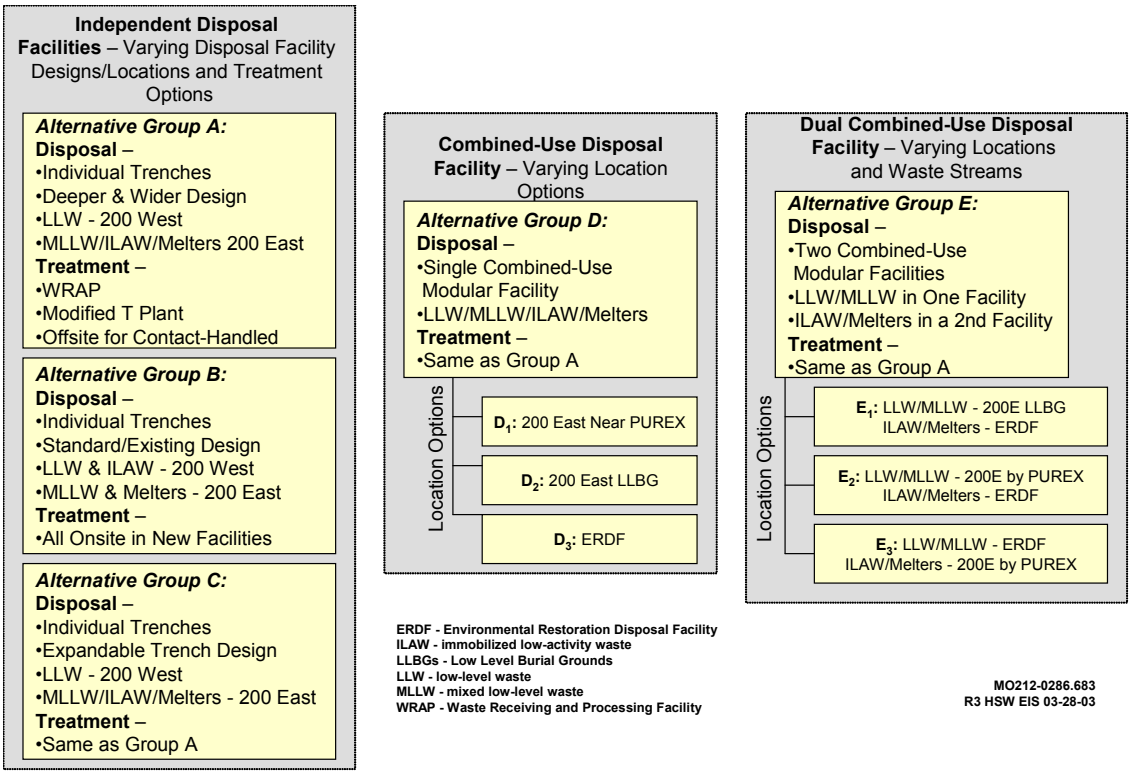

Figure S.15. Development of Alternative Action Groups

together. New LLW facilities would be located in the 200 West Area and new MLLW, ILAW, and melter facilities would be located in the 200 East Area. Treatment alternatives would be the same as those described in Alternative Group A.

Alternative Group D – ***Single Combined-Use Disposal Facility – Onsite and Offsite Treatment***: LLW, MLLW, ILAW, and melters would be disposed of in a single facility. Disposal would occur either near the Plutonium-Uranium Extraction Plant (D_1), in the 200 East Area Low Level Burial Grounds (D_2), or at the Environmental Restoration Disposal Facility (D_3). Treatment alternatives would be the same as those described in Alternative Group A.

Alternative Group E – ***Dual Combined-Use Disposal Facilities – Onsite and Offsite Treatment***: LLW and MLLW would be disposed of in a single facility; ILAW and melters would be disposed of in another single facility. Disposal would occur in some combination of locations as shown in Table S.1. Treatment alternatives would be the same as those described in Alternative Group A.

S.7 Comparison of Alternatives

We have prepared the following sections to summarize the results of the environmental analyses prepared in this revised draft HSW EIS. We have included a high-level summary of the environmental consequences associated with the various alternative groups. We also discuss the results of our cumulative impacts analysis, potential mitigation measures, and our long-term stewardship plans.

Table S.1. Alternative Group E – Dual Combined-Use Disposal Facilities Options

Options	Disposal Facility Location		
	ERDF	**200 East LLBG**	**200 East Near PUREX**
E_1	WTP Melter & ILAW	LLW & MLLW	
E_2	WTP Melter & ILAW		LLW & MLLW
E_3	LLW & MLLW		WTP Melter & ILAW

Environmental Consequences

We have examined the potential environmental impacts associated with implementing each of the alternative groups. For some consequences, such as long-term effects of waste disposal on groundwater and the Columbia River, the evaluation period extends well beyond the end of the site operations. For many of the resources, minimal impacts would be expected to occur as a result of implementing any of the alternatives and the differences between the alternative groups are also small. However, for some resources, differences in impacts among the alternative groups do exist. These differences are described below and in Section 3.4 and Section 5 of this HSW EIS.

Table S.2 provides a summary of the range of potential environmental consequences during operations of our alternatives under the projected waste volumes. Table S.3 provides our summary of the potential long-term (10,000-year) impacts associated with our alternatives. Because the differences between alternatives are often small, we have chosen to illustrate the differences by waste volumes in these two tables.

We have chosen to make a number of assumptions in our analysis that provide a conservative view of the potential impacts. These assumptions include such things as the absence of active institutional controls 100 years after site closure. Without active institutional controls the analysis further assumes that caps and covers would not be maintained and would degrade over time, maintenance and monitoring activities are not performed, and there is no long-term credit taken for the presence of liners in preventing contamination movement. Considering that many engineered structures and administrative or institutional controls have remained in place for several hundreds of years (Europe is replete with examples of both), this is considered a very, if not overly, conservative assumption.

