doses from food and water during this period are not considered.

The mitigating action model for the intermediate phase is very simple. If the intermediate-phase dose criterion is satisfied, the resident population is assumed to be present and subject to radiological exposure from ground shine and resuspension for the entire intermediate phase. If the intermediate-phase exposure exceeds the dose criterion, the population is assumed to have relocated to uncontaminated areas for the entire intermediate phase.

The long-term phase begins at each successive downwind distance point upon conclusion of the intermediate phase. The exposure pathways considered during this period are ground shine, resuspension inhalation, and ingestion of food and water.

The exposure pathways considered are those resulting from material deposited on the ground. A number of protective measures, such as decontamination, temporary interdiction, and condemnation, can be modeled in the long-term phase to reduce doses to user-specified levels. The decisions on mitigating action in the long-term phase are based on two factors: (1) whether land at a specific location and time is suitable for human habitation (habitability) and (2) whether land at a specific location and time is suitable for agricultural production (ability to farm).

All of the calculations of MACCS2 are stored based on a polar coordinate spatial grid. Treatment differs somewhat between calculations of the emergency phase and calculations of the intermediate and long-term phases. The region potentially affected by a release is represented with a (r, θ) grid system centered on the location of the release. The radius, r, represents downwind distance. The angle, θ, is the angular offset from the north, going clockwise.

The user specifies the number of radial divisions, as well as their endpoint distances. The angular divisions used to define the spatial grid are fixed in the code. They correspond to the 16 points of the compass; each division is 22.5 degrees wide. The 16 points of the compass are used in the United States to express wind direction. The compass sectors are referred to as the "coarse grid." Figures K–2, K–3, and K–4 are examples of Hanford population distributions utilizing the 16 standard compass sectors.

Because emergency phase calculations use dose-response models for early fatalities and early injuries that can be highly nonlinear, these calculations are performed on a finer grid basis than the calculations of the intermediate and long-term phases. For this reason, the calculations of the emergency phase are performed with the 16 compass sectors divided into three, five, or seven equal, angular subdivisions. The subdivided compass sectors are referred to as the "fine grid."

Two types of doses may be calculated by the code: acute and lifetime.

Acute doses are calculated to estimate deterministic health effects that can result from high doses delivered at high dose rates. Such conditions may occur in the immediate vicinity of a nuclear facility following hypothetical severe accidents in which confinement and/or containment failure has occurred. Examples of the health effects based on acute doses are early fatality, prodromal vomiting (a precursory symptom of disease), and hypothyroidism (insufficient production of the thyroid hormone).

Lifetime doses are the conventional measure of detriment used for radiation protection. These are 50-year dose commitments to specific tissues (e.g., red marrow, lungs) or a weighted sum of tissue doses defined by the ICRP and referred to as "effective dose." Lifetime doses may be used to calculate the stochastic (probabilistic) health effect risk resulting from exposure to radiation. MACCS2 uses the calculated lifetime dose in cancer risk calculations.

MACCS2 implementation. As implemented, the MACCS2 model evaluated doses due to inhalation of airborne material, as well as direct (external) exposure to the passing plume. These two modes of exposure represent the major portion of the dose that an individual would receive due to a *TC & WM EIS* alternative facility accident. The longer-term effects of airborne radioactive material deposited on the ground after a postulated accident, including the resuspension and subsequent inhalation of radioactive material and the ingestion of contaminated crops, were not modeled for this EIS. These pathways have been studied and found to contribute insignificantly to the total dose compared with inhalation of radioactive material in the passing plume; they are also controllable through cleanup and other mitigation measures. Hence, the deposition velocity of the radioactive material was set to zero, so that material that might otherwise be deposited on surfaces would remain airborne and available for inhalation. This method results in a higher degree of conservatism compared with dose results that would be obtained if deposition and resuspension were taken into account.

The impacts were assessed for the offsite population surrounding the WTP, the 200-East and 200-West Areas, FFTF, the INL MFC, and the INL INTEC; the MEI; and a noninvolved worker. The impacts on involved workers were addressed qualitatively because no adequate method exists for calculating meaningful consequences at or very near an accident location. Involved workers are also fully trained in emergency procedures, including response to potential accidents.

The offsite population is defined as the general public residing within 80 kilometers (50 miles) of the site. The population distribution for each proposed site was developed from the 2010 decennial census

(Census 2011). These data were fitted to a polar coordinate grid with 16 angular sectors aligned with the 16 compass directions, with radial intervals that extend outward to 80 kilometers (50 miles). The offsite populations within 80 kilometers (50 miles) of the 200-East, WTP, and 200-West Areas were estimated to be 546,746, 542,324 and 589,668 persons, respectively. The population within 80 kilometers (50 miles) of FFTF was estimated to be 445,002. The INL MFC population was estimated to be 250,838, and the INL INTEC population was estimated to be 152,493. For this analysis, no credit was taken for emergency response evacuations or temporary relocation of the public.

The MEI is defined as a hypothetical individual member of the public who would receive the maximum dose from an accident. This individual is usually assumed to be located at a site boundary. However, because there are public access points within the Hanford boundary, the MEI could be at any of these onsite locations.

The MEI location was determined for each *TC & WM EIS* alternative. The MEI location at Hanford can vary based on the type and location of an accident. For this analysis, the MEI was assumed to be located 8.6 kilometers (5.4 miles) south of the WTP and 200-East Area facilities, 3.6 kilometers (2.3 miles) southwest of the 200-West Area facilities, and 6.8 kilometers (4.2 miles) east of FFTF. The MEI for the INL MFC was assumed to be located 4.0 kilometers (2.5 miles) to the south-southwest. The MEI for the INL INTEC was assumed to be located 5.9 kilometers (3.7 miles) to the south-southwest.

A noninvolved worker is defined as an onsite worker who is not directly involved in the facility activity pertaining to the accident. The noninvolved worker was assumed to be exposed to all or part of the release at a distance of 100 meters (110 yards) without any protection. For some scenarios, workers would evacuate the area after becoming aware of the emergency, thereby reducing their exposure potential.

Doses to the offsite population, the MEI, and a noninvolved worker were calculated based on site-specific meteorological conditions. Site-specific meteorology was represented by 1 year of hourly windspeed, wind direction, atmospheric stability, and rainfall data at each site. The MACCS2 calculations produced statistical distributions based on the meteorological conditions. For these analyses, the results presented were based on the mean (average) results, which reflect more-realistic consequences than the 95th percentile results sometimes used in accident analyses for safety analysis reports. The 95th percentile results represent low-probability meteorological conditions that are not exceeded more than 5 percent of the time.

The health risk coefficient for determining the likelihood of an LCF for low doses or dose rates is 0.0006 LCFs per rem, applied to individual workers and members of the public (see Section K.1.1.3). For high doses or dose rates, a health risk coefficient of 0.0012 was applied to individual workers and members of the public. The higher health risk coefficient applies when individual doses exceed 20 rem.

K.3.2.2 Modeling and Analysis of Airborne Chemical Releases

One of the computer models included in the DOE Safety Software Central Registry, EPIcode [Emergency Prediction Information Code], was selected to obtain estimates of atmospheric dispersion and resultant downwind concentrations of hazardous chemicals (DOE 2004b; Homann 2003). The codes included in the central registry have been determined to be compliant with the DOE Safety Software Quality Assurance requirements. These codes are routinely used by DOE to perform calculations and develop data used to establish the safety basis for DOE facilities and their operation and to support the variety of safety analyses and evaluations developed for these facilities.

EPIcode uses the Gaussian dispersion model to determine plume dispersion. The Gaussian model computes airborne concentrations at a given distance based on: (1) amount released, (2) effective release

height, (3) windspeed at the release height, (4) inversion layer, and (5) standard deviation of the integrated concentration distribution both in the crosswind direction (sigma-y) and the vertical direction (sigma-z). Both sigma-y and sigma-z depend on the Pasquill stability class (classification according to the degree of atmospheric turbulence, described below) and the terrain. EPIcode allows selection of either standard (rural) or urban terrain. The standard terrain assumes surface roughness lengths ranging from 0.01 to 0.1 meters (0.03 to 0.3 feet). The urban terrain accounts for increased dispersion due to large urban structures. Standard terrain was conservatively selected for all scenarios even though there are various large structures at both Hanford and INL. This choice resulted in higher downwind concentrations.

EPIcode accounts for plume depletion processes, by which very small particles and gases or vapors are deposited on or incorporated within surfaces as a result of turbulent diffusion and Brownian motion (random movement of small particles suspended in liquid or gas caused by collisions with molecules of the surrounding medium). Chemical reactions; impaction; and other biological, chemical, and physical processes combine to keep material that is deposited from becoming re-entrained. As this material is deposited, the plume above becomes depleted. EPIcode uses a source-depletion algorithm to adjust the air concentration in the plume to account for this removal of material. This integrated effect of all removal processes is represented in the plume depletion equation by a deposition velocity term. The code does not account for wind shifts, terrain steering effects, chemical reactions, dense gas effects, or radioactive materials (see Homann 2003).

EPIcode was used to model chemical concentrations in air at each receptor location for each release scenario. Each chemical release was assumed to be at ground level. A neutral atmospheric stability (stability class D) and a windspeed of 5 meters (16.4 feet) per second were used for all EPIcode simulations in this document. The most frequent stability class at Hanford is D.

K.3.2.3 Accident Frequencies

Accident frequency or probability reflects the likelihood of occurrence of an unplanned event during operations that could potentially cause the release of hazardous materials and harm the public, workers, and environment. The unit of measure for accident frequency in this EIS is usually expressed as occurrences per unit of time.

Risk is the overall measure of an accident's potential for endangering the health and safety of workers and the public. As explained in Section K.3.7, an accident's risk is the mathematical product of the accident's frequency of occurrence and its consequences and is expressed in terms of LCFs per year.

Accident scenarios and frequencies used in this EIS were based on extensive studies that are documented in safety analysis reports and related documents. The accident frequencies in these reports typically reflect the effects of mitigating factors designed to prevent or minimize the magnitude of hazardous material releases. The accident frequencies used in this EIS were conservatively adjusted to reflect unmitigated conditions that result in higher releases of hazardous materials, and thus, higher consequences. Because of uncertainties in the factors that affect an accident's frequency, many were initially expressed as a range. For estimating risk, the higher, conservative end of the estimated frequency range was used in the multiplication of frequency and consequences.

K.3.2.4 Secondary Impacts

Secondary impacts occur due to deposition of radioactive material or chemicals from a plume released during an accident. Although further exposure to humans can occur from deposited material, the radiation dose or chemical exposure associated with the passing plume dominates human health impacts. However, for NEPA purposes, other impacts of deposition are also important. These impacts, discussed

further in Section K.3.8 (for radionuclide releases) and Section K.3.9 (for chemical releases), may result in imposition of protective actions and temporary access restrictions to contaminated land or property.

For radionuclide releases, the MACCS2 code was used to estimate the level of ground contamination caused by deposition from a passing radioactive plume. The level of contamination is measured in units of microcuries per square meter at specified distances from the accident location. Releases were assumed to occur at ground level with no thermal lift. Mean meteorological conditions were assumed and the deposition velocity was set to 0.01 meters (0.03 feet) per second. The EPA level of concern for ground contamination was set to 0.1 microcuries per square meter. For the analyzed chemical release scenarios, a combination of quantitative and qualitative means was used to assess the secondary impacts presented in Section K.3.9.

K.3.3 Radiological Accident Analyses

In accordance with DOE NEPA guidelines, an EIS should contain a representative set of accidents that includes various types, such as fire, explosion, mechanical impact, criticality, spill, human error, natural phenomena, and external events. DOE's Office of NEPA Policy and Compliance provides guidance for preparing accident analyses in EISs in *Recommendations for Analyzing Accidents Under the National Environmental Policy Act* (DOE 2002). This document clarifies and supplements *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements* (DOE 2004c).

Facility accidents fall into three broad categories: (1) internally initiated operational events, (2) externally initiated events, and (3) natural phenomena. The first category, internally initiated operational events, includes accidents such as fires, explosions, criticalities, spills, floods, mechanical impacts, and human errors. The second category, externally initiated events, includes airplane crashes, land vehicle impacts, and accidents at adjacent facilities that could impact DOE facilities. The third category, natural phenomena, includes earthquakes, tornados, lightning, high winds, floods, fires, and other naturally occurring events. Other accidents could be identified in each category specific to a facility's operations, design, location, and mission. Intentional acts by terrorists or saboteurs are not considered accidents in the context of NEPA; however, potential impacts of intentional destructive acts are addressed in Section K.3.11.

For this *TC & WM EIS*, a large number of potential accidents were considered in each category. The sources of these accident descriptions, which include identification, definition, and assessment of impacts, are documented in safety analysis reports for the WTP, Pretreatment Facility, LAW Vitrification Facility, and HLW Vitrification Facility. Other documents prepared in support of these safety analysis reports and related EISs were also referenced as needed.

From the large list of accident scenarios, a number were selected that were consistent with NEPA purposes and supportive of public interests and DOE decisions associated with this *TC & WM EIS*. Screening criteria for accident selection and further analysis included the following:

- Applicability (i.e., is the accident scenario applicable to this *TC & WM EIS*?)
- Likelihood of occurrence (i.e., is the accident's occurrence reasonably foreseeable?)
- Material at risk (MAR) (i.e., does the accident scenario involve a significant amount of hazardous MAR as a source term?)
- Magnitude of impacts (i.e., how would the accident's impacts illustrate the range of possible consequences and risks for workers and the public for a particular accident category such as fire or spill?)

- Differentiation of alternatives (i.e., would the accident's impacts help to differentiate between alternatives for decision making purposes?)

- Public interest (i.e., is the accident scenario one that is of particular interest and concern to the public?)

The results of the process of accident selection are provided in Sections K.3.4 for Tank Closure alternatives, K.3.5 for FFTF Decommissioning alternatives, and K.3.6 for Waste Management alternatives. These sections describe the accident scenarios and corresponding source terms developed for the *TC & WM EIS* alternatives. The spectrum of accidents discussed below was used to determine the range of consequences (public and worker doses) and associated risks. Additional assumptions were made when further information was required to clarify the accident condition, update various parameters, or facilitate the evaluation process. The assumptions are referenced in each accident description.

Assuming the occurrence of a postulated accident, the source term is the amount of respirable radioactive material released to the air, in terms of curies or grams. The airborne source term is typically estimated by the following equation:

$$\text{Source term} = MAR \times DR \times ARF \times RF \times LPF$$

where:

MAR	=	material at risk
DR	=	damage ratio
ARF	=	airborne release fraction
RF	=	respirable fraction
LPF	=	leak path factor

The MAR is the amount of radionuclides (in curies of activity or grams for each radionuclide) available to be acted upon by a given physical stress. The MAR is specific to a given process in the facility of interest. It is not necessarily the total quantity of material present, but rather the amount of material in the scenario of interest postulated to be available for release.

The DR is the fraction of material exposed to the effects of the energy, force, or stress generated by the postulated event. For the accident scenarios discussed in this analysis, the value of the DR ranges from 0.1 to 1.0.

The ARF is the fraction of material that becomes airborne due to the accident. In this analysis, ARFs were obtained from applicable source documents or the DOE Handbook, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Vol. 1, *Analysis of Experimental Data* (DOE Handbook 3010-94).

The RF is the fraction of the material with a 10-micron (0.0004-inch) or less aerodynamic-equivalent diameter particle size that could be retained in the respiratory system following inhalation. The RF values are also taken from applicable source documents or the DOE Handbook (DOE Handbook 3010-94).

The LPF accounts for the action of removal mechanisms (e.g., containment systems, filtration, deposition) to reduce the amount of airborne radioactivity ultimately released to occupied spaces in the facility or the environment. The LPF values were taken from applicable sources when possible. Otherwise, an LPF of 1.0 (i.e., no reduction) was assigned. An LPF of 1.0 was also assigned in accident scenarios involving a major failure of confinement barriers.

For example, if for a particular waste process vessel accident, the MAR is 100 curies of a specified radionuclide in a fixed amount of tank waste, the DR is 0.5, the ARF is 0.01, the RF is 0.02, and the LPF is 0.05, the source term would be calculated as follows:

$$\text{Source term} = MAR \times DR \times ARF \times RF \times LPF = 100 \times 0.5 \times 0.01 \times 0.02 \times 0.05 = 0.0005 \text{ curies}$$

In other words, a process vessel contains 100 curies of a radionuclide that is at risk of being released to the environment. Because of an accident, for example, vessel failure, 50 percent (the DR is 0.5) of the vessel's contents are released to the immediate area, 1.0 percent (the ARF is 0.01) becomes airborne, and 2.0 percent (the RF is 0.02) of the airborne material is of respirable size. Depending on the nature of the accident, availability of filtration equipment, and other mitigating factors, 5 percent (the LPF is 0.05) of the respirable airborne material is released to the environment. The net effect is the release of 0.0005 curies of the radionuclide.

K.3.4 Tank Closure Accident Scenarios

This section describes the tank waste storage, retrieval, treatment, and handling accident scenarios applicable to the Tank Closure alternatives. The scenarios, selected in accordance with the process and criteria described in Section K.3.3, are organized according to facility or activity, and their applicability to the alternatives is shown in Table K–67. Many of the accident impacts are based on unmitigated releases, meaning that no credit is taken for HEPA filtration or other design features that may limit the amount of radioactive material released to the environment. Assessing accident impacts based on unmitigated releases is particularly applicable to accident scenarios initiated by seismic events, which were assumed to cause failure of the filtration systems or other mitigating features. In these cases, the lower frequency of the accident reflects the seismic initiating event's effects on mitigating features and accident risk. If these accident scenarios were initiated by events internal to the facility and operations, the HEPA filters and other mitigating features would have a high likelihood of functioning properly, thereby reducing the amount of radioactivity released to the environment. However, the frequency of accident occurrence in these cases would be higher, which would be reflected in the accident's resultant risk. The alphanumeric code following the accident's title (e.g., HL11) corresponds with the accident's description in the tables of this section and in Chapter 4, Section 4.1.11; it is provided to facilitate cross-referencing between tables and accident descriptions.

Table K–67. Tank Closure Alternatives – Applicability of Radiological Accident Scenarios

Accident Scenario[a]	Alternative										
	1	**2A**	**2B**	**3A**	**3B**	**3C**	**4**	**5**	**6A**	**6B**	**6C**
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	–	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Spray leak in transfer line during excavation – unmitigated (PT23)	–	Y	Y	Y	Y	Y	Y	Y	–	Y	Y
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	–	Y	Y	Y	Y	Y	Y	Y	–	Y	Y
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (6 MTG/day) (HL11)	–	Y	Y	Y	Y	Y	Y	Y	–	Y	Y
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (15 MTG/day) (HL11)	–	–	–	–	–	–	–	–	Y	–	–

Table K–67. Tank Closure Alternatives – Applicability of Radiological Accident Scenarios *(continued)*

Accident Scenario[a]	Alternative										
	1	2A	2B	3A	3B	3C	4	5	6A	6B	6C
HLW molten glass spill caused by HLW melter failure – unmitigated (6 MTG/day) (HL14)	–	Y	Y	Y	Y	Y	Y	Y	-	Y	Y
HLW molten glass spill caused by HLW melter failure – unmitigated (15 MTG/day) (HL14)	–	–	–	–	–	–	–	–	Y	–	–
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (30 MTG/day) (LA31)	–	Y	–	Y	Y	Y	Y	–	–	–	–
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (45 MTG/day) (LA31)	–	–	–	–	–	–	–	Y	–	–	–
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (90 MTG/day) (LA31)	–	–	Y	–	–	–	–	–	–	Y	Y
Seismically induced WTP collapse and failure – unmitigated (HLW 6 MTG/day; LAW 30 MTG/day) (WT41)	–	Y	–	Y	Y	Y	Y	–	–	–	–
Seismically induced WTP collapse and failure – unmitigated (HLW 6 MTG/day; LAW 45 MTG/day) (WT41)	–	–	–	–	–	–	–	Y	–	–	–
Seismically induced WTP collapse and failure – unmitigated (HLW 6 MTG/day; LAW 90 MTG/day) (WT41)	–	–	Y	–	–	–	–	–	–	Y	Y
Seismically induced WTP collapse and failure – unmitigated (HLW 15 MTG/day; LAW 0 MTG/day) (WT41)	–	–	–	–	–	–	–	–	Y	–	–
Cast stone feed receipt tank failure – unmitigated (200-East Area) (CS71)	–	–	–	–	Y	–	Y	Y	–	–	–
Cast stone feed receipt tank failure – unmitigated (200-West Area) (CS71)	–	–	–	–	Y	–	–	–	–	–	–
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	–	–	–	Y	Y	Y	Y	Y	–	–	–
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	–	–	–	Y	Y	Y	Y	Y	–	–	–
Bulk vitrification waste receipt tank failure – unmitigated (200-East Area) (BV61)	–	–	–	Y	–	–	–	–	–	–	–
Bulk vitrification waste receipt tank failure – unmitigated (200-West Area) (BV61)	–	–	–	Y	–	–	Y	Y	–	–	–
Steam reforming feed receipt tank failure – unmitigated (200-West Area) (SRF1)	–	–	–	–	–	Y	–	–	–	–	–
Steam reforming feed receipt tank failure – unmitigated (200-East Area) (SRF1)	–	–	–	–	–	Y	–	–	–	–	–
Seismically induced waste tank dome collapse – unmitigated (TK53)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
IHLW glass canister drop – unmitigated (SH91)	–	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

[a] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4 and Chapter 4, Section 4.1.11.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant; Y=yes.

K.3.4.1 HLW Vitrification Facility

K.3.4.1.1 Seismically Induced Failure of HLW Melter Feed Preparation Vessels—Unmitigated (HL11)

This accident scenario involves seismically induced structural failure of two HLW melter feed preparation vessels containing the most concentrated waste materials in the HLW Vitrification Facility. The resultant leaks would drain the tanks, creating internal pools of liquid 10 to 34 centimeters (about 4 to 13 inches) deep in each room, with subsequent entrainment of aerosols in the airflow across the liquid surface. HEPA filters were assumed to fail as a result of the seismic event. The MAR would be in 58,300 liters (15,400 gallons) of HLW (BNI 2005). An initial ARF of 0.00005 would apply to the vessels' contents as they spill to the floor. A continuing airborne release of 4×10^{-7} per hour of the spilled material due to entrainment from the pool surface was assumed to contribute to worker exposure for a period of 8 hours and to public exposure for 24 hours. The RFs would be 0.8 for aerosols formed as the waste spills and 1.0 for aerosols entrained from the pool surface (Lindquist 2006a). The LPF would be 1.0 for the unmitigated case.

The frequency of the accident was estimated to be in the range of 0.00005 to 0.0005 per year (Woolfolk 2007a). For risk calculation purposes, a conservative frequency of 0.0005 per year was assumed.

K.3.4.1.2 HLW Melter Feed Preparation Vessel Failure—Mitigated (HL12)

This accident scenario involves structural failure of an HLW melter feed preparation vessel caused by internal release mechanisms. The resultant leak would drain the tank in 8 hours, creating an internal pool of liquid 10 to 34 centimeters (about 4 to 13 inches) deep in the room with subsequent entrainment of aerosols in the airflow across the liquid. HEPA filters were assumed to be operational. The MAR would be in the contents of a single vessel, 29,100 liters (7,700 gallons) of HLW received from the Pretreatment Facility (BNI 2005). An initial ARF of 0.00005 would apply to the vessel's contents as they spill to the floor. Continuing airborne release at a rate of 4×10^{-7} of the spilled material per hour due to entrainment from the pool surface was assumed to contribute to worker exposure for a period of 8 hours and to public exposure for 24 hours. The RFs would be 0.8 for aerosols formed as the waste spills and 1.0 for aerosols entrained from the pool surface. The LPF would be 2.5×10^{-5} (Lindquist 2006a). This accident's impacts would be less than those of the seismically induced failure of HLW melter feed preparation vessels (HL11) and were not analyzed further.

K.3.4.1.3 Overflow—Mitigated (HL13)

This accident scenario involves overflow of an HLW melter feed preparation vessel into the melter cave sumps and then into the bermed area of the melter cave; the overflow would be caused by excessive volume transfer from the pretreatment vessel or by transfer of material from the pretreatment vessel when the melter feed preparation vessel is full. The MAR would be in 29,100 liters (7,700 gallons) of HLW received from the Pretreatment Facility (BNI 2005). An initial ARF of 0.00005 would apply to the vessel's contents as they spill to the floor. A continuing airborne release of 4×10^{-7} of the spilled material per hour due to entrainment from the pool surface was assumed to contribute to worker exposure for a period of 8 hours and to public exposure for 24 hours. The RFs would be 0.8 for aerosols formed as the waste spills and 1.0 for aerosols entrained from the pool surface. The LPF would be 2.5×10^{-5} (Lindquist 2006a). This accident's impacts would be less than those of the seismically induced failure of HLW melter feed preparation vessels (HL11) and were not analyzed further.

K.3.4.1.4 HLW Molten Glass Spill Caused by HLW Melter Failure—Unmitigated (HL14)

This accident scenario involves a seismically induced catastrophic failure of the HLW melter shell, causing molten glass at 1,150 °C (2,100 °F) to flow out into the HLW melter cave and pour tunnel. Rapid steam generation from the feed material would continue for 1 hour. The depth of the spilled molten glass would vary from 0.03 to 0.46 meters (0.09 to 1.51 feet), depending on the surface area. A depth of 1 centimeter (0.4 inches) was conservatively assumed to maximize the amount of cesium released from the glass as it cools (BNI 2004). HEPA filters were assumed to have failed as a result of the seismic event, resulting in an unfiltered release of radioactive material. The LPF was thereby assumed to be 1.0. The frequency of the accident was estimated to be in the range of 0.00005 to 0.0005 per year (Woolfolk 2007b). For risk calculation purposes, a conservative frequency of 0.0005 per year was assumed.

K.3.4.1.5 HLW Molten Glass Spill Caused by Failed Melter—Mitigated (HL15)

This accident scenario involves a catastrophic failure of the HLW melter shell, causing molten glass at 1,150 °C (2,100 °F) to flow out into the HLW melter cave and pour tunnel. Rapid steam generation from the feed material would continue for 1 hour. The depth of the spilled molten glass would vary from 0.03 to 0.46 meters (0.09 to 1.51 feet), depending on the surface area. A depth of 1 centimeter (0.4 inches) was conservatively assumed to maximize the amount of cesium released from the glass as it cools (BNI 2004). HEPA filters were assumed to be operational, resulting in a filtered release of radioactive material. The LPF was estimated to be 2.5×10^{-5} (Lindquist 2006a). This accident's impacts would be less than those of the unmitigated scenario for the HLW melter failure (HL14) and were not analyzed further.

K.3.4.2 Pretreatment Facility

K.3.4.2.1 Dropped Ultrafilter Module—Mitigated (PT21)

This accident scenario involves a plugged ultrafilter module lifted for replacement using the hot cell crane. The module would be lifted to the maximum height and then a failure of the crane, hook, or lifting device would allow it to fall to the hot cell floor. The dropped module would create a radioactive aerosol that would be released into the hot cell with the potential for migrating into other areas and the environment. The MAR would be in 38.8 liters (10.2 gallons) of HLW. The ARF and RF were estimated to be 0.001 and 0.1, respectively (Woolfolk 2007b). The LPF was estimated to be 2.5×10^{-5} (Lindquist 2006a). This accident's impacts would be less than those of other Pretreatment Facility accidents and were not analyzed further.

K.3.4.2.2 Pretreatment Facility Waste Feed Receipt Vessel or Piping Leak—Unmitigated (PT22)

This accident scenario involves a seismically induced failure of one of four waste feed receipt process vessels or submerged transfer lines. Contributing failure mechanisms include corrosion, erosion, thermal cycling fatigue, faulty welds, and chemical/waste incompatibilities. The entire vessel's contents would spill from the vessel or piping to the floor of the cell due to failure of either the vessel's nozzles or the transfer line within the cell. HEPA filters were assumed to be inoperative, resulting in an unfiltered release of radioactive material. The MAR would be in 1.53 million liters (0.40 million gallons) of untreated waste. An initial ARF of 0.00005 would apply to the vessel's contents as they spill to the floor. A continuing airborne release of 4×10^{-7} of the spilled material per hour due to entrainment from the pool surface was assumed to contribute to worker exposure for a period of 8 hours and to public exposure for 24 hours. The RFs would be 0.8 for aerosols formed as the waste spills and 1.0 for aerosols entrained from the pool surface (Woolfolk 2007b). The LPF would be 1.0 for the unmitigated case (the LPF would be 2.5×10^{-5} for the mitigated case) (Lindquist 2006a). The frequency of the accident was estimated to be

in the range of 0.00005 to 0.0005 per year (Woolfolk 2007b). For risk calculation purposes, a conservative frequency of 0.0005 per year was assumed.

K.3.4.2.3 Spray Leak in Transfer Line During Excavation—Unmitigated (PT23)

This accident scenario involves failure of the coaxial transfer piping that delivers waste from the tank farms to the Pretreatment Facility due to an excavation accident. The outer pipe wall was postulated to break so that the waste is released directly to the environment.

The MAR would be in a waste stream transferring 1,080 liters (285 gallons) per hour for 8 hours from the tank farms to the Pretreatment Facility. The release rate was estimated to be 0.30 liters (0.08 gallons) per second. The ARF and RF were estimated to be 0.0001 and 1.0, respectively. The LPF for the excavation case was estimated to be 1.0. The frequency of the accident was estimated to be 0.0001 per year (Woolfolk 2007b).

K.3.4.3 LAW Vitrification Facility

K.3.4.3.1 Seismically Induced LAW Vitrification Facility Collapse and Failure—Unmitigated (LA31)

This accident scenario involves a seismically induced failure of LAW vessels, product glass containers, melters, and HEPA filters. The MAR is the sum of the radionuclide inventories in 17 major process vessels (Medsker 2007). The product of ARF × RF was estimated to be 0.00005 (Lindquist 2006a). The LPF was estimated to be 1.0. The frequency of the accident was estimated to be in the range of 0.00005 to 0.0005 per year (Medsker 2007). For risk calculation purposes, a conservative frequency of 0.0005 per year was assumed.

K.3.4.4 Waste Treatment Plant

K.3.4.4.1 Seismically Induced Waste Treatment Plant Collapse and Failure—Unmitigated (WT41)

This accident involves a seismically induced catastrophic failure of the WTP. The MAR is all radioactive materials in the WTP vessels, glass containers, melters, filters, transfer pipes, and other equipment. The material was postulated to spill or fall and to be subjected to impact by falling debris. The Pretreatment Facility MAR is the product of the vessel capacities (Woolfolk 2007b) and radionuclide concentrations (BNI 2007) for 17 pretreatment process streams that contain significant amounts of radioactivity. The LAW Vitrification Facility MAR is the sum of the radionuclide inventories in 17 major process vessels (Medsker 2007). The HLW Vitrification Facility MAR is the product of the process vessel capacities (Woolfolk 2007a) and the radionuclide concentrations (BNI 2005) for seven process streams that contain significant amounts of radioactivity. To represent the different alternatives, the MAR values for the Pretreatment, LAW Vitrification, and HLW Vitrification Facilities were assumed to be proportional to the immobilized high-level radioactive waste (IHLW) and immobilized low-activity waste (ILAW) production rates. Total MAR values were calculated for WTP production rates (IHLW × ILAW) of 6 × 30, 6 × 90, 6 × 45, and 15 × 0 metric tons of glass per day. An initial airborne respirable release fraction (ARF × RF) of 0.00005 would apply to liquid waste that spills to the floor. A continuing airborne release of 4×10^{-7} of the spilled material per hour due to entrainment from the pool surface was assumed to contribute to worker exposure for a period of 8 hours and to public exposure for 24 hours (Lindquist 2006a). The HEPA filtration system was assumed to fail, resulting in unfiltered releases to the environment (an LPF of 1.0). The frequency of the accident was estimated to be in the range of 0.00005 to 0.0005 per year (Woolfolk 2007b). For risk calculation purposes, a conservative frequency of 0.0005 was assumed.