While we have used these conservative assumptions in our analysis, the federal government fully intends to maintain institutional controls and implement long-term stewardship, mitigation, maintenance, and monitoring activities for as long as necessary. Based on comments, we may provide additional information in the final HSW EIS regarding the potential variation in the environmental impacts associated with continued active maintenance and control measures.

Land Use: We prepared an estimate of the total amount of land committed to the storage, treatment, and disposal of waste for each alternative group. Land permanently committed to waste disposal includes about 130 hectares already occupied by waste previously disposed of in the Low Level Burial Grounds.

Table S.2. Range of Incremental Impacts from Alternatives Analyzed in this EIS (Operational Period)

Consequence Category	**Measure of Impact** - where differences exist among alternative groups, a range is provided and the low and high alternative group(s) are identified by letter: Low Value (Alternative) to High Value (Alternative)	Range of Waste Volumes		
		Hanford Only	**Lower Bound**	**Upper Bound**
		Hanford 728,752 m^3	Offsite 20,977 m^3 + Hanford 728,752 m^3 = 749,729 m^3	Offsite 361,659 m^3 + Hanford 728,752 m^3 = 1,090,411 m^3
Routine Operations				
Land Committed to Waste Management	Additional Land Needed – Hectares	19 (D/E) to 93(N)	20 (D/E) to 95 (N)	25 (D/E) to 80 (B)
Ecological Resources	Shrub-Steppe Habitat Disturbed – Hectares	0 (N/B/D2) to 32 (A/C)	0 (N/B/D2) to 32 (A/C)	0 (B/D2) to 32 (A/C)
Geological Resources	Millions of cubic meters	1.4 (N) to 2.6 (B)	1.4 (N) to 2.6 (B)	2.3 (C/D/E) to 2.8 (B)
Consumption of Non-renewable Resources	Diesel Fuel - Thousands of cubic meters	66 (C/D/E) to 189 (N)	66 (C/D/E) to 189 (N)	67 (C/D/E) to 141 (B)
Air Quality	Maximum fraction of an air quality limit (particulate matter)	0.38 (N) to 0.47 (B)	0.38 (N) to 0.47 (B)	0.41 (C/D/E) to 0.60 (B)
Human Health and Safety – Workers and Public	Occupational Exposure - person-rem	765 (A/C) to 873 (N)	766 (A/C) to 873 (N)	774 (C) to 786 (B)
	General Population Dose - person-rem (routine atmospheric emissions)	0.08 (N) to 0.15 (B)	0.094 (N) to 0.17 (B)	0.22 (B) to 0.27 (A/C/D/E)
Cost	Cost in Billions of Dollars	$3.2 (D) to $3.8 (B)	$3.2 (D) to $3.9 (B)	$3.5 (D) to $4.2 (B)
Accident Analysis				
Transportation of Waste and Materials – Accidents/Fatalities	Onsite & for Offsite Treatment	2/0 (N) to 20/1 (A/C/D/E)	2/0 (N) to 20/1 (A/C/D/E)	9/0 (B) to 20/1 (A/C/D/E)
	Within the State of Oregon	0/0 (all alternatives)	2/0 (all alternatives)	4/0 (all alternatives)
	Within the State of Washington	0/0 (all alternatives)	1/0 (all alternatives)	1/0 (all alternatives)
	TRU Waste to WIPP	9/1 (N) to 18/3 (A/B/C/D/E)	9/1 (N) to 18/3 (A/B/C/D/E)	18/3 (all alternatives)
Worker Health & Safety – Industrial Accidents	Number of Recordable Cases	620 (A/C/D/E) to 770 (N)	620 (A/C/D/E) to 770 (N)	640 (A/C/D/E) to 660 (B)
	Number of Lost Workday Cases	260 (A/C/D/E) to 320 (N)	260 (A/C/D/E) to 320 (N)	260 (A/C/D/E) to 270 (B)
	Number of Lost Workdays	8900 (A/C/D/E) to 10,900 (N)	8900 (A/C/D/E) to 10,900 (N)	9200 (A/C/D/E) to 9300 (B)
Fatalities from Operational Accident Having the Largest Consequences	The Beyond-Design-Basis Earthquake at the Central Waste Complex is the accident with the largest consequences. A number of other potential accident scenarios were also evaluated.			
	Public - Number of latent cancer fatalities	34 (all alternatives)	34 (all alternatives)	34 (all alternatives)
	Non-Involved Worker - probability of a latent cancer fatality	1 (all alternatives)	1 (all alternatives)	1 (all alternatives)

Table S.3. Range of Incremental Impacts from Alternatives Analyzed in this EIS (long-term – 10,000 years)

Consequence Category	**Measure of Impact** - where differences exist among alternative groups, a range is provided and the low and high alternative group(s) are identified by letter: Low Value (Alternative) to High Value (Alternative)	**Range of Waste Volumes**		
		Hanford Only	**Lower Bound**	**Upper Bound**
		Hanford 728,752 m^3	Offsite 20,977 m^3 + Hanford 728,752 m^3 749,729 m^3	Offsite 361,659 m^3 + Hanford 728,752 m^3 1,090,411 m^3
Maximum Waste Site Intruder Risk of Fatality at 100 Years After Closure	Residential Basement Excavation	Precluded due to depth	Precluded due to depth	Precluded due to depth
	Drilling	4 in 100	4 in 100	4 in 100
	For the intruder scenarios the results are the same for all the alternatives and waste volumes, with the exception of the excavation scenario for the No Action Alternative. Because the No Action Alternative does not include protective caps over the burial ground, the excavation scenario would likely result in an acute fatality, if intrusion were to take place in the year 2150.			
Water Quality (Groundwater) – Sum of the fractions in year of greatest value	Sum-of-the-Fractions Calculation for the **Maximum** Projected combined Iodine-129 and Technetium-99 concentrations			
	200 East NW line of analysis down	58% in the year 2100 AD ($D_1/D_3/E_2/E_3/NA$) to 100% in the year 3400 AD (D_2/E_1)	58% in the year 2100 AD ($D_1/D_3/E_2/E_3/NA$) to 100% in the year 3400 AD (D_2/E_1)	58% in 2100 AD ($D_1/D_3/E_2/E_3$) to 136% in 3400 AD (B)
	ERDF line of analysis	49% in 12,050 AD (E_1/E_2) to 117% in 3790 AD (D_3)	49% in 12,050 AD (E_1/E_2) to 117% in 3790 AD (D_3)	49% in 12050 AD (E_1/E_2) to 120% in 3800 AD (D_3)
	For all other lines of analysis (200 W, 200 E SE, and along the River) the sum of the fraction never exceeds 100%.			
Exposure to Radionuclides via the Groundwater Pathway				
Maximum Annual Drinking Water Dose (2 liters per day consumption)	200 Area - Highest Results (mrem)	0.21 (E_2) to 0.51 (N)	0.21 (E_2) to 0.75 (N)	0.26 (E_2) to 2.4 (B/D_1)
	Near River – Highest Results (mrem)	0.04 (N) to 0.13 (B)	0.04 (N) to 0.13 (B)	0.09 ($A/C/D/E_1/E_3$) to 0.21 (B)
Fatality to Lifetime Onsite Resident Gardener	200 Area (chances in a million)	28 (E_2) to 65 (A/C)	28 (E_2) to 65 (A/C)	29 (E_2) to 130 (B)
	Near River (chances in a million)	6 (E_2) to 13 (B)	6 (E_2) to 13 (B)	7 ($A/C/E_3$) to 15 (B)
Fatality to Lifetime Onsite Resident Gardener with a Sauna/ Sweat Lodge	200 Area - Highest Result (chances of a fatality)	1 in 400 ($A/C/D_1/E_3$) to 1 in 50 (N)	1 in 400 ($A/C/D_1/E_3$) to 1 in 50 (N)	1 in 10 (all alternatives)
	Near River (chances of a fatality)	1 in 2000 (C/D/E) to 1 in 200 (B)	1 in 2000 (C/D/E) to 1 in 200 (B)	1 in 300 ($A/C/D/E_1/E_3$) to 1 in 100 (B)
Fatalities in Populations over 10,000 Years	Based on person-rem calculations, the impacts to populations downstream of Hanford were evaluated for the Tri-Cities, Washington, and for Portland, Oregon, over the 10,000-year period. Based on the population dose (person-rem), no latent cancer fatalities are predicted.			

Disposal of the Hanford Only waste volume would increase the area of land permanently committed from a low of 19 hectares of land within the 200 Area under Alternative Groups D and E, to 56 hectares for Alternative Group B, and 95 hectares for the No Action Alternative (of which 66 hectares would be for continued storage). Table S.2 provides the incremental increases in land use for the Lower and Upper Bound waste volume estimates. At most, total land use for solid waste operations, including treatment, storage, and disposal facilities, would represent about 4 percent of the 200 Area Industrial-Exclusive zone.

Transportation: We describe the impacts of shipments of solid waste from offsite generators to the Hanford Site, paying specific attention to transportation impacts with the states of Washington and Oregon, and shipments of TRU waste from Hanford to the Waste Isolation Pilot Plant. Figure S.16 shows the primary transportation routes of radioactive waste through the states of Oregon and Washington.

We also evaluated the impacts of shipments within the Hanford Site of LLW, MLLW, TRU waste, ILAW, and melters to disposal facilities, shipments of MLLW from Hanford to offsite treatment facilities, and shipments of construction and capping materials.

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Figure S.16. Planned Transportation Routes of Radioactive Waste through Oregon and Washington

From the analysis, we project no radiological fatalities from any of the alternatives. Within Oregon and Washington (including the Hanford Site), we estimate the number of potential traffic accidents range from a low of 5 to a high of 25, with only one traffic fatality projected. The transport of TRU waste to the Waste Isolation Pilot Plant for Alternative Groups A through E might result in 18 accidents and 3 fatalities; and the No Action Alternative might result in 9 accidents and 1 fatality somewhere in the United States. Because the No Action Alternative leaves waste in storage or at the generator site, it results in the lowest number of accidents overall. The transportation impacts in Oregon and Washington from receiving the additional waste volumes from the Lower Bound waste volumes to the Upper Bound waste volumes is estimated at 2 additional accidents.

Air Quality and Noise: Air quality impacts are based on concentrations of particulate matter, sulfur dioxide, carbon monoxide, and nitrogen dioxide at points of public occupancy compared to State and federal air quality standards. Air quality standards are not exceeded under any of the alternatives over the entire range of waste volumes. In addition to the analysis of air quality, we also assess construction noise. Because all alternatives would involve essentially the same activities, noise levels produced by those activities at any given point in time would be essentially the same. Moreover, noise was not considered to be an important impact element because of distance to public receptors.

Ecological Resources: Potential impacts on ecological resources are small among the alternative groups and the No Action Alternative; we do not expect them to be important discriminators in the selection process. However, the loss of the shrub-steppe habitat for the alternative groups using the near PUREX disposal facility location represents a discriminating ecological resource impact. If this location were selected, mitigation measures would be expected in accordance with our biological resources mitigation strategy. Conclusions regarding potential impacts on terrestrial biota were based on appropriate seasonally adjusted surveys. Conclusions regarding potential impacts on aquatic and riparian biota near and in the Columbia River were based on an ecological risk assessment of potential future releases from waste sites through groundwater to the river. The risk of radiological impacts to aquatic and riparian biota from future contaminant releases is well below levels expected to cause any discernible impacts. The risk to threatened and endangered species is likewise negligible for all the alternative groups.