K.3.4.5 Tank Waste Storage and Retrieval

K.3.4.5.1 Spray Release from Jumper Pit During Waste Retrieval—Unmitigated (TK51)

This accident scenario involves a spray release of pressurized liquid from a mispositioned jumper in an SST double-contained receiver tank pump pit that services the transfer from the double-contained receiver tank to the double-shell tank or pumps into or out of a receiver tank. A jumper is a short connection pipe that is used in a jumper or pump pit to route tank waste from one line to another when transferring waste to a specific location. It was postulated that a jumper is mispositioned and pinhole leaks develop at both ends of the jumper. All spray particles were assumed to evaporate to less than 10 microns before reaching the ground. All of the spray was considered respirable. The respirable release (MAR × ARF × RF) would be in 52 liters (14 gallons) of untreated tank waste (Shire et al. 1995). The frequency of this accident was estimated to be 0.011 per year (DOE and Ecology 1996).

K.3.4.5.2 Hydrogen Deflagration in Waste Storage Tanks—Mitigated (TK52)

This accident scenario involves hydrogen generated in tank waste that rises into the tank headspace and reaches the concentration necessary for combustion. Ignition would occur in the tank headspace during a 1-hour period when the gas concentration would exceed the lower flammability limit. Turbulence accompanying rapid combustion would suspend waste as aerosols, and pressure would drive some of the particulates out of the ventilation system into the environment. The MAR would be in 500,000 liters (130,000 gallons) of waste tank constituents. The product of ARF × RF was estimated to be 6.5×10^{-6}. The LPF was estimated to be 0.75 due to mitigation of the aerosol by soil collapsing into the tank (Shire et al. 1995). The estimated impacts of this accident would be represented by other storage and retrieval accident impacts and have not been analyzed further.

K.3.4.5.3 Seismically Induced Waste Tank Dome Collapse—Unmitigated (TK53)

This accident scenario involves radioactive and chemical contaminants in the tank headspace that were conservatively assumed to be available for release. The collapse of a portion of the dome and overburden would compress the vapor in the headspace as they descend, enhancing the vapor release rate by a sudden pressure difference. Assumptions for each tank included a respirable concentration of contaminants in the headspace of 10 milligrams per cubic meter, a liquid specific gravity of 1.0, and a headspace volume of 935 cubic meters (1,223 cubic yards). The MAR, representative of all tanks, would be in 0.1 liters (0.026 gallons) of vapor and 410,000 liters (108,000 gallons) of salt cake, sludge, and liquid. The product of ARF × RF was estimated to be 1.0 for aerosols in the headspace and 0.00002 for solids and liquids. The LPF was estimated to be 1.0. Entrainment from the material splashed out of the tank would contribute an additional 4.6×10^{-6} liters per second to the source term (Shire et al. 1995). The reference for this scenario (Shire et al. 1995) cites an earthquake with a frequency of 0.00004 per year as the possible initiator. However, for risk calculation purposes, a conservative frequency of 0.0005 per year was assumed, consistent with the frequency used for earthquake scenarios involving severe damage to the WTP.

K.3.4.5.4 Rapid Exothermic Ferrocyanide-Nitrate Reaction (TK54)

A postulated accident of concern is the occurrence of a sustainable, rapid exothermic ferrocyanide-nitrate (or nitrite) reaction in the stored waste. Such a sustainable, rapid exothermic reaction could produce sufficient heat and evolve gases to pressurize the tank headspace, releasing aerosolized waste from the tank vents and potentially damaging the tank's structure.

Waste tank operations at Hanford during the 1950s used ferrocyanide in a number of waste tanks to scavenge cesium-137 from waste supernatant, which led to the formation of ferrocyanide-containing sludge that settled in layers in a number of waste tanks. As a result of these operations, approximately

140 metric tons of ferrocyanide (as $Fe(CN)^{+4}$) were added to 18 SSTs at Hanford. Ferrocyanide, in sufficiently high concentrations and mixed with oxidizing material such as sodium nitrate/nitrite, can react exothermically or even explode when heated to high temperatures.

The risk posed by the continued storage of ferrocyanide waste in Hanford underground storage tanks has been studied extensively. Waste sample data coupled with laboratory experiments show that the ferrocyanide has decomposed (aged) to inert chemicals through radiolysis and hydrolysis and that the waste cannot combust or explode (WHC 1996). As a result, all 18 ferrocyanide tanks are categorized as safe and this event has not been analyzed further.

K.3.4.6 Supplemental Treatment—Bulk Vitrification

K.3.4.6.1 Bulk Vitrification Waste Receipt Tank Failure—Unmitigated (BV61)

This accident scenario involves a seismically induced failure of a waste receipt tank used in the bulk vitrification waste treatment process in either the 200-East or 200-West Area. Contributing failure mechanisms might include corrosion, erosion, thermal cycling fatigue, faulty welds, or chemical/waste incompatibilities. The vessel's entire contents would spill from the vessel or piping to the floor of the cell where the tank is located. HEPA filters were assumed to be inoperative, resulting in an unfiltered release of radioactive material. The MAR would be in 129,000 liters (34,100 gallons) of waste (CH2M HILL 2003b). An initial ARF of 0.00005 would apply to the vessel's contents as they spill to the floor. A continuing airborne release of 4×10^{-7} of the spilled material per hour due to entrainment from the pool surface was assumed to contribute to worker exposure for a period of 8 hours and to public exposure for 24 hours. The RFs would be 0.8 for aerosols formed as the waste spills and 1.0 for aerosols entrained from the pool surface (DOE Handbook 3010-94). The LPF would be 1.0 for the unmitigated case (2.5×10^{-5} for the mitigated case) (Lindquist 2006a). The frequency of the accident was estimated to be in the range of 0.00005 to 0.0005 per year (Woolfolk 2007b). For risk calculation purposes, a conservative frequency of 0.0005 per year was assumed.

K.3.4.7 Supplemental Treatment—Cast Stone

K.3.4.7.1 Cast Stone Feed Receipt Tank Failure—Unmitigated (CS71)

This accident scenario involves a seismically induced failure of a feed receipt and storage tank used in the cast stone waste treatment process in either the 200-East or 200-West Area. Contributing failure mechanisms may include corrosion, erosion, thermal cycling fatigue, faulty welds, or chemical/waste incompatibilities. The vessel's entire contents would spill from the vessel or piping to the floor of the cell where the tank is located. HEPA filters were assumed to be inoperative, resulting in an unfiltered release of radioactive material. The MAR would be in 129,000 liters (34,100 gallons) of waste (CH2M HILL 2003b). An initial ARF of 0.00005 would apply to the vessel's contents as they spilled to the floor. A continuing airborne release of 4×10^{-7} of the spilled material per hour due to entrainment from the pool surface was assumed to contribute to worker exposure for a period of 8 hours and to public exposure for 24 hours. The RFs would be 0.8 for aerosols formed as the waste spills and 1.0 for aerosols entrained from the pool surface (DOE Handbook 3010-94). The LPF would be 1.0 for the unmitigated case (2.5×10^{-5} for the mitigated case) (Lindquist 2006a). The frequency of the accident was estimated to be in the range of 0.00005 to 0.0005 per year (Woolfolk 2007b). For risk calculation purposes, a conservative frequency of 0.0005 per year was assumed.

K.3.4.8 Supplemental Treatment—Steam Reforming

K.3.4.8.1 Steam Reforming Feed Receipt Tank Failure—Unmitigated (SRF1)

This accident scenario involves a seismically induced failure of a feed receipt tank used in the steam reforming waste treatment process in either the 200-East or 200-West Area. Contributing failure mechanisms may include corrosion, erosion, thermal cycling fatigue, faulty welds, or chemical/waste incompatibilities. The vessel's entire contents would spill from the vessel or piping to the floor of the cell where the tank is located. HEPA filters were assumed to be inoperative, resulting in an unfiltered release of radioactive material. The MAR would be in 129,000 liters (34,100 gallons) of waste (CH2M HILL 2003b). An initial ARF of 0.00005 would apply to the vessel's contents as they spill to the floor. A continuing airborne release of 4×10^{-7} of the spilled material per hour due to entrainment from the pool surface was assumed to contribute to worker exposure for a period of 8 hours and to public exposure for 24 hours. The RFs would be 0.8 for aerosols formed as the waste spills and 1.0 for aerosols entrained from the pool surface (DOE Handbook 3010-94). The LPF would be 1.0 for the unmitigated case (2.5×10^{-5} for the mitigated case) (Lindquist 2006a). The frequency of the accident was estimated to be in the range of 0.00005 to 0.0005 per year (Woolfolk 2007b). For risk calculation purposes, a conservative frequency of 0.0005 per year was assumed.

K.3.4.9 Supplemental Treatment—Remote-Handled TRU Waste

K.3.4.9.1 Mixed TRU Waste/Mixed Low-Level Radioactive Waste Liquid Sludge Transfer Line Spray Leak—Unmitigated (TR81)

This accident scenario involves a seismically induced break and spray leak in the TRU waste treatment system in the 200-East or 200-West Area. A spray leak could occur when waste slurry is transferred from the retrieval system to the feed receipt tanks. A small hole or orifice could develop in the transfer line, resulting in a spray leak. The MAR was based on a leak rate of 0.22 liters (0.06 gallons) per second for the duration of the assumed exposure (8 hours for the noninvolved worker, 24 hours for the MEI and population). The ARF was estimated to be 0.0001. The RF and LPF were estimated to be 1.0 (Woolfolk 2007a). The frequency of the accident was estimated to be in the range of 0.00005 to 0.0005 per year (Woolfolk 2007b). For risk calculation purposes, a conservative frequency of 0.0005 per year was assumed.

K.3.4.10 Waste Product Storage and Handling

K.3.4.10.1 IHLW Glass Canister Drop (SH91)

An IHLW glass canister drop was postulated at the 200-East Area IHLW Interim Storage Facilities. The height of the drop was assumed to be 16.8 meters (55 feet). The MAR would be in 1,220 liters (322 gallons) of glass IHLW. The DR was conservatively assumed to be 1. The product of the ARF and RF was estimated to be 0.0000943. The LPF was estimated to be 0.1. The resulting source term for material released to the environment was based on 0.0115 liters (0.003 gallons) of respirable glass particles. The frequency of the initiating event was estimated to be in the range of 0.1 to 0.01 per year (Woolfolk 2007a). With credit given for controls that would lower the frequency of the initiating event and reduce the actual aerosol release, a frequency of 0.001 per year was assumed for risk calculation purposes. The impacts of this accident represent the upper end of the range of waste product storage and handling accidents.

K.3.4.10.2 ILAW Glass Canister Drop (SH92)

An ILAW glass canister drop was postulated at the 200-East Area ILAW Interim Storage Facilities. The height of the drop was assumed to be 9.5 meters (31 feet). The MAR would be in 6,000 kilograms (13,228 pounds) of waste. The DR was estimated to be 0.5, meaning that only 50 percent of the canister's contents would be damaged by the impact. The product of the ARF and RF was estimated to be 0.000048 (BNI 2002). The LPF was estimated to be 1.0. The resulting source term for material released to the environment was based on 0.145 kilograms (0.32 pounds) of waste. The frequency of the accident was assumed to be the same as that of the IHLW canister drop (SH91), 0.001 per year. The estimated impacts of this accident would be less than those of the IHLW glass canister drop (SH91) and were not analyzed further.

K.3.4.10.3 Bulk Vitrification Glass Canister Drop (SH93)

A bulk vitrification glass canister drop was postulated at the 200-East Area storage facility. The height of the drop was assumed to be 2 meters (6.6 feet). The MAR would be in 27,600 kilograms (60,900 pounds) of waste (CH2M HILL 2003b). The DR was estimated to be 0.5, meaning that only 50 percent of the container's contents would be damaged by the impact. The product of the ARF and RF from the impaction stress was estimated to be 9.8×10^{-6} (DOE Handbook 3010-94). The LPF was estimated to be 1.0. The resulting source term for material released to the environment was 0.135 kilograms (0.298 pounds) of waste. The frequency of the accident was assumed to be the same as that of the IHLW canister drop (SH91), 0.001 per year. The estimated impacts of this accident would be less than those of the IHLW glass canister drop (SH91) and were not analyzed further.

K.3.4.10.4 Cast Stone Storage Canister Drop (SH94)

A cast stone storage canister drop was postulated at the 200-East Area storage facility. The height of the drop was assumed to be 2 meters (6.6 feet). The MAR would be in 25,000 kilograms (55,100 pounds) of waste (CH2M HILL 2003c). The DR was estimated to be 0.5, meaning that only 50 percent of the container's contents would be damaged by the impact. The product of the ARF and RF from the impaction stress was estimated to be 9.8×10^{-6} (DOE Handbook 3010-94). The LPF was estimated to be 1.0. The resulting source term for material released to the environment was 0.123 kilograms (0.27 pounds) of waste. The frequency of the accident was assumed to be the same as that of the IHLW canister drop (SH91), 0.001 per year. The estimated impacts of this accident would be less than those of the IHLW glass canister drop (SH91) and were not analyzed further.

K.3.5 Fast Flux Test Facility Accident Scenarios

This section describes the accident scenarios applicable to the FFTF Decommissioning alternatives. Four of the scenarios involve fires that consume radioactively contaminated sodium metal formerly used as FFTF coolant or reactor coolant system components containing radioactive materials. Two other fire scenarios involve sodium that was formerly used in other reactors, is now stored at Hanford, and would be converted to sodium hydroxide along with the FFTF sodium for use on site under FFTF Decommissioning Alternatives 2 and 3. The scenarios are attributed to a variety of initiating events, including aircraft crash, material defect, human error, and high winds. Each one might also be initiated by a seismic event of sufficient magnitude to cause severe damage to structures in which the sodium is stored. Applicability of scenarios to the FFTF Decommissioning alternatives is shown in Table K–68. All of the accident impacts were based on unmitigated releases, meaning that no credit is taken for HEPA filtration, structural confinement, or other engineered features that may limit the amount of radioactive material released to the environment. The alphanumeric code following the accident's title (e.g., SSF1) corresponds with the accident's description in the tables of this section and in Chapter 4, Section 4.2.11; it is provided to facilitate cross-referencing between tables and accident descriptions.

Table K–68. FFTF Decommissioning Alternatives – Applicability of Radiological Accident Scenario

Accident Scenario[a]	Alternative 1	Alternatives 2 and 3			
		Disposition of RH-SCs		Disposition of Bulk Sodium	
		Hanford Option	Idaho Option	Hanford Reuse Option	Idaho Reuse Option
Sodium Storage Facility fire (SSF1)	Y	Y	Y	Y	Y
Hanford sodium storage tank failure (HSTF1)	Y	Y	Y	Y	Y
Remote-handled special component fire (RHSC1)	–	Y	Y	Y	Y
Hallam Reactor sodium fire (HSF1)	Y	Y	Y	Y	Y
Sodium Reactor Experiment sodium fire (SRE1)	Y	Y	Y	Y	Y
INL Sodium Processing Facility storage tank failure (INLSPF1)	–	–	–	–	Y

[a] The alphanumeric code following the accident's title (e.g., SSF1) corresponds with the code in the accident's description in Section K.3.5.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; INL=Idaho National Laboratory; RH-SCs=remote-handled special components; Y=yes.

K.3.5.1 Accidents in the Hanford 400 Area

K.3.5.1.1 Sodium Storage Facility Fire (SSF1)

This accident scenario involves a postulated aircraft crash into the FFTF Sodium Storage Facility (SSF) that breaches all four sodium storage tanks and ignites the sodium metal within them. Although the SSF tanks would contain contaminated primary coolant mixed with relatively clean secondary coolant, it was conservatively assumed that the radionuclide inventory levels for the primary sodium represent the mix. The MAR would be the entire 984,000-liter (260,000-gallon) inventory of sodium stored in the SSF (ANL-W and Fluor Hanford 2002). The surface of each tank was assumed to burn at the standard rate for an open pool of sodium on a steel liner, 10.8 grams per square meter per second (8 pounds per square foot per hour) (Himes 1996). The combined surface area for all four tanks is approximately 224 square meters (2,410 square feet) (WHC 1994). These factors would result in a burn rate of approximately 8,730 kilograms (19,200 pounds) per hour. Therefore, it would take approximately 105 hours for the entire contents of the tanks to burn. No credit was taken for any mitigation of the release by the building features; the LPF is therefore considered to be 1. Although Hanford safety analyses indicated that the probability of an accidental aircraft crash into a specific hazardous facility is less than 1×10^{-6} per year, the frequency of this scenario was conservatively assumed to be 1×10^{-6} per year (Oberg 2003).

K.3.5.1.2 Hanford Sodium Storage Tank Failure (HSTF1)

This accident was postulated to result from a large leak due to growth of a metal defect in one SSF storage tank. The contents of the tank would spill onto the steel floor of the secondary containment (an area of approximately 581 square meters [6,250 square feet]) and burn, releasing a sodium hydroxide aerosol plume (WHC 1994). Exposure to the burning pool of sodium was assumed to breach the other three tanks, causing the entire SSF inventory of 984,000 liters (260,000 gallons) of sodium to spill onto the floor and burn (ANL-W and Fluor Hanford 2002). Using the standard burn rate for an open pool of sodium on a steel liner, 10.8 grams per square meter per second (8 pounds per square foot per hour), the burn rate was estimated to be 22,600 kilograms (49,800 pounds) per hour, and the fire duration was estimated to be approximately 41 hours (Himes 1996). The estimated frequency of this scenario, based on the frequency of tank leaks, is 0.00001 per year (Bowman 1994).

K.3.5.1.3 Remote-Handled Special Component Fire (RHSC1)

This scenario represents the upper range of impacts from possible accidents involving removal and transport of the FFTF RH-SCs. A handling mishap was postulated to cause a breach of the largest, most radioactive component (the primary cold trap), resulting in exposure of the contained radioactive sodium to water and air. A portion (30 percent) of the sodium was assumed to burn, releasing the radionuclides in that amount of sodium as well as an equal percentage of the total cesium-137 and cobalt-60 inventory estimated to be in the cold trap. Ground-level release to the atmosphere was assumed. The sodium was assumed to have the radiological characteristics of FFTF primary sodium (ANL-W and Fluor Hanford 2002). The amount of sodium burned would equal 750 kilograms (1,650 pounds). Additionally, 30 percent of the 470 curies of cesium-137 and 70 curies of cobalt-60 retained within the cold trap medium would be released (141 and 21 curies, respectively) (CEES 2006). For purposes of this analysis, this scenario was assumed to be initiated by human error and assigned a frequency of 0.01 per year (Fluor Hanford 2004a). This accident could also occur at the INL INTEC under the Idaho Option for disposition of RH-SCs.

K.3.5.2 Accidents in the Hanford 200-West Area

K.3.5.2.1 Hallam Reactor Sodium Fire (HSF1)

Sodium formerly used as coolant in the Hallam Reactor is stored as a solid in five tanks in the 2727-W Building in the Hanford 200-West Area. Two tanks are full, one is half-full, and the remaining two contain only residual heels. In this scenario, the building would be damaged by high winds, causing a roof support beam to puncture a tank, releasing the cover gas. Rainwater would run down the beam and enter the tank, starting a fire from the exothermic reaction between sodium and water. The entire contents of the tank, 59,600 kilograms (131,000 pounds) of sodium, would burn and be released at ground level over a period of 69 hours. The frequency of this accident was estimated to be 0.00002 per year (Himes 1996).

K.3.5.2.2 Sodium Reactor Experiment Sodium Fire (SRE1)

Sodium formerly used as coolant in the Sodium Reactor Experiment (SRE) is stored as a solid in drums in the South Alkali Metal Storage Modules near the 200-West Area Solid Waste Operations Complex (SWOC). In this scenario, a vehicle impacts a single storage module and comes to rest inside of it. The module contains 20 drums, each of which holds 168 kilograms (370 pounds) of sodium (Fluor Hanford 2004b). The fuel from the vehicle was assumed to drain into the module reservoir and ignite, burning the total amount of sodium in the 20 drums (3,360 kilograms [7,410 pounds]) in approximately 15 hours. For purposes of this analysis, this scenario was assumed to be initiated by human error and was assigned a frequency of 0.01 per year (Fluor Hanford 2004a).

K.3.5.3 Accidents at Idaho National Laboratory

K.3.5.3.1 INL Sodium Processing Facility Storage Tank Failure (INLSPF1)

The accident associated with disposition of bulk sodium at the INL SPF with the largest expected impacts would be a failure of the secondary sodium drain tank located in the EBR-II secondary sodium boiler building, a part of the MFC, with an accompanying fire. The structure and associated features were assumed to provide no mitigation of the release. Although this storage tank would contain a mixture of bulk sodium, it was conservatively assumed that the radionuclide inventory levels for the FFTF primary sodium represent the mixture. Failure of the tank would result in a spill of its working capacity of 56,800 liters (15,000 gallons) of molten sodium (ANL-W and Fluor Hanford 2002). The burn rate was estimated to be 2,260 kilograms (4,980 pounds) per hour and the duration was estimated to be 23 hours.

The estimated frequency of this accident, based on the frequency of tank leaks, is 0.00001 per year (Bowman 1994).

K.3.6 Waste Management Accident Scenarios

The documented safety analysis for solid waste operations (DSASW) (Fluor Hanford 2007) identifies and analyzes a range of potential accidents at the Hanford low-level radioactive waste burial grounds (LLBGs), the CWC, the T Plant complex, and WRAP. These four facilities compose SWOC, which performs the solid waste management function for Hanford. The accidents analyzed in the DSASW represent a range of severity (consequences) and frequency and provide the basis for SWOC operating controls and limits. The solid-waste management operations covered by the DSASW would continue under each of the three Waste Management alternatives examined in this *TC & WM EIS*. Under Waste Management Alternatives 2 and 3, new facilities or expansions of existing facilities would be required and there would be limited shipments of low-level radioactive waste (LLW) and mixed low-level radioactive waste (MLLW) to Hanford from other DOE sites. Accordingly, each of the scenarios analyzed in the current DSASW or some updated and refined version of it would be applicable to each of the Waste Management alternatives. The frequency of, and human health risk from, a particular type of accident may vary somewhat as a function of the volume of waste that is managed and/or the duration (years) of each specific waste management component under each Waste Management alternative. Under Waste Management Alternative 1: No Action, 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. Scenarios for accidents involving ILAW were taken from *Project 520, Immobilized Low-Activity Waste Disposal Facility, Preliminary Documented Safety Analysis* (Burbank 2002). Applicability of the accident scenarios to the Waste Management alternatives is shown in Table K–69.

Table K–69. Waste Management Alternatives – Applicability of Radiological Accident Scenarios

Accident Scenario[a]	Alternative		
	1	2	3
Single-drum deflagration (SWOC FIR-1)	Y	Y	Y
Medium fire inside facility (SWOC FIR-6)	Y	Y	Y
Glovebox or greenhouse fire (SWOC FIR-8)	Y	Y	Y
Large fire of waste containers outside facility (SWOC FIR-4)	Y	Y	Y
Handling spill of single waste container (SWOC SP-2)	Y	Y	Y
Large handling spill of boxes or multiple waste containers (SWOC SP-3A)	Y	Y	Y
Spill of single large-diameter container (SWOC SP-4)	Y	Y	Y
Design-basis seismic event (SWOC NPH-1)	Y	Y	Y
Beyond-design-basis accident (SWOC NPH-2)	Y	Y	Y
Range fire (SWOC EE-1)	Y	Y	Y
Aircraft crash (SWOC EE-2)	Y	Y	Y
Earthmover shears tops off six ILAW containers (ILAW1)	–	Y	Y
Crushing of ILAW containers by falling crane boom (ILAW2)	–	Y	Y

[a] The alphanumeric code following the accident's title (e.g., SWOC FIR-1) corresponds with the code in the accident's description in Section K.3.6.

Key: ILAW=immobilized low-activity waste; Y=yes.

Source: Burbank 2002; Fluor Hanford 2007.

K.3.6.1 Solid Waste Operations Complex Accidents

Appendix D identifies total inventories of waste. However, only a portion of those totals would be subject to the accidents hypothesized in the scenarios at any given time. Waste would be received and managed in accordance with waste acceptance criteria and operational controls established on the basis of the DSASW results. Therefore, the quantities of radioactive material in individual waste packages and the total amounts in specific locations would be controlled such that accident source terms for reasonably foreseeable scenarios would be no greater than those assumed in the DSASW and used in these EIS calculations.

The DSASW describes and analyzes a range of severities for several accident types. Because the potential for all of the scenarios would be present regardless of the Waste Management alternative selected, a detailed examination of each scenario does little to discriminate between the alternatives or inform the decisionmaking process. Accordingly, only selected representative DSASW scenarios with relatively higher human health impacts are described here for several event types (e.g., fires, spills, natural phenomena). The other DSASW scenarios of each type are summarized with respect to their salient features, frequencies, and consequences. Consistent with the DSASW accident descriptions, the SWOC accident source terms are specified as plutonium-239 dose-equivalent curies (Pu-239 DE-curies), the amount of plutonium-239 (in curies) that would deliver the same radiation dose to an exposed individual or population as the mixture of radionuclides that would actually be released if an accident occurred.

Plutonium-239 Dose-Equivalent Curies

- Dose equivalence is a method of expressing amounts of radionuclide mixtures in terms of the amount of a single radionuclide that, if inhaled, would produce the same dose to an individual as the mixture.
- Transuranic (TRU) waste managed at the Hanford Site Solid Waste Operations Complex (SWOC) are contaminated with mixtures of several different radionuclides, including plutonium-238, -239, -240, and -241; americium-241; and others.
- SWOC safety documents use a value of 0.165 plutonium-239 dose-equivalent curies per gram of TRU isotopes to calculate doses to workers and the public from accidents involving TRU waste.

K.3.6.1.1 Fires and Deflagrations

K.3.6.1.1.1 Single-Drum Deflagration (SWOC FIR-1)

The single-container (i.e., drum) deflagration event would result from the ignition of accumulated flammable gases (e.g., hydrogen) or a chemical reaction between incompatible materials. This scenario could occur in any SWOC facility, indoors or outdoors, and during many activities. It was postulated to occur at the LLBGs because that location has the greatest number of containers susceptible to the scenario. Ignition of the flammable gases was postulated to result in lid loss and ejection of a fraction of the container's contents, followed by partial or total combustion of both the ejected portion of the waste and the waste remaining in the container. However, the resulting fire was not postulated to propagate to other waste containers. The highest inventory selected for a hypothetical single standard drum at SWOC was selected as 82.5 Pu-239 DE-curies of TRU waste material, of which 5 percent (4.13 Pu-239 DE-curies) was assumed to be ejected by the deflagration. ARF and RF values of 0.001 and 1.0, respectively, apply to the material that is ejected, yielding a source term contribution of 0.0041 Pu-239 DE-curies. Both the ejected material and the material remaining in the container (78.4 Pu-239 DE-curies) would be subject to burning, resulting in additional release of radioactive material (Fluor Hanford 2007).

A DR of 0.18 was assumed for the ejected material because it was calculated that the radiant energy from the deflagration would only be sufficient to ignite 18 percent of the material. The ARFs for ejected plastics (31 percent of ejected material) and nonplastic combustibles (34 percent of ejected material) were

assumed to be 0.05 and 0.01, respectively. The RFs and LPFs were assumed to be 1.0 (Fluor Hanford 2007). The contribution to the source term from this material is 0.0145 Pu-239 DE-curies.

For the waste that remains in the container, the DR and LPF were assumed to be 1.0. The combustible portion (65 percent) was treated as packaged waste (ARF of 0.0005, RF of 1.0). The noncombustible portion (35 percent) was assumed to have an ARF of 0.006 and an RF of 0.01. The contribution to the source term from this material is 0.0267 Pu-239 DE-curies (Fluor Hanford 2007).

The cumulative source term would be 0.045 Pu-239 DE-curies. Without credit for any controls, the frequency of this accident was estimated to be greater than 0.001 per year (Fluor Hanford 2007). For purposes of this analysis, the frequency was assumed to be 0.01 per year.

K.3.6.1.1.2 Medium Fire Inside Facility (SWOC FIR-6)

A medium fire is one in which several containers are subject to a fire. The postulated scenario involves failure of the WRAP Automated Stacker/Retrieval System (AS/RS), which would cause a pallet of four drums to fall, breaching the drums and spilling some of their contents. The falling pallet would also sever the AS/RS hydraulic lines, releasing up to 53 liters (14 gallons) of hydraulic fluid. The hydraulic fluid would ignite due to heating from nearby equipment or an electrical short circuit, engulfing the breached drums. An additional 48 drums in the storage rack would be heated by the fire and lose their lids, ejecting part of their contents. Both the ejected contents and the contents remaining in the drum would burn in the fire. The fire would not propagate through the facility.

The MAR for the scenario would be the sum of the 4 drums dropped and the 48 drums enveloped by the burning puddle of hydraulic fluid. The resulting source term would be 0.83 Pu-239 DE-curies. Without credit for any controls, the frequency of this accident was estimated to be greater than 0.01 per year (Fluor Hanford 2007). For purposes of this analysis, the frequency of this accident was estimated to be 0.01 per year.

K.3.6.1.1.3 Glovebox or Greenhouse Fire (SWOC FIR-8)

This scenario was postulated to occur in a WRAP glovebox line (either the TRU waste or TRU waste/LLW line) where a maximum of eight drums would be present. Only two of the drums were considered to represent uncontained waste. The other drums in the TRU waste glovebox would be considered packaged waste and would be represented by a closed, intact container on the transfer car. A variety of initiating events could cause the fire, such as the presence of flammable or combustible materials and ignition sources within the waste being repackaged or electrical or static ignition sources. This postulated fire was assumed to engulf all open waste being processed in the glovebox line. Staged drums outside the glovebox line would not become involved in the fire. The MAR would be the radionuclide inventory of eight containers involved in the accident: four containers at 33 Pu-239 DE-curies each, two containers at 12.4 Pu-239 DE-curies each, and two containers at 2.3 Pu-239 DE-curies each. The MAR used to calculate the source term from the glovebox would be combined with the 2.3 Pu-239 DE-curies of MAR from the HEPA filter for a total of 164 Pu-239 DE-curies. The cumulative source term value would be 1.6 Pu-239 DE-curies derived from the burning of the waste material. The glovebox fire accident is one of a group of accidents hypothesized for SWOC. The impacts of such a fire would be larger than those of others such as a greenhouse fire. Without credit for any controls, the frequency of this accident was estimated to be greater than 0.01 per year (Fluor Hanford 2007). For purposes of this analysis, the frequency was assumed to be 0.01 per year.

K.3.6.1.1.4 Large Fire of Waste Containers Outside Facility (SWOC FIR-4)

This scenario postulates that a transport vehicle crashes into an outside stored waste array, causing spills and vehicle damage that create a flammable fuel pool that ignites and burns the stored waste and the transported waste containers. This scenario is based on a fire at the T Plant, but it could occur at any SWOC facility. Waste containers are stored or staged outside in stacks when they need to be transferred to other facilities or when they are received from offsite generators during waste management operations. These waste container pick-up and drop-off activities are typically performed using tractor-trailers that carry up to 80 containers and travel close to the stored or staged waste. Operator error or mechanical failure of the vehicle could cause loss of control, causing the vehicle to travel at high speed into the stored or staged waste array. The high-energy impact was postulated to overturn or otherwise impact the trailer so that the drums on it are thrown violently from the vehicle, impacted, and breached. The 80 containers were assumed to land in a burning fuel pool, and 100 percent of the drum contents were conservatively assumed to burn as unconfined waste. The collision would also impact a stored waste array of 384 drums, breaching 12 containers by direct impact and spilling 100 percent of their contents, which would also burn unconfined. The other 372 drums would experience varying degrees of damage and lid loss, and different portions of their contents would burn as contained or uncontained waste. The total MAR involved in the fire would be 2,310 Pu-239 DE-curies, of which 14 Pu-239 DE-curies would be ultimately released to the atmosphere. The frequency of the initiating event (truck impact) was estimated to be greater than 0.01 per year, but a truck impact resulting in a large fire was estimated to have a frequency of less than 0.01 per year (Fluor Hanford 2007). For purposes of this analysis, the frequency was assumed to be 0.01 per year.

K.3.6.1.1.5 Other Solid Waste Operations Complex Fire/Deflagration Scenarios

The DSASW describes and analyzes an additional seven fire scenarios. Table K–70 shows how the source terms (and therefore, the consequences) of those scenarios compare with the four scenarios detailed above (shown in bold font). The scenarios are arranged by source term, in ascending order.