Cultural, Aesthetic, and Scenic Resources: The principal potential for impacts on cultural resources would be associated with disturbance of the surface and near-surface portions of the Area C borrow pit (Figure S.17). Although it is possible that we may find archeological sites in Area C, a recent field reconnaissance failed to reveal any sites or artifacts on the surface. Because construction would be halted in the event that an artifact of possible cultural significance were found and would remain so until a professional evaluation was made, it would be unlikely that impact to cultural resources would be important discriminators among the alternative groups. In addition, no particular distinction was made among any of the alternative groups for impacts on aesthetic and scenic resources.

Socioeconomic and Environmental Justice: Implementation of any of the alternative groups or the No Action Alternative would have minimal and barely differentiable impacts on local socioeconomic infrastructure, including housing, schools, medical support, traffic, and environmental justice impacts.

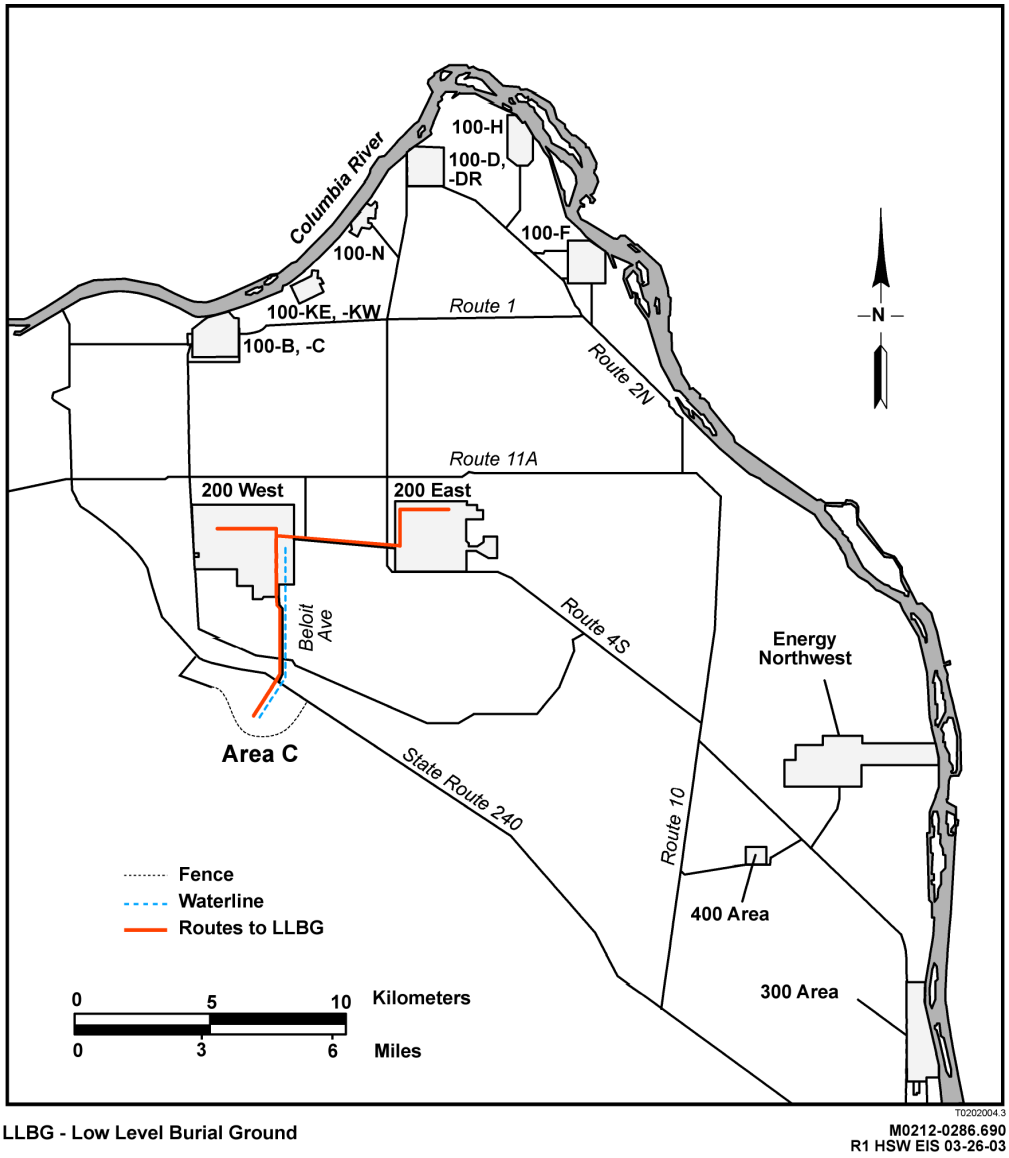


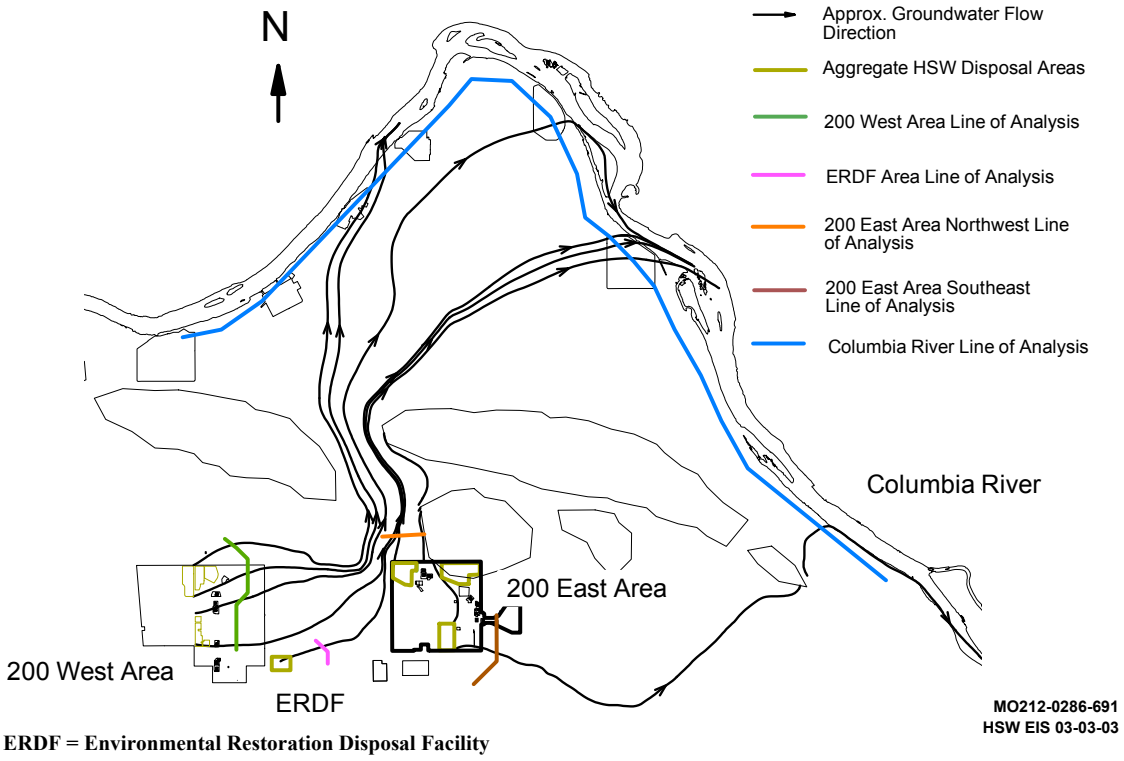
Figure S.17. Area C Location Relative to the 200 East and 200 West Burial Grounds

Geological and Non-Renewable Resources: Although large quantities of gravel, silt/ loam, and basalt would be needed in the construction of waste disposal site covers upon closure, these resources are readily available in the Area C borrow pit. The quantities of these resources range from a low of 1.4 million cubic meters for the No Action Alternative to a high of 2.8 million cubic meters for Alternative Group B. In addition to geologic resources, the consumption of fossil fuel (diesel, gasoline, and propane) has been estimated for all the alternative groups. Alternative Groups A and B have noticeably higher fossil fuel demands than the other alternative groups because of the additional construction and operation of new onsite treatment facilities.

Water Quality: One measure of water quality for purposes of comparison among the alternatives is taken as the annual dose to an individual from drinking 2 liters per day of groundwater from hypothetical wells. These hypothetical wells are assumed to contain the maximum combined concentrations of radionuclides in predicted plumes along several lines of analysis downgradient (toward the river) from the solid waste disposal facilities. These lines of analysis were positioned at a distance to capture maximum combined contributions from the disposal facilities and are illustrated in Figure S.18.

Maximum doses from drinking water containing combined radionuclide concentrations from the Hanford solid waste disposal facilities predicted at all lines of analysis in groundwater for any of the alternatives and waste volumes disposed of fall below 1 mrem per year for the first 1,000 years after disposal, and below 4 mrem per year for the entire 10,000-year period of analysis. The dose from drinking maximum cumulative concentrations predicted adjacent to the Columbia River is less than 0.1 mrem per year for about 9,000 years and does not exceed 1 mrem per year for the entire 10,000-year period of analysis. To put this in perspective, the average background dose to individuals in the United States is about 300 mrem per year.

Action alternatives analyzed in this EIS do not exceed the 4 mrem per year benchmark public drinking water dose (see Section 3.4.3). By the time the waste constituents from the action alternatives are predicted to reach groundwater (hundreds of years), the waste constituents would not superimpose on existing plumes and would not exceed the benchmark dose, because the existing groundwater contaminant plumes will have migrated out of the unconfined aquifer by then.



ERDF = Environmental Restoration Disposal Facility

Figure S.18. Lines of Analysis for Determining Maximum Annual Drinking Water Dose

We also use maximum concentration levels as benchmarks to compare potential contamination levels. Under all alternative groups and the No Action Alternative, the highest impacts to groundwater quality were estimated from releases of two key long-lived and mobile radionuclides, iodine-129 and technetium-99. For most of the alternative groups, predicted iodine-129 concentration levels approached but did not exceed the benchmark maximum concentration level of 1 picocurie per liter. The highest iodine-129 levels were associated with the Upper Bound waste volume considered in Alternative B. For the Upper Bound waste volume evaluated under Alternative B, maximum iodine-129 levels downgradient from the 200 East Area were at 123 percent (1.2 picocurie per liter) of the benchmark maximum concentration level.

For all the alternative groups, technetium-99 concentration levels do not exceed the benchmark maximum concentration level (900 picocurie per liter) over the 10,000-year period for all lines of analysis. Using the sum-of-fractions rule, the total concentration of technetium-99 and iodine-129 when combined ranged from 58 percent to 136 percent with the maximum occurring in the 200 Areas for Alternative Group B and the Upper Bound waste volume in about the year 3290 AD. Combined technetium-99 and iodine-129 concentration levels were well below benchmark maximum concentration levels by the time they reached the Columbia River well for all alternative groups and the No Action Alternative. At a maximum, uranium caused contamination levels of up to about 58 percent of its maximum concentration level in 200 Area wells about 10,000 years after closure. None of the alternatives resulted in concentrations of uranium exceeding 5 percent of the maximum concentration level at the river well.