Table K–70. Fire and Deflagration Scenarios Analyzed in the DSASW

Source Term (Pu-239 DE-curies)	Description	DSASW Designator	Frequency
0.0052	Fire of large-diameter container in T Plant	FIR-10	U
0.0045	**Single-drum deflagration**	**FIR-1**	**A**
0.063	Vapor cloud explosions and boiling liquid expanding vapor explosions	FIR-9	EU
0.83	**Medium fire inside facility**	**FIR-6**	**A**
1.6	Small fire inside facility	FIR-5	A
1.6	Small fire of waste containers outside facility	FIR-2	A
2.0	Medium fire of waste containers outside facility	FIR-3	A
1.6	**Glovebox or greenhouse fire**	**FIR-8**	**A**
7.0	Large fire inside facility	FIR-7	U
7.4	Large fire inside facility with aisle spacing	FIR-7A	U
14	**Large fire of waste containers outside facility**	**FIR-4**	**U**

Note: Entries evaluated in this environmental impact statement are in **bold** text.

Key: A=anticipated (frequency $>10^{-2}$ per year); DSASW=documented safety analysis for solid waste operations; EU=extremely unlikely (10^{-4} per year > frequency > 10^{-6} per year); Pu-239 DE-curies=plutonium-239 dose-equivalent curies; U=unlikely (10^{-2} per year > frequency $>10^{-4}$ per year).

K.3.6.1.2 Spills and Sprays

K.3.6.1.2.1 Handling Spill of Single Waste Container (SWOC SP-2)

Waste containers can be impacted physically or lose confinement from various causes during storage and handling. Material-handling equipment (e.g., forklifts) or other vehicles can inadvertently impact waste containers—puncturing, crushing, or toppling them. Raised or suspended loads can drop onto waste containers as a result of lifting equipment failure or improper rigging. This scenario postulates that waste handling operations cause a single-container spill during retrieval of TRU waste drums from buried stacks of TRU waste. The MAR for this scenario would be 82.5 Pu-239 DE-curies of TRU waste. The DR would be 1.0 for mechanical release from the drop of a corroded drum. The ARF and RF values for external impact on packaged waste in drums would be 0.001 and 0.1, respectively. The resultant source term for the single-container spill would be 0.0083 Pu-239 DE-curies. The frequency of this accident was estimated to be 0.01 per year (Fluor Hanford 2007).

K.3.6.1.2.2 Large Handling Spill of Boxes or Multiple Waste Containers (SWOC SP-3A)

This multiple-container spill was postulated to occur as the result of a large, heavy waste box dropping onto TRU waste containers stored or staged in arrays. The large waste box was assumed to be concrete and large enough to impact several stacked waste containers. Based on the dimensions of the waste box, 48 drums would be directly impacted and two layers of drums directly beneath the impacted drums (48 drums each) would also be damaged, for a total of 144 drums plus the waste box. The MAR would be 82.5 Pu-239 DE-curies for the waste box and 818 Pu-239 DE-curies for the 144 impacted containers. The resultant source term would be 0.041 Pu-239 DE-curies. Without credit for any controls, the frequency of this accident was estimated to be greater than 0.01 per year (Fluor Hanford 2007). For purposes of this analysis, the frequency was assumed to be 0.01 per year.

K.3.6.1.2.3 Spill of Single Large-Diameter Container (SWOC SP-4)

A large-diameter container (LDC) spill was postulated to occur in the 221-T Canyon Building because it is the only location where an LDC is removed from its shipping cask or lifted over other LDCs or blanket fuel assemblies in a storage cell. The drop scenario assumes that the LDC contains dry, high-activity sludge. Based on the largest expected inventory for this sludge mix, the total content (MAR) would be 1,610 Pu-239 DE-curies in 3,800 kilograms (8,380 pounds) of sludge. Applying a conservative ARF and RF of 0.0025, the source term for this scenario would be 0.4 Pu-239 DE-curies. No credit was taken for confinement provided by the T Plant structure or systems. Without credit for any controls, the frequency of this accident was estimated to be greater than 0.01 per year (Fluor Hanford 2007). For purposes of this analysis, the frequency was assumed to be 0.01 per year.

K.3.6.1.2.4 Other Solid Waste Operations Complex Spill/Spray Scenarios

The DSASW describes and analyzes an additional five spill/spray scenarios. Table K–71 shows how the source terms (and therefore, the consequences) of these scenarios compare with the scenarios detailed above (shown in bold font). The scenarios are arranged by source term, in ascending order.

Table K–71. Spill and Spray Scenarios Analyzed in the DSASW

Source Term (Pu-239 DE-curies)	Description	DSASW Designator	Frequency
0.0021	Spray release event	SP-7	A
0.0083	**Handling spill of single waste container**	**SP-2**	**A**
0.012	Waste container spill due to vehicle collision	SP-1	A
0.014	Handling spill of multiple waste containers	SP-3	A
0.017	Glovebox spill due to loss of confinement	SP-6	A
0.024	Spill of multiple large-diameter containers	SP-5	A
0.041	**Large handling spill of boxes or multiple waste containers**	**SP-3A**	**A**
0.4	**Spill of single large-diameter container**	**SP-4**	**A**

Note: Entries evaluated in this environmental impact statement are in **bold** text.
Key: A=anticipated (frequency $>10^{-2}$ per year); DSASW=documented safety analysis for solid waste operations; Pu-239 DE-curies=plutonium-239 dose-equivalent curies.
Source: Fluor Hanford 2007.

K.3.6.1.3 Natural Phenomena

K.3.6.1.3.1 Design-Basis Seismic Event (SWOC NPH-1)

A design-basis seismic event was postulated to impact the four SWOC facilities and result in the release of radioactive materials. All exposed waste containers stored outside would topple. Unstacked waste containers and the bottom tiers of stacked waste containers would not fail because they were assumed to be robust and able to survive a fall of less than 1.2 meters (4 feet). It was conservatively assumed that all stacked waste containers above the first tier would topple and spill. Most waste containers stored inside structures qualified to seismic Performance Category (PC-2) parameters (DOE Standard 1021-93) would topple. Waste containers would topple and spill, except for fuel assemblies stored in the pool cell of the 221-T Canyon Building, sludge stored in LDCs in storage arrays in cells in the 221-T Canyon Building, unstacked containers, and the bottom tiers of stacked containers. The event would cause structures not qualified to PC-2 parameters to fail and buildings to collapse, causing waste containers stored inside to spill. Waste containers stored inside would be impacted and breached by falling objects (e.g., lights, fire suppression sprinkler lines) and other overhead equipment not seismically rated in structures that are qualified to PC-2 parameters. The total source term would be the sum of 0.027 Pu-239 DE-curies (LLBGs), 0.35 Pu-239 DE-curies (CWC), 0.005 Pu-239 DE-curies (T Plant), and 0.0038 Pu-239 DE-curies (WRAP), for a total of 0.39 Pu-239 DE-curies. Impacts from this event are larger than those for all other design-basis natural phenomena impacts (lightning, high wind/tornado, flood, volcano, snow loading). The frequency of this accident was estimated to be 0.001 per year (Fluor Hanford 2007).

K.3.6.1.3.2 Beyond-Design-Basis Accident (SWOC NPH-2)

A beyond-design-basis earthquake was postulated to impact the four SWOC facilities and result in the release of radioactive materials. All exposed waste containers stored outside would topple. Unstacked waste containers and the bottom tiers of stacked waste containers would not spill because they were assumed to be robust and able to survive a fall of less than 1.2 meters (4 feet). It was conservatively assumed that all stacked waste containers above the first tier would topple and spill. All structures would collapse, impacting waste containers stored inside and causing them to spill. Waste containers stored inside would be impacted and breached by falling objects (e.g., lights, fire suppression sprinkler lines, structural members) and other overhead equipment. The total source term would be the sum of

0.027 Pu-239 DE-curies (LLBGs), 0.35 Pu-239 DE-curies (CWC), 0.50 Pu-239 DE-curies (T Plant), and 0.57 Pu-239 DE-curies (WRAP), for a total of 1.5 Pu-239 DE-curies. Because this earthquake would be stronger than the design-basis seismic event, the frequency would be lower (less than 0.001). However, a quantitative estimate of the frequency of this event was not made. Therefore, the frequency was conservatively assumed to be 0.001 for purposes of this analysis (Fluor Hanford 2007).

K.3.6.1.4 External Events

K.3.6.1.4.1 Range Fire (SWOC EE-1)

The postulated range fire would encroach on SWOC facility structures, vehicles, and stacked waste, burning waste containers and releasing radioactive materials. Range fires can impact all SWOC facilities. The CWC was selected to represent the most conservative analysis of impacts of a range fire event because it is the westernmost facility, closest to a large amount of natural vegetation. It also has the largest inventory (17,500 waste containers located in the 2403-WD Waste Storage Building). The 2403-WD Waste Storage Building also was considered more vulnerable than buildings constructed of less-combustible materials (i.e., the 221-T Canyon Building, WRAP structure). Because of the lack of combustibles inside the building, not all containers would be affected. The fire was postulated to affect 1,019 drums. The resultant source term would be 7.0 Pu-239 DE-curies. Without credit for any controls, the frequency of this accident was estimated to be greater than 0.01 per year (Fluor Hanford 2007). For the purposes of this analysis, the frequency was assumed to be 0.01 per year.

K.3.6.1.4.2 Aircraft Crash (SWOC EE-2)

An aircraft crash into SWOC facilities was postulated to forcefully impact the CWC 2403-WD Waste Storage Building, penetrate the building, and impact waste containers stacked three tiers high. The impact would breach containers and puncture the aircraft fuel tank, causing a pool fire. The exposed MAR would burn, and the pool fire would cause additional damage and release of MAR through lid loss and partial ejection of contents, lid loss and contained burning, and lid seal failure with pyrolysis (chemical change brought about by the action of heat). The SWOC facilities considered for selection as the crash location with the largest impact were the structures at the LLBGs, CWC, WRAP, and T Plant that contain a relatively high amount of MAR. The CWC 2403-WD Waste Storage Building was selected as the accident location because (1) it contains the largest vulnerable "footprint"; (2) it is expected to provide little protection to the MAR; and (3) with 17,500 stacked waste containers, it contains the greatest amount of vulnerable MAR of all SWOC facilities. The aircraft crash impacts would be larger than those for accident scenarios involving other SWOC structures and areas. The total source term is 16 Pu-239 DE-curies. The frequency of this accident was estimated to be 0.00003 per year (Fluor Hanford 2007).

K.3.6.1.5 Criticality

The DSASW analyzes two criticality events: a liquid criticality at the T Plant (CR-1) and a solid-waste criticality (CR-2). The DSASW shows that radiation doses to workers in the immediate vicinity might be in the range where severe radiation injury or death could result (337 rem from CR-1 and 467 rem from CR-2 to a worker 100 meters [110 yards] from the accident). The dose to the maximum offsite individual would be 0.12 rem from CR-1 and 0.2 rem from CR-2. Both criticalities were determined to be "beyond extremely unlikely" (because the frequency is less than one in a million per year, they are not considered "reasonably foreseeable" events for the purposes of this *TC & WM EIS*) (Fluor Hanford 2007).

K.3.6.2 ILAW Disposal Accidents

K.3.6.2.1 Earthmover Shears Tops Off Six ILAW Containers (ILAW1)

An earthmover was assumed to be pushing fill dirt over the tops of rows of ILAW containers when the blade shears the tops off of six containers. The blade force exerted by the earthmover was assumed to be entirely expended in shattering and grinding vitrified waste, producing a total release of 94 cubic centimeters (5.7 cubic inches) of ILAW glass particles in the respirable size range. More than 99 percent of the potential dose from the aerosol would be due to releases of strontium-90 (0.00666 curies), plutonium-238 (3.52×10^{-7} curies), plutonium-239 (0.0000115 curies), plutonium-240 (1.96×10^{-6} curies), and americium-241 (0.000122 curies). The estimated frequency of this accident is between 0.01 and 1 per year (Burbank 2002). For purposes of this analysis, it was assigned a frequency value of 0.1.

K.3.6.2.2 Crushing of ILAW Containers by Falling Crane Boom (ILAW2)

A crane is used to lift ILAW containers from the transporter and place them in the burial trench. It was assumed that the crane boom falls into the trench and strikes part of the exposed container array. The impact energy of the falling boom was assumed to be entirely expended in shattering and grinding the vitrified waste, producing a total release of 846 cubic centimeters (52 cubic inches) of ILAW glass particles in the respirable size range. More than 99 percent of the potential dose from the aerosol would be due to releases of strontium-90 (0.0599 curies), plutonium-238 (3.17×10^{-6} curies), plutonium-239 (0.000104 curies), plutonium-240 (0.0000176 curies), and americium-241 (0.0011 curies). The estimated frequency of this accident is between 0.01 and 1 per year (Burbank 2002). For purposes of this analysis, the frequency was assumed to be 0.1 per year.

K.3.7 Radiological Impacts of Accidents

The consequences of a radiological accident to workers and the public can be expressed in a number of ways. Three ways are used in this *TC & WM EIS*. The first measure of consequences is radiation dose, expressed in terms of rem or millirem for an individual worker or member of the public and in terms of person-rem for a population of workers or members of the public. The second measure is the increase in the likelihood of an LCF for an exposed individual or the expected number of LCFs in a population of exposed individuals. The third measure, risk, is the mathematical product of the probability (or frequency) of the accident and the LCF consequences. Risk is calculated as follows:

$$R_i = D_i \times F \times P$$

or

$$R_p = D_p \times F \times P$$

where:

R_i	=	risk of an LCF for an individual receiving a dose D_i
R_p	=	risk of a number of LCFs for a population receiving a collective dose D_p
D_i	=	dose to a worker or member of the public, rem or millirem
D_p	=	collective dose to a population of workers or members of the public, person-rem
F	=	dose-to-LCF conversion factor, which is 0.0006 LCFs per rem (for individual doses less than 20 rem) or person-rem (for a population)
P	=	probability or frequency of the accident, usually expressed on a per-year basis

Once the source term, the amount of radioactive material released to the environment for each accident scenario, is determined, the radiological consequences are calculated. The calculations and resulting impacts vary depending on how the release is dispersed, what material is involved, and which receptor is being considered.

For example, if the dose to the MEI or worker is 10 rem, the probability of an LCF for an individual is 10 × 0.0006 = 0.006, where 0.0006 is the dose-to-LCF conversion factor. If the MEI or worker receives a dose exceeding 20 rem, the dose-to-LCF conversion factor is doubled to 0.0012. Thus, if the MEI receives a dose of 30 rem, the probability of an LCF is 30 × 0.0012 = 0.036. For an individual, the calculated probability that an LCF would result from a particular accident would be independent of (in addition to) the probability of cancer from all other causes.

For the population, the same dose-to-LCF conversion factor is used to estimate the number of LCFs. The calculated number of additional LCFs in the population as a result of a particular accident would be independent of the number of cancer fatalities that would result from all other causes. The MACCS2 computer code is used to calculate the dose to an average individual living in a particular geographic area (sector) near the site. The individual dose is then multiplied by the number of people in that sector and the appropriate dose-to-LCF conversion factor to estimate the probability of an LCF (or number of LCFs) within the entire sector's population. The probabilities (or numbers) for all sectors are then summed to produce an estimate of the total probability of an LCF (or total number of LCFs) in the population living within 80 kilometers (50 miles) of the site.

K.3.7.1 Radiological Impacts of Tank Closure Accidents

For the Tank Closure No Action Alternative, severe accidents involving waste tanks are represented by a seismically induced waste tank dome collapse. Table K–72 shows the consequences for this accident. Table K–73 shows the frequency and annual cancer risks for this accident.

Table K–72. Tank Closure Alternative 1 Radiological Consequences of Accidents[a]

	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
Accident[c, d]	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Seismically induced waste tank dome collapse – unmitigated (TK53)	2.1×10^{-4}	1×10^{-7}	1.3	0 (8×10^{-4})	2.2×10^{-1}	1×10^{-4}

[a] The doses presented here result from accident releases of radioactive materials to the atmosphere and are from direct exposure to the plume and inhalation only. Doses from other pathways, such as consumption of foodstuffs and exposure to radioactive material deposited on the ground, are small by comparison.

[b] Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.

[c] The alphanumeric code following the accident's title (i.e., TK53) corresponds with the code in the accident's description in Section K.3.4.

[d] The accident listed was analyzed because it had the highest consequences and/or risks in its category (e.g., leak, spill, mechanical impact, natural phenomena). For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[e] Increased likelihood of an LCF for an individual, assuming the accident occurs.

[f] The reported value is the projected number of LCFs in the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: LCF=latent cancer fatality.

Table K–73. Tank Closure Alternative 1 Annual Cancer Risks from Accidents

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}

[a] The alphanumeric code following the accident's title (i.e., TK53) corresponds with the code in the accident's description in Section K.3.4.
[b] The accident listed was analyzed because it had the highest consequences and/or risks in its category (e.g., leak, spill, mechanical impact, natural phenomena). For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.
[c] Increased risk to the individual of an LCF, taking into account the probability (frequency) of the accident.
[d] The reported value is the projected number of LCFs in the population, based on the accident probability (frequency), and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.
[e] Based on a population of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area.
Key: LCF=latent cancer fatality.

The following tables (Tables K–74 through K–93) provide the accident consequences for each Tank Closure action alternative. For each alternative, there are two tables showing the impacts. The first table presents the consequences (doses and LCFs) assuming the accident occurs—that is, not reflecting the frequency of accident occurrence. The second table shows accident risks that are obtained by multiplying the LCF values in the first table by the frequency of the corresponding accident.

Table K–74. Tank Closure Alternative 2A Radiological Consequences of Accidents[a]

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.3×10^{-3}	8×10^{-7}	7.6	0 (4×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	7.0×10^{-3}	4×10^{-6}	1.2×10^{2}	0 (7×10^{-2})	2.4×10^{1}	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	8.8×10^{-1}	5×10^{-4}	1.5×10^{4}	9	2.9×10^{3}	1
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	1.1×10^{-2}	7×10^{-6}	2.0×10^{2}	0 (1×10^{-1})	3.3×10^{1}	4×10^{-2}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	1.9×10^{-2}	1×10^{-5}	3.2×10^{2}	0 (2×10^{-1})	6.3×10^{1}	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	1.4×10^{-5}	9×10^{-9}	2.5×10^{-1}	0 (1×10^{-4})	4.3×10^{-2}	3×10^{-5}

Table K–74. Tank Closure Alternative 2A Radiological Consequences of Accidents[a] *(continued)*

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	4.3	3×10^{-3}	7.5×10^{4}	5×10^{1}	1.3×10^{4}	1
Seismically induced waste tank dome collapse – unmitigated (TK53)	2.1×10^{-4}	1×10^{-7}	1.3	0 (8×10^{-4})	2.2×10^{-1}	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	2.6×10^{-4}	2×10^{-7}	4.6	0 (3×10^{-3})	9.1×10^{-1}	5×10^{-4}

[a] The doses presented here result from accident releases of radioactive materials to the atmosphere and are from direct exposure to the plume and inhalation only. Doses from other pathways, such as consumption of foodstuffs and exposure to radioactive material deposited on the ground, are small by comparison.

[b] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[c] The alphanumeric code following the accident's title (e.g. TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day or LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[d] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[e] Increased likelihood of an LCF, 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.

[f] The reported value is the projected number of LCFs in the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Table K–75. Tank Closure Alternative 2A Annual Cancer Risks from Accidents

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Spray leak in transfer line during excavation – unmitigated (PT23)	1×10^{-4}	4×10^{-10}	0 (7×10^{-6})	3×10^{-6}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	5×10^{-4}	3×10^{-7}	0 (5×10^{-3})	2×10^{-3}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	5×10^{-4}	3×10^{-9}	0 (6×10^{-5})	2×10^{-5}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	5×10^{-4}	6×10^{-9}	0 (1×10^{-4})	4×10^{-5}

Table K–75. Tank Closure Alternative 2A Annual Cancer Risks from Accidents *(continued)*

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	5×10^{-4}	4×10^{-12}	0 (7×10^{-8})	1×10^{-8}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	5×10^{-4}	1×10^{-6}	0 (2×10^{-2})	8×10^{-3}
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

[a] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[b] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[c] Increased risk to the individual of an LCF, taking into account the probability (frequency) of the accident.

[d] The reported value is the projected number of LCFs in the population, based on the accident probability (frequency), and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[e] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Table K–76. Tank Closure Alternative 2B Radiological Consequences of Accidents[a]

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.3×10^{-3}	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	7.0×10^{-3}	4×10^{-6}	1.2×10^{2}	0 (7×10^{-2})	2.4×10^{1}	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	8.8×10^{-1}	5×10^{-4}	1.5×10^{4}	9	2.9×10^{3}	1
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	1.1×10^{-2}	7×10^{-6}	2.0×10^{2}	0 (1×10^{-1})	3.3×10^{1}	4×10^{-2}

Table K–76. Tank Closure Alternative 2B Radiological Consequences of Accidents[a] *(continued)*

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	1.9×10^{-2}	1×10^{-5}	3.2×10^{2}	0 (2×10^{-1})	6.3×10^{1}	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (90 MTG/day)	4.3×10^{-5}	3×10^{-8}	7.4×10^{-1}	0 (4×10^{-4})	1.3×10^{-1}	8×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×90 MTG/day)	4.3	3×10^{-3}	7.5×10^{4}	5×10^{1}	1.3×10^{4}	1
Seismically induced waste tank dome collapse – unmitigated (TK53)	2.1×10^{-4}	1×10^{-7}	1.3	0 (8×10^{-4})	2.2×10^{-1}	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	2.6×10^{-4}	2×10^{-7}	4.6	0 (3×10^{-3})	9.1×10^{-1}	5×10^{-4}

[a] The doses presented here result from accident releases of radioactive materials to the atmosphere and are from direct exposure to the plume and inhalation only. Doses from other pathways, such as consumption of foodstuffs and exposure to radioactive material deposited on the ground, are small by comparison.

[b] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[c] The alphanumeric code following the accident's title (e.g. TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day or LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[d] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[e] Increased likelihood of an LCF, 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.

[f] The reported value is the projected number of LCFs in the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Table K–77. Tank Closure Alternative 2B Annual Cancer Risks from Accidents

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Spray leak in transfer line during excavation – unmitigated (PT23)	1×10^{-4}	4×10^{-10}	0 (7×10^{-6})	3×10^{-6}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	5×10^{-4}	3×10^{-7}	0 (5×10^{-3})	2×10^{-3}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	5×10^{-4}	3×10^{-9}	0 (6×10^{-5})	2×10^{-5}

Table K–77. Tank Closure Alternative 2B Annual Cancer Risks from Accidents *(continued)*

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	5×10^{-4}	6×10^{-9}	0 (1×10^{-4})	4×10^{-5}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (90 MTG/day)	5×10^{-4}	1×10^{-11}	0 (2×10^{-7})	4×10^{-8}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×90 MTG/day)	5×10^{-4}	1×10^{-6}	0 (2×10^{-2})	8×10^{-3}
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

a The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

b The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

c Increased risk to the individual of an LCF, taking into account the probability (frequency) of the accident.

d The reported value is the projected number of LCFs in the population, based on the accident probability (frequency), and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

e Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Table K–78. Tank Closure Alternative 3A Radiological Consequences of Accidents[a]

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.3×10^{-3}	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	7.0×10^{-3}	4×10^{-6}	1.2×10^{2}	0 (7×10^{-2})	2.4×10^{1}	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	8.8×10^{-1}	5×10^{-4}	1.5×10^{4}	9	2.9×10^{3}	1

Table K–78. Tank Closure Alternative 3A Radiological Consequences of Accidents[a] *(continued)*

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	1.1×10^{-2}	7×10^{-6}	2.0×10^{2}	0 (1×10^{-1})	3.3×10^{1}	4×10^{-2}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	1.9×10^{-2}	1×10^{-5}	3.2×10^{2}	0 (2×10^{-1})	6.3×10^{1}	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	1.4×10^{-5}	9×10^{-9}	2.5×10^{-1}	0 (1×10^{-4})	4.3×10^{-2}	3×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	4.3	3×10^{-3}	7.5×10^{4}	5×10^{1}	1.3×10^{4}	1
Bulk vitrification waste receipt tank failure – unmitigated (200-East Area) (BV61)	2.8×10^{-8}	2×10^{-11}	4.9×10^{-4}	0 (3×10^{-7})	8.3×10^{-5}	5×10^{-8}
Bulk vitrification waste receipt tank failure – unmitigated (200-West Area) (BV61)	3.5×10^{-6}	2×10^{-9}	2.1×10^{-2}	0 (1×10^{-5})	3.2×10^{-3}	2×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	2.2×10^{-6}	1×10^{-9}	3.8×10^{-2}	0 (2×10^{-5})	2.5×10^{-3}	1×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	6.6×10^{-6}	4×10^{-9}	4.0×10^{-2}	0 (2×10^{-5})	2.4×10^{-3}	1×10^{-6}
Seismically induced waste tank dome collapse – unmitigated (TK53)	2.1×10^{-4}	1×10^{-7}	1.3	0 (8×10^{-4})	2.2×10^{-1}	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	2.6×10^{-4}	2×10^{-7}	4.6	0 (3×10^{-3})	9.1×10^{-1}	5×10^{-4}

[a] The doses presented here result from accident releases of radioactive materials to the atmosphere and are from direct exposure to the plume and inhalation only. Doses from other pathways, such as consumption of foodstuffs and exposure to radioactive material deposited on the ground, are small by comparison.

[b] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[c] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[d] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[e] Increased likelihood of an LCF, 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.

Table K–78. Tank Closure Alternative 3A Radiological Consequences of Accidents *(continued)*

f The reported value is the projected number of LCFs in the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Table K–79. Tank Closure Alternative 3A Annual Cancer Risks from Accidents

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Spray leak in transfer line during excavation – unmitigated (PT23)	1×10^{-4}	4×10^{-10}	0 (7×10^{-6})	3×10^{-6}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	5×10^{-4}	3×10^{-7}	0 (5×10^{-3})	2×10^{-3}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	5×10^{-4}	3×10^{-9}	0 (6×10^{-5})	2×10^{-5}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	5×10^{-4}	6×10^{-9}	0 (1×10^{-4})	4×10^{-5}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	5×10^{-4}	4×10^{-12}	0 (7×10^{-8})	1×10^{-8}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	5×10^{-4}	1×10^{-6}	0 (2×10^{-2})	8×10^{-3}
Bulk vitrification waste receipt tank failure – unmitigated (200-East Area) (BV61)	5×10^{-4}	8×10^{-15}	0 (1×10^{-10})	3×10^{-11}
Bulk vitrification waste receipt tank failure – unmitigated (200-West Area) (BV61)	5×10^{-4}	1×10^{-12}	0 (6×10^{-9})	1×10^{-9}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	5×10^{-4}	6×10^{-13}	0 (1×10^{-8})	7×10^{-10}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	5×10^{-4}	2×10^{-12}	0 (1×10^{-8})	7×10^{-10}

Table K–79. Tank Closure Alternative 3A Annual Cancer Risks from Accidents *(continued)*

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

[a] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[b] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[c] Increased risk to the individual of an LCF, taking into account the probability (frequency) of the accident.

[d] The reported value is the projected number of LCFs in the population, based on the accident probability (frequency), and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[e] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Table K–80. Tank Closure Alternative 3B Radiological Consequences of Accidents[a]

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.3×10^{-3}	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	7.0×10^{-3}	4×10^{-6}	1.2×10^{2}	0 (7×10^{-2})	2.4×10^{1}	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	8.8×10^{-1}	5×10^{-4}	1.5×10^{4}	9	2.9×10^{3}	1
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	1.1×10^{-2}	7×10^{-6}	2.0×10^{2}	0 (1×10^{-1})	3.3×10^{1}	4×10^{-2}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	1.9×10^{-2}	1×10^{-5}	3.2×10^{2}	0 (2×10^{-1})	6.3×10^{1}	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	1.4×10^{-5}	9×10^{-9}	2.5×10^{-1}	0 (1×10^{-4})	4.3×10^{-2}	3×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	4.3	3×10^{-3}	7.5×10^{4}	5×10^{1}	1.3×10^{4}	1

Table K–80. Tank Closure Alternative 3B Radiological Consequences of Accidents[a] *(continued)*

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Cast stone feed receipt tank failure – unmitigated (200-East Area) (CS71)	2.8×10^{-8}	2×10^{-11}	4.9×10^{-4}	0 (3×10^{-7})	8.3×10^{-5}	5×10^{-8}
Cast stone feed receipt tank failure – unmitigated (200-West Area) (CS71)	3.5×10^{-6}	2×10^{-9}	2.1×10^{-2}	0 (1×10^{-5})	3.2×10^{-3}	2×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	2.2×10^{-6}	1×10^{-9}	3.8×10^{-2}	0 (2×10^{-5})	2.5×10^{-3}	1×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	6.6×10^{-6}	4×10^{-9}	4.0×10^{-2}	0 (2×10^{-5})	2.4×10^{-3}	1×10^{-6}
Seismically induced waste tank dome collapse – unmitigated (TK53)	2.1×10^{-4}	1×10^{-7}	1.3	0 (8×10^{-4})	2.2×10^{-1}	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	2.6×10^{-4}	2×10^{-7}	4.6	0 (3×10^{-3})	9.1×10^{-1}	5×10^{-4}

[a] The doses presented here result from accident releases of radioactive materials to the atmosphere and are from direct exposure to the plume and inhalation only. Doses from other pathways, such as consumption of foodstuffs and exposure to radioactive material deposited on the ground, are small by comparison.

[b] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[c] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[d] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[e] Increased likelihood of an LCF, 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.

[f] The reported value is the projected number of LCFs in the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Table K–81. Tank Closure Alternative 3B Annual Cancer Risks from Accidents

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Spray leak in transfer line during excavation – unmitigated (PT 23)	1×10^{-4}	4×10^{-10}	0 (7×10^{-6})	3×10^{-6}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	5×10^{-4}	3×10^{-7}	0 (5×10^{-3})	2×10^{-3}

Table K–81. Tank Closure Alternative 3B Annual Cancer Risks from Accidents *(continued)*

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	5×10^{-4}	3×10^{-9}	0 (6×10^{-5})	2×10^{-5}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	5×10^{-4}	6×10^{-9}	0 (1×10^{-4})	4×10^{-5}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	5×10^{-4}	4×10^{-12}	0 (7×10^{-8})	1×10^{-8}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	5×10^{-4}	1×10^{-6}	0 (2×10^{-2})	8×10^{-3}
Cast stone feed receipt tank failure – unmitigated (200-East Area) (CS71)	5×10^{-4}	8×10^{-15}	0 (1×10^{-10})	3×10^{-11}
Cast stone feed receipt tank failure – unmitigated (200-West Area) (CS71)	5×10^{-4}	1×10^{-12}	0 (6×10^{-9})	1×10^{-9}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	5×10^{-4}	6×10^{-13}	0 (1×10^{-8})	7×10^{-10}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	5×10^{-4}	2×10^{-12}	0 (1×10^{-8})	7×10^{-10}
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

a The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

b The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

c Increased risk to the individual of an LCF, taking into account the probability (frequency) of the accident.

d The reported value is the projected number of LCFs in the population, based on the accident probability (frequency), and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

e Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Table K–82. Tank Closure Alternative 3C Radiological Consequences of Accidents[a]

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.3×10^{-3}	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	7.0×10^{-3}	4×10^{-6}	1.2×10^{2}	0 (7×10^{-2})	2.4×10^{1}	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	8.8×10^{-1}	5×10^{-4}	1.5×10^{4}	9	2.9×10^{3}	1
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	1.1×10^{-2}	7×10^{-6}	2.0×10^{2}	0 (1×10^{-1})	3.3×10^{1}	4×10^{-2}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	1.9×10^{-2}	1×10^{-5}	3.2×10^{2}	0 (2×10^{-1})	6.3×10^{1}	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	1.4×10^{-5}	9×10^{-9}	2.5×10^{-1}	0 (1×10^{-4})	4.3×10^{-2}	3×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	4.3	3×10^{-3}	7.5×10^{4}	5×10^{1}	1.3×10^{4}	1
Steam reforming feed receipt tank failure – unmitigated (200-East Area) (SRF1)	2.8×10^{-8}	2×10^{-11}	4.9×10^{-4}	0 (3×10^{-7})	8.3×10^{-5}	5×10^{-8}
Steam reforming feed receipt tank failure – unmitigated (200-West Area) (SRF1)	3.5×10^{-6}	2×10^{-9}	2.1×10^{-2}	0 (1×10^{-5})	3.2×10^{-3}	2×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	2.2×10^{-6}	1×10^{-9}	3.8×10^{-2}	0 (2×10^{-5})	2.5×10^{-3}	1×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	6.6×10^{-6}	4×10^{-9}	4.0×10^{-2}	0 (2×10^{-5})	2.4×10^{-3}	1×10^{-6}
Seismically induced waste tank dome collapse – unmitigated (TK53)	2.1×10^{-4}	1×10^{-7}	1.3	0 (8×10^{-4})	2.2×10^{-1}	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	2.6×10^{-4}	2×10^{-7}	4.6	0 (3×10^{-3})	9.1×10^{-1}	5×10^{-4}

[a] The doses presented here result from accident releases of radioactive materials to the atmosphere and are from direct exposure to the plume and inhalation only. Doses from other pathways, such as consumption of foodstuffs and exposure to radioactive material deposited on the ground, are small by comparison.