Human Health – Operational Period (present to 2046): We compare radiological impacts on the public from the routine atmospheric releases of radioactive materials or chemicals during operations in various alternative groups. Airborne emissions from routine operations were determined to be very small and would not result in any additional latent cancer fatalities in the exposed population. We also compare radiological impacts to workers (both non-involved workers and occupational radiation workers). The No Action Alternative represents the highest cumulative dose, followed by Alternative Group B, with the remaining groups very closely related. At the highest collective worker dose (873 person-rems), which is associated with the No Action Alternative, 1 latent cancer fatality might be inferred (0.52). No latent cancer fatalities would be expected among workers for the other alternative groups.

We do not expect either occupational radiation exposure or occupational injuries as a result of accidents to result in radiation-related fatalities among workers involved in the waste management operations, although some reportable and lost workday accidents of an industrial nature would be expected based on Hanford Site labor statistics (see Table S.2). The radiological impacts of accidents vary greatly depending on the circumstances of the events analyzed, and are described in detail in Appendix F.

Human Health – Post Closure Period: As stated previously, we have chosen to make a number of assumptions in our analysis that provide a conservative view of the potential long-term impacts. These assumptions include such things as the absence of active institutional controls 100 years after site closure. While we have used these conservative assumptions in our analysis, the federal government fully intends to maintain institutional controls and implement long-term stewardship and maintenance and monitoring activities for as long as necessary. In the case of intruder scenarios (e.g., unauthorized use of or entry into

an area), the consequences are essentially the same for all alternative groups, and while not discriminators among alternatives, they do present potential impacts. Because of these impacts, we will employ mitigation techniques such as the use of institutional controls and long-term stewardship actions.

Impacts on the public in the long term are expressed in terms of the annual dose a hypothetical gardener might receive, if the individual were to intrude on the Hanford Site, drill a well into a contaminated aquifer, spread the drilling mud about the garden plot, and use the well water for both domestic and irrigation purposes. Plots of the annual doses to the hypothetical resident gardener are provided in Section 3.4. There are differences in the annual doses over time as a function of the alternative under consideration; however, the maximum values are all less than 25 mrem per year, which is the limit for all pathways (DOE 2001b).

To account for the possibility that the hypothetical gardener had a sauna, or in the case of a Native American, a sweat lodge, the annual dose to such an individual as a function of time was also determined. Plots of the annual doses to the resident gardener are again compared among the alternatives in Section 3.4. The much higher doses associated with the sauna/sweat lodge scenario are attributable to inhalation of radionuclides released as a result of elevated water temperatures used in saunas or sweat lodges. For all alternatives, the annual dose is at or less than 4 mrem for the first 1,000 years. Late in the 10,000-year period there is considerable difference among the alternatives with the risk of a latent cancer fatality ranging up to about 1 in 10 for well locations on the Central Plateau. This rise is due primarily to the arrival of uranium in groundwater at some sites. In terms of this analysis, Alternative Group B tends to be the least preferred action alternative with others closely grouped together.

Under all of the alternatives, radioactive or hazardous chemical exposures to populations using Columbia River water downstream from the Hanford Site would be far below those from which we would expect any health effects.

Cumulative Impacts

Here, we summarize potential cumulative impacts associated with implementing the various alternative groups and waste volumes considered. The cumulative impacts analysis focused on past, present, and reasonably foreseeable future actions. Current and future actions at Hanford include preparation for and disposal of tank waste, CERCLA remediation projects, decontamination and decommissioning of the Hanford reactors, operation of a commercial LLW disposal site by US Ecology, and operation of the Columbia Generating Station by Energy Northwest. We evaluate cumulative impacts regarding worker health and safety; public health (for atmospheric, surface water, and groundwater pathways); land use; air quality; and ecological, cultural, and socioeconomic resources. For most resource and potential impact areas, the combined effects from the HSW EIS proposed actions added to these activities are small.

Because of public interest in cumulative impacts associated with contamination of groundwater and the Columbia River, these impacts are summarized here in more detail. Cumulative impacts on groundwater and the Columbia River are examined in the context of existing sources of contamination in the soil, vadose zone, and groundwater. Groundwater beneath the operational areas and in plumes from the Central Plateau moving towards the Columbia River is currently contaminated with hazardous chemicals

and radionuclides from past liquid and other disposal practices and unplanned releases. Mobile radionuclides leached from wastes in the environment could eventually be transported through the vadose zone to groundwater.

Although not used as a source of drinking water today nor expected to be in the foreseeable future, groundwater was analyzed as a scenario in which an individual in the future drills a well through the vadose zone to groundwater and uses the groundwater as a source of drinking water. To understand cumulative Hanford groundwater impacts, we analyzed the annual dose to an individual drinking 2 liters of that water per day. The annual dose was also calculated for an individual drinking 2 liters per day of water taken from the Columbia River at the Richland pumphouse. We took into account all wastes intentionally or unintentionally disposed of on the Hanford Site since the beginning of operations and waste forecasted to be disposed of through cleanup completion. The long-lived mobile radionuclides selected with which to make these estimates were technetium-99 and uranium isotopes using the System Assessment Capability (SAC) (Kincaid et al. 2000) software and data. Other long-lived radionuclides occur in sufficient quantity in various Hanford sources to also be of interest (such as iodine-129). However, the SAC program had not completed the inventory and classification of waste forms in time to integrate these other radionuclides into the present analysis.

This analysis does not include the contribution to cumulative impacts of all radionuclides because of the uncertainties in the inventory and modeling approach. In particular, for one contaminant of interest, iodine-129, such source information has only been partially developed and validated. However, if all sources of iodine-129 were to be considered, it is felt that the cumulative impacts to groundwater could be greater than the impacts presented here by a factor of up to about 3 (see Section 5.14). This is due to the fact that over one-third of the available inventory of iodine-129 is included in the solid waste and ILAW streams. Although it is likely that the actual factor would be less than 3, DOE is continuing to refine computer models to provide more precise estimates. If further analysis shows the potential for adverse cumulative groundwater impacts, then DOE would implement appropriate mitigation measures to prevent such cumulative impacts from occurring. Potential mitigation measures include treating waste by such methods as macroencapsulation, grouting, or placing it in robust containers.

The approach taken by the SAC is consistent with the methods, characteristics, and controls associated with a composite analysis as described by the Columbia River Comprehensive Impact Assessment team (DOE-RL 1998). The SAC is being applied in this HSW EIS to examine the cumulative dose from technetium-99 and uranium associated with all wastes to remain at Hanford after closure of the site, and to provide an overall perspective regarding the contribution of solid waste from implementing any of the HSW EIS alternatives to cumulative impacts from other potential sources. Results of these analyses are provided in Section 5.14 and Appendix L.

Using SAC, we can conclude that the potential dose from groundwater contamination by technetium-99 is dominated by the existing groundwater plumes and releases from liquid waste disposal sites (e.g., cribs, ponds, ditches) over the next 2,000 years. Releases of contaminants from solid waste begin to have noticeable contributions between the years 3000 and 5000 and decline thereafter, with contributions from

tank residuals causing a later secondary peak, and with long-term releases from solid wastes, including ILAW, appearing during the last several thousand years of the 10,000-year post-closure analysis. Figure S.19 illustrates these results.

SAC was also employed to evaluate the relative role in overall release of different waste types, including solid waste, past liquid discharges, past tank leaks, future tank losses, tank residuals, unplanned releases, and facilities including canyon buildings. The variability in the results is due to variability in the inventory, release, and transport of the contaminants. In the simulation, the contribution to technetium-99 from solid waste releases to groundwater would amount to approximately 20 percent of the cumulative release from all Hanford sources. For uranium, releases from solid waste to groundwater are much lower. The majority of the technetium-99 and uranium releases from wastes (other than ILAW) were predicted to occur from liquid discharge sites (e.g., cribs, ponds, ditches) used in the past and from unplanned releases on the Central Plateau and from off-plateau waste sites.

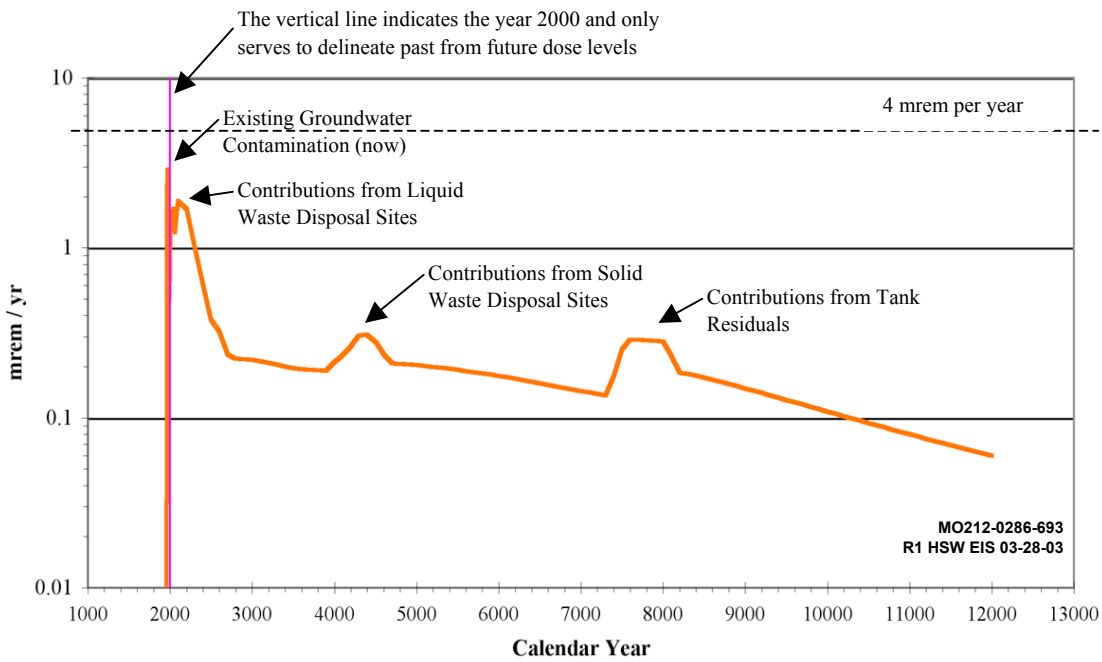


Figure S.19. Annual Drinking Water Dose from Technetium-99 in Groundwater Southeast of the 200 East Area from All Hanford Sources Including ILAW

Uncertainties

Even with the knowledge gained over the past decade in addressing our environmental cleanup challenges, there still are a great many unknowns. Waste site inventories, both in terms of chemical and radioactive contaminants, are not precisely known for many of the solid and liquid wastes sites present on the Central Plateau. Although the overall quantities of radionuclides generated at the Hanford Site are relatively well known, the actual amount in specific waste sites is uncertain. In addition, the long-term performance of our in-place waste site remedies and closure techniques is largely unproven. The analysis conducted within the HSW EIS employed a range of models and techniques, each with its own set of

assumptions and associated uncertainties. In general, the approach we took was to use best-estimate or conservative assumptions, so that the estimated impacts would appear to be greater than we would actually experience.

Overall, the largest uncertainties for the HSW EIS surround the actual volumes of waste we must treat, store, and dispose of and their associated levels of activity. To deal with this uncertainty we took the approach of using a range of potential waste volumes, with the Upper Bound waste volume being a very conservative (larger than expected) estimate of the maximum expected volume of waste to be managed.