[b] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[c] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

Table K–82. Tank Closure Alternative 3C Radiological Consequences of Accidents *(continued)*

[d] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[e] Increased likelihood of an LCF, 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.

[f] The reported value is the projected number of LCFs in the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Table K–83. Tank Closure Alternative 3C Annual Cancer Risks from Accidents

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Spray leak in transfer line during excavation – unmitigated (PT23)	1×10^{-4}	4×10^{-10}	0 (7×10^{-6})	3×10^{-6}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	5×10^{-4}	3×10^{-7}	0 (5×10^{-3})	2×10^{-3}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	5×10^{-4}	3×10^{-9}	0 (6×10^{-5})	2×10^{-5}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	5×10^{-4}	6×10^{-9}	0 (1×10^{-4})	4×10^{-5}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	5×10^{-4}	4×10^{-12}	0 (7×10^{-8})	1×10^{-8}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	5×10^{-4}	1×10^{-6}	0 (2×10^{-2})	8×10^{-3}
Steam reforming feed receipt tank failure – unmitigated (200-East Area) (SRF1)	5×10^{-4}	8×10^{-15}	0 (1×10^{-10})	3×10^{-11}
Steam reforming feed receipt tank failure – unmitigated (200-West Area) (SRF1)	5×10^{-4}	1×10^{-12}	0 (6×10^{-9})	1×10^{-9}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	5×10^{-4}	6×10^{-13}	0 (1×10^{-8})	7×10^{-10}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	5×10^{-4}	2×10^{-12}	0 (1×10^{-8})	7×10^{-10}

Table K–83. Tank Closure Alternative 3C Annual Cancer Risks from Accidents *(continued)*

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

[a] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[b] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[c] Increased risk to the individual of an LCF, taking into account the probability (frequency) of the accident.

[d] The reported value is the projected number of LCFs in the population, based on the accident probability (frequency), and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[e] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Table K–84. Tank Closure Alternative 4 Radiological Consequences of Accidents[a]

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.3×10^{-3}	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	7.0×10^{-3}	4×10^{-6}	1.2×10^{2}	0 (7×10^{-2})	2.4×10^{1}	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	8.8×10^{-1}	5×10^{-4}	1.5×10^{4}	9	2.9×10^{3}	1
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	1.1×10^{-2}	7×10^{-6}	2.0×10^{2}	0 (1×10^{-1})	3.3×10^{1}	4×10^{-2}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	1.9×10^{-2}	1×10^{-5}	3.2×10^{2}	0 (2×10^{-1})	6.3×10^{1}	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	1.4×10^{-5}	9×10^{-9}	2.5×10^{-1}	0 (1×10^{-4})	4.3×10^{-2}	3×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	4.3	3×10^{-3}	7.5×10^{4}	5×10^{1}	1.3×10^{4}	1
Cast stone feed receipt tank failure – unmitigated (200-East Area) (CS71)	2.8×10^{-8}	2×10^{-11}	4.9×10^{-4}	0 (3×10^{-7})	8.3×10^{-5}	5×10^{-8}

Table K–84. Tank Closure Alternative 4 Radiological Consequences of Accidents[a] *(continued)*

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Bulk vitrification waste receipt tank failure – unmitigated (200-West Area) (BV61)	3.5×10^{-6}	2×10^{-9}	2.1×10^{-2}	0 (1×10^{-5})	3.2×10^{-3}	2×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	2.2×10^{-6}	1×10^{-9}	3.8×10^{-2}	0 (2×10^{-5})	2.5×10^{-3}	1×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	6.6×10^{-6}	4×10^{-9}	4.0×10^{-2}	0 (2×10^{-5})	2.4×10^{-3}	1×10^{-6}
Seismically induced waste tank dome collapse – unmitigated (TK53)	2.1×10^{-4}	1×10^{-7}	1.3	0 (8×10^{-4})	2.2×10^{-1}	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	2.6×10^{-4}	2×10^{-7}	4.6	0 (3×10^{-3})	9.1×10^{-1}	5×10^{-4}

[a] The doses presented here result from accident releases of radioactive materials to the atmosphere and are from direct exposure to the plume and inhalation only. Doses from other pathways, such as consumption of foodstuffs and exposure to radioactive material deposited on the ground, are small by comparison.

[b] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[c] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[d] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[e] Increased likelihood of an LCF, 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.

[f] The reported value is the projected number of LCFs in the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Table K–85. Tank Closure Alternative 4 Annual Cancer Risks from Accidents

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Spray leak in transfer line during excavation – unmitigated (PT 23)	1×10^{-4}	4×10^{-10}	0 (7×10^{-6})	3×10^{-6}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	5×10^{-4}	3×10^{-7}	0 (5×10^{-3})	2×10^{-3}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	5×10^{-4}	3×10^{-9}	0 (6×10^{-5})	2×10^{-5}

Table K–85. Tank Closure Alternative 4 Annual Cancer Risks from Accidents *(continued)*

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	5×10^{-4}	6×10^{-9}	0 (1×10^{-4})	4×10^{-5}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (30 MTG/day)	5×10^{-4}	4×10^{-12}	0 (7×10^{-8})	1×10^{-8}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×30 MTG/day)	5×10^{-4}	1×10^{-6}	0 (2×10^{-2})	8×10^{-3}
Cast stone feed receipt tank failure – unmitigated (200-East Area) (CS71)	5×10^{-4}	8×10^{-15}	0 (1×10^{-10})	3×10^{-11}
Bulk vitrification waste receipt tank failure – unmitigated (200-West Area) (BV61)	5×10^{-4}	1×10^{-12}	0 (6×10^{-9})	1×10^{-9}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	5×10^{-4}	6×10^{-13}	0 (1×10^{-8})	7×10^{-10}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	5×10^{-4}	2×10^{-12}	0 (1×10^{-8})	7×10^{-10}
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

[a] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[b] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[c] Increased risk to the individual of an LCF, taking into account the probability (frequency) of the accident.

[d] The reported value is the projected number of LCFs in the population, based on the accident probability (frequency), and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[e] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Table K–86. Tank Closure Alternative 5 Radiological Consequences of Accidents[a]

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.3×10^{-3}	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	7.0×10^{-3}	4×10^{-6}	1.2×10^{2}	0 (7×10^{-2})	2.4×10^{1}	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	8.8×10^{-1}	5×10^{-4}	1.5×10^{4}	9	2.9×10^{3}	1
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	1.1×10^{-2}	7×10^{-6}	2.0×10^{2}	0 (1×10^{-1})	3.3×10^{1}	4×10^{-2}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	1.9×10^{-2}	1×10^{-5}	3.2×10^{2}	0 (2×10^{-1})	6.3×10^{1}	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (45 MTG/day)	2.1×10^{-5}	1×10^{-8}	3.7×10^{-1}	0 (2×10^{-4})	6.5×10^{-2}	4×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×45 MTG/day)	4.3	3×10^{-3}	7.5×10^{4}	5×10^{1}	1.3×10^{4}	1
Cast stone feed receipt tank failure – unmitigated (200-East Area) (CS71)	2.8×10^{-8}	2×10^{-11}	4.9×10^{-4}	0 (3×10^{-7})	8.3×10^{-5}	5×10^{-8}
Bulk vitrification waste receipt tank failure – unmitigated (200-West Area) (BV61)	3.5×10^{-6}	2×10^{-9}	2.1×10^{-2}	0 (1×10^{-5})	3.2×10^{-3}	2×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	2.2×10^{-6}	1×10^{-9}	3.8×10^{-2}	0 (2×10^{-5})	2.5×10^{-3}	1×10^{-6}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	6.6×10^{-6}	4×10^{-9}	4.0×10^{-2}	0 (2×10^{-5})	2.4×10^{-3}	1×10^{-6}
Seismically induced waste tank dome collapse – unmitigated (TK53)	2.1×10^{-4}	1×10^{-7}	1.3	0 (8×10^{-4})	2.2×10^{-1}	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	2.6×10^{-4}	2×10^{-7}	4.6	0 (3×10^{-3})	9.1×10^{-1}	5×10^{-4}

[a] The doses presented here result from accident releases of radioactive materials to the atmosphere and are from direct exposure to the plume and inhalation only. Doses from other pathways, such as consumption of foodstuffs and exposure to radioactive material deposited on the ground, are small by comparison.

[b] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[c] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

Table K–86. Tank Closure Alternative 5 Radiological Consequences of Accidents *(continued)*

[d] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[e] Increased likelihood of an LCF, 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.

[f] The reported value is the projected number of LCFs in the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Table K–87. Tank Closure Alternative 5 Annual Cancer Risks from Accidents

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Spray leak in transfer line during excavation – unmitigated (PT 23)	1×10^{-4}	4×10^{-10}	0 (7×10^{-6})	3×10^{-6}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	5×10^{-4}	3×10^{-7}	0 (5×10^{-3})	2×10^{-3}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	5×10^{-4}	3×10^{-9}	0 (6×10^{-5})	2×10^{-5}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	5×10^{-4}	6×10^{-9}	0 (1×10^{-4})	4×10^{-5}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (45 MTG/day)	5×10^{-4}	6×10^{-12}	0 (1×10^{-7})	2×10^{-8}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×45 MTG/day)	5×10^{-4}	1×10^{-6}	0 (2×10^{-2})	8×10^{-3}
Cast stone feed receipt tank failure – unmitigated (200-East Area) (CS71)	5×10^{-4}	8×10^{-15}	0 (1×10^{-10})	3×10^{-11}
Bulk vitrification waste receipt tank failure – unmitigated (200-West Area) (BV61)	5×10^{-4}	1×10^{-12}	0 (6×10^{-9})	1×10^{-9}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-East Area) (TR81)	5×10^{-4}	6×10^{-13}	0 (1×10^{-8})	7×10^{-10}
Mixed TRU waste/MLLW liquid sludge transfer line spray leak – unmitigated (200-West Area) (TR81)	5×10^{-4}	2×10^{-12}	0 (1×10^{-8})	7×10^{-10}

Table K–87. Tank Closure Alternative 5 Annual Cancer Risks from Accidents *(continued)*

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

[a] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[b] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[c] Increased risk to the individual of an LCF, taking into account the probability (frequency) of the accident.

[d] The reported value is the projected number of LCFs in the population, based on the accident probability (frequency), and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[e] Based on populations of 546,746 and 589,668.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MLLW=mixed low-level radioactive waste; MTG/day=metric tons of glass per day; TRU=transuranic; WTP=Waste Treatment Plant.

Table K–88. Tank Closure Alternative 6A Radiological Consequences of Accidents[a]

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.3×10^{-3}	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (15 MTG/day)	2.9×10^{-2}	2×10^{-5}	5.0×10^{2}	0 (3×10^{-1})	8.3×10^{1}	1×10^{-1}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (15 MTG/day)	4.6×10^{-2}	3×10^{-5}	8.1×10^{2}	0 (5×10^{-1})	1.6×10^{2}	2×10^{-1}
Seismically induced WTP collapse and failure – unmitigated (WT41) (15 MTG/day)	5.8×10^{-2}	4×10^{-5}	1.0×10^{3}	0 (6×10^{-1})	1.8×10^{2}	2×10^{-1}
Seismically induced waste tank dome collapse – unmitigated (TK53)	2.1×10^{-4}	1×10^{-7}	1.3	0 (8×10^{-4})	2.2×10^{-1}	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	2.6×10^{-4}	2×10^{-7}	4.6	0 (3×10^{-3})	9.1×10^{-1}	5×10^{-4}

[a] The doses presented here result from accident releases of radioactive materials to the atmosphere and are from direct exposure to the plume and inhalation only. Doses from other pathways, such as consumption of foodstuffs and exposure to radioactive material deposited on the ground, are small by comparison.

[b] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[c] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

Table K–88. Tank Closure Alternative 6A Radiological Consequences of Accidents *(continued)*

[d] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[e] Increased likelihood of LCF for an individual, assuming the accident occurs.

[f] The reported value is the projected number of LCFs in the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LCF=latent cancer fatality; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Table K–89. Tank Closure Alternative 6A Annual Cancer Risks from Accidents

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (15 MTG/day)	5×10^{-4}	9×10^{-9}	0 (1×10^{-4})	5×10^{-5}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (15 MTG/day)	5×10^{-4}	1×10^{-8}	0 (2×10^{-4})	9×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (15 MTG/day)	5×10^{-4}	2×10^{-8}	0 (3×10^{-4})	1×10^{-4}
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

[a] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[b] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[c] Increased risk to the individual of an LCF, taking into account the probability (frequency) of the accident.

[d] The reported value is the projected number of LCFs in the population, based on the accident probability (frequency), and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[e] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LCF=latent cancer fatality; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Table K–90. Tank Closure Alternative 6B Radiological Consequences of Accidents[a]

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.3×10^{-3}	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	7.0×10^{-3}	4×10^{-6}	1.2×10^{2}	0 (7×10^{-2})	2.4×10^{1}	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	8.8×10^{-1}	5×10^{-4}	1.5×10^{4}	9	2.9×10^{3}	1
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	1.1×10^{-2}	7×10^{-6}	2.0×10^{2}	0 (1×10^{-1})	3.3×10^{1}	4×10^{-2}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	1.9×10^{-2}	1×10^{-5}	3.2×10^{2}	0 (2×10^{-1})	6.3×10^{1}	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (90 MTG/day)	4.3×10^{-5}	3×10^{-8}	7.4×10^{-1}	0 (4×10^{-4})	1.3×10^{-1}	8×10^{-5}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×90 MTG/day)	4.3	3×10^{-3}	7.5×10^{4}	5×10^{1}	1.3×10^{4}	1
Seismically induced waste tank dome collapse – unmitigated (TK53)	2.1×10^{-4}	1×10^{-7}	1.3	0 (8×10^{-4})	2.2×10^{-1}	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	2.6×10^{-4}	2×10^{-7}	4.6	0 (3×10^{-3})	9.1×10^{-1}	5×10^{-4}

[a] The doses presented here result from accident releases of radioactive materials to the atmosphere and are from direct exposure to the plume and inhalation only. Doses from other pathways, such as consumption of foodstuffs and exposure to radioactive material deposited on the ground, are small by comparison.

[b] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[c] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[d] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[e] Increased likelihood of an LCF, 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.

[f] The reported value is the projected number of LCFs in the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Table K–91. Tank Closure Alternative 6B Annual Cancer Risks from Accidents

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Spray leak in transfer line during excavation – unmitigated (PT 23)	1×10^{-4}	4×10^{-10}	0 (7×10^{-6})	3×10^{-6}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	5×10^{-4}	3×10^{-7}	0 (5×10^{-3})	2×10^{-3}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	5×10^{-4}	3×10^{-9}	0 (6×10^{-5})	2×10^{-5}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	5×10^{-4}	6×10^{-9}	0 (1×10^{-4})	4×10^{-5}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (90 MTG/day)	5×10^{-4}	1×10^{-11}	0 (2×10^{-7})	4×10^{-8}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×90 MTG/day)	5×10^{-4}	1×10^{-6}	0 (2×10^{-2})	8×10^{-3}
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

a The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

b The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

c Increased risk to the individual of an LCF, taking into account the probability (frequency) of the accident.

d The reported value is the projected number of LCFs in the population, based on the accident probability (frequency), and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

e Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Table K–92. Tank Closure Alternative 6C Radiological Consequences of Accidents[a]

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.3×10^{-3}	8×10^{-7}	7.6	0 (5×10^{-3})	1.4	8×10^{-4}
Spray leak in transfer line during excavation – unmitigated (PT23)	7.0×10^{-3}	4×10^{-6}	1.2×10^{2}	0 (7×10^{-2})	2.4×10^{1}	3×10^{-2}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	8.8×10^{-1}	5×10^{-4}	1.5×10^{4}	9	2.9×10^{3}	1
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	1.1×10^{-2}	7×10^{-6}	2.0×10^{2}	0 (1×10^{-1})	3.3×10^{1}	4×10^{-2}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	1.9×10^{-2}	1×10^{-5}	3.2×10^{2}	0 (2×10^{-1})	6.3×10^{1}	8×10^{-2}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (90 MTG/day)	4.3×10^{-5}	3×10^{-8}	7.4×10^{-1}	0 (4×10^{-4})	1.3×10^{-1}	8×10^{-5}
Seismically inducted WTP collapse and failure – unmitigated (WT41) (6×90 MTG/day)	4.3	3×10^{-3}	7.5×10^{4}	5×10^{1}	1.3×10^{4}	1
Seismically induced waste tank dome collapse – unmitigated (TK53)	2.1×10^{-4}	1×10^{-7}	1.3	0 (8×10^{-4})	2.2×10^{-1}	1×10^{-4}
IHLW glass canister drop – unmitigated (SH91)	2.6×10^{-4}	2×10^{-7}	4.6	0 (3×10^{-3})	9.1×10^{-1}	5×10^{-4}

[a] The doses presented here result from accident releases of radioactive materials to the atmosphere and are from direct exposure to the plume and inhalation only. Doses from other pathways, such as consumption of foodstuffs and exposure to radioactive material deposited on the ground, are small by comparison.

[b] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[c] The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

[d] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[e] Increased likelihood of an LCF, 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.

[f] The reported value is the projected number of LCFs in the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

Table K–93. Tank Closure Alternative 6C Annual Cancer Risks from Accidents

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Spray release from jumper pit during waste retrieval – unmitigated (TK51)	1.1×10^{-2}	8×10^{-9}	0 (5×10^{-5})	9×10^{-6}
Spray leak in transfer line during excavation – unmitigated (PT 23)	1×10^{-4}	4×10^{-10}	0 (7×10^{-6})	3×10^{-6}
Pretreatment Facility waste feed receipt vessel or piping leak – unmitigated (PT22)	5×10^{-4}	3×10^{-7}	0 (5×10^{-3})	2×10^{-3}
Seismically induced failure of HLW melter feed preparation vessels – unmitigated (HL11) (6 MTG/day)	5×10^{-4}	3×10^{-9}	0 (6×10^{-5})	2×10^{-5}
HLW molten glass spill caused by HLW melter failure – unmitigated (HL14) (6 MTG/day)	5×10^{-4}	6×10^{-9}	0 (1×10^{-4})	4×10^{-5}
Seismically induced LAW Vitrification Facility collapse and failure – unmitigated (LA31) (90 MTG/day)	5×10^{-4}	1×10^{-11}	0 (2×10^{-7})	4×10^{-8}
Seismically induced WTP collapse and failure – unmitigated (WT41) (6×90 MTG/day)	5×10^{-4}	1×10^{-6}	0 (2×10^{-2})	8×10^{-3}
Seismically induced waste tank dome collapse – unmitigated (TK53)	5×10^{-4}	6×10^{-11}	0 (4×10^{-7})	7×10^{-8}
IHLW glass canister drop – unmitigated (SH91)	1×10^{-3}	2×10^{-10}	0 (3×10^{-6})	5×10^{-7}

a The alphanumeric code following the accident's title (e.g., TK51) corresponds with the code in the accident's description in Section K.3.4. The term "Z×Y MTG/day," read as "Z by Y MTG/day," refers to a WTP design capacity of Z MTG/day of HLW and Y MTG/day of LAW; for example, 6×30, 6×45, 6×90, or 15×0 MTG/day.

b The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

c Increased risk to the individual of an LCF, taking into account the probability (frequency) of the accident.

d The reported value is the projected number of LCFs in the population, based on the accident probability (frequency), and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

e Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

Key: HLW=high-level radioactive waste; IHLW=immobilized high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; MTG/day=metric tons of glass per day; WTP=Waste Treatment Plant.

K.3.7.2 Radiological Impacts of FFTF Decommissioning Accidents

The accident scenarios involving the stored sodium inventories at Hanford in the 400 Area SSF and the 200-West Area are applicable under any of the FFTF Decommissioning alternatives. Table K–94 shows the consequences of these accidents. Table K–95 shows the annual probability and the cancer risks of the accidents. The Hallam Reactor sodium fire and SRE sodium fire could occur either in the 200-West Area where the sodium is stored or in the 400 Area after the sodium is transferred there for processing. Tables K–94 and K–95 present the impacts of these accidents occurring in the

200-West Area. The Hanford sodium storage tank failure has the largest impacts of accidents occurring in the 400 Area.

Table K–94. FFTF Decommissioning Alternatives – Radiological Consequences of Accidents[a]

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Sodium Storage Facility fire (SSF1)	1.0×10^{-6}	6×10^{-10}	6.3×10^{-3}	0 (4×10^{-6})	3.4×10^{-7}	2×10^{-10}
Hanford sodium storage tank failure (HSTF1)	1.1×10^{-6}	6×10^{-10}	6.4×10^{-3}	0 (4×10^{-6})	8.7×10^{-7}	5×10^{-10}
Hallam Reactor sodium fire (HSF1)	4.6×10^{-10}	3×10^{-13}	7.7×10^{-6}	0 (5×10^{-9})	2.5×10^{-10}	2×10^{-13}
Sodium Reactor Experiment sodium fire (SRE1)	4.5×10^{-8}	3×10^{-11}	7.6×10^{-4}	0 (5×10^{-7})	1.1×10^{-7}	7×10^{-11}

[a] The doses presented here result from accident releases of radioactive materials to the atmosphere and are from direct exposure to the plume and inhalation only. Doses from other pathways, such as consumption of foodstuffs and exposure to radioactive material deposited on the ground, are small by comparison.

[b] Based on populations of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area (HSF1 and SRE1) and 445,002 persons residing within 80 kilometers (50 miles) of the 400 Area (SSF1 and HSTF1).

[c] The alphanumeric code following the accident's title (e.g., SSF1) corresponds with the code in the accident's description in Section K.3.5.

[d] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[e] Increased likelihood of LCF for an individual, assuming the accident occurs.

[f] The reported value of the projected number of LCFs in the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; LCF=latent cancer fatality.

Table K–95. FFTF Decommissioning Alternatives – Annual Cancer Risks from Accidents

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Sodium Storage Facility fire (SSF1)	1×10^{-6}	6×10^{-16}	0 (4×10^{-12})	2×10^{-16}
Hanford sodium storage tank failure (HSTF1)	1×10^{-5}	6×10^{-15}	0 (4×10^{-11})	5×10^{-15}
Hallam Reactor sodium fire (HSF1)	2×10^{-5}	5×10^{-18}	0 (9×10^{-14})	3×10^{-18}
Sodium Reactor Experiment sodium fire (SRE1)	1×10^{-2}	3×10^{-13}	0 (5×10^{-9})	7×10^{-13}

[a] The alphanumeric code following the accident's title (e.g., SSF1) corresponds with the code in the accident's description in Section K.3.5.

[b] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[c] Increased risk to the individual of an LCF, taking into account the probability (frequency) of the accident.

[d] The reported value is the projected number of LCFs in the population, based on the accident probability (frequency), and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[e] Based on populations of 589,668 persons residing within 80 kilometers (50 miles) of the 200-West Area (HSF1 and SRE1) and 445,002 persons residing within 80 kilometers (50 miles) of the 400 Area (SSF1 and HSTF1).

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; LCF=latent cancer fatality.

The sodium storage fire accident scenarios represent a reasonable range of potential accidents for the FFTF Decommissioning No Action Alternative. For the two FFTF Decommissioning action alternatives, additional scenarios are considered for the options for dispositioning RH-SCs and bulk sodium at Hanford or INL. These accidents could occur under either FFTF Decommissioning Alternative 2 or 3.

Under FFTF Decommissioning Alternatives 2 and 3, RH-SCs would be removed from FFTF prior to final disposition of the structures. A fire could occur at the Hanford 400 Area during handling of the RH-SCs. Table K–96 presents the radiological consequences of a fire under the Hanford Option for disposition of RH-SCs. The risks of such an accident, determined by multiplying the consequences by the estimated frequency of the accident, are presented in Table K–97. Under the Hanford Reuse Option for disposition of bulk sodium, the accidents listed in Tables K–94 and K–95 represents a reasonable range of accidents, and no additional scenarios need to be evaluated.

Table K–96. FFTF Decommissioning Alternatives 2 and 3, Hanford Option for Disposition of RH-SCs, Radiological Consequences of Accidents[a]

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Remote-handled special component fire (RHSC1) at Hanford	1.2×10^{-4}	7×10^{-8}	4.3	0 (3×10^{-3})	7.3×10^{-4}	4×10^{-7}

[a] The dose presented here results from an accident release of radioactive materials to the atmosphere and is from direct exposure to the plume and inhalation only. Doses from other pathways, such as consumption of foodstuffs and exposure to radioactive material deposited on the ground, are small by comparison.

[b] Based on a population of 445,002 persons residing within 80 kilometers (50 miles) of the 400 Area.

[c] The alphanumeric code following the accident's title (i.e., RHSC1) corresponds with the code in the accident's description in Section K.3.5.

[d] The accident listed was analyzed because it had the highest consequences and/or risks in its category (e.g., leak, spill, mechanical impact, natural phenomena). For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[e] Increased likelihood of LCF for an individual, assuming the accident occurs.

[f] The reported value is the projected number of LCFs in the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; LCF=latent cancer fatality; RH-SCs=remote-handled special components.

Table K–97. FFTF Decommissioning Alternatives 2 and 3, Hanford Option for Disposition of RH-SCs, Annual Cancer Risks from Accidents

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Remote-handled special component fire (RHSC1) at Hanford	1×10^{-2}	7×10^{-10}	0 (3×10^{-5})	4×10^{-9}

[a] The alphanumeric code following the accident's title (i.e., RHSC1) corresponds with the code in the accident's description in Section K.3.5.

[b] The accident listed was analyzed because it had the highest consequences and/or risks in its category (e.g., leak, spill, mechanical impact, natural phenomena). For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[c] Increased risk to the individual of an LCF, taking into account the probability (frequency) of the accident.

[d] The reported value is the projected number of LCFs in the population, based on the accident probability (frequency), and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[e] Based on a population of 445,002 persons residing within 80 kilometers (50 miles) of the 400 Area.

Key: FFTF=Fast Flux Test Facility; Hanford=Hanford Site; LCF=latent cancer fatality; RH-SCs=remote-handled special components.

However, the Idaho Option for either of these activities would introduce new accident scenarios. Under the Idaho Option for disposition of RH-SCs, the RH-SC fire (RHSC1) could occur both at Hanford (during removal) and at INL (during processing). The consequences and risks of an RH-SC fire at Hanford are presented in Tables K–96 and K–97. The radiological consequences of an RH-SC fire at INL are presented in Table K–98. Table K–99 presents the annual risks from an RH-SC fire at INL, taking into account the probability of the accident occurring. The Idaho Reuse Option for disposition of bulk sodium would introduce a new scenario involving failure of the SPF sodium storage tank (INLSPF1) at INL. The consequences if the accident were to occur and the annual risks associated with the accident are presented in Tables K–98 and K–99.

Table K–98. FFTF Decommissioning Alternatives 2 and 3, Idaho Option for Disposition of RH-SCs and Idaho Reuse Option for Disposition of Bulk Sodium, Radiological Consequences of Accidents[a]

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Remote-handled special component fire (RHSC1) at INL	2.5×10^{-4}	2×10^{-7}	3.0×10^{-1}	0 (2×10^{-4})	1.8×10^{-4}	1×10^{-7}
INL Sodium Processing Facility storage tank failure (INLSPF1)	3.0×10^{-8}	2×10^{-11}	5.8×10^{-5}	0 (3×10^{-8})	3.9×10^{-9}	2×10^{-12}

a The doses presented here result from accident releases of radioactive materials to the atmosphere and are from direct exposure to the plume and inhalation only. Doses from other pathways, such as consumption of foodstuffs and exposure to radioactive material deposited on the ground, are small by comparison.

b Based on populations of 250,838 and 152,493 persons residing within 80 kilometers (50 miles) of the INL Materials and Fuels Complex and the Idaho Nuclear Technology and Engineering Center, respectively.

c The alphanumeric code following the accident's title (e.g., RHSC1) corresponds with the code in the accident's description in Section K.3.5.

d The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

e Increased likelihood of an LCF for an individual, assuming the accident occurs.

f The reported value is the projected number of LCFs in the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: FFTF=Fast Flux Test Facility; INL=Idaho National Laboratory; LCF=latent cancer fatality; RH-SCs=remote-handled special components.

Table K–99. FFTF Decommissioning Alternatives 2 and 3, Idaho Option for Disposition of RH-SCs and Idaho Reuse Option for Disposition of Bulk Sodium, Annual Cancer Risks from Accidents

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Remote-handled special component fire (RHSC1) at INL	1×10^{-2}	2×10^{-9}	0 (2×10^{-6})	1×10^{-9}
INL Sodium Processing Facility storage tank failure (INLSPF1)	1×10^{-5}	2×10^{-16}	0 (3×10^{-13})	2×10^{-17}

a The alphanumeric code following the accident's title (e.g., INLSPF1) corresponds with the code in the accident's description in Section K.3.5.

b The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

c Increased risk to the individual of an LCF, taking into account the probability (frequency) of the accident.

d The reported value is the projected number of LCFs in the population, based on the accident probability (frequency), and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

e Based on populations of 250,838 and 152,493 persons residing within 80 kilometers (50 miles) of the INL Materials and Fuels Complex and the Idaho Nuclear Technology and Engineering Center, respectively.

Key: FFTF=Fast Flux Test Facility; INL=Idaho National Laboratory; LCF=latent cancer fatality; RH-SCs=remote-handled special components.

K.3.7.3 Radiological Impacts of Waste Management Accidents

Table K–100 shows the consequences of the accidents associated with the Waste Management No Action Alternative. For the No Action Alternative, the accident scenarios involving the disposal of ILAW in the IDF-East are not applicable. Table K–101 shows the frequency and annual cancer risks for the accidents.

Table K–100. Waste Management Alternative 1 Radiological Consequences of Accidents[a]

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Single-drum deflagration (SWOC FIR-1)	7.9×10^{-4}	5×10^{-7}	4.7	0 (3×10^{-3})	8.4×10^{-1}	5×10^{-4}
Medium fire inside facility (SWOC FIR-6)	1.5×10^{-2}	9×10^{-6}	8.7×10^{1}	0 (5×10^{-2})	1.6×10^{1}	9×10^{-3}
Glovebox or greenhouse fire (SWOC FIR-8)	2.8×10^{-2}	2×10^{-5}	1.7×10^{2}	0 (1×10^{-1})	3.0×10^{1}	4×10^{-2}
Large fire of waste containers outside facility (SWOC FIR-4)	2.5×10^{-1}	1×10^{-4}	1.5×10^{3}	1 (9×10^{-1})	2.6×10^{2}	3×10^{-1}
Handling spill of single waste container (SWOC SP-2)	1.5×10^{-4}	9×10^{-8}	8.7×10^{-1}	0 (5×10^{-4})	1.6×10^{-1}	9×10^{-5}
Large handling spill of boxes or multiple waste containers (SWOC SP-3A)	7.2×10^{-4}	4×10^{-7}	4.3	0 (3×10^{-3})	7.7×10^{-1}	5×10^{-4}
Spill of single large-diameter container (SWOC SP-4)	7.0×10^{-3}	4×10^{-6}	4.2×10^{1}	0 (3×10^{-2})	7.5	4×10^{-3}
Design-basis seismic event (SWOC NPH-1)	6.8×10^{-3}	4×10^{-6}	4.1×10^{1}	0 (2×10^{-2})	7.3	4×10^{-3}
Beyond-design-basis accident (SWOC NPH-2)	2.6×10^{-2}	2×10^{-5}	1.6×10^{2}	0 (9×10^{-2})	2.8×10^{1}	3×10^{-2}
Range fire (SWOC EE-1)	1.2×10^{-1}	7×10^{-5}	7.4×10^{2}	0 (4×10^{-1})	1.3×10^{2}	2×10^{-1}
Aircraft crash (SWOC EE-2)	2.8×10^{-1}	2×10^{-4}	1.7×10^{3}	1	3.0×10^{2}	4×10^{-1}

[a] The doses presented here result from accident releases of radioactive materials to the atmosphere and are from direct exposure to the plume and inhalation only. Doses from other pathways, such as consumption of foodstuffs and exposure to radioactive material deposited on the ground, are small by comparison.