Another set of uncertainties occurs in our use of the various models and modeling techniques. For example, the science of modeling waste movement in the vadose zone and groundwater is still very young. Our SAC is an example of a good, but still emerging, tool. Because we are still uncertain about the nature and extent of some of the sources and types of contaminants, the SAC modeling input has built-in uncertainties. In particular, the inventory of iodine-129 in the solid waste, vadose zone and groundwater is uncertain by up to a factor two, and thus, so are the associated cumulative effects. However, when the performance measure is human dose, variability with regard to individual behavior and exposure affects uncertainty in the estimated dose even more than variability in inventory, release, or environmental transport of the contaminant.

Mitigation

We have identified measures we could take to avoid or reduce environmental impacts that might occur as a result of the Hanford Solid Waste Program. The text box on the following page provides a brief list of potential mitigation measures that could be pursued. For example, to avoid loss of cultural resources, we will conduct cultural resource surveys before constructing solid waste management facilities. If we discovered cultural resources, we would confer with Tribal governments in evaluating the find and determine appropriate management actions. In addition, if mature sage-steppe habitat needs to be removed to construct a solid waste management facility, we could mitigate the habitat loss by revegetating or protecting other parcels of land.

In addition, we will continue to evaluate additional measures to improve the long-term performance of the disposal facilities and to reduce performance uncertainties. These measures include barriers or waste form technologies (e.g., macroencapsulation) to limit releases and transport of radionuclides, actions to restrict public access, and more protective designs during operations.

Besides identifying specific mitigation actions, the alternatives evaluated in this HSW EIS incorporate various mitigation features as part of the alternatives, such as use of a multi-use lined modular disposal facility, which would be considered an action to minimize the amount of land used.

Any mitigation plan(s), if necessary, would be prepared after the Record(s) of Decision is published because the specific actions needed to reduce or avoid potential environmental impacts would be dependent on the specific decisions and associated mitigation commitments documented in that Record(s) of Decision.

What are some of our potential mitigation measures?

- Continue implementing DOE's pollution prevention/waste minimization program.
- Perform cultural surveys prior to construction.
- Implement guidelines (such as the replacement of sage-steppe community disturbed by construction or capping activities) consistent with the *Hanford Site Biological Resources Management Plan* and the *Hanford Site Biological Resources Mitigation Strategy*.
- Continue implementing As-Low-As-Reasonably-Achievable principles during operations and construction.
- Continue training and practices to prepare for possible emergencies and accidents.
- Perform large movements of construction and capping materials during low traffic times.
- Prepare and implement resource management plans and mitigation plans associated with the *Hanford Comprehensive Land-Use Plan.*
- Construct new facilities and trenches in areas that have already been disturbed. This would minimize the chances of encountering items of cultural significance or disturbing items of cultural significance that have not been disturbed. It would also minimize the impacts to animal, plants, and ecosystems.
- Construct new trenches in uncontaminated areas within the Low Level Burial Grounds to minimize potential health impacts to workers.
- Construct final closure caps that would allow the growth or re-growth of sage-steppe habitat on them.
- Plan construction activities to avoid nesting seasons.
- Reuse soils removed during construction of disposal trenches for construction of final closure caps to the extent possible.
- Install and use rain curtains in operating trenches. This would prevent some of the rainwater and snow melt from coming into contact with waste already in place. This, in turn, would reduce the amount of waste that could leach into the rainwater, reduce the amount of contaminated rainwater (leachate) that would have to be treated, and reduce the amount of leachate that could possibly reach the vadose zone or groundwater.
- Use soil fixants to minimize dust generated during construction activities, waste disposal, and final closure activities.
- Treat and dispose of MLLW in storage as quickly as possible to minimize accidents and exposure to workers from aboveground storage.
- Certify and ship transuranic waste in storage as quickly as possible to minimize accidents and exposure to workers from aboveground storage.
- Keep areas around facilities and trenches clear of flammable material to limit impacts from wildfires.
- Keep trenches clear of tumbleweeds, other deep-rooted plants, and burrowing animals to minimize the potential for spreading contamination.

Long-Term Stewardship and Post Closure

The Hanford Site is being cleaned up to meet certain land-use and regulatory requirements. These requirements are based, in part, on limitations of the level of cleanup that can be practically achieved. Limitations that prevent unrestricted use of all land and groundwater at the Hanford Site include the following:

- ***technical and economic limitations*** – technically and economically practicable technologies may not exist to perform cleanup activities. For example, no technology known or anticipated can remove 100 percent of the contents of Hanford's HLW tanks.

- ***worker safety and health issues*** – impacts to workers from cleaning up may be greater than the impacts to the general public from not cleaning up. For example, the impacts to workers from digging up and treating waste from old burial grounds might be greater than the impacts to the general public from capping the waste in place.

- ***environmental issues*** – cleanup may result in greater impacts to the environment than already exist. For example, the risk of accidental releases to the environment during retrieval of waste from old burial grounds might be larger than the risk to the environment of capping the waste in place.

These limitations result in some hazards remaining after cleanup activities are complete. Because some hazards will remain, we need a program to monitor them and deal with any problems that occur. These post-cleanup activities are referred to as long-term stewardship. Specific long-term stewardship activities are dependent on rules and regulations under which the specific cleanup and post-cleanup activities are performed and the specific hazards that remain. Long-term stewardship activities are intended to continue isolating hazards from people and the environment.

What are typical long-term stewardship activities?

- monitoring to verify the integrity of caps placed over disposal sites
- maintaining caps to ensure their continued integrity
- monitoring groundwater and the vadose zone to determine whether systems to contain hazards are working
- monitoring for surface contamination
- monitoring animals, plants, and the ecosystem
- performing groundwater pump-and-treatment operations
- installing and maintaining fences and other barriers
- posting warning signs
- establishing easements and deed restrictions
- establishing zoning and land-use restrictions
- maintaining records on cleanup activities, remaining hazards, and locations of the hazards
- maintaining necessary infrastructure (e.g., utilities, roads, communication systems).