[b] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East Area and 200-West Areas, respectively.

[c] The alphanumeric code following the accident's title (e.g., SWOC FIR-1) corresponds with the code in the accident's description in Section K.3.6.

[d] The reported value of the projected number of LCFs in the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[e] Increased likelihood of an LCF for an individual, assuming the accident occurs.

[f] The reported value is the projected number of LCFs in the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: LCF=latent cancer fatality.

Table K–101. Waste Management Alternative 1 Annual Cancer Risks from Accidents

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Single-drum deflagration (SWOC FIR-1)	1×10^{-2}	5×10^{-9}	0 (3×10^{-5})	5×10^{-6}
Medium fire inside facility (SWOC FIR-6)	1×10^{-2}	9×10^{-8}	0 (5×10^{-4})	9×10^{-5}
Glovebox or greenhouse fire (SWOC FIR-8)	1×10^{-2}	2×10^{-7}	0 (1×10^{-3})	4×10^{-4}
Large fire of waste containers outside facility (SWOC FIR-4)	1×10^{-2}	1×10^{-6}	0 (9×10^{-3})	3×10^{-3}
Handling spill of single waste container (SWOC SP-2)	1×10^{-2}	9×10^{-10}	0 (5×10^{-6})	9×10^{-7}
Large handling spill of boxes or multiple waste containers (SWOC SP-3A)	1×10^{-2}	4×10^{-9}	0 (3×10^{-5})	5×10^{-6}
Spill of single large-diameter container (SWOC SP-4)	1×10^{-2}	4×10^{-8}	0 (3×10^{-4})	4×10^{-5}
Design-basis seismic event (SWOC NPH-1)	1×10^{-3}	4×10^{-9}	0 (2×10^{-5})	4×10^{-6}
Beyond-design-basis accident (SWOC NPH-2)	1×10^{-3}	2×10^{-8}	0 (9×10^{-5})	3×10^{-5}
Range fire (SWOC EE-1)	1×10^{-2}	7×10^{-7}	0 (4×10^{-3})	2×10^{-3}
Aircraft crash (SWOC EE-2)	3×10^{-5}	5×10^{-9}	0 (3×10^{-5})	1×10^{-5}

[a] The alphanumeric code following the accident's title (e.g., SWOC FIR-1) corresponds with the code in the accident's description in Section K.3.6.

[b] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[c] Increased risk to the individual of an LCF, taking into account the probability (frequency) of the accident.

[d] The reported value is the projected number of LCFs in the population, based on the accident probability (frequency), and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[e] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

Key: LCF=latent cancer fatality.

Tables K–102 and K–103 provide the accident consequences for Waste Management Alternatives 2 and 3. Table K–102 presents the consequences (doses and LCFs), assuming the accident occurs, that is, not reflecting the frequency of accident occurrence. Table K–103 shows accident risks obtained by multiplying the LCF values from Table K–102 by the frequency of the accident. Under Alternatives 2 and 3, new facilities or expansions of existing facilities would be required and there would be limited shipments of LLW and MLLW to Hanford from other DOE sites. As noted previously, each of the scenarios analyzed in the current DSASW, or some variant of it, would be applicable to each of the Waste Management alternatives, although the human health risk from a particular type of accident would depend on the volume of waste that is ultimately managed and the duration (years) of each operation.

Table K–102. Waste Management Alternatives 2 and 3 Radiological Consequences of Accidents[a]

Accident[c, d]	Maximally Exposed Individual		Offsite Population[b]		Noninvolved Worker	
	Dose (rem)	LCF[e]	Dose (person-rem)	LCFs[f]	Dose (rem)	LCF[e]
Single-drum deflagration (SWOC FIR-1)	7.9×10^{-4}	5×10^{-7}	4.7	0 (3×10^{-3})	8.4×10^{-1}	5×10^{-4}
Medium fire inside facility (SWOC FIR-6)	1.5×10^{-2}	9×10^{-6}	8.7×10^{1}	0 (5×10^{-2})	1.6×10^{1}	9×10^{-3}
Glovebox or greenhouse fire (SWOC FIR-8)	2.8×10^{-2}	2×10^{-5}	1.7×10^{2}	0 (1×10^{-1})	3.0×10^{1}	4×10^{-2}
Large fire of waste containers outside facility (SWOC FIR-4)	2.5×10^{-1}	1×10^{-4}	1.5×10^{3}	1 (9×10^{-1})	2.6×10^{2}	3×10^{-1}
Handling spill of single waste container (SWOC SP-2)	1.5×10^{-4}	9×10^{-8}	8.7×10^{-1}	0 (5×10^{-4})	1.6×10^{-1}	9×10^{-5}
Large handling spill of boxes or multiple waste containers (SWOC SP-3A)	7.2×10^{-4}	4×10^{-7}	4.3	0 (3×10^{-3})	7.7×10^{-1}	5×10^{-4}
Spill of single large-diameter container (SWOC SP-4)	7.0×10^{-3}	4×10^{-6}	4.2×10^{1}	0 (3×10^{-2})	7.5	4×10^{-3}
Design-basis seismic event (SWOC NPH-1)	6.8×10^{-3}	4×10^{-6}	4.1×10^{1}	0 (2×10^{-2})	7.3	4×10^{-3}
Beyond-design-basis accident (SWOC NPH-2)	2.6×10^{-2}	2×10^{-5}	1.6×10^{2}	0 (9×10^{-2})	2.8×10^{1}	3×10^{-2}
Range fire (SWOC EE-1)	1.2×10^{-1}	7×10^{-5}	7.4×10^{2}	0 (4×10^{-1})	1.3×10^{2}	2×10^{-1}
Aircraft crash (SWOC EE-2)	2.8×10^{-1}	2×10^{-4}	1.7×10^{3}	1	3.0×10^{2}	4×10^{-1}
Earthmover shears tops off six ILAW containers (ILAW1)	3.4×10^{-6}	2×10^{-9}	2.0×10^{-2}	0 (1×10^{-5})	3.6×10^{-3}	2×10^{-6}
Crushing of ILAW containers by falling crane boom (ILAW2)	3.1×10^{-5}	2×10^{-8}	1.8×10^{-1}	0 (1×10^{-4})	3.3×10^{-2}	2×10^{-5}

[a] The doses presented here result from accident releases of radioactive materials to the atmosphere and are from direct exposure to the plume and inhalation only. Doses from other pathways, such as consumption of foodstuffs and exposure to radioactive material deposited on the ground, are small by comparison.

[b] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

[c] The alphanumeric code following the accident's title (e.g., SWOC FIR-1) corresponds with the code in the accident's description in Section K.3.6.

[d] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[e] Increased likelihood of an LCF for an individual, assuming the accident occurs.

[f] The reported value is the projected number of LCFs in the population, assuming the accident occurs, and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

Key: ILAW=immobilized low-activity waste; LCF=latent cancer fatality.

Table K–103. Waste Management Alternatives 2 and 3 Annual Cancer Risks from Accidents

Accident[a, b]	Frequency	Risk of LCF		
		Maximally Exposed Individual[c]	Offsite Population[d, e]	Noninvolved Worker[c]
Single-drum deflagration (SWOC FIR-1)	1×10^{-2}	5×10^{-9}	0 (3×10^{-5})	5×10^{-6}
Medium fire inside facility (SWOC FIR-6)	1×10^{-2}	9×10^{-8}	0 (5×10^{-4})	9×10^{-5}
Glovebox or greenhouse fire (SWOC FIR-8)	1×10^{-2}	2×10^{-7}	0 (1×10^{-3})	4×10^{-4}
Large fire of waste containers outside facility (SWOC FIR-4)	1×10^{-2}	1×10^{-6}	0 (9×10^{-3})	3×10^{-3}
Handling spill of single waste container (SWOC SP-2)	1×10^{-2}	9×10^{-10}	0 (5×10^{-6})	9×10^{-7}
Large handling spill of boxes or multiple waste containers (SWOC SP-3A)	1×10^{-2}	4×10^{-9}	0 (3×10^{-5})	5×10^{-6}
Spill of single large-diameter container (SWOC SP-4)	1×10^{-2}	4×10^{-8}	0 (3×10^{-4})	4×10^{-5}
Design-basis seismic event (SWOC NPH-1)	1×10^{-3}	4×10^{-9}	0 (2×10^{-5})	4×10^{-6}
Beyond-design-basis accident (SWOC NPH-2)	1×10^{-3}	2×10^{-8}	0 (9×10^{-5})	3×10^{-5}
Range fire (SWOC EE-1)	1×10^{-2}	7×10^{-7}	0 (4×10^{-3})	2×10^{-3}
Aircraft crash (SWOC EE-2)	3×10^{-5}	5×10^{-9}	0 (3×10^{-5})	1×10^{-5}
Earthmover shears tops off six ILAW containers (ILAW1)	1×10^{-1}	2×10^{-10}	0 (1×10^{-6})	2×10^{-7}
Crushing of ILAW containers by falling crane boom (ILAW2)	1×10^{-1}	2×10^{-9}	0 (1×10^{-5})	2×10^{-6}

[a] The alphanumeric code following the accident's title (e.g., SWOC FIR-1) corresponds with the code in the accident's description in Section K.3.6.

[b] The accidents listed were analyzed because they had the highest consequences and/or risks in their category (e.g., leak, spill, mechanical impact, natural phenomena). In some instances, more than one accident is in a category to include similar accidents at different facilities. For some categories (e.g., criticality, flooding), no accidents are listed because either none are applicable or the risks of accidents in the categories are very low.

[c] Increased risk to the individual of an LCF, taking into account the probability (frequency) of the accident.

[d] The reported value is the projected number of LCFs in the population, based on the accident probability (frequency), and is therefore presented as a whole number. When the reported value is zero, the result calculated by multiplying the collective dose to the population by the risk factor (0.0006 LCFs per person-rem) is shown in parentheses.

[e] Based on populations of 546,746 and 589,668 persons residing within 80 kilometers (50 miles) of the 200-East and 200-West Areas, respectively.

Key: ILAW=immobilized low-activity waste; LCF=latent cancer fatality.

K.3.8 Secondary Impacts of Accidents

As previously described in this appendix, technological emergencies or terrorist attacks involving release of radionuclides could produce airborne plumes and cause inhalation impacts on workers and the public. Secondary impacts on human health and other resource areas (e.g., land use, ecology) could also result from the deposition of radioactive material on the ground. The magnitude of any secondary impacts depends on the characteristics of the release, the meteorological conditions at the time of the event, and the type of land area affected. In general, the concentration of radioactive material deposited on the ground will decrease with increasing distance from the point of release. Low windspeeds will usually result in more deposition near the release point and less deposition at greater distances, whereas higher

windspeeds may increase the distance at which ground concentration exceeds levels of concern. The occurrence of rain or snow at the time of the release may accelerate deposition and cause higher concentrations in areas where precipitation has fallen. The radiation dose and associated human health impacts on workers and the public resulting from resuspension (inhalation exposure), ingestion, or ground shine (direct exposure) would not significantly add to the impacts from exposure to the passing plume. However, deposition of radionuclides may also have impacts on land use, socioeconomics, environmental justice, ecology, and other environmental resource areas.

After the initial phase of response to an emergency, EPA may lead efforts to protect human health and the environment from adverse impacts. Working with various stakeholders, EPA may provide technical advice and response support to state, tribal, and local governments; the site or facility owner/operator; and Federal agencies. EPA also has the authority to order private-party cleanup and to oversee and monitor emergency response by others (EPA 2000b). EPA has concluded that soil concentration levels (i.e., deposition) on the order of 0.1 to 1 microcuries per square meter "represent a proper level for concern and initiation of protective actions and temporary access restrictions. A realistic assessment would be expected to lead to less restrictive conclusions" (Burley 1990). Actions and restrictions may take the form of interdiction of agricultural products and limitations on commercial and residential activities, which could in turn affect employment. Cleanup of contaminated areas or property use restrictions may involve substantial monetary cost and loss of beneficial use of property for commercial, residential, agricultural, recreational, institutional, or other purposes. Impacts on water, biological, ecological, and cultural resources are also possible in areas with contamination in excess of the EPA level of 0.1 microcuries per square meter.

A full quantitative assessment of secondary impacts would involve characterizing the amount and current use of onsite and offsite land affected by each accident, as well as the cost of any use restrictions, mitigation efforts, and cleanup. The magnitude of secondary impacts would, in general, be proportional to the amount of radioactive material released and to the direct human health impacts reported in detail in this appendix. A full quantitative analysis of secondary impacts therefore was not performed for this *TC & WM EIS*. Instead, the distances at which the EPA contamination limits would be exceeded are reported as a semi-quantitative expression of the secondary impacts of representative tank closure, FFTF decommissioning, and waste management accidents.

K.3.8.1 Secondary Impacts of Tank Closure Accidents

Severe accidents, such as the seismically induced WTP collapse and failure (WT41), could produce large secondary impacts because of the large release. However, the frequency of this accident is low (1 chance in 2,000 years); therefore, the risk of secondary impacts would be low. In addition, a seismic event could cause simultaneous releases from other Hanford facilities and additional injuries and fatalities that are not associated with exposure to radioactivity. For these reasons, severe accidents are not good examples for estimating secondary impacts.

An accident associated with operations is the spray release from a jumper pit during waste retrieval (TK51). This accident has a higher frequency of occurrence (about 1 chance in 100 years) than a severe accident and serves as a good example for estimating secondary impacts. The analysis of this accident indicates that the 0.1-microcurie-per-square-meter limit would be exceeded out to a distance of 12.9 kilometers (8 miles), while the 1.0-microcurie-per-square-meter limit would be exceeded out to a distance of 3.2 kilometers (2 miles) from the release location. The specific area affected would depend upon the wind direction at the time, duration of the release, and deposition velocity. For this analysis, a 1-hour release and a 0.01-meter-per-second deposition velocity were assumed for all relevant radionuclides. Longer release durations and/or slower deposition velocities would produce larger affected areas. At Hanford, the prevailing wind direction is from the northwest to the southeast. If this accident were to occur at a time of the prevailing wind direction, the secondary impacts and post-accident

cleanup would occur in areas within the site boundary. In the event that the wind direction at the time of the accident were from the east to the west, it would be possible for the 0.1-microcurie-per-square-meter limit to be exceeded a short distance off site, depending on wind and deposition velocities.

Based on information in safety documentation for the WTP, postulated accidents with a higher frequency of occurrence would have smaller releases; therefore, their secondary impacts would likely be within the Hanford boundary. In the event of a lower-frequency/higher-consequence accident, the limits could be exceeded off site, but the risk of secondary impacts would be low.

K.3.8.2 Secondary Impacts of Fast Flux Test Facility Accidents

An RH-SC fire (RHSC1) has an estimated frequency of occurring about once in 100 years and would produce the largest release of radioactive material of all the analyzed FFTF accident scenarios. The analysis of this accident indicates that the 0.1-microcurie-per-square-meter limit would be exceeded out to a distance of 38.2 kilometers (23.7 miles), while the 1.0-microcurie-per-square-meter limit would be exceeded out to a distance of 0.35 kilometers (0.22 miles) from the release location. The specific area affected would depend upon the wind direction at the time, duration of the release, and deposition velocity. For this analysis, an 8-hour release and a 0.01-meter-per-second deposition velocity were assumed for all relevant radionuclides. Longer release durations and/or slower deposition velocities would produce larger affected areas. Regardless of the wind direction at the time of this accident, the secondary impacts and post-accident cleanup would likely extend to areas outside the Hanford boundary. However, the most heavily impacted areas (with deposition greater than the 1.0-microcurie-per-square-meter limit) would be entirely within the site boundary. The SSF fire (SSF1) would result in the 0.1-microcurie-per-square-meter limit being exceeded out to a distance of 22.2 kilometers (13.8 miles), while the 1.0-microcurie-per-square-meter limit would be exceeded out to a distance of 1.75 kilometers (1.1 miles) from the release location. However, the estimated frequency of SSF1 is much lower than that of RHSC1 (about 1 in 1 million years for SSF1 versus 1 in 100 years for RHSC1).

K.3.8.3 Secondary Impacts of Waste Management Accidents

A large fire of waste containers outside a facility (SWOC FIR-4) at the 200-West Area SWOC has an estimated frequency of occurring about once in 100 years; this fire would cause the 0.1-microcurie-per-square-meter limit to be exceeded out to a distance of 12 kilometers (7.5 miles) from the point of release, while the 1.0-microcurie-per-square-meter limit would be exceeded out to a distance of 0.1 kilometers (0.06 miles) from the release location. The specific area affected would depend upon the wind direction at the time, duration of the release, and deposition velocity. For this analysis, a 1-hour release and a 0.01-meter-per-second deposition velocity were assumed for all relevant radionuclides. Longer release durations and/or slower deposition velocities would produce larger affected areas. Depending on the wind direction at the time of this accident, the secondary impacts and post-accident cleanup might extend a few kilometers beyond the Hanford boundary. However, the most heavily impacted areas (with deposition greater than the 1.0-microcurie-per-square-meter limit) would be entirely within the site boundary. The aircraft crash at SWOC with ensuing fire (SWOC EE-2) would result in the 0.1-microcurie-per-square-meter limit being exceeded at a distance of 14.5 kilometers (9.0 miles). However, the estimated frequency of SWOC EE-2 is much lower than that of SWOC FIR-4 (about 3 in 100,000 years for SWOC EE-2 versus 1 in 100 years for SWOC FIR-4).

K.3.9 Chemical Impacts of Accidents

The evaluation of chemical impacts of potential accidents at Hanford considers the accidental release of two kinds of chemicals or toxic materials: (1) those chemicals used in the treatment process or supporting operations, and (2) potentially toxic materials that are constituents of the treated waste.

K.3.9.1 Chemical Impacts of Tank Closure Accidents

A project report issued in September 2002, *Determination of Extremely Hazardous Substances* (Lindquist 2006b), documents the process by which chemicals used in the WTP were evaluated to determine which would be treated as "extremely hazardous substances." This identification plays a part in the regulatory process that will be applied to the WTP management of chemical safety.

Chemicals stored in substantial quantities and used for the vitrification process or supporting operations were addressed in determining which WTP chemicals might be considered extremely hazardous substances, whereas quantities of chemicals contained within the process streams or chemicals created as byproducts of the process were not considered. The evaluation resulted in two chemicals (anhydrous ammonia and 12.2 molar nitric acid) being declared "extremely hazardous substances" (Lindquist 2006b). Table K–104 presents a summary of chemicals that would be used at the WTP and their approximate quantities and locations.

Table K–104. Summary of Chemicals at the Waste Treatment Plant Complex

Chemical Name	Formula	Concentration	Quantity[a, b]			
			Pretreatment Facility	Balance of Facilities at WTP Complex	LAW Vitrification Facility	HLW Vitrification Facility
Alkyl epoxy carboxylate	Proprietary	N/A[c]	–	550 gal	–	–
Aluminum silicate	$A1_2SiO_5$	100%	–	2,175 ft^3	–	–
Ammonia, anhydrous	NH_3	100%	–	12,000 gal	–	–
Antifoam 1520	(Emulsion)	N/A[c]	1,500 gal		–	–
Argon	Ar	100%	–	–	120 ft^3	5,372 ft^3 at 2,400 psig
Borax	$Na_2B_4O_7 \cdot 10H_2O$	100%	–	2,150 ft^3	–	–
Boric acid	H_3BO_3	100%	–	3,000 ft^3	–	–
Calcium silicate	$CaSiO_3$	100%	–	3,000 ft^3	–	–
Carbon (activated)	C	70 wt%	–	–	446 ft^3	1,320 ft^3
Carbon dioxide	CO_2	100%	–	–	28 tons	–
Cerium nitrate	$Ce(NO_3)_3 \cdot H_2O$	0.5 M	–	–	–	550 gal
Ferric oxide	Fe_2O_3	100%	–	1,000 ft^3	–	–
Hydrogen peroxide	H_2O_2	30%	–	–	–	5 gal
Ion exchange resins	SuperLig®[644]	100%	1,200 gal	–	–	–
Lithium carbonate	Li_2CO_3	100%	–	2,500 ft^3	–	–
Magnesium silicate	$MgSiO_3$	100%	–	1,000 ft^3	–	–
Nitric acid	HNO_3	12.2 M	–	21,000 gal	–	–
Nitric acid	HNO_3	5 M	–	1,800 gal	–	–
Nitric acid	HNO_3	2 M	–	2,900 gal	–	1,300 gal
Nitric acid	HNO_3	0.5 M	14,000 gal	–	–	1,500 gal
Nitrogen	N_2	100%	2,688 ft^3 at 2,100 psig	–	–	–
Silica	SiO_2	100%	–	8,500 ft^3	–	–
Silver mordenite	AgZ	18 wt%	–	–	–	414 ft^3
Sodium bromide	NaBr	40%	–	400 gal	–	–
Sodium carbonate	Na_2CO_3	100%	–	1,500 ft^3	–	–

Table K–104. Summary of Chemicals at the Waste Treatment Plant Complex *(continued)*

Chemical Name	Formula	Concentration	Quantity[a, b]			
			Pretreatment Facility	Balance of Facilities at WTP Complex	LAW Vitrification Facility	HLW Vitrification Facility
Sodium hydroxide	NaOH	19 M	–	21,000 gal	–	–
Sodium hydroxide	NaOH	5 M	–	3,900 gal	5,100 gal	1,400 gal
Sodium hydroxide	NaOH	2 M	–	2,700 gal	–	–
Sodium hydroxide	NaOH	0.25 M	–	1,200 gal	–	–
Sodium hydroxide	NaOH	0.1 M	3,042 gal	–	–	–
Sodium hypochlorite	NaOCl	12%	–	1,100 gal	–	–
Sodium permanganate	$NaMnO_4$	40 wt%	–	2,000 gal	–	–
Strontium nitrate	$Sr(NO_3)_2$	40 wt%	–	4,000 gal	–	–
Sucrose	$C_{12}H_{22}O_{11}$	100%	–	1,800 ft^3	–	–
Titanium dioxide	TiO_2	100%	–	1,000 ft^3	–	–
Zinc oxide	ZnO	100%	–	2,500 ft^3	–	–
Zirconium silicate	$ZrSiO_4$	100%	–	1,000 ft^3	–	–

[a] Quantities are approximate and based on current design estimates. A dash (–) indicates that significant quantities of the chemical would not be present in the indicated portion of the WTP (Lindquist 2006b).

[b] Mixtures of glass formers exist in LAW and HLW, but are not listed.

[c] The named product is a proprietary compound or mixture.

Note: To convert cubic feet to cubic meters, multiply by 0.028317; gallons to liters, by 3.7854.

Key: %=percent; ft^3=cubic feet; gal=gallon; HLW=high-level radioactive waste; LAW=low-activity waste; M=molar (moles per liter); N/A=not applicable; psig=pounds per square inch gauge; wt%=weight-percent; WTP=Waste Treatment Plant.

Source: Lindquist 2006b.

K.3.9.1.1 Ammonia

Anhydrous ammonia is a gas stored as a liquid under pressure; its normal boiling point at 1 standard atmosphere unit of pressure is –33 °C (–28 °F). Therefore, under most conditions, it rapidly returns to its gaseous state upon release to the environment. Inhalation may cause irritation (possibly severe), lack of sense of smell, nausea, vomiting, chest pain, difficulty breathing, headache, and lung damage; inhalation may be fatal. Skin contact may cause irritation (possibly severe), blisters, and frostbite. Eye contact may cause irritation (possibly severe), frostbite, tearing, blindness, and glaucoma. Ingestion may cause irritation (possibly severe), difficulty breathing, and kidney damage.

Ammonia is a negligible fire hazard and a moderate explosion hazard. Containers could rupture or explode if exposed to heat.

It is incompatible with acids, combustible materials, metals, oxidizing materials, metal salts, halo carbons, amines, reducing agents, cyanides, and bases. When used at the HLW Vitrification Facility within the WTP, it may react with boric acid, cerium nitrate, hydrogen peroxide, lithium carbonate, nitric acid, or sucrose to produce heat. The reaction with hydrogen peroxide may also liberate toxic gas, and the reaction with cerium nitrate may liberate flammable gas. However, because anhydrous ammonia is a gas stored as a liquid under pressure, it returns to the gaseous state upon release at ambient pressure. All of the HLW chemicals that might cause a reaction are in the form of either solids as powders or liquids. As a result, there is very limited potential for these materials to mix and produce a reaction, and potential reactions would be limited by the surface area available for contact.

A catastrophic failure of the 45,400-liter (12,000-gallon) storage tank (with an operating capacity of approximately 43,500 liters [11,500 gallons]) containing anhydrous ammonia could rapidly release its

entire contents as ammonia gas (Lindquist 2006b). The gas was assumed to be released directly to the atmosphere over a period of 30 minutes. This assumption does not credit the mitigative effects of the control equipment or the building that houses the storage tanks, which would limit the amount of ammonia released to the atmosphere.

K.3.9.1.2 Nitric Acid

In its concentrated form, nitric acid is an acute inhalation hazard. It is not combustible, but it is a strong oxidizer, and the heat produced by its reaction with reducing agents or combustibles may cause irritation. It can react with metals to release nitrogen oxides and flammable hydrogen gas. It may react explosively with combustible organic or readily oxidizable materials.

Nitric acid is present in various concentrations in the Pretreatment Facility, Wet Chemical Storage Facility, and HLW Vitrification Facility. At the Wet Chemical Storage Facility, nitric acid in any concentration could react with any concentration of sodium hydroxide to produce heat. The reaction between the highest concentrations of nitric acid and highest concentrations of sodium hydroxide could generate extreme heat, resulting in fire. In the HLW Vitrification Facility, nitric acid could react with ammonia, boric acid, cerium nitrate, hydrogen peroxide, lithium carbonate, sodium hydroxide, or sucrose to generate heat. Reactions between concentrated nitric acid and lithium carbonate or sucrose could generate heat and flammable gas, igniting byproducts of the reaction and causing a fire. During pretreatment, weak concentrations of nitric acid (0.5 molar) and sodium hydroxide (0.1 molar) could react to create heat. The reaction between ion exchange resins and weak nitric acid is part of the process to remove captured cesium; however, reaction of the resin with concentrated nitric acid (greater than 10 molar) is vigorous and exothermic and releases large quantities of carbon monoxide gas.

The consequences of a spill release involving 12.2 molar nitric acid from the storage tank at the balance of facilities at the WTP complex have been investigated (Graves 2003) and are considered representative of a severe accident involving this material. The consequences of chemical spills in the balance of facilities would be less than those of a spill of the entire contents of the 79,500-liter (21,000-gallon) 12.2 molar nitric acid storage vessel (with an operating capacity of approximately 64,400 liters [~17,000 gallons]). This vessel is surrounded by a berm that is designed to contain at least 100 percent of the largest volume of the largest tank within it. A number of different mechanisms that could result in the total or partial loss of contents of this storage vessel have been identified. As the storage area is covered but open on all sides, the vapor would be released directly to the atmosphere. Parameters used in developing inputs for the dispersion code are shown in Table K–105.

The temperature of the spilled pool was assumed to be 35 °C (95 °F). This temperature corresponds to a hot summer day and yields a conservative value for vapor pressure. The surface area of the spill is equal to the area of the berm minus the area of the storage tank:

$$A_{spill} = 1{,}725 \text{ square feet} - [(12 \text{ feet}/2)^2 (3.14)] = 1{,}610 \text{ square feet (150 square meters)}$$

Table K–105. Balance-of-Facilities Nitric Acid Spill Dispersion Modeling Parameters

Item	Value
Operating volume	64,400 liters (17,000 gallons)
Maximum capacity	79,500 liters (21,000 gallons)
Area of berm	160 square meters (23 feet×75 feet = 1,725 square feet)
Nitric acid storage temperature	20 °C (68 °F)
Diameter of storage tank	3.7 meters (12 feet)
Molecular weight of nitric acid	63.01 grams per mole
Density of 12.2 molar nitric acid at 20 °C (68 °F)	1,350.5 grams per liter (84 pounds per cubic foot) (Perry, Green, and Maloney 1984)
Concentration (weight-percent) of 12.2 molar nitric acid	57 percent
Vapor pressure at 35 °C (95 °F)	1.69 millimeters (0.07 inches) of mercury (Perry, Green, and Maloney 1984)

Key: °C=degrees Celsius; °F=degrees Fahrenheit.

K.3.9.1.3 Direct Human Health Impacts

Two chemicals, nitric acid and ammonia, were selected to represent all chemicals and would have the largest expected impacts due to accident releases. The selection of these two chemicals was based on the large quantities that are potentially available for release and their chemical properties and health effects. For both chemicals, an accident scenario was postulated in which a break in a tank or piping occurs, allowing the chemical to be released over a short period. The cause of the break could be mechanical failure, corrosion, mechanical impact, or natural phenomena. The frequency of the accident is in the range of 0.001 to 0.01 per year. Nitric acid would form a pool within a berm surrounding the tank and, by evaporation, be released as a plume that disperses into the environment. Ammonia would be released from its storage tank in a gaseous form. The chemical plume would move away from its point of release in a prevailing wind direction and could potentially impact workers and the public.

Table K–106 shows the estimated concentrations of each chemical at specified distances for comparison with the 60-minute AEGL-2 and AEGL-3 (EPA 2009). The levels of concern for ammonia are 160 ppm for AEGL-2 and 1,100 ppm for AEGL-3. The levels of concern for nitric acid are 24 ppm for AEGL-2 and 92 ppm for AEGL-3. The results indicate that AEGL-2 and AEGL-3 thresholds would not be exceeded beyond the nearest site boundary. For the noninvolved worker 100 meters (110 yards) from the accident, both the AEGL-2 and AEGL-3 thresholds would be exceeded for the ammonia release, but not for the nitric acid release.

Table K–106. Tank Closure Accidents – Chemical Impacts

Chemical	Quantity Released (gallons)	AEGL-2[a]		AEGL-3[b]		Concentration (ppm)	
		Limit (ppm)	Distance to Limit (meters)	Limit (ppm)	Distance to Limit (meters)	Noninvolved Worker at 100 Meters	Nearest Site Boundary at 8,600 Meters
Ammonia	11,500	160	2,450	1,100	730	41,000	27.0
Nitric acid	17,000	24	<30	92	<30	4.7	0.004

[a] AEGL-2 (60-minute) is the airborne concentration (expressed as ppm or milligrams per cubic meter) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting, adverse health effects or an impaired ability to escape (EPA 2009).

[b] AEGL-3 (60-minute) is the airborne concentration (expressed as ppm or milligrams per cubic meter) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death (EPA 2009).

Note: To convert gallons to liters, multiply by 3.7854; meters to yards, by 1.0936.

Key: AEGL=Acute Exposure Guideline Level; ppm=parts per million.

K.3.9.1.4 Secondary Impacts

Ammonia releases are fairly common events. Each year, about 40 releases resulting in injuries or evacuation occur in the state of Washington alone (WSDOH 2008). Ammonia is a gas at normal ambient temperatures that disperses into the atmosphere following its release. If a large release occurs, the gas may burn the leaves of nearby downwind vegetation but will not affect the roots, so damaged plants may fully recover. If ammonia were directly spilled into surface water or if water used by a fire department to suppress an ammonia vapor cloud were allowed to reach surface water, aquatic life could be harmed. After a release of ammonia, the vapors react with moisture in the air to form ammonium, which eventually returns to the earth in rainfall. Deposition of ammonium may be heavy near the location of release if it rains during or shortly after the release, before the plume has dispersed. Ammonium rarely accumulates in soil because whatever is not taken up by plant roots is rapidly converted by bacteria into nitrates. Nitrates in the soil are taken up by plants or leach vertically through the root zone (MDOA 2008).

The only secondary impacts expected from a large ammonia release at Hanford would be possible temporary damage to green vegetation in the plume path, followed by enhanced growth of all plants in the same area as a result of the infusion of nitrates into the typically nitrogen-poor desert soils. Because essentially all of the annual precipitation that falls on the site is taken up by plant roots or evaporates directly from the soil, leaching of nitrates through the vadose zone to the water table is not expected to present a discernible environmental impact.

Nitric acid released to the atmosphere as a gas is removed by deposition processes. The estimated half-life for dry deposition of nitric acid is 1.5 to 2 days, and it is efficiently scrubbed from the atmosphere by precipitation. Nitric acid reacts with gaseous ammonia in the atmosphere to form particulate or aerosol nitrate, which in turn is removed by wet and dry deposition of the particles. The average half-life and lifetime for particles in the atmosphere is about 3.5 to 10 days (DEWHA 2005). During the timeframe suggested by these removal rates, a nitric acid plume from the analyzed WTP release is expected to disperse widely over the region rather than be concentrated on or near the release site. The effect of nitrates produced and subsequently deposited on the soil would be the same as described previously for those derived from an ammonia release.

Concentrated acidic rainfall during or shortly after a nitric acid release (before the plume disperses) might harm vegetation and crops in areas near the site. However, effects lasting more than a single growing season are not expected because the surface soils of the Columbia Basin typically range from neutral to quite alkaline (with pH values of 7 or higher) and contain significant amounts of carbonates. They therefore have the capacity to neutralize acids without significant changes in soil pH. In fact, farmers and gardeners in the region frequently apply elemental sulfur and fertilizers containing iron sulfate, ammonium sulfate, or aluminum sulfate specifically to reduce soil pH to a more favorable range for crops (WSU 2004).

K.3.9.2 Chemical Impacts of Fast Flux Test Facility Accidents

During FFTF decommissioning activities, the only chemical capable of creating a significant airborne hazard resulting from an accidental release is the sodium formerly used as a reactor coolant. Three inventories of bulk sodium are addressed under the FFTF Decommissioning alternatives covered by this EIS. These inventories include the FFTF bulk sodium stored in the SSF, the Hallam Reactor sodium stored in the 2727-W Building, and the SRE sodium stored in the South Alkali Metal Storage Modules in the 200-West Area. Under the FFTF Decommissioning alternatives proposed and analyzed in this EIS, these inventories would be either stored for the foreseeable future or processed at INL or Hanford into a 50 weight-percent solution of sodium hydroxide for use at Hanford.

Bulk sodium in its solid or molten form does not represent a significant airborne hazard. However, metallic sodium reacts violently with a broad range of materials, including water. On contact with water, it will ignite and produce hydrogen. Metallic sodium is highly flammable and may ignite spontaneously on exposure to moisture in the air. If sodium is burned in air, the resulting combustion byproducts are mostly sodium oxide, with a small percentage of sodium carbonate and a very small percentage of sodium hydroxide. Because of the ability of sodium oxide to react with water in the air (or in the human respiratory tract) to form sodium hydroxide, all of the sodium released from a fire was assumed to come off as sodium hydroxide; 1 gram (0.035 ounces) of sodium would produce 1.74 grams (0.061 ounces) of sodium hydroxide (Himes 1996).

An accidental spill and evaporative release of the 50 weight-percent sodium hydroxide produced under the Hanford and Idaho Reuse Options of FFTF Decommissioning Alternatives 2 and 3 would not represent an airborne hazard. As evaporation occurred, the water in solution would escape, leaving an even more concentrated solution of sodium hydroxide behind. Eventually, the sodium hydroxide would dry out to the point that it formed crystalline sodium hydroxide. Sodium hydroxide would also be produced during component cleaning and residual sodium treatment. This waste material would be pumped from the point of generation to collection, storage, or treatment tanks for processing. A spray release could occur during pumping operations, which would create an airborne release. However, the pumping operation would have to occur at pressures of 100 pounds per square inch or more to generate aerosols that are an inhalation concern. It is not anticipated that pressures of 100 pounds per square inch or more will be used in any of the operations planned under any of the FFTF Decommissioning alternatives.

Because the sodium metal is contaminated with radioactive material, any airborne release caused by a fire would cause radiological as well as chemical impacts. For each sodium fire scenario analyzed as part of the radiological impacts of facility accidents, there is also a chemical impact. Therefore, the accident scenarios analyzed in this section of this appendix are the same as those analyzed in Section K.3.5.

As with the analysis of radiological impacts due to accidents, analysis of chemical impacts due to accidents was based on unmitigated releases, meaning that no credit was taken for HEPA filtration, structural confinement, or other engineered features that may limit the amount of the chemical released to the environment. Although a fire normally implies some degree of thermal lofting, which would reduce ground-level air concentrations, the intensity of the fire, and therefore the degree of the lofting, cannot be predicted. For this reason, fire scenarios were conservatively assumed to be ground-level sources for purposes of estimating direct receptor exposures. Results of sodium fire studies indicate that rapid agglomeration and fallout of the combustion particles occur in the first 50 to 100 meters (55 to 110 yards) of transport (Himes 1996). This process would greatly reduce the downwind air concentrations; however, because of the difficulty in quantifying this effect, it was not included as a factor in the release model. Because of the conservative assumptions discussed above, air concentration results near the source may exceed 100 milligrams per cubic meter, commonly thought to be the highest particulate concentration that can be supported in the air at a point away from the source (Himes 1996).

The alphanumeric code following the accident's title (e.g., SSF1) corresponds with the code in the accident's description in the tables of this section and in Chapter 4, Section 4.2.11; it is provided to facilitate cross-referencing between tables and accident descriptions.

K.3.9.2.1 Accidents in the Hanford 400 Area

K.3.9.2.1.1 Sodium Storage Facility Fire (SSF1)

This accident scenario involves a postulated aircraft crash into the FFTF SSF, breaching all four sodium storage tanks and igniting the sodium metal within them. This accident would result in a sodium burn

rate of approximately 8,730 kilograms (19,200 pounds) per hour. Assuming an ARF of 0.35 and a yield of 1.74 grams of sodium hydroxide per gram of sodium burned (Himes 1996), the resulting production rate of airborne sodium hydroxide particulate would be 8,730 kilograms (19,200 pounds) per hour × 0.35 × 1.74 = 5,320 kilograms (11,700 pounds) per hour.

A complete description of this scenario can be found in Section K.3.5.1.1.

K.3.9.2.1.2 Hanford Sodium Storage Tank Failure (HSTF1)

This accident was postulated to result from a large leak due to growth of a metal defect in one SSF storage tank. The tank was assumed to be initially filled with molten sodium and the entire inventory of the tank was assumed to discharge onto the steel floor of the secondary containment and burn. Exposure to the burning pool of sodium was assumed to breach the other three tanks, causing the sodium to leak into the burning pool. The resulting burn rate was estimated to be 22,600 kilograms (49,800 pounds) per hour, and the fire duration was estimated to be approximately 41 hours. Using an ARF of 0.35 and a yield of 1.74 grams of sodium hydroxide per gram of sodium burned (Himes 1996), the resulting production rate of airborne sodium hydroxide particulate would be 22,600 kilograms (49,800 pounds) per hour × 0.35 × 1.74 = 13,800 kilograms (30,340 pounds) per hour.

A complete description of this scenario can be found in Section K.3.5.1.2.

K.3.9.2.1.3 Remote-Handled Special Component Fire (RHSC1)

This scenario represents possible accidents involving removal and transport of the FFTF RH-SCs that would have the largest impacts. A handling mishap was postulated to cause a breach of the largest component (the primary cold trap) and exposure of the contained sodium to water and air. As a result, a portion (30 percent) of the sodium, 750 kilograms (1,650 pounds), would burn. Assuming that the diameter of the primary cold trap is approximately 1.53 meters (5 feet), the surface area of the burning sodium would be approximately 1.84 square meters (19.64 square feet). Using the standard burn rate for an open pool of sodium on a steel liner, 10.8 grams per square meter per second (8 pounds per square foot per hour) (Himes 1996), the burn rate was estimated to be 71.5 kilograms (157 pounds) per hour, and the fire duration was estimated to be approximately 36 hours. Using the sodium burn release parameters previously listed, the resulting production rate of airborne sodium hydroxide particulate would be 71.5 kilograms (157 pounds) per hour × 0.35 × 1.74 = 43.5 kilograms (96 pounds) per hour. The release rate for this event is less than 1 percent of that for the Hanford sodium storage tank failure. Because the consequences of a chemical release are directly proportional to the release rate, the consequences of this release would be a very small fraction of those from either the Hanford sodium storage tank failure or the SSF fire discussed above. As impacts of this event would be less than those of the preceding events, it was not analyzed further.

A complete description of this scenario can be found in Section K.3.5.1.3.

K.3.9.2.2 Accidents in the Hanford 200-West Area

K.3.9.2.2.1 Hallam Reactor Sodium Fire (HSF1)

Sodium formerly used as coolant in the Hallam Reactor is stored as a solid in five tanks in the 2727-W Building in the Hanford 200-West Area. Two tanks are full; one is half-full; and the remaining two contain only residual heels. In this scenario, the building and a tank would be breached, allowing water to enter a tank, causing a fire to start. The entire contents of the full tank, 59,600 kilograms (131,000 pounds) of sodium, would burn and be released at ground level over a period of 69 hours. The postulated maximum release rate corresponds to a sodium pool fire with a size equal to the area of the

internal tank dimensions, i.e., a 3.66-meter-diameter by 6.10-meter effective length (12-foot diameter by 20-foot length), equivalent to 22.3 square meters (240 square feet). Using the sodium burn release parameters previously listed (Himes 1996), the sodium burn rate was estimated to be 867 kilograms (1,911 pounds) per hour. The resulting production rate of airborne sodium hydroxide particulate would be 867 kilograms (1,911 pounds) per hour × 0.35 × 1.74 = 528 kilograms (1,164 pounds) per hour.

A complete description of this scenario can be found in Section K.3.5.2.1.

K.3.9.2.2.2 Sodium Reactor Experiment Sodium Fire (SRE1)

Sodium formerly used as coolant in the SRE is stored as a solid in drums in the South Alkali Metal Storage Modules near the 200-West Area CWC. In this scenario, a vehicle would impact a single storage module, causing a fire, which would involve 20 drums consisting of a total of 3,360 kilograms (7,410 pounds) of sodium. The burning area was estimated to be equivalent to the 5.9-square-meter (63-square-foot) footprint of 20 drums within a single storage module. Using the sodium burn release parameters previously listed (Himes 1996), the sodium burn rate was estimated to be 228 kilograms (503 pounds) per hour. The resulting production rate of airborne sodium hydroxide particulate would be 228 kilograms (503 pounds) per hour × 0.35 × 1.74 = 139 kilograms (306 pounds) per hour.

A complete description of this scenario can be found in Section K.3.5.2.2.

K.3.9.2.3 Accidents at Idaho National Laboratory

K.3.9.2.3.1 INL Sodium Processing Facility Storage Tank Failure (INLSPF1)

The accident with the largest impacts from disposition of bulk sodium at the INL SPF would be a failure of the secondary sodium drain tank located in the EBR-II secondary sodium boiler building with an accompanying fire. Failure of the tank would result in a spill of its working capacity of molten sodium. The burn rate of the resulting fire was estimated to be 2,260 kilograms (4,982 pounds) per hour. Using the sodium burn release parameters previously listed (Himes 1996), the resulting production rate of airborne sodium hydroxide particulate would be 2,260 kilograms (4,982 pounds) per hour × 0.35 × 1.74 = 1,376 kilograms (3,030 pounds) per hour.

A complete description of this scenario can be found in Section K.3.5.3.1.

K.3.9.2.4 Direct Human Health Impacts

A sodium fire produces a heavy, opaque, white plume. Contact with the plume in high concentrations near the source of release is immediately irritating and can cause burns to the upper respiratory tract, exposed skin, and surface of the eyes. The recognizable and characteristic heavy white plume, coupled with the immediate and severe health effects, create a self-evacuation effect for personnel in close proximity to a release.

Table K–107 shows the estimated concentrations of particulate sodium hydroxide for each accident scenario analyzed. As AEGL values have not been developed for sodium hydroxide, the American Industrial Hygiene Association ERPG levels 2 and 3 were compared with the concentrations at specific distances as an indicator of human health impacts. The guideline levels for sodium hydroxide are 5 milligrams per cubic meter for ERPG-2 and 50 milligrams per cubic meter for ERPG-3 (DOE 2008). The results indicate that, for the Hanford sodium storage tank failure scenario, the ERPG-2 value is slightly exceeded beyond the site boundary. For the remaining scenarios, the ERPG-2 and ERPG-3 thresholds would not be exceeded beyond the nearest site boundary. For the noninvolved worker 100 meters (110 yards) from an accident, both the ERPG-2 and ERPG-3 thresholds would be exceeded for all scenarios analyzed.

Table K–107. Fast Flux Test Facility Accidents – Chemical Impacts

Scenario	Distance to Site Boundary (meters)	Release Rate (kg/hr)	ERPG-2[a]		ERPG-3[b]		Concentration (mg/m^3)	
			Limit (mg/m^3)	Distance to Limit (meters)	Limit (mg/m^3)	Distance to Limit (meters)	Noninvolved Worker at 100 Meters	Site Boundary
Sodium Storage Facility fire (SSF1)	6,800	5,320	5	3,700	50	850	2,400	2.2
Hanford sodium storage tank failure (HSTF1)	6,800	13,800	5	7,350	50	1,520	6,200	5.6
Hallam Reactor sodium fire (HSF1)	4,300	531	5	855	50	233	240	0.41
Sodium Reactor Experiment sodium fire (SRE1)	3,500	139	5	395	50	113	63	0.14
INL Sodium Processing Facility storage tank failure (INLSPF1)	5,500	1,376	5	1,530	50	390	620	0.75

[a] ERPG-2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.

[b] ERPG-3 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

Note: To convert kilograms to pounds, multiply by 2.2046; meters to yards, by 1.093.

Key: ERPG=Emergency Response Planning Guideline; Hanford=Hanford Site; INL=Idaho National Laboratory; kg/hr=kilograms per hour; mg/m^3=milligrams per cubic meter.

K.3.9.2.5 Secondary Impacts

Section K.3.8.2 presents the secondary radiological impacts of FFTF accidents. The SSF fire (SSF1) was estimated to produce ground deposition of radionuclides exceeding 1.0 microcurie per square meter to a distance of 1.75 kilometers (1.1 miles) and 0.1 microcuries per square meter to a distance of 22.2 kilometers (13.8 miles) from the release location. These ground contamination levels were calculated using the sum of all radionuclide concentrations in FFTF primary sodium (i.e., the sum 5.6×10^{-9} curies per gram of sodium-22, 4.8×10^{-11} curies per gram of cesium-137, and 5.2×10^{-8} curies per gram of tritium). Dividing the calculated ground contamination level by the total sodium activity concentration (5.8×10^{-8} curies per gram) indicates that the 0.1-microcurie-per-square-meter contamination level corresponds to deposition of 1.72 grams of sodium per square meter (3.0 grams of sodium hydroxide per square meter). The sodium hydroxide deposition corresponding to 1.0 microcurie per square meter is 10 times greater (30 grams per square meter).

In areas where high levels of dry deposition have occurred, airborne (resuspended) particles of sodium hydroxide could cause skin, eye, and respiratory system irritation and other acute toxic effects associated with inhalation of sodium hydroxide aerosol. These effects might necessitate evacuation or relocation of people from heavily contaminated areas. Sodium hydroxide is very soluble in water. Once dissolved, it would be transported into the soil, where it would be rapidly neutralized by organic chemicals (Salocks and Kaley 2003). Therefore, evacuation or relocation would likely be necessary only until a significant precipitation event occurs. Significant precipitation events on or near Hanford are infrequent during the typically dry period between late spring and mid-autumn, and the duration of an evacuation or relocation might be weeks or even months if the release were to occur during those seasons.

Heavy precipitation events that could produce strongly alkaline runoff into streams and rivers are infrequent in the vicinity of Hanford. However, a strongly alkaline solution that could be formed by the dissolution of sodium hydroxide in rain or irrigation water could harm the foliage or tender shoots of growing plants. Sodium hydroxide does not accumulate in the food chain (ATSDR 2002).

Significant long-term effects on soil fertility or productivity could occur in those areas where the deposition is heavy enough to cause a pronounced increase in soil pH. Most surface soils on and near Hanford are slightly to moderately alkaline (WSU 2008), and a large addition of sodium hydroxide might increase the pH to a level that causes essential minerals and nutrients to become less available to plants or the growth of beneficial microorganisms to be inhibited (SUNY ESF 2008). Soil texture and the ability of water and plant roots to penetrate it can also be negatively affected by excessive sodium. However, these effects can be remediated by addition of various fertilizers and soil amendments (Warrence, Bauder, and Pearson 2002).

K.3.9.3 Chemical Impacts of Waste Management Accidents

Hazardous waste at the SWOC exists in the contents of TRU waste containers and suspect TRU waste[3] containers and in sodium in storage modules at the CWC. The future disposition of the bulk sodium stored at the CWC is addressed in the FFTF Decommissioning alternatives. The consequences of accidents involving this inventory of hazardous material are addressed in Section K.3.9.2, Chemical Impacts of Fast Flux Test Facility Accidents.

To estimate the potential impacts of an accidental release of the hazardous chemicals at SWOC, SWOC waste containers were evaluated using the methodologies of both the DOE safety analysis and emergency management programs to identify which hazardous chemicals should be subjected to quantitative analyses.

K.3.9.3.1 Safety Analysis Evaluation of Chemical Hazards

The DSASW (Fluor Hanford 2007) identifies a list of known hazardous chemical constituents that may be present in retrieved TRU waste and suspect TRU waste containers. The list was generated in 1992 by performing a survey of the *Solid Waste Information and Tracking System (SWITS)* database. The results are documented in the *Solid Waste Stream Hazardous and Dangerous Components Study* (Olson 1992). The survey identified nearly 400 chemicals known to exist in the containers present at SWOC through 1991. Because of the relative constancy of waste streams since the list was generated, it was assumed that the types and quantities of hazardous materials present in the SWOC containers are consistent with the types and quantities on the list (Fluor Hanford 2007). Using a set of criteria intended to identify hazardous materials that could result in significant impacts on workers and the public, the list of 400 was condensed to a list of 24 hazardous materials. This condensed list is presented in Table K–108. The inventories of the materials on the condensed list were updated with the most current information and served as the starting point for the identification of materials requiring additional analysis in the DSASW. The DSASW notes that the material list and associated inventories are not intended to be inclusive of all hazardous chemicals that might be present in solid waste containers at SWOC, but the list is representative of the wide assortment of materials anticipated to be retrieved, handled, stored, and processed and results in a conservative estimate of impacts (Fluor Hanford 2007).

[3] Suspect TRU waste is radioactive waste that is thought to be TRU waste, but for which adequate characterization data are not yet available to confirm the classification.

Table K–108. Potential Hazardous Materials in Waste Feed Streams

Hazardous Material (CASRN)	Number of Containers with Amount Listed[a]	Maximum Amount in a Single Container (kilograms)	Median (kilograms)	Maximum Amount in a Single Location (kilograms)
Ammonia (7664-41-7)	5	2.61	0.45	2.94
Ammonium nitrate (6484-52-2)	3	32.5	7.4	32.5
Beryllium (7440-41-7)	118	7	1.814	7
Cadmium (7440-43-9)	157	93.54	0.0003	195.2
Cyclohexane (110-82-7)	4	18.1	2.22	18.1
Dioxane (123-91-1)	1	25.22	25.22	25.22
Hydrogen peroxide (7722-84-1)	4	0.50	0.10	1.85
Manganese (7439-96-5)	2	0.06	0.04	0.06
Mercury (7439-97-6)	184	31.8	0.041	661.5
Naphthylamine (91-59-8)	1	102.1	102.1	102.1
Nitric acid (7697-37-2)	149	130	0.02	411.6
Phosphoric acid (7664-38-2)	44	76.26	3.0	1,884.12
Propane (74-98-6)	1	3.35	0.90	5.9
Sodium (7440-23-5)	2	23.16	1.28	392.1
Sodium hydroxide (1310-73-2)	3,011	105.25	0.0004	3,247.3
Sodium hypochlorite (7681-52-9)	1	0.36	0.0075	0.36
Sodium oxide (12401-86-4)	16	48.26	48.26	724.4
Styrene (100-42-5)	6	15.46	0.556	15.46
Tetrahydrofuran (109-99-9)	6	2.98	0.0007	2.98
Uranium oxide (1344-57-6)	342	351.6	1.325	1,391.3
Uranyl nitrate hexahydrate (13520-83-7)	7	6.1	0.7	6.1
Vinyl chloride/ resins (75-01-4)	11	254	0.4536	1,135.5
Vinyl ester/acetate resins (9003-22-9)	4	2.75	0.95	2.75
Zirconium (7440-67-7)	187	13.8	11.64	1,168.4

[a] The number of individual containers for which the amount of the constituent was listed in the Solid Waste Information and Tracking System (SWITS) database. In some cases, records indicate contents only as a total for a group of containers.

Note: To convert kilograms to pounds, multiply by 2.2046.

Key: CASRN=Chemical Abstracts Service Registry Number.

Source: Fluor Hanford 2007:Table 3D-1.

The methodology used in the DSASW to evaluate danger associated with hazardous materials in retrieved TRU waste and suspect TRU waste involved comparison of the values of maximum inventories at a single location from Table K–108 with the reportable quantities, threshold quantities (TQs), and threshold planning quantities (TPQs) provided in applicable Federal regulations; see Table K–109 for a summary comparison. The goal of this process was to identify the hazardous waste material inventories that represent significant potential risks and select them for more-detailed analysis within the DSASW and comparison with the risk guidelines.

The first step of the screening process used in the DSASW included a comparison of values of maximum hazardous material inventories at a single location (see Table K–108) with the reportable quantity values

presented in "Designation, Reportable Quantities, and Notification" (40 CFR 302, Table 302.4). The Hanford safety analysis methodology requires that a qualitative assessment of the adequacy of controls be performed for chemical waste constituents that exceed reportable quantity values. As shown in Table K–109, this screening process concluded that the following chemical inventories at a single location exceed their respective reportable quantity values: beryllium, cadmium, mercury, naphthylamine, sodium, sodium hydroxide, and vinyl chloride/resins. The results of the qualitative assessment of control adequacy determined that existing safety management programs would provide adequate protection for all receptors. The significant safety management programs are those designated for hazardous material protection (training, communication program), radioactive and hazardous waste management, operational safety (conduct of operations, fire protection), emergency preparedness (protective actions), and institutional safety (industrial safety). As a result, no quantitative accident analysis was performed in the DSASW for these chemicals (Fluor Hanford 2007).

Table K–109. Reportable Quantities (kilograms)

Hazardous Material (CASRN)	Maximum Amount in a Single Location	Reportable Quantity[a]	Threshold Quantity[b]	Threshold Planning Quantity[c]	Threshold Quantity for Accidental Release Prevention[d]
Ammonia (7664-41-7)	2.94	45.4	4,540	227	9,074
Ammonium nitrate (6484-52-2)	32.5	NR	NR	NR	NR
Beryllium (7440-41-7)	7	4.54	NR	NR	NR
Cadmium (7440-43-9)	195.2	4.54	NR	NR	NR
Cyclohexane (110-82-7)	18.1	454	NR	NR	NR
Dioxane (123-91-1)	25.22	45.4	NR	NR	NR
Hydrogen peroxide (7722-84-1)	1.85	NR	3,400	454	NR
Manganese (7439-96-5)	0.06	0.45	NR	NR	NR
Mercury (7439-97-6)	661.5	0.45	NR	NR	NR
Naphthylamine (91-59-8)	102.1	4.54	NR	NR	NR
Nitric acid (7697-37-2)	411.6	454	227	NR	6,805
Phosphoric acid (7664-38-2)	1,884.12	2,270	NR	NR	NR
Propane (74-98-6)	5.9	454	NR	NR	NR
Sodium (7440-23-5)	392.1	4.54	NR	NR	NR
Sodium hydroxide (1310-73-2)	3,247.3	454	NR	NR	NR

Table K–109. Reportable Quantities (kilograms) *(continued)*

Hazardous Material (CASRN)	Maximum Amount in a Single Location	Reportable Quantity[a]	Threshold Quantity[b]	Threshold Planning Quantity[c]	Threshold Quantity for Accidental Release Prevention[d]
Sodium hypochlorite (7681-52-9)	0.36	45.4	NR	NR	NR
Sodium oxide (12401-86-4)	724.4	NR	NR	NR	NR
Styrene (100-42-5)	15.46	454	NR	NR	NR
Tetrahydrofuran (109-99-9)	2.98	454	NR	NR	NR
Uranium oxide (1344-57-6)	1,391.3	NR	NR	NR	NR
Uranyl nitrate hexahydrate (13520-83-7)	6.1	45.4	NR	NR	NR
Vinyl chloride/resins (75-01-4)	1,135.5	0.45	NR	NR	4,540
Vinyl ester/acetate resins (9003-22-9)	2.75	2,270	NR	454	6,805
Zirconium (7440-67-7)	1,168.4	NR	NR	NR	NR

[a] Reportable quantity values taken from Table 302.4 of Title 40 of the *Code of Federal Regulations* (CFR), Section 302.4.
[b] Threshold quantity values taken from Appendix A of 29 CFR 1910.119.
[c] Threshold planning quantity values taken from Appendix A of 40 CFR 355.40.
[d] Threshold quantity values for accidental release prevention taken from Tables 1 and 3 of 40 CFR 68.130.
Note: To convert kilograms to pounds, multiply by 2.2046.
Key: CASRN=Chemical Abstracts Service Registry Number; NR=not reported—no reportable quantity, threshold quantity, or threshold planning quantity value was listed for these chemicals.
Source: Fluor Hanford 2007:Table 3D-2.

The next step of the DSASW screening process included a comparison of the maximum hazardous material inventories at single location (see Table K–109) with the TQ values presented in "Process Safety Management of Highly Hazardous Chemicals" (29 CFR 1910.119, Appendix A). Appendix A of 29 CFR 1910.119 provides a list of highly hazardous chemicals, toxics, and reactives with the potential to cause a catastrophic event when present at or above the TQ value. As shown in Table K–109, the maximum hazardous material inventories at a single location are below the respective TQ values for those chemicals that have a TQ listed in the appendix. Therefore, a process hazard analysis pursuant to 29 CFR 1910.119 was not required.

The maximum hazardous material inventories at a single location were then compared with the TPQ values presented in "Emergency Planning and Notification" (40 CFR 355, Appendix A) and the TQ values in "Chemical Accident Prevention Provisions" (40 CFR 68, Table 1). Hazardous constituents of waste that did not exceed a TPQ or TQ value from the CFR sections listed above or that did not have a TPQ or TQ value listed were screened from further analysis based on the conclusion that these materials are not deemed to be highly hazardous materials by OSHA or EPA; thus, no further hazards assessments are required by the CFR.

The Hanford safety analysis methodology for assessing hazards associated with chemical waste constituents specifies that a quantitative analysis to compare potential exposures with evaluation guidelines be considered if a TQ (29 CFR 1910.119) or TPQ value (40 CFR 355) is exceeded. The methodology does not explicitly require a comparison with the 40 CFR 68 TQ values or direct actions if these values are exceeded. None of the maximum hazardous material inventories at a single location

exceeded the TQ value from 29 CFR or 40 CFR or the TPQ value from 40 CFR. Consequently, it was not necessary to perform a quantitative analysis in the DSASW for any of the hazardous materials listed in Table K–109.

K.3.9.3.2 Emergency Management Evaluation of Chemical Hazards

In addition to evaluating chemical hazards found in the SWOC waste according to the safety analysis methodology, chemical hazards were evaluated using the methodology provided for the DOE Comprehensive Emergency Management Program, as required in DOE Order 151.1C, *Comprehensive Emergency Management System*. This methodology is intended to identify specific hazardous materials that, if released, could (1) cause impacts that would immediately threaten or endanger personnel and emergency responders in close proximity to the event, (2) disperse beyond the immediate vicinity in quantities that threaten the health and safety of onsite personnel or the public, and (3) disperse at a rate sufficient to require a time-urgent response to implement protective actions for workers and the public. Identified materials are quantitatively analyzed in an Emergency Preparedness Hazards Assessment to determine if they will be included as part of the technical planning basis for the DOE facility or activity.

The screening process prescribed by DOE Order 151.1C examines potential chemical hazards and eliminates materials from further consideration if they (1) are commonly used by the public, (2) are not readily dispersed in the atmosphere, (3) are not hazardous (toxic) to humans, or (4) exist in limited quantities. Because of the nature of the hazardous material within the waste found at SWOC, the "public use" exclusion does not apply.

The degree to which a substance represents an acute airborne hazard to humans is somewhat dependent on whether the material is in a form that can be readily dispersed. Solids that cannot be reduced to small particles by some mechanism are generally excluded from quantitative analysis. Liquids with a low vapor pressure (less than about 1 millimeter of mercury) are also excluded from quantitative analysis. However, waste packaging requirements generally prohibit free liquids from being disposed of in waste containers. Therefore, significant quantities of liquids that would create an airborne hazard due to evaporation are not likely to exist within SWOC waste containers. Most materials found in SWOC waste containers are powders consisting of a small percentage of particles of respirable size (less than about 10 microns in diameter) and small enough to be transported a significant distance in air before they are removed due to gravitational settling. Also, most powders found in waste are contained in secondary containers (e.g., bags, cans, boxes). Therefore, mechanical impact or container spills are not expected to result in a significant airborne release of powders. The methodology used in the DSASW to produce the condensed list of chemicals shown in Table K–108 eliminated waste configurations that were not in a dispersible form, such as stabilized waste, grouted monoliths, waste containers in concrete high-integrity containers, waste containers in concrete culverts with lids in place, EBR-II casks in concrete storage vaults with lids in place, and alpha and mixed fission product caissons. As the waste forms that were obviously nondispersible have already been eliminated and little specific information was provided about the physical form of the materials listed, it was assumed that all materials listed were dispersible; thus, none were eliminated based on this criterion.

The DOE Hazardous Materials Emergency Management Program is primarily concerned with materials that cause significant adverse human health impacts as a result of acute exposures. In the chemical screening process, the National Fire Protection Association (NFPA) health hazard rating assigned to a chemical is used to indicate whether the possibility of adverse health effects is significant enough to warrant quantitative evaluation (DOE Order 151.1C). Chemicals with an NFPA health hazard rating of 0, 1, or 2 were presumed not to represent significant acute toxic health hazards to humans and were generally excluded from further analysis.

The DOE emergency management screening methodology specifies that hazardous materials should be eliminated as candidates for analysis if the materials are stored and used only in small quantities. A small quantity is considered a quantity that can be "easily and safely manipulated by one person" (DOE Order 151.1C). DOE guidance that accompanies the DOE emergency management order suggests that the following values are consistent with the intent of the order: approximately 19 liters (5 gallons) for liquids, 18 kilograms (40 pounds) for solids, or 4.5 kilograms (10 pounds) for compressed gases (DOE Guide 151.1-2).

The results of applying the screening process discussed above are shown in Table K–110; the following chemicals would have been retained for further analysis based on emergency screening: cadmium, mercury, naphthylamine, nitric acid, phosphoric acid, sodium, sodium hydroxide, sodium oxide and uranium oxide. In the following discussion, these materials are subjected to the same analysis considerations used in an Emergency Preparedness Hazards Assessment to determine whether a material poses a significant hazard such that a quantitative analysis of the potential human health impacts would be included in a technical planning basis for a facility or activity.

Table K–110. Results of Emergency Management Screening

Hazardous Material (CASRN)	Maximum Amount in a Single Location (kilograms)	NFPA Health Hazard Rating[a]	Screening Results
Ammonia (7664-41-7)	2.94	3	Q
Ammonium nitrate (6484-52-2)	32.5	1	H
Beryllium (7440-41-7)	7	3	Q
Cadmium (7440-43-9)	195.2	4	R
Cyclohexane (110-82-7)	18.1	1	H
Dioxane (123-91-1)	25.22	2	H
Hydrogen peroxide (7722-84-1)	1.85	3	Q
Manganese (7439-96-5)	0.06	1	Q/H
Mercury (7439-97-6)	661.5	3	R
Naphthylamine (91-59-8)	102.1	NF	R
Nitric acid (7697-37-2)	411.6	3	R
Phosphoric acid (7664-38-2)	1,884.12	3	R
Propane (74-98-6)	5.9	1	Q/H
Sodium (7440-23-5)	392.1	3	R
Sodium hydroxide (1310-73-2)	3,247.3	3	R
Sodium hypochlorite (7681-52-9)	0.36	3	Q
Sodium oxide (1313-59-3)	724.4	3	R
Styrene (100-42-5)	15.46	2	Q/H
Tetrahydrofuran (109-99-9)	2.98	2	Q/H
Uranium oxide (1344-57-6)	1,391.3	3	R
Uranyl nitrate hexahydrate (13520-83-7)	6.1	1	Q/H
Vinyl chloride/resins (75-01-4)	1,135.5	2	H
Vinyl ester/acetate resins (9003-22-9)	2.75	2	Q/H
Zirconium (7440-67-7)	1,168.4	2	H

[a] NFPA health hazard ratings were obtained from the Savannah River Site database of hazard ratings (WSRC 2005).

Key: CASRN=Chemical Abstracts Service Registry Number; H=eliminated from further analysis based on health hazard rating criteria; NF=value not found; NFPA=National Fire Protection Association; Q=eliminated from further analysis based on quantity criteria; R=retained for further consideration.

K.3.9.3.2.1 Cadmium

Cadmium, a metal, was most likely used at Hanford in the form of sheets, foil, or wire. In these forms the material is nondispersible and could be screened from further consideration. However, it can also be found in granular or powder form; under accident conditions it was assumed to respond to dispersion like a noncombustible contaminated solid. Table K–108 shows that the maximum amount in a single location is 195.2 kilograms (430.3 pounds) and the maximum amount in a single container is 93.54 kilograms (206.2 pounds). Therefore, the maximum quantity of cadmium at a single location is found in multiple containers. The accident event most likely to cause the maximum release from multiple containers is a fire event. Using the source term methodology employed in the DSASW for radionuclide releases, the ARF for a noncombustible contaminated solid (i.e., powders of nonreactive compounds) is 0.006, the RF is 0.01, and the DR for fire is 1.0 (Fluor Hanford 2007). Assuming the entire inventory at the location was involved in a fire, the resulting airborne release would be 0.006 × 0.01 × 1.0 × 195.2 kilograms (430.3 pounds) = 0.00117 kilograms (0.026 pounds). Under average meteorological dispersal conditions (i.e., 5 meters [16.4 feet] per second and D stability), the airborne concentration 100 meters (110 yards) from a fire would be 0.021 milligrams per cubic meter. TEELs 1, 2, and 3 for cadmium are 0.03, 1.25, and 9 milligrams per cubic meter (DOE 2008). Because the consequences of an airborne release from an accident would not exceed 10 percent of the TEEL-2 value at 100 meters (110 yards), the results of a quantitative accident analysis would not be included in the emergency management technical planning basis for the facility according to the Hanford criteria used to implement the DOE Comprehensive Emergency Management Program (DOE Order 151.1C).

K.3.9.3.2.2 Mercury

Mercury is a silver-white, odorless, heavy transition metal; it is one of five elements that are liquid at or near room temperature and pressure. Long-term exposure to mercury vapors presents a severe health hazard. Short-term overexposure to high concentrations of mercury vapors can lead to breathing difficulty, coughing, acute chemical pneumonia, and pulmonary edema (fluid accumulation in the lungs/swelling). Mercury has a vapor pressure of 0.002 millimeters of mercury at 25 °C (77 °F); because it has a low vapor pressure, it evaporates extremely slowly. As a result, it would not be considered a significant acute airborne release hazard during a container spill, failure, or mechanical damage. Therefore, a fire event involving waste containers would be the most likely to cause an airborne release. Mercury is not flammable, but if heated to high temperatures will decompose into toxic vapors of mercury and mercury oxide. Using the same source term methodology employed previously, the ARF for packaged waste is 0.0005, the RF is 1.0, and the DR for fire is 1.0 (Fluor Hanford 2007). Assuming the entire inventory at a single location was involved in a fire, the resulting airborne release would be 0.0005 × 1.0 × 1.0 × 661.5 kilograms (1,460 pounds) = 0.331 kilograms (0.73 pounds). Under average meteorological dispersal conditions (i.e., 5 meters [16.4 feet] per second and D stability), the airborne concentration 100 meters (110 yards) from a fire would be 0.6 milligrams per cubic meter. The ERPG-1, -2, and -3 values for mercury vapor are 0.3, 2.05, and 4.1 milligrams per cubic meter, and the TEEL-1, -2, and -3 values for mercury oxide are 0.15, 1.08, and 10.8 milligrams per cubic meter (DOE 2008). As the consequences of an airborne release from an accident would not exceed either the ERPG-2 value for mercury vapor or the TEEL-2 value for mercury oxide at 100 meters (110 yards), emergency planning for response to the release would be needed only within the local area (i.e., within SWOC) according to the Hanford criteria used to implement in the DOE Comprehensive Emergency Management Program (DOE Order 151.1C).

K.3.9.3.2.3 Naphthylamine

2-Naphthylamine is a white to red, shiny, flake-like solid that darkens on exposure to light. This substance is a known human carcinogen; chronic exposure has been shown to cause bladder cancer. The following acute health effects may occur immediately or shortly after exposure: contact can irritate the

skin and eyes and high levels can interfere with the ability of blood to carry oxygen, causing headaches, fatigue, dizziness, and blue coloring of the skin and lips (NJDHSS 2004). The TEEL-1, -2, and -3 values for this substance are 5, 35, and 300 milligrams per cubic meter, respectively (DOE 2008); these values are relatively high because temporary exposure causes generally mild acute effects that are not life-threatening. Although no NFPA health hazard rating was found for this chemical, relevant data indicated that it is a health hazard because chronic exposure can cause cancer. The DOE emergency management program is primarily concerned with protecting workers and the public from acute health effects; thus, this material would be excluded from consideration in a facility technical planning basis because its primary health hazard (cancer) results from chronic exposure.

K.3.9.3.2.4 Nitric Acid

Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison. It is corrosive to the respiratory track if inhaled and can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Nitric acid was used in a number of processing operations across Hanford in concentrations ranging from approximately 50 percent to 70 percent. The 60-minute AEGL-1, -2, and -3 values for nitric acid are 1.37, 61.8, and 237 milligrams per cubic meter, respectively (EPA 2009). These values were developed for white fuming nitric acid, which is a much more highly concentrated (with a higher percentage) nitric acid. It is most commonly found in liquid form; however, because free-standing liquids are prohibited in waste containers, it is most likely carried in absorbent materials within the waste. Nitric acid is not flammable but will decompose into toxic oxides of nitrogen when exposed to high temperatures. However, many of the materials found in waste containers (e.g., cellulose, plastics, rubber) also decompose to toxic oxides of nitrogen when exposed to high temperatures; many of these materials generate larger volumes of the toxic gases than nitric acid. The most severe dispersal condition would be a liquid spill. For purposes of estimating consequences of a severe release, it was assumed that all of the nitric acid listed in Table K–110 is in liquid form at an approximate percentage of 70 percent. At 25 °C (77 °F), 70 percent nitric acid has a partial pressure of 4.1 millimeters of mercury (Perry, Green, and Maloney 1984), and, assuming a spill depth of 1 centimeter (0.39 inches), would result in a pool surface area of approximately 27.4 square meters (295 square feet). Using this information and the EPIcode to model a liquid spill release results in a concentration of 6.7 milligrams per cubic meter at a distance of 100 meters (110 yards) from an accident. As the consequences of an artificially severe airborne release from an accident would not exceed the AEGL-2 value at 100 meters (110 yards), emergency planning for response to the release would be needed only within the local area (i.e., within SWOC) according to the Hanford criteria used to implement the DOE Comprehensive Emergency Management Program (DOE Order 151.1C).

K.3.9.3.2.5 Phosphoric Acid

Phosphoric acid is a clear, colorless, syrupy liquid. Inhalation is not an expected hazard unless the material is released as an aerosol spray or heated to a high temperature. Mist or vapor inhalation can cause irritation to the nose, throat, and upper respiratory tract. Severe exposures can lead to chemical pneumonitis (inflammation of lung tissue). The vapor pressure is very low, 0.03 millimeters of mercury at 20 °C (68 °F); therefore, it is not an airborne dispersal hazard due to its extremely slow evaporation (Mallinckrodt 2006). It is most commonly found in liquid form; however, because free-standing liquids are prohibited in waste containers, it is most likely carried in absorbent materials within the waste. The most likely means for phosphoric acid to be released to the air would be during a fire involving waste containers. The same source term methodology employed above is used to obtain an estimate of the consequences 100 meters (110 yards) from a fire. The ARF for packaged waste is 0.0005, the RF is 1.0, and the DR is 1.0 (Fluor Hanford 2007). Assuming the entire inventory at a single location was involved in a fire, the resulting airborne release would be 0.0005 × 1.0 × 1.0 × 1,884.12 kilograms (4,160 pounds) = 0.942 kilograms (2.08 pounds). Under average meteorological dispersal conditions (i.e., 5 meters [5.5 yards] per second and D stability), the airborne concentration 100 meters (110 yards) from a fire

would be 0.17 milligrams per cubic meter. The TEEL-1, -2, and -3 values for phosphoric acid are 3, 500, and 500 milligrams per cubic meter, respectively (DOE 2008). As the consequences of an airborne release do not exceed 10 percent of the TEEL-2 value at 100 meters (110 yards) from an accident, the results of a quantitative accident analysis would not be included in the emergency management technical planning basis for the facility according to the Hanford criteria used to implement the DOE Comprehensive Emergency Management Program (DOE Order 151.1C).

K.3.9.3.2.6 Sodium Metal

As previously stated, the future disposition of the bulk sodium stored at the CWC is addressed in the discussion of the FFTF Decommissioning alternatives. The consequences of accidents involving this inventory of hazardous material are addressed in Section K.3.9.2, Chemical Impacts of Fast Flux Test Facility Accidents.

K.3.9.3.2.7 Sodium Hydroxide

Sodium hydroxide is an odorless white solid usually found in the form of pellets or flakes. It was often used at Hanford in the form of a water-based solution. It is a severe irritant; effects from inhalation of sodium hydroxide dust or mist vary from mild irritation to serious damage of the upper respiratory tract, depending on severity of exposure. Symptoms may include sneezing, sore throat, and runny nose. Pneumonitis may occur following a severe acute exposure. Either in a water-based solution or as a solid, sodium hydroxide has a negligible vapor pressure; therefore, it is not a potential airborne hazard due to extremely slow evaporation. It is not flammable and is not considered a fire or explosion hazard. However, small particles of the solid could be suspended in the air during a fire if the material were absorbed in, packaged in, or in close contact with burning waste materials. Using the methodology referenced above for packaged waste and assuming that the entire maximum inventory at a single location is involved in a fire, the amount of material released to the atmosphere would be 0.0005 × 1.0 × 1.0 × 3,247.3 kilograms (7,170 pounds) = 1.62 kilograms (3.58 pounds). Under average meteorological dispersal conditions (i.e., 5 meters [5.5 yards] per second and D stability), the airborne concentration 100 meters (110 yards) from a fire would be 0.29 milligrams per cubic meter. The ERPG-1, -2, and -3 values for sodium hydroxide are 0.5, 5, and 50 milligrams per cubic meter, respectively (DOE 2008). As the consequences of an airborne release from an accident would not exceed 10 percent of the ERPG-2 value at 100 meters (110 yards), the results of a quantitative accident analysis would not be included in the emergency management technical planning basis for the facility according to the Hanford criteria used to implement the DOE Comprehensive Emergency Management Program (DOE Order 151.1C).

K.3.9.3.2.8 Sodium Oxide

Sodium oxide is a white granular material; it reacts with water to produce sodium hydroxide and heat. When sodium oxide fumes or dust is inhaled, it comes into contact with the water in the respiratory tract and may result in severe burns, injury, or death. It is a noncombustible material, but it may decompose upon heating to produce corrosive and/or toxic fumes. However, many of the materials found in waste containers (e.g., cellulose, plastics, rubber) also decompose to toxic fumes when exposed to high temperatures; many of these materials would generate larger volumes of the toxic gases than sodium oxide when heated. The most likely means for sodium oxide to be released to the air would be a fire involving waste containers. The same source term methodology employed above was used to obtain an estimate of the consequences 100 meters (110 yards) from a fire resulting in the release of sodium oxide. The ARF for packaged waste is 0.0005, the RF is 1.0, and the DR for fire is 1.0 (Fluor Hanford 2007). Assuming the entire inventory at a single location was involved in a fire, the resulting airborne release would be 0.0005 × 1.0 × 1.0 × 724.4 kilograms (1,600 pounds) = 0.362 kilograms (0.80 pounds). Under average meteorological dispersal conditions (i.e., 5 meters [5.5 yards] per second and D stability), the

airborne concentration 100 meters (110 yards) from a fire would be 0.65 milligrams per cubic meter. The TEEL-1, -2, and -3 values for sodium oxide are 0.25, 2.5, and 25 milligrams per cubic meter, respectively (DOE 2008). As the consequences of an airborne release from an accident would not exceed the TEEL-2 value at 100 meters (110 yards), emergency planning for response to the release would be needed only within the local area (i.e., within SWOC) according to the Hanford criteria used to implement the DOE Comprehensive Emergency Management Program (DOE Order 151.1C).

K.3.9.3.2.9 Uranium Oxide

Uranium oxide (uranium black oxide) is a black, radioactive, crystalline powder. It occurs naturally in the mineral uraninite and, if produced from enriched uranium, it is used in nuclear fuel rods in nuclear reactors. Prior to 1960, it was used as yellow and black color in ceramic glazes and glass. Depleted uranium oxide can be used as a material for radiation shielding. The form found primarily in the mixed waste containers is depleted. Using the methodology referenced above for packaged waste and assuming that the maximum inventory at a single location is involved in a fire, the amount of material released to the atmosphere would be $0.0005 \times 1.0 \times 1.0 \times 1{,}391.3$ kilograms (3,072 pounds) = 0.7 kilograms (1.55 pounds). Under average meteorological dispersal conditions (i.e., 5 meters [5.5 yards] per second and D stability), the airborne concentration 100 meters (110 yards) from a fire would be 1.3 milligrams per cubic meter. The ERPG-1, -2, and -3 values for uranium oxide (uranium black oxide) are 0.681, 10, and 30 milligrams per cubic meter, respectively (DOE 2008). As the consequences of an airborne release from an accident would not exceed the ERPG-2 value at 100 meters (110 yards), emergency planning for response to the release would be needed only within the local area (i.e., within SWOC) according to the Hanford criteria used to implement the DOE Comprehensive Emergency Management Program (DOE Order 151.1C).

K.3.9.3.3 Impacts

The chemicals listed as known chemical hazardous constituents that may be present in retrieved TRU waste and suspect TRU waste containers (see Table K–108 above) were examined using the methodologies for identifying hazardous chemicals that should be subjected to quantitative analyses in both the DOE safety analysis and emergency management programs. Except for sodium metal, which is addressed in Section K.3.8.2, none of the chemicals listed would require analysis or inclusion in a documented facility safety analysis or Emergency Preparedness Hazards Assessment because their forms, quantities, and associated health hazards do not warrant such analysis.

The chemical hazards in the waste management containers are generally mixed together with the radiological hazards. Radiological accident scenarios analyzed in Section K.3.6, Waste Management Accident Scenarios, would be expected to release both radioactive and chemical materials. Based on the discussions above, the scenario most likely to release a significant quantity of hazardous chemicals is a fire event involving multiple waste containers. Of the radiological scenarios analyzed in Section K.3.6, the large fire of waste containers outside a facility (SWOC FIR-4) most closely resembles the maximum foreseeable scenario postulated for the release of a chemical hazard. The dose consequence to the noninvolved worker 100 meters (110 yards) from this event would be 260 rem, and doses from the other fire scenarios analyzed would range from approximately 1 rem to a maximum of 300 rem (see Tables K–100 and K–102).

The evaluation of chemical exposures shows that exposures to the noninvolved worker do not exceed the AEGLs (i.e., 60-minute AEGL-2 value) established by EPA and implemented by DOE as the trigger points for planning protective measures for the public in the event of a large release of hazardous chemicals. The equivalent radiation dose threshold established by EPA for planning protective measures in the event of a large release of radioactive material is 1 rem. From the results of the radiological analysis and the chemical evaluations, it is clear that the potential health impacts of the radioactive

components of the waste far outweigh those of the chemical components. Therefore, further quantitative analysis to determine potential human health impacts due to an accidental release of hazardous chemicals from within the mixed waste is not necessary.

K.3.10 Impacts on Workers

In the event of an accident involving the release of radioactive material or toxic chemicals, onsite workers would be at risk of exposure and potentially harmful health effects. For the purposes of this EIS, the onsite worker population varies from approximately 2,000 to about 20,000, depending on the alternative.

The harmful impacts of an accidental release of radioactive or chemical materials were assessed in terms of the probability (or frequency) of an accident's occurrence and consequences if the accident were to occur. For radiological accidents, the consequences are expressed in terms of radiation dose and the resulting risk of an LCF. For chemical accidents, the consequences are expressed in terms of the chemical concentrations in the air (ppm or milligrams per cubic meter) to which a worker might be exposed compared with the applicable concentration threshold (limit) at which certain health effects are expected. Depending on the severity of an accident, the consequences may also include prompt fatalities, particularly for involved workers close to the accident.

For this EIS, the impacts on an individual noninvolved worker located 100 meters (110 yards) from an accident were analyzed for a range of accidents. However, the impacts on the populations of involved and noninvolved workers were not analyzed for two reasons. First, the impacts on the populations of involved and noninvolved workers would depend on the distribution of the population, including the distance of each group from the accident location and whether each individual is indoors or outdoors. This information is too dynamic to properly model. Second, because Hanford tank closure facilities where involved workers would be located have not yet been constructed, no useful estimates of involved worker locations and protective features are available. That information is needed to accurately estimate accident impacts.

Alternatives with the lowest number of involved workers would generally have the lowest worker population impacts in the event of an accident. Workers nearest the accident would be the most vulnerable to harmful health effects and fatalities. Prior to initiation of operations, analyses would be conducted and documented in safety analysis reports and hazard assessment documents to ensure worker protection and safety during operations. Furthermore, technical safety requirements would be defined in conjunction with safety analysis reports for all facilities to minimize the risk to workers from potential accidents.

K.3.11 Assessment of Intentional Destructive Acts

Recent world events draw attention to the possibility of acts of sabotage and terrorism against U.S. interests, domestic and abroad. To protect against such actions, safeguards and security measures are employed at all DOE facilities. Because of the significance of its nuclear and chemical facilities as potential targets of such actions and for the purposes of this EIS, DOE has assessed the potential impacts of a deliberate airplane or vehicular crash into Hanford facilities.

K.3.11.1 Safeguards and Security

DOE has acted strongly and proactively to understand and to preclude or mitigate the threats posed by intentional destructive acts. In accordance with DOE Orders 470.4B and 470.3B, DOE conducts vulnerability assessments and risk analyses of facilities and equipment under its jurisdiction to evaluate the physical protection elements, technologies, and administrative controls needed to protect DOE assets. DOE Order 470.4B establishes the roles and responsibilities for the conduct of DOE's Safeguards and Security Program. DOE Order 470.3B (a) specifies those national security assets that require protection;

(b) outlines threat considerations for safeguards and security programs to provide a basis for planning, design, and construction of new facilities or modifications to existing facilities; and (c) provides an adversary threat basis for evaluating the performance of safeguards and security systems. DOE also protects against espionage, sabotage, and theft of radioactive, chemical, or biological materials; classified information and matter; nonnuclear weapon components; and critical technologies.

No environmental impacts are expected because of compliance with DOE safeguard and security provisions based on the adequacy of the existing Hanford security provisions. Before startup of any new or substantially modified operations, DOE would conduct an indepth, site-specific safeguards and security inspection to ensure that existing safeguards and security programs satisfy DOE requirements. Any inadequacies would be resolved before the startup of the operations. Although it is not anticipated, if the safeguards and security review determined that additional security provisions were required, DOE would perform the appropriate NEPA review.

K.3.11.2 Assessment of Potential Impacts

The tank closure accident with the highest consequences and risks for all Tank Closure action alternatives is the unmitigated, seismically induced WTP collapse and failure (WT41). For the Tank Closure No Action Alternative, the unmitigated, seismically induced waste tank dome collapse (TK53) has the highest consequences and risks. The FFTF accident with the highest consequences and risks for all FFTF Decommissioning action alternatives is the RH-SC fire (RHSC1). For the FFTF Decommissioning No Action Alternative, the Hanford sodium storage tank failure (HSTF1) has the highest consequences and risks. The waste management accident with the highest consequences and risks for both the Waste Management No Action Alternative and the two action alternatives is the aircraft crash (SWOC EE-2). The accident scenarios are described in Sections K.3.4 through K.3.6.

A number of release scenarios that might be initiated by acts of terror or sabotage were considered in regard to how or whether they might aid in the comparison of EIS alternatives. The potential for and consequences of some intentional destructive act (IDA) scenarios are essentially the same under each of the alternatives. Because analysis of such acts would do little to aid or inform the decision making process, scenarios were selected based primarily on whether the likelihood or consequences of the event would be substantially different under some EIS alternatives than under others. Primary considerations for selecting scenarios to be analyzed included the following:

- Quantities of radioactive or toxic material associated with each alternative
- Location(s) where the hazardous material is used or stored
- Degree of inherent physical protection against destructive acts that is associated with each alternative (e.g., material that is kept in an underground vault under one alternative, but is stored above ground at some time under another)
- Properties of the material that affect its toxicity and/or dispersibility
- Proximity of a postulated release event to the MEI and/or general population (and hence, the health consequences of any given release to the environment)

Five scenarios caused by IDAs were selected for analysis: IDA-1 through IDA-5.

Explosive Device in Underground Waste Tank (IDA-1). It was postulated that explosions occur that displace a large portion of the soil overburden, breach the tank dome, and disperse a portion of the tank waste into the atmosphere. To maximize the radiological impact, all the tank waste was assumed to be solid (salt cake, sludge). In accordance with the recommendation of DOE Handbook 3010-94, the

respirable release would be less than the TNT-equivalent weight of the explosive charge. The release was modeled as a ground-level release without mitigation (LPF of 1).

The assumptions and parameter values used to analyze the seismically induced waste tank dome collapse scenario (TK53) and explosive device in underground waste tank scenario (IDA-1) are summarized and compared in Table K–111. The results indicate that the impacts of an explosive device in an underground waste tank would be about four times greater than those of the seismically induced waste tank dome collapse.

Table K–111. Comparison of Seismically Induced Waste Tank Dome Collapse (TK53) and Explosive Device in Underground Waste Tank (IDA-1)

Scenario Assumption or Parameter	Seismically Induced Waste Tank Dome Collapse (TK53)	Intentional Destructive Act: Explosive Device in Underground Waste Tank (IDA-1)
Affected structures/buildings	One single-shell tank	One single-shell tank
Degree of structural damage	Collapse of dome with overburden falling into tank	Explosion that clears overburden followed by in-tank explosion that breaches tank dome and disperses waste
Material at risk	Contents of a typical single-shell tank	Contents of a typical single-shell tank
Damage ratio	1.0	1.0
Release mechanisms considered	Expulsion of headspace vapor and aerosols, splash of liquid, resuspension (entrainment) from exposed waste	Expulsion of headspace vapor and aerosols, explosive dispersal of solid waste
Release fraction (ARF×RF)	Headspace aerosols: 100 milligrams per cubic meter×1,000 cubic meters Splash: 0.002 Entrainment – public (24 hour): 9.6×10^{-6} Entrainment – worker (8 hour): 3.2×10^{-6}	Headspace aerosols: 100 milligrams per cubic meter×1,000 cubic meters (insignificant contributor to dose) Explosive dispersal: Respirable aerosols equal to TNT-equivalent weight of explosive
Release height	Ground level	Ground level
Mitigation	None (LPF=1)	None (LPF=1)
Consequences Population dose/risk MEI dose/risk Noninvolved worker dose/risk	 1.3 person-rem/0 (8×10^{-4}) LCFs 2.1×10^{-4} rem/1×10^{-7} LCFs 2.2×10^{-1} rem/1×10^{-4} LCFs	 4.9 person-rem/0 (3×10^{-3}) LCFs 8.3×10^{-4} rem/5×10^{-7} LCFs 8.8×10^{-1} rem/5×10^{-4} LCFs

Note: To convert cubic meters to cubic feet, multiply by 35.315; kilograms to pounds, by 2.2046.

Key: ARF=airborne release fraction; LCF=latent cancer fatality; LPF=leak path factor; MEI=maximally exposed individual; RF=respirable fraction; TNT=trinitrotoluene.

Aircraft or Ground Vehicle Impact on WTP (IDA-2). A vehicle or aircraft crash and/or explosions initiated by an insider were postulated. It was assumed that these acts are sufficiently energetic to breach a portion of the exterior wall of the HLW Vitrification Facility. The HLW melter feed preparation vessels in the HLW vitrification process cell are protected by reinforced concrete radiation shielding walls 0.91 to 1.52 meters (3 to 5 feet) thick. For purposes of this analysis, it was postulated that the shield wall was penetrated and the two vessels were breached, causing the contents of 58,300 liters (15,400 gallons) of HLW melter feed to be spilled into the cell (BNI 2005). At the same time, aircraft or vehicle fuel was assumed to enter the cell and burn. The spilled radioactive waste slurry was assumed to heat to the boiling point. A boiling ARF × RF value of 0.001 (DOE Handbook 3010-94) was assumed, as

well as the release of radioactive material to the environment through holes in the building walls (LPF of 1.0).

The assumptions and parameter values used to analyze the WTP collapse and IDA scenarios are summarized and compared in Table K–112. The results indicate that the impacts of a deliberate airplane or ground transport vehicle crash into the WTP would be about one order of magnitude lower than those for WT41, the seismically induced collapse and failure of the entire WTP.

Table K–112. Comparison of Seismically Induced WTP Collapse and Failure (WT41) and Aircraft or Ground Vehicle Impact on WTP (IDA-2)

Scenario Assumption or Parameter	Seismically Induced WTP Collapse and Failure (WT41 – 6×30)	Intentional Destructive Act: Aircraft or Ground Vehicle Impact on WTP (IDA-2)
Affected WTP structures/buildings	Pretreatment, LAW Vitrification, and HLW Vitrification Facilities	HLW Vitrification Facility
Degree of structural damage	Total structural failure, breach of external walls and cell walls	Penetration of external wall and cell wall
Material at risk	Contents of all tanks and vessels in all three buildings	Contents of HLW melter feed preparation vessels only
Damage ratio	1.0	1.0
Release mechanisms considered	Spill and resuspension (entrainment) from pool	Spill and boiling from burning 2,000 gallons of diesel or jet fuel in cell[a]
Release fraction (ARF×RF)	Spill: 0.00005 Entrainment – public (24 hour): 9.6×10^{-6} Entrainment – worker (8 hour): 3.2×10^{-6}	Spill: 0.00004 Boiling: 0.001
Release height	Ground level	Ground level
Mitigation	None (LPF=1)	None (LPF=1)
Consequences Population dose/risk MEI dose/risk Noninvolved worker dose/risk[b]	 7.5×10^{4} person-rem/50 LCFs 4.3 rem/3×10^{-3} LCFs 1.3×10^{4} rem/1 LCF	 4.4×10^{3} person-rem/3 LCFs 2.5×10^{-1} rem/2×10^{-4} LCFs 8.6×10^{2} rem/1 LCF

[a] Heavy construction equipment (crawlers, earthmovers, etc.) typically have fuel tanks with a capacity of a few hundred gallons or less. The Boeing 737, a common commercial aircraft of a size that a skilled pilot might be able to fly into a preexisting breach in the external wall of the HLW Vitrification Facility, has a fuel capacity of about 6,800 gallons. Of that, about 45 percent is carried within the wings, which would likely be sheared off on impact and not penetrate intact into the cell. Depending on the takeoff fuel load and distance flown, the center tank might contain somewhat less than 4,000 gallons, half of which was assumed to enter the cell before being ignited

[b] Increased likelihood of an LCF for an individual, assuming the event occurs; value cannot exceed 1.

Note: To convert gallons to liters, multiply by 3.7854.

Key: ARF=airborne release fraction; HLW=high-level radioactive waste; LAW=low-activity waste; LCF=latent cancer fatality; LPF=leak path factor; MEI=maximally exposed individual; RF=respirable fraction; WTP=Waste Treatment Plant.

Intentional Breach of WTP Ammonia Tank (IDA-3). Under all Tank Closure alternatives except the No Action Alternative, the WTP would be completed and a 45,000-liter (12,000-gallon) (nominal capacity) tank of anhydrous ammonia would be part of the WTP (Lindquist 2006a). Section K.3.9.1.1 analyzes a tank failure that releases the tank's entire contents (43,500 liters, or 11,500 gallons) over a period of 30 minutes, approximating the leak rate from a 2.5-centimeter-diameter (1-inch-diameter) hole in the tank. An event that causes a near-instantaneous release of the entire tank's contents would produce the highest release rate and the greatest potential health impact. An IDA was postulated whereby an explosion caused massive damage to the WTP ammonia tank. The entire 43,500 liters (11,500 gallons) of

liquid ammonia was assumed to be vaporized over a period of 1 minute. Typical (average) atmospheric dispersion conditions were assumed. The results of the 30-minute accident release and the explosion are summarized and compared in Table K–113.

Table K–113. Comparison of Ammonia Tank Failure Accident with Intentional Destructive Act (IDA-3)

Scenario	Quantity Released (liters)	AEGL-2[a]		AEGL-3[b]		Concentration (ppm)	
		Limit (ppm)	Distance to Limit (meters)	Limit (ppm)	Distance to Limit (meters)	Noninvolved Worker at 100 Meters	Nearest Site Boundary at 8,600 Meters
Tank failure (30-minute release)	43,500	160	2,450	1,100	780	41,000	27.0
Explosion (1-minute release)	43,500	160	22,000	1,100	8,000	>500,000	950

[a] **AEGL-2** (60-minute) is the airborne concentration (expressed as ppm or milligrams per cubic meter) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape (EPA 2009).

[b] **AEGL-3** (60-minute) is the airborne concentration (expressed as ppm or milligrams per cubic meter) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death (EPA 2009).

Note: To convert liters to gallons, multiply by 0.26417; meters to yards, by 1.0936.

Key: AEGL=Acute Exposure Guideline Levels; ppm=parts per million.

Explosion in FFTF Primary Cold Trap (IDA-4). The doses associated with an accident that releases the primary cold trap radionuclide inventory have been shown to be about 100 times greater than the impacts from burning the entire Hanford bulk sodium inventory. Furthermore, a deliberate high-energy dispersal of the cold trap inventory might release substantially more of the material than the 30 percent assumed to be released under accident conditions (scenario RHSC1). The potential for an IDA to occur in the 400 Area or at one of two other destinations (Hanford 200 Area or INL) provides an opportunity for comparing the FFTF Decommissioning No Action Alternative with both the Hanford and Idaho Reuse Options for disposition of bulk sodium. Accordingly, an IDA was postulated whereby the FFTF primary cold trap, containing 2,700 liters (710 gallons) of sodium, 470 curies of cesium-137, and 70 curies of cobalt-60 (ANL-W and Fluor Hanford 2002), was destroyed by an explosive/incendiary device during removal or handling. All the radioactive material was assumed to aerosolize and be released to the atmosphere. The results of the accident scenario (RHSC1) and the deliberate act scenario (IDA-4) for the Hanford 400 Area location are summarized and compared in Table K–114.

Table K–114. Comparison of Remote-Handled Special Component Fire (RHSC1) and Deliberate Explosion Scenario (IDA-4)

Scenario Assumption or Parameter	Remote-Handled Special Component Fire (RHSC1)	Intentional Destructive Act: Explosion in FFTF Primary Cold Trap (IDA-4)
Cold trap contents	2,700 liters sodium 470 curies cesium-137 70 curies cobalt-60	2,700 liters sodium 470 curies cesium-137 70 curies cobalt-60
Damage mode, degree of damage	Handling mishap with breach of cold trap shell	Total disassembly of cold trap by explosive/incendiary device
Damage ratio	1.0	1.0
Release fraction (ARF×RF)	0.3	1.0
Release height	Ground level	Ground level
Mitigation	None (LPF=1)	None (LPF=1)

Table K–114. Comparison of Remote-Handled Special Component Fire (RHSC1) and Deliberate Explosion Scenario (IDA-4) *(continued)*

Scenario Assumption or Parameter	Remote-Handled Special Component Fire (RHSC1)	Intentional Destructive Act: Explosion in FFTF Primary Cold Trap (IDA-4)
Consequences		
Population dose/risk	4.3 person-rem/0 (3×10^{-3}) LCFs	11 person-rem/0 (7×10^{-3}) LCFs
MEI dose/risk	1.2×10^{-4} rem/7×10^{-8} LCFs	3.3×10^{-4} rem/2×10^{-7} LCFs
Noninvolved worker dose/risk	7.3×10^{-4} rem/4×10^{-7} LCF	7.3×10^{-3} rem/4×10^{-6} LCFs

Note: To convert liters to gallons, multiply by 0.26417.

Key: ARF=airborne release fraction; FFTF=Fast Flux Test Facility; LCF=latent cancer fatality; LPF=leak path factor; MEI=maximally exposed individual; RF=respirable fraction.

Large Aircraft Crash at SWOC Storage Building (IDA-5). The potential for IDAs that disperse radioactive or toxic materials to the environment would be eliminated only when the waste is finally disposed of (buried on site or transported off site). Varying amounts of radioactive material would remain vulnerable to dispersal as long as wastes are being generated by tank closure and other onsite operations or are being received from offsite sources for disposal at Hanford. Waste Management alternatives are not distinguished from each other by quantitative analysis of hypothetical IDAs that could occur under any of them. However, the scale of potential impacts from an IDA directed at waste management operations can be understood by a simple extrapolation from the most severe accident analyzed, the aircraft crash (EE-2) (Fluor Hanford 2007). That scenario involves damage to 960 out of 17,500 waste containers in a SWOC storage building. The estimated mean population dose from that release would be 1,700 person-rem, and 1 LCF would be expected as a result. The dose to the MEI was estimated to be 0.28 rem, and the dose to the noninvolved worker was estimated to be 300 rem. The most pessimistic extrapolation from that scenario would involve a larger airplane, more fuel, and a comparable degree of damage to all 17,500 containers. About 18 times as much radioactive material would thereby be released, and the consequences would be proportionately greater (31,000 person-rem to the population, 5.0 rem to the MEI, and 5,400 rem to the noninvolved worker). However, as pointed out in the DSASW, a larger fire would tend to produce a more buoyant plume, resulting in greater dispersion in the atmosphere and a lower dose to the MEI for each unit of radioactive material released.

K.3.12 Analysis Conservatism, Uncertainty, and Design Changes

The analysis of accidents was based on calculations relevant to hypothetical sequences of events and models of the effects of these events. The models make use of a variety of information and assumptions, including estimates of event frequencies and source terms, assumed pathways for environmental transport and exposure, and risk factors relating exposure to effects on human health and the environment. Within the scope of the analysis, the inputs are as realistic as possible. However, uncertainties associated with each selected input value and model assumption contribute to overall uncertainty in the results. The uncertainty associated with the result of each individual analysis was not estimated, but from one alternative to the next, the overall uncertainties associated with the analyses were estimated to be about the same.

In many cases, the scarcity of experience with the postulated accidents leads to uncertainty in the calculation of the consequences and frequencies. This fact has promoted the use of models or input values that yield conservative estimates of consequences and frequency. Due to the layers of conservatism built into the accident analysis for the spectrum of postulated accidents, the estimated consequences and risks to the public and workforce represent the upper limit for the individual classes of accidents. The uncertainties associated with the accident frequency estimates are enveloped by the conservatism of the analysis.

Of particular interest are the uncertainties in the estimates of cancer fatalities from exposure to radioactive materials. As discussed in Section K.1, the numerical values of the health risk estimators used in this *TC & WM EIS* were obtained by linear extrapolation from the nominal risk estimate for lifetime total cancer mortality resulting from exposures of 10 rad. Because the health risk estimators were multiplied by conservatively calculated radiation doses to predict fatal cancer risks, the fatal cancer values presented in this EIS are overestimates.

For the purposes of this EIS, the impacts calculated from the linear model were treated as an upper limit, consistent with the widely used methodologies for quantifying radiogenic health impacts. This does not imply that health effects are expected. Moreover, in cases where the upper-limit estimators predicted more than 1 LCF, this does not imply that the LCF risk can be determined for a specific individual.

Following the Record of Decision and selection of alternatives, actions could be taken during implementation of the alternatives that would change the basis for the analyses and results presented in this final EIS. Under DOE NEPA requirements, any such changes are subject to NEPA review to determine whether additional NEPA analyses or evaluations are necessary. Additionally, in accordance with DOE safety requirements, facility designs, modifications, and changes in operations are subject to a safety review process to safeguard the health and safety of workers and the public during operations. The process includes hazards assessments, safety analyses, and operational safety requirements that define conditions and requirements for a safe operating envelope and an authorization basis. Following construction and startup of operations, any change in facility design and operations would be reviewed for compliance with the authorization basis for operations. If deemed necessary, further safety studies would be conducted, which could influence planned design changes, identify mitigation measures, and revise the operational safety requirements for continued safeguarding of public health and safety.

K.4 INDUSTRIAL SAFETY

This section provides supporting information for estimating the industrial safety impacts presented in Chapter 4 of this *TC & WM EIS*. Tables in Appendix I list the work phases, activities specific to each phase, total labor hours for each activity, and the total number of years a work activity would be conducted. Using the historical accident and fatality incident rates and total labor hours, the potential impacts on worker safety were evaluated.

Two categories of industrial safety impacts, total recordable cases (TRCs) and fatalities, are represented in Chapter 4 of this EIS. TRCs include work-related illnesses or injuries that result in loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment beyond first aid. A fatal occurrence is a work-related injury or illness that causes the death of an employee.

DOE and contractor TRC and fatality incident rates were obtained from the CAIRS database (DOE 2007b, 2007c). The CAIRS database is used to collect and analyze DOE and DOE contractor reports of injuries, illnesses, and other accidents that occur during DOE operations. General industry data were obtained from information maintained by the U.S. Bureau of Labor Statistics (BLS 2008, 2009).

The review of data from 2001 through 2006 indicates that occupational injuries and illnesses have decreased from 208 in 2001 to 83 in 2006. ORP has also recorded a decreasing trend in the rate of TRCs, ranging from 1.1 to 2.6 per 200,000 labor hours, over the same period. This rate includes all labor categories (e.g., construction, operations, engineering) associated with tank farm management and operations. During the same period, ORP has not experienced a fatality.

A number of occupational incident rates were available for use in estimating the industrial safety impacts of the alternatives considered in this *TC & WM EIS*. The rates vary between 1.3 and 6.7 incidents per 200,000 labor hours, as shown in Table K–115. This table provides the four most relevant sources of data

for this EIS: ORP data, Idaho Operations Office data, DOE and contractor data, and private industry data maintained by the U.S. Bureau of Labor Statistics.

Table K–115. Total Recordable Cases and Fatality Incident Rates

Labor Category	Total Recordable Case Rate[a]	Fatality Rate[b]
DOE and contractor	1.88	0.26
Construction (DOE and contractor)	2.4	0.0
Operations/production (DOE and contractor)	1.3	0.0
DOE Office of River Protection	2.0	0.0
Idaho Operations Office	1.5	0.0
Private industry (BLS)	5.0	4.0
Construction (private industry) (BLS)	6.7	11.8

[a] Average illness and injury cases per 200,000 labor hours.
[b] Average fatality rate per 200 million labor hours.
Key: BLS=U.S. Bureau of Labor Statistics; DOE=U.S. Department of Energy.
Sources: BLS 2008, 2009; DOE 2007b, 2007c.

The ORP TRC rate of 2.0 per 200,000 labor hours was selected as representative of the types of work associated with the alternatives under consideration. It includes contributions from all labor categories (e.g., construction, operations, engineering) and is slightly higher than the 1.88 rate experienced by all facilities DOE-wide. The incident rate for private industry was deemed not representative of typical DOE project experience. One set of alternatives identifies activities taking place at INL. A different TRC rate specifically for Idaho operations (1.5 per 200,000 labor hours) was used in these calculations.

As ORP and INL have not experienced a fatality during recent history, the DOE and contractor rate (for all labor categories) of 0.26 per 200 million labor hours was adopted as representative of fatal occurrences. The impacts of illness and injury can be calculated using the total project labor hours and the appropriate incident rate. The total labor hours were calculated from the scaled data sets (SAIC 2010a, 2010b, 2010c) and are listed in the Appendix I tables for each of the alternatives. The subtotal for each type of activity (i.e., construction, operations, deactivation, and closure) is also provided.

Using the incident rates selected above and the projected labor hours provided in Appendix I, the occupational safety impacts associated with each of the alternatives were calculated. These impacts were calculated by multiplying the total labor hours by the TRC rate and dividing by 200,000 (i.e., incidents per 200,000 labor hours).

The number of fatalities per year for an activity can be calculated by multiplying the projected number of labor hours for that activity by the selected fatality rate shown in Table K–115 and dividing by 200 million labor hours. When the estimated number of fatalities per year is less than 0.5, no fatalities would be expected. Chapter 4, Tables 4–98, 4–127, and 4–150, provide the projected number of TRCs and fatalities for Tank Closure, FFTF Decommissioning, and Waste Management alternatives, respectively.

K.5 REFERENCES

ACGIH (American Conference of Governmental Industrial Hygienists), 2011, *2011 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*, Cincinnati, Ohio.

ACS (American Cancer Society, Inc.), 2010, *Cancer Facts & Figures 2010*, Atlanta, Georgia.

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.

Aromi, E., 2004, CH2M HILL Hanford Group, Inc., Richland, Washington, personal communication (memorandum) to all CH2M HILL Hanford Group, Inc. employees and subcontractors, "Changes in Respiratory Protection Measures," March 27.

ATSDR (Agency for Toxic Substances and Disease Registry), 2002, *ToxFAQs for Sodium Hydroxide*, accessed through http://www.atsdr.cdc.gov/tfacts178.html, April.

Beyeler, W.E., W.A. Hareland, F.A. Durán, T.J. Brown, E. Kalinina, D.P. Gallegos, and P.A. Davis, 1999, *Residual Radioactive Contamination from Decommissioning, Parameter Analysis, Draft Report for Comment*, NUREG/CR-5512, Vol. 3, U.S. Nuclear Regulatory Commission, Washington, D.C., October.

BLS (U.S. Bureau of Labor Statistics), 2008, *Industry Injury and Illness Data, Charts 2001 Through 2006*, Injuries, Illnesses, and Fatalities Program, accessed through http://www.bls.gov/iif/oshsum.htm, October 23.

BLS (U.S. Bureau of Labor Statistics), 2009, *Census of Fatal Occupational Injuries (CFOI) – Current and Revised Data*, "Rate of Fatal Work Injuries per 100,000 Workers, 1992–2006," "Number and Rate of Fatal Occupational Injuries, by Industry Sector, 2003–2006," "Numbers and Rates of Fatal Occupational Injuries per Industry Division, 2001–2002," Injuries, Illnesses, and Fatalities Program, accessed through http://www.bls.gov/iif/oshcfoi1.htm, March 11.

BNI (Bechtel National, Inc.), 2002, *Revised Severity Level Calculations for the LAW Facility*, 24590-LAW-Z0C-W14T-00003, Rev. B, Richland, Washington, January 26.

BNI (Bechtel National, Inc.), 2004, *Design Basis Event: High Level Waste Molten Glass Spills*, 24590-HLW-Z0C-HMP-00001, Rev. E, Richland, Washington, December 14.

BNI (Bechtel National, Inc.), 2005, *Revised Severity Level Calculations for the HLW Facility*, 24590-HLW-Z0C-W14T-00013, Rev. C, Richland, Washington, October 20.

BNI (Bechtel National, Inc.), 2007, *Revised Severity Level Calculations for the Pretreatment Facility*, 24590-PTF-ZOC-W14T-00002, Rev. F, Richland, Washington, May 10.

Bowman, B.R., 1994, *Preliminary Safety Evaluation for the Sodium Storage Facility*, WHC-SD-FF-PSE-002, Rev. 0, Westinghouse Hanford Company, Richland, Washington, September 30.

Burbank, D.A., 2002, *Project 520, Immobilized Low-Activity Waste Disposal Facility, Preliminary Documented Safety Analysis*, RPP-13201, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington, December 18.

Burk, K.W., 2007, Battelle, Pacific Northwest National Laboratory, Richland, Washington, personal communication (email) to K.W. Owens, Science Applications International Corporation, Germantown, Maryland, "JFDs," May 15.

Burley, G., 1990, *Transuranium Elements*, Vol. 2, *Technical Basis for Remedial Actions*, EPA 520/1-90-016, U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, D.C., June.

Cash, R.J., 2004, Babcock Services, Richland, Washington, personal communication (email) to D.L. Parker, CH2M HILL Hanford Group, Inc., Richland, Washington, "Vapor Exposure Events," July 9.

CEES (Columbia Energy & Environmental Services, Inc.), 2006, *FFTF Remote-Handled Special Components Inventory*, 6734-FFTF-Inventory-001, Rev. 0, Richland, Washington, May 24.

Census (U.S. Census Bureau), 2011, *2010 Decennial Census Summary File 1*, Table P5 – Hispanic or Latino Origin by Race (Universe – Total Population), accessed through http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml, August 25.

CH2M HILL (CH2M HILL Hanford Group, Inc.), 2003a, *Improved Worker Protection from Chemical Vapors: Integrated Safety Management (ISM)*, CHG0310-07, Richland, Washington, October.

CH2M HILL (CH2M HILL Hanford Group, Inc.), 2003b, *Production Bulk Vitrification System Pre-Conceptual Engineering Report*, RPP-16215, Rev. 1, Richland, Washington, July 31.

CH2M HILL (CH2M HILL Hanford Group, Inc.), 2003c. This reference is for Official Use Only.

CH2M HILL (CH2M HILL Hanford Group, Inc.), 2004a, *Tank Farm Abnormal Operating Procedure: Response to Reported Odors or Vapor Exposures*, TF-AOP-015, Rev. B-1, Richland, Washington, April 30.

CH2M HILL (CH2M HILL Hanford Group, Inc.), 2004b, *Integrated Safety Management Update: Taking Action to Enhance Worker Protection from Chemical Vapors*, CHG0401-06, Richland, Washington, February.

CH2M HILL (CH2M HILL Hanford Group, Inc.), 2004c, *Integrated Safety Management Update: Taking Action to Enhance Worker Protection from Chemical Vapors*, RPP-21487, Richland, Washington, June.

Chanin, D.I., and M.L. Young, 1997, *Code Manual for MACCS2*, Vol. 1, *User's Guide*, SAND97-0594, Sandia National Laboratories, Accident Analysis/Consequence Assessment Department, Albuquerque, New Mexico, March.

CIRRPC (Committee on Interagency Radiation Research and Policy Coordination), 1992, *Use of BEIR V and UNSCEAR 1988 in Radiation Risk Assessment: Lifetime Total Cancer Mortality Risk Estimates at Low Doses and Low Dose Rates for Low-LET Radiation*, ORAU 92/F-64, Science Panel Report No. 9, Office of Science and Technology Policy, Executive Office of the President, Washington, D.C., December.

DEWHA (Australian Government Department of the Environment, Water, Heritage and the Arts), 2005, *Nitric Acid – Substance Fact Sheet*, accessed through http://www.npi.gov.au/database/substance-info/profiles/65.html, August 15.

DOE (U.S. Department of Energy), 1992, *Environmental Assessment, Hanford Environmental Compliance Project, Hanford Site, Richland Washington*, DOE/EA-0383, Washington, D.C., March.

DOE (U.S. Department of Energy), 1995, *Hanford Site Risk Assessment Methodology*, DOE/RL-91-45, Rev. 3, Richland Operations Office, Richland, Washington, May.

DOE (U.S. Department of Energy), 2002, *Recommendations for Analyzing Accidents Under the National Environmental Policy Act*, Office of Environment, Safety and Health, Office of NEPA Policy and Compliance, Washington, D.C., July.

DOE (U.S. Department of Energy), 2003, *Estimating Radiation Risk from Total Effective Dose Equivalent (TEDE)*, ISCORS Technical Report No. 1, DOE/EH-412/0015/0802, Rev. 1, Office of Environmental Policy and Guidance, Washington, D.C., January.

DOE (U.S. Department of Energy), 2004a, *Investigation of Worker Vapor Exposure and Occupational Medicine Program Allegations at the Hanford Site*, Office of Security and Safety Performance Assurance, Office of Independent Oversight and Performance Assurance, April.

DOE (U.S. Department of Energy), 2004b, *EPIcode Computer Code Application Guidance for Documented Safety Analysis, Final Report*, DOE-EH-4.2.1.3-EPIcode Code Guidance, Office of Environment, Safety and Health, Washington, D.C., June.

DOE (U.S. Department of Energy), 2004c, *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), 2006, *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), 2007a, *Type A Accident Investigation Report: The July 27, 2007, Tank 241-S-102 Waste Spill at the Hanford Tank Farms*, Vol. 1, Office of Health, Safety and Security, Office of Corporate Safety Programs, Washington, D.C., September.

DOE (U.S. Department of Energy), 2007b, *Computerized Accident Incident Reporting and Recordkeeping System (CAIRS)*, "DOE and Contractor Fatality Incidence Rates," Office of Health, Safety and Security, accessed through http://www.hss.energy.gov/CSA/Analysis/cairs/cairs/summary/oipds064/fatrate.gif, January 5.

DOE (U.S. Department of Energy), 2007c, *Computerized Accident Incident Reporting and Recordkeeping System (CAIRS)*, "DOE and Contractor Injury and Illness Experience by Year by Quarter, 2001 Through 2006, 4th Quarter," Office of Health, Safety and Security, accessed through http://www.hss.energy.gov/CSA/Analysis/cairs/cairs/, January 31.

DOE (U.S. Department of Energy), 2008, *Protective Action Criteria (PAC) with AEGLs, ERPGs, and TEELs: Rev. 24 for Chemicals of Concern (09/2008)*, Office of Health, Safety and Security, accessed through http://www.hss.energy.gov/HealthSafety/WSHP/chem_safety.teel.html, September.

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.

Eckerman, K.F., A.B. Wolburst, and A.C.B. Richardson, 1988, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, Federal Guidance Report No. 11, EPA 520/1-88-020, U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, D.C, September.

Eckerman, K.F., R.W. Leggett, C.B. Nelson, J.S. Puskin, and A.C.B. Richardson, 1999, *Cancer Risk Coefficients for Environmental Exposure to Radionuclides*, Federal Guidance Report No. 13, EPA 402-R-99-001, U.S. Environmental Protection Agency, Office of Radiation and Indoor Air, Washington, D.C., September.

EPA (U.S. Environmental Protection Agency), 1989, *Risk Assessment Guidance for Superfund*, Vol. 1, *Human Health Evaluation Manual (Part A)*, EPA/540/1-89/002, Office of Emergency and Remedial Response, Washington, D.C., December.

EPA (U.S. Environmental Protection Agency), 2000a, *Soil Screening Guidance for Radionuclides: User's Guide*, EPA/540-R-00-007, Office of Radiation and Indoor Air, Office of Solid Waste and Emergency Response, Washington, D.C., October.

EPA (U.S. Environmental Protection Agency), 2000b, *Radiological Emergency Response Plan*, Office of Radiation and Indoor Air, Washington, D.C., January 10.

EPA (U.S. Environmental Protection Agency), 2009, *Acute Exposure Guideline Levels (AEGLs)*, "AEGL Chemicals: Ammonia Results, Nitric Acid Results," accessed through http://www.epa.gov/opptintr/aegl/pubs/chemlist.htm, February 25.

Fluor Hanford (Fluor Hanford, Inc.), 2004a, *Hanford Safety Analysis and Risk Assessment Handbook (SARAH)*, HNF-8739, Rev. 1, Richland, Washington, August.

Fluor Hanford (Fluor Hanford, Inc.), 2004b, *Analysis of Sodium Hazards for the Solid Waste Operations Complex*, HNF-17444, Rev. 1, Richland, Washington, April.

Fluor Hanford (Fluor Hanford, Inc.), 2007. This reference is for Official Use Only.

Friedman, G.H., 2004, U.S. Department of Energy, Office of the Inspector General, Washington, D.C., personal communication (memorandum) to the Secretary of Energy, U.S. Department of Energy, Washington, D.C., "Investigation of Allegations Involving Occupational Medical Services and Tank Farm Vapor Exposures at the Hanford Site (OIG Case No. I04RL003)," June 1.

GAP (Government Accountability Project), 2003, *Knowing Endangerment: Worker Exposure to Toxic Vapors at the Hanford Tank Farms*, Nuclear Oversight Campaign, Washington, D.C., September.

Graves, R., 2003, *Design Basis Event: Balance of Facilities 12.2 M HNO_3 Vessel*, 24590-BOF-Z0C-30-00001, Rev. D, Bechtel National, Inc., Richland, Washington, May 19.

Himes, D.A., 1996, *Consequence Analysis of a Postulated NaOH Release from the 2727-W Sodium Storage Facility*, WHC-SD-WM-CN-045, Rev. 1, Westinghouse Hanford Company, Richland, Washington, September 27.

Homann, S., 2003, *Introduction to EPIcode*, Version 7.0, Homann Associates, Inc., September.

Lindquist, C., 2006a, *Consequence Analysis Methods for WTP Accident Analyses*, 24590-WTP-GPG-SANA-004, Rev. 3, Bechtel National, Inc., Richland, Washington, December 8.

Lindquist, C., 2006b, *Determination of Extremely Hazardous Substances*, 24590-WTP-RPT-ESH-01-001, Rev. 2, Bechtel National, Inc., Richland, Washington, March 23.

Mallinckrodt (Mallinckrodt Baker, Inc.), 2006, *Material Safety Data Sheet: Phosphoric Acid*, Phillipsburg, New Jersey, January 3.

MDOA (Minnesota Department of Agriculture), 2008, *Ecological Effects of Ammonia*, accessed through http://www.mda.state.mn.us/chemicals/spills/ammoniaspills/ecoeffects.htm on December 9.

Medsker, M., 2007, *Safety Envelope Document; LAW Facility Specific Information*, 24590-WTP-SED-ENS-03-002-03, Rev. 1n, Bechtel National, Inc., Richland, Washington, October 11.

Napier, B.A., 2007, *GENII – Version 2 Users' Guide*, PNNL-14583, Rev. 2, Pacific Northwest National Laboratory Richland, Washington, March.

Napier, B.A., R.A. Peloquin, D.L. Strenge, and J.V. Ramsdell, 1988, *GENII – The Hanford Environmental Radiation Dosimetry Software System*, PNL-6584, Pacific Northwest Laboratory, Richland, Washington, December.

Napier, B.A., D.L. Strenge, J.V. Ramsdell, P.W. Eslinger, and C. Fosmire, 2004, *GENII Version 2 Software Design Document*, PNNL-14584, Pacific Northwest National Laboratory, Richland, Washington, November.

National Research Council, 1990, *Health Effects of Exposure to Low Levels of Ionizing Radiation, BEIR V*, Committee on the Biological Effects of Ionizing Radiations, Board of Radiation Effects Research, Commission on Life Sciences, National Academy Press, Washington, D.C.

National Research Council, 2006, *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2*, Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation, Board on Radiation Effects Research, Division on Earth and Life Sciences, National Academies Press, Washington, D.C.

NCRP (National Council on Radiation Protection and Measurements), 1993, *Risk Estimates for Radiation Protection*, NCRP Report No. 115, Bethesda, Maryland, December 31.

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.

NJDHSS (New Jersey Department of Health and Senior Services), 2004, *Hazardous Substance Fact Sheet; 2-Naphthylamine*, Trenton, New Jersey, August.

NRC (U.S. Nuclear Regulatory Commission), 1990, *MELCOR Accident Consequences Code System (MACCS)*, NUREG/CR-4691, Washington, D.C., February.

Oberg, B.D., 2003, *Assessment of Aircraft Crash Frequency for the Hanford Site 200 Area Tank Farms*, RPP-11736, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington, March 22.

Olson, W.W., 1992, *Solid Waste Stream Hazardous and Dangerous Components Study*, WHC-SD-WM-RPT-056, Rev. 0, Westinghouse Hanford Company, Richland, Washington, August.

Osborne, J.W., and J.L. Huckaby, 1994, *Program Plan for the Resolution of Tank Vapor Issues*, WHC-EP-0562, Rev. 1, Westinghouse Hanford Company, Richland, Washington, May.

Osborne, J.W., J.L. Huckaby, E.R. Hewitt, C.M. Anderson, D.D. Mahlum, B.A. Pulsipher, and J.Y. Young, 1995, *Data Quality Objectives for Generic In-tank Health and Safety Vapor Issue Resolution*, WHC-SD-WM-DQO-002, Rev. 1, Westinghouse Hanford Company, Richland, Washington, April.

Perry, R.H., D.W. Green, and J.O. Maloney, eds., 1984, *Perry's Chemical Engineers' Handbook*, 6th ed., McGraw-Hill Book Company, New York, New York.

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.

Rokkan, D.J., N.A. Homan, K. Rhoads, S.F. Snyder, and L.H. Staven, 2007, *Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 2006*, DOE/RL-2007-01, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington, June.

SAIC (Science Applications International Corporation), 2010a, *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, December 10.

SAIC (Science Applications International Corporation), 2010b, *Fast Flux Test Facility Alternatives, Scaled Data Sets to Support the "Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington,"* Germantown, Maryland, November 8.

SAIC (Science Applications International Corporation), 2010c, *Waste Management 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.

Salocks, C., and K.B. Kaley, 2003, *Technical Support Document: Toxicology, Clandestine Drug Labs: Methamphetamine*, Vol. 1, No. 7, *Sodium Hydroxide*, California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, Sacramento, California, September 24.

Schepens, R.J., 2005, U.S. Department of Energy, Office of River Protection, Richland, Washington, personal communication (letter) to E.S. Aromi, CH2M HILL Hanford Group, Inc., Richland, Washington, "Contract No. DE-AC27-99RL14047 – Assessment Report A-05-ESQ-TANKFARM-007, Industrial Hygiene (IH) Program," May 27.

Schofield, J.S., 2004, *Results of Nitrous Oxide Monitoring Equipment Tests and Badge Monitoring Non-personnel Area Tests Within Hanford Single Shell Tank Farms*, RPP-21448, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington, June.

Shire, P.R., W.L. Cowley, B.H. Gilbert, D.A. Smith, and G.L. Smith, 1995, *Potential Accidents with Radiological and Toxicological Source Terms for Hanford Tank Waste Remediation System Environmental Impact Statement*, WHC-SD-WM-ANAL-041, Rev. 0, Westinghouse Hanford Company, Richland, Washington, June.

Stock, L.M., and J.L Huckaby, 2000, *A Survey of Vapors in the Headspaces of Single-Shell Waste Tanks*, PNNL-13366, Pacific Northwest National Laboratory, Richland, Washington, October.

SUNY ESF (State University of New York College of Environmental Science and Forestry E-Center), 2008, *Soil pH: What it Means*, accessed through http://www.esf.edu/pubprog/brochure/soilph/soilph.htm on December 9.

Valentin, J., ed., 2007, *Annals of the ICRP: The 2007 Recommendations of the International Commission on Radiological Protection*, ICRP Publication 103, International Commission on Radiological Protection, Elsevier, Amsterdam, The Netherlands, December.

Warrence, N.J., J.W. Bauder, and K.E. Pearson, 2002, *The Basics of Salinity and Sodicity Effects on Soil Physical Properties*, Montana State University, Land Resources and Environmental Sciences Department, accessed through http://waterquality.montana.edu/docs/methane/basics_highlight.shtml.

WHC (Westinghouse Hanford Company), 1994, *Conceptual Design Report: Sodium Storage Facility, Fast Flux Test Facility, Project F-031*, WHC-SD-FF-CDR-006, Rev. 0, Richland, Washington, October.

WHC (Westinghouse Hanford Company), 1996, *Assessment of the Potential for Ferrocyanide Propagating Reaction Accidents*, WHC-SD-WM-SARR-038, Rev. 1, Richland, Washington, July.

Woolfolk, S., 2007a, *Safety Envelope Document; HLW Facility Specific Information*, 24590-WTP-SED-ENS-03-002-04, Rev. 1q, Bechtel National, Inc., Richland, Washington, October 22.

Woolfolk, S., 2007b, *Safety Envelope Document; PT Facility Specific Information*, 24590-WTP-SED-ENS-03-002-02, Rev. 1o, Bechtel National, Inc., Richland, Washington, October 26.

WSDOH (Washington State Department of Health), 2008, *Ammonia Emergency Release Events in Washington State, 1993–2001*, Office of Environmental Health and Safety, Office of Environmental Health Assessments, Olympia, Washington.

WSRC (Westinghouse Savannah River Company), 2005, *Savannah River Site (SRS) Chemical Products Hazard Ratings*, July.

WSU (Washington State University), 2004, *Soil pH*, Tree Fruit Research and Extension Center, accessed through http://soils.tfrec.wsu.edu/webnutritiongood/soilprops/soilpH.htm, November 22.

WSU (Washington State University), 2008, *Soils of Washington: Sagemoor Series, Hezel Series, Burbank Series*, accessed through http://remotesens.css.wsu.edu/washingtonsoil/ on October 20.

Code of Federal Regulations

10 CFR 20, U.S. Nuclear Regulatory Commission, "Standards for Protection Against Radiation."

10 CFR 835, U.S. Department of Energy, "Occupational Radiation Protection."

10 CFR 835.1002, U.S. Department of Energy, "Occupational Radiation Protection: Facility Design and Modifications."

29 CFR 1910, Occupational Safety and Health Administration, U.S. Department of Labor, "Occupational Safety and Health Standards."

29 CFR 1910.106, Occupational Safety and Health Administration, U.S. Department of Labor, "Occupational Safety and Health Standards: Flammable and Combustible Liquids."

29 CFR 1910.119, Occupational Safety and Health Administration, U.S. Department of Labor, "Occupational Safety and Health Standards: Process Safety Management of Highly Hazardous Chemicals."

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 68, U.S. Environmental Protection Agency, "Chemical Accident Prevention Provisions."

40 CFR 68.130, U.S. Environmental Protection Agency, "Chemical Accident Prevention Provisions: List of Substances."

40 CFR 141, U.S. Environmental Protection Agency, "National Primary Drinking Water Regulations."

40 CFR 302, U.S. Environmental Protection Agency, "Designation, Reportable Quantities, and Notification."

40 CFR 355, U.S. Environmental Protection Agency, "Emergency Planning and Notification."

40 CFR 355.40, U.S. Environmental Protection Agency, "Emergency Planning and Notification: Emergency Release Notification."

U.S. Department of Energy Guides, Handbooks, Orders, and Standards

DOE Order 151.1C, *Comprehensive Emergency Management System*, November 2, 2005.

DOE Guide 151.1-2, *Technical Planning Basis – Emergency Management Guide*, July 11, 2007.

DOE Order 458.1, *Radiation Protection of the Public and the Environment*, Change 2, June 6, 2011.

DOE Order 470.3B, Certified May 10, 2011. This reference is Classified.

DOE Order 470.4B, *Safeguards and Security Program*, July 21, 2011.

DOE Standard 1021-93, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components*, Reaffirmed with Errata, April 2002.

DOE Standard 1098-2008, *Radiological Control*, Change Notice 1, May 2009.

DOE Handbook 3010-94, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, Vol. 1, *Analysis of Experimental Data*, Change Notice 1, March 2000